ADDENDUM

TO

INTERVIEW 7000 SERIES TECHNICAL MANUAL

ATLC-107-951-100 and ATLC-107-951-108, Issue 4, November 1989
(951-B0055-01, Rev A and 951-B0062, Rev A)

A) General Instructions. This is Addendum ADD-951-10, the first addendum to Issue 4 (November 1989) of the INTERVIEW 7000 Series Technical Manual.

B) Software Revision 7.02. The present addendum is released concurrently with software revision 7.02. This software, in conjunction with specific hardware, supports a new 44-Megabyte hard disk drive that is now standard in all *TURBO* units.

C) Hardware Revision. At the time of this release, the hardware configuration of the 7200 *TURBO* has been modified to include a hard disk drive as standard. References in the manual to the optional hard disk, therefore, apply only to the INTERVIEW 7000.

In addition, the standard hard disk drive in the 7200 *TURBO* and 7700 *TURBO* has been upgraded from a 20-Megabyte to a 44-Megabyte hard disk drive. This change requires firmware revision 6.00.

D) Improvements to the Manual. The addendum updates three sections of the manual that relate to the hard disk drive.

Apart from supporting a new software release, this addendum also incorporates packing and shipping information relating to Maintenance Agreement plans now offered by AR Division.

E) Specific Instructions for Incorporating this Addendum.

At this location in current manual,	*replace or insert new material as follows:*
Old p. v	Replace old pages v through xx with new pages v through xx. Updates Table of Contents.
Old p. 1-1	Replace old pages 1-1 through 1-16 with new pages 1-1 through 1-16. Adds storage capacity and data rate figures for the 44-Megabyte hard disk in the 7200 *TURBO* and 7700 *TURBO*.
Old p. 2-1	Replace old pages 2-1 through 2-26 with new pages 2-1 through 2-26. Updates the section with respect to the standard hard disk in the 7200 *TURBO*.

Old p. 12-1	Replace old pages 12-1 through 12-16 with new pages 12-1 through 12-18. Adds new selection to the Disk Maintenance Format command to support the 44-Mbyte hard disk.
Old p. E-1	Replace old pages E-1 through E-4 with new pages E-1 through E-4. Updates packing and shipping information in accordance with new AR Division Maintenance Agreement plans.
Old Index A	Insert Index To ADD-951-10. Contains index listings for sections in the current addendum.

INTERVIEW® 7000 Series

TECHNICAL MANUAL

Issue 4, November 1989

AR DIVISION OF TELENEX
7401 Boston Boulevard
Springfield, Virginia 22153

Notice

This is Issue 4 of the INTERVIEW® 7000 Series Technical Manual, November 1989.

Issue 4 is written to specifications for the INTERVIEW® 7000 Series—the 7000, 7200 *TURBO*, 7500, and 7700 *TURBO*—software revision 7.00. In most instances, further software revisions will be accompanied by an addendum to this issue. In cases where new software does not affect the accuracy of the manual, however, an addendum may not be produced.

Software revision 7.00 adds support for two new INTERVIEW units, the 7200 *TURBO* and the 7700 *TURBO*. In addition to supporting all of the capabilities of the 7000 and 7500, the *TURBO*s operate at much higher speeds. A comparison of data-display rates among the units in the 7000 Series has been added to Section 1.

The INTERVIEW's remote port can now be used to receive and transmit data. The new C variables and routines relating to the remote port are documented in Section 67.

The software also expands the use of the Compile operation and linkable-object files. In addition to compiling a file, the user now may select the Protocol Spreadsheet as the source code for Compile. See Section 13. The compiled spreadsheet can later be combined with the active spreadsheet program. Refer to Section 24.

The use of the ↑ and ↓ cursor keys in the Display Window has changed. In Run mode, these keys previously controlled the playback speed of disk data. They are now under the programmer's control when the Run-mode screen is the Display Window. See Sections 3 and 5.

Two addenda to Issue 3 of the manual, dated May and June 1989, have been incorporated into Issue 4. Issue 4 also improves the previous manual and addenda in the following areas:

- Section 26 on the spreadsheet editor has been updated to include the automatic return to the spreadsheet when errors are detected.
- Section 47 on the RS-485 Test Interface Module has been added.
- Section 52 on Program Main has been improved to show how linkable-object files are incorporated.
- The status of the Layer 2 and 3 Protocol Trace buffers has been made accessible to the user. Section 61 describes the C structures used for this purpose.
- The C structures and variables used to monitor the status of the INTERVIEW's print buffer are included in Section 64.

The AR Division of Telenex Corporation reserves the right to improve this manual or the equipment it describes without prior notice.

For technical information, programming assistance, error decoding, and repairs, contact Customer Service. Customers within the Washington D.C. Greater Metropolitan Area call 644-9190. Those outside of the local area call 1-800-368-3261 (in Virginia, call 1-703-644-9190).

Address questions and comments about this manual and other AR Division technical publications to Technical Writing. Customers within the Washington D.C. Greater Metropolitan Area call 644-9078. Those outside of the local area call 1-800-368-3261, extension 9078 (in Virginia, call 1-703-644-9078).

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Part I

Basic Operation

1 Hardware

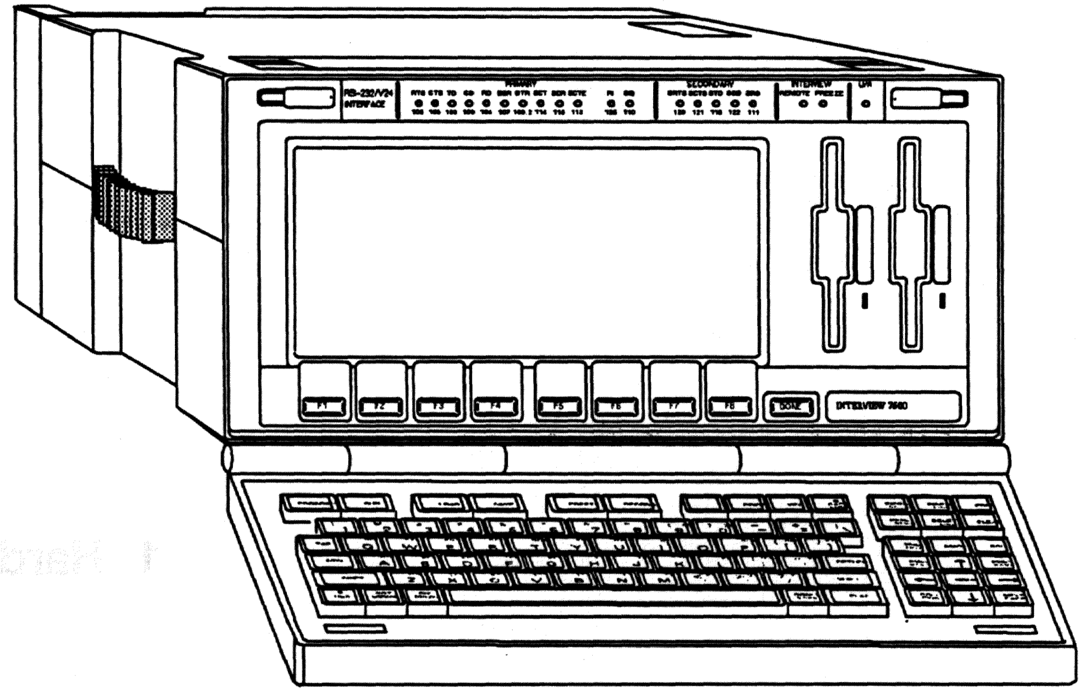


Figure 1-1 INTERVIEW 7500.

1 Hardware

NOTE: AR Division offers extended and expedited Maintenance Agreement plans for INTERVIEW 7000 Series hardware. Call Customer Service for more information.

1.1 Physical Dimensions

The protocol analyzers in the INTERVIEW 7000 Series, represented by the INTERVIEW 7500 in Figure 1-1, measure 7 inches high by 14 inches wide by 18.5 inches deep. The unit weighs approximately 29-32 pounds.

1.2 Keyboard

The INTERVIEW has a 94-key keyboard containing ASCII keys and special keys separated into pads according to function. The keyboard is described in detail in Section 3.

1.3 Front Panel

(A) Plasma Display

The INTERVIEW's flat plasma display screen measures 3.7 inches high by 8.4 inches wide. The high-resolution display (576 X 256 pixels) is black and red. No brightness adjustment is required for the plasma display.

The screen has 21 display lines, 16 of which are devoted to data display. Data is displayed in lines 64 characters long, making the capacity of the screen 1344 characters (of which 1024 characters are devoted to line data). The top 2 lines of the data screen are devoted to status information; the bottom 3 lines to function key identification (see Figure 1-2).

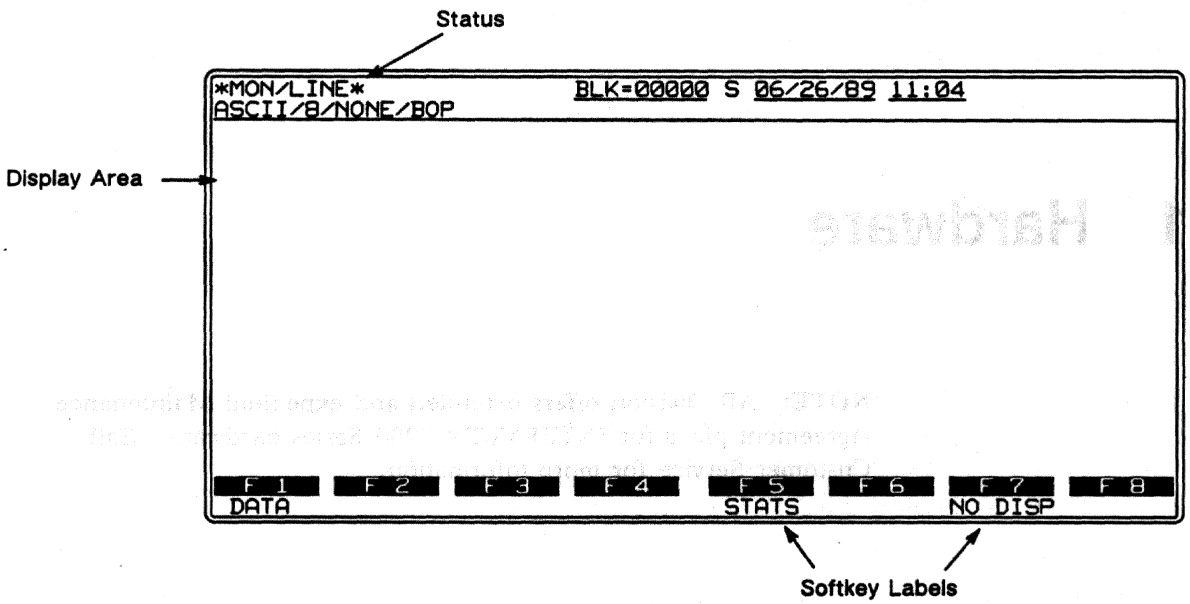


Figure 1-2 INTERVIEW display screen.

(B) Function Keys

Eight function keys and the [DONE] key are located directly below the display screen. The uses of the function keys vary from program menu to program menu; however, their function is always defined on the screen in rectangular windows located above the keys. (Refer to Section 3 for a discussion of their use.)

(C) LED's

Twenty LED's are placed above the display screen. These LED's are divided into three banks: interface status LED's, INTERVIEW status LED's, and the U/A LED. Figure 1-3 shows the assignment of LED's for an RS-232 interface.

RS-232/V24 INTERFACE	PRIMARY												SECONDARY					INTERVIEW		U/A
	RTS	CTS	TD	CD	RD	DSR	DTR	SCT	SCR	SCTE	RI	SQ	SRTS	SCTS	STD	SCD	SRD	REMOTE	FREEZE	
	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	105	106	103	109	104	107	108.2	114	115	113	125	110	120	121	118	122	119			

Figure 1-3 There are 20 LED's, divided by function, above the plasma display.

1. *Interface status indicators*. Interface status indicators may be assigned to different signals, depending on the Test Interface Module which is installed in the rear panel. An overlay accompanies each module and should be

placed over the front panel LED's whenever the module is installed. Assignment of each of the front panel indicators is illustrated in Appendix I, which also gives the interface specifications for each Test Interface Module.

Primary and Secondary indicators on the front panel glow red to indicate that the lead is on (space voltage) and green to indicate that the lead is off (mark voltage). U/A lead indicators on Test Interface Modules operate differently. See Section 1.5(F).

2. *INTERVIEW status indicators*. There are three status indicators: REMOTE, FREEZE, and U/A. The REMOTE indicator is red when the INTERVIEW is under remote control. The FREEZE indicator is red when the display screen has been frozen (with the FREEZE key) while in Run mode. Both REMOTE and FREEZE LED's are dark when off.

3. *U/A LED*. The last indicator, U/A, is user-assigned and may be programmed to track any lead of the operator's choosing. See Section 10.3(C) for the use of the UA-input jack in RS-232/V.24 testing.

(D) The Test Interface Overlay

Each Test Interface Module is accompanied by a front panel overlay. The overlay is placed over the interface status LED's and identifies the lead tracked by that LED when that particular Test Interface Module is installed. The overlay masks out any unused LED's. Replace the overlay each time that you change the Test Interface Module.

1.4 Disk Drives

The INTERVIEW uses 3.5 inch double-sided, high-density microfloppy diskettes (see Figure 1-4). Each formatted microfloppy has a storage capacity of 1.4 Mbytes.

Each disk has a write-protect window (see Figure 1-4). To write-protect a disk, slide the window open so that you can see through the disk.

If a high density disk has been used on another piece of equipment which has a 1 Mbyte drive, it must be reformatted before it is used on the INTERVIEW. The data it contains cannot be read.

There are two 3.5 inch microfloppy disk drives immediately to the right of the display screen. An LED just to the right of each drive is lit to indicate that the microfloppy in the drive is being accessed. Insert disks in the direction shown in Figure 1-5.

To remove a disk, press in the black bar next to the drive containing the disk.

CAUTION: Never remove a disk from its drive when the LED indicates that the disk is being accessed.

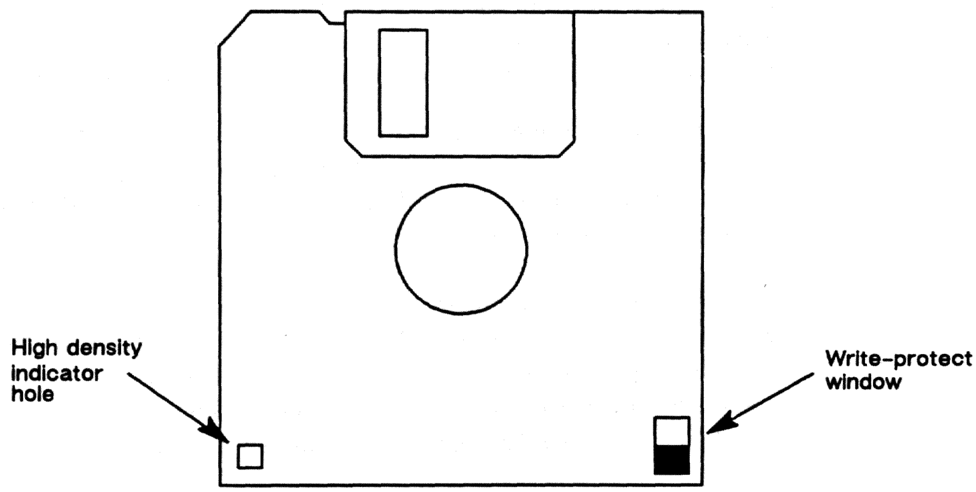


Figure 1-4 The INTERVIEW uses 3.5 inch quad- or high-density, double-sided microfloppy diskettes.

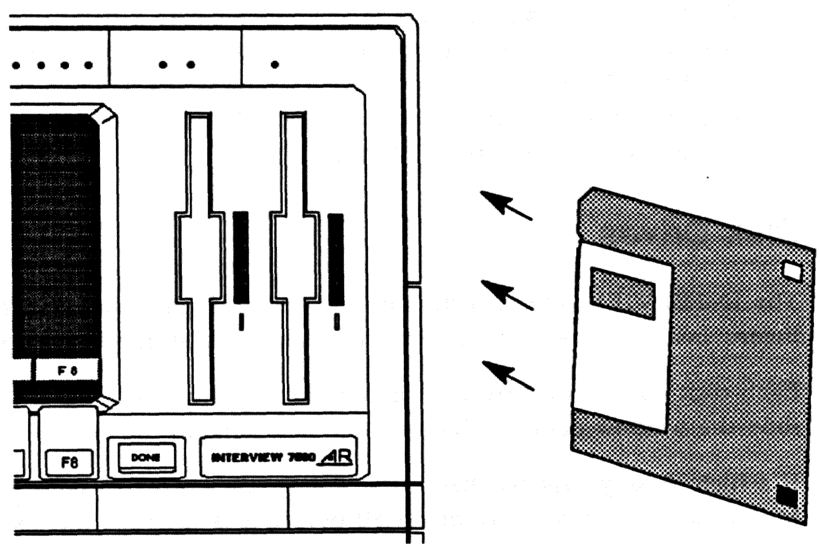


Figure 1-5 The INTERVIEW is equipped with two micro-floppy disk drives. Hard disk is standard in the 7200 *TURBO*, 7500, and the 7700 *TURBO*. It is available as an option in the 7000.

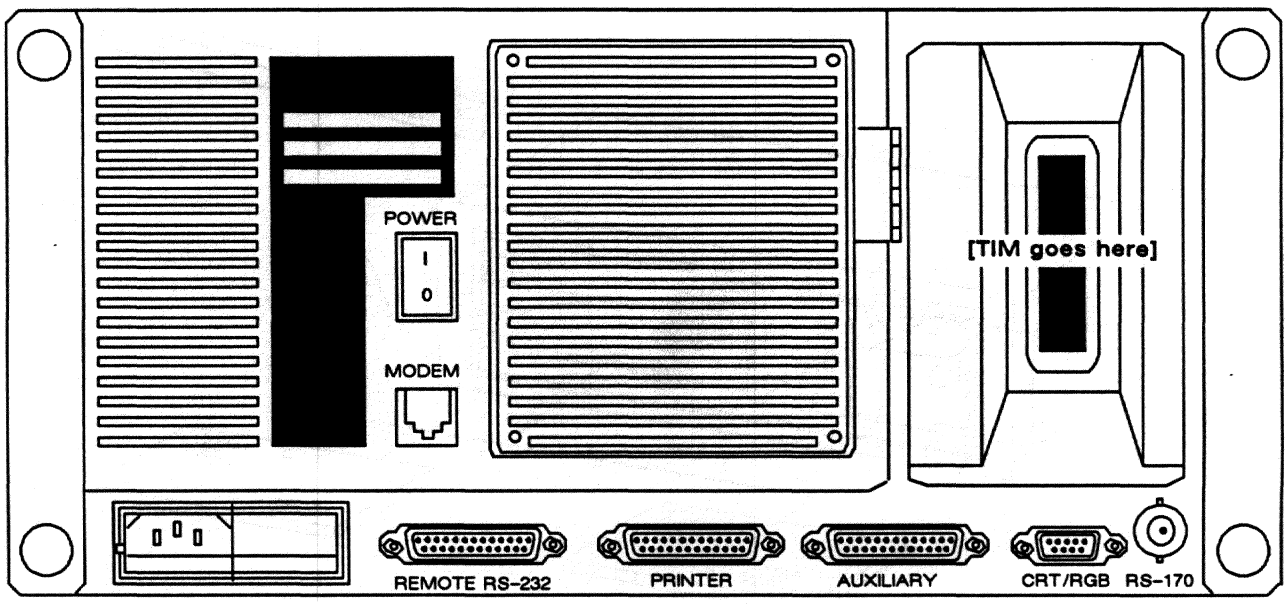


Figure 1-6 Back panel and connectors.

The INTERVIEW 7500, 7200 *TURBO*, and the 7700 *TURBO* are equipped with a Winchester hard disk. The hard disk has a total storage capacity of 20 Mbytes in the 7500 and 44 Mbytes in the 7200 *TURBO* and 7700 *TURBO*. The 20–Megabyte hard disk is available as an option in the INTERVIEW 7000.

Since the hard disk cannot be write-protected, you may wish to save its contents to microfloppy backup disks on a regular basis.

1.5 Back Panel

The back panel and its various connectors are shown in Figure 1-6.

(A) Power Module

The power connector is located at the bottom left of the rear panel. It is a standard three-wire grounded male connector, with selectable voltage.

(B) Voltage Selection

To determine the voltage currently selected, slide the transparent window of the power connector module to the left (see Figure 1-7). You will see the line voltage selector card at the bottom of the window. Current voltage selection is visible—and right side up.

The INTERVIEW is designed to operate at 95 to 130 Volts ac when 115 V is selected; or from 190 to 260 Volts ac when 230 V is selected.

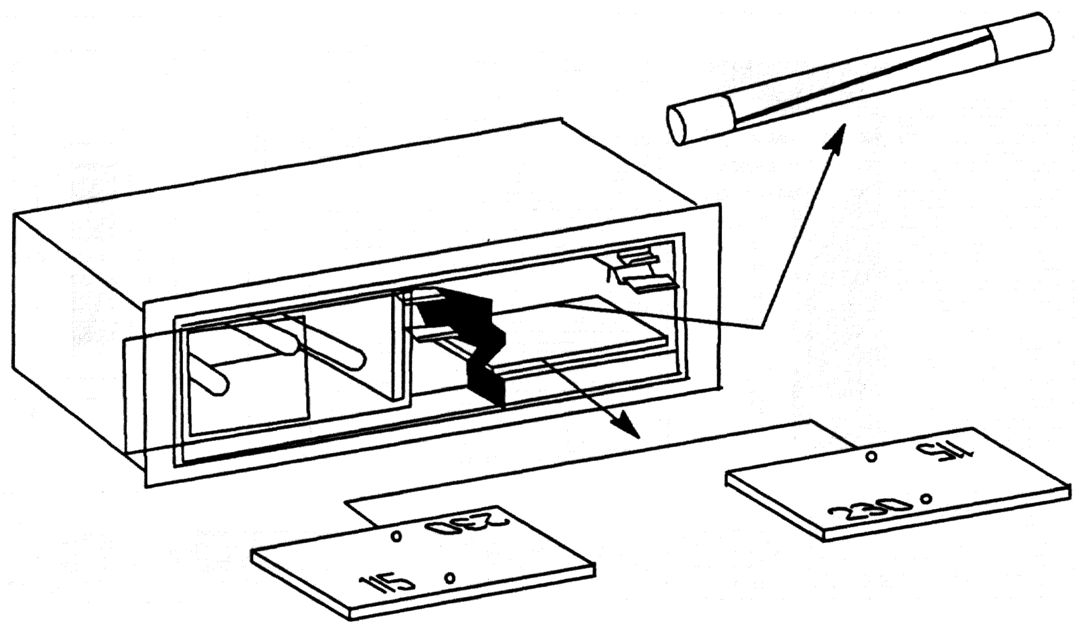


Figure 1-7 Voltage is selectable in the power connector module.

To change the line voltage selection, swing the fuse extractor handle (labeled FUSE PULL) out toward the left, and remove the fuse. The voltage selector card can then be removed and turned so the correct line voltage can be read right side up in the window. When the voltage selector card has been seated correctly, rotate the fuse extractor handle to the right and in, and replace the fuse.

Included in your shipment is a detachable power-supply cord with a NEMA 5-15 attachment plug rated 15 A, 125 V. If you configure the unit for 220-240 V operation, you should employ a UL-listed power-supply cord set furnished with a grounding plug suitable for connection to the 220-240 V source of supply.

The unit will operate the display at either 50 or 60 Hz refresh rate. It defaults to 60 Hz *unless* a file named */sys/fifty_hertz* is listed on the boot-drive disk. If a file with this name is created, the unit will operate at 50 Hz. (The content of the file is irrelevant and will be ignored by the boot-up software.)

(C) On/Off Switch

The power switch is located above the power connector and to the right. Press the side of the switch marked "1" to turn power on. Press the side marked "0" to turn power off.

(D) The Fan

The INTERVIEW is cooled by a fan which may be accessed through the rear panel.

A fan filter prevents dust and dirt from getting into the INTERVIEW. As the filter gets dirty, less cooling air gets to the unit. To prevent your INTERVIEW from overheating, we recommend that you periodically clean the filter. A plastic grill on the rear of the unit covers the fan filter.

CAUTION: Do not insert objects through the grill covering the fan. Do not remove the grill without turning off the unit and disconnecting power.

Turn the INTERVIEW off, disconnect the power, and remove the screws holding the grill in position. Remove the filter, rinse it in clean water, dry it thoroughly, and replace it. Screw the grill back on the the unit.

If your INTERVIEW is overheating and cleaning the filter does not alleviate the problem, contact Customer Service.

(E) Connectors

The following is a brief description of all I/O connectors on the rear panel of the INTERVIEW. Interface specifications for each of the connectors are given in Appendix I.

1. *Internal modem connector*. The Internal Modem Connector, if present, is just below the power switch. It is a standard RJ-11C connector. This interface is intended for future expansion of the remote utilities.

2. *Remote RS-232 connector*. This is an RS-232/V.24 25-pin connector located just to the right of the power connector. It provides access to an external modem (or directly to another INTERVIEW unit).

3. *Printer connector*. The RS-232/V.24 25-pin printer connector is located directly to the right of the Remote connector. It allows access to most serial printers. The connector acts as DCE and transmits on RD. Printer operations are described in Section 14.

4. *Auxiliary connector*. The Auxiliary I/O connector is a 16-bit bidirectional TTL connector which allows access to external peripheral devices. Use the C routines discussed in Section 68 to control and monitor this interface. Other references to AUX leads in this manual pertain to the four AUX pins on the TIM. See discussion, Section 10.6(C).

   CAUTION: Never plug an RS-232/V.24 cable into the Auxiliary connector, as the signal voltage is likely to damage the interface.

5. *CRT/RGB connector*. This is the color video connector. Signals from the INTERVIEW display can be passed through this connector to a color monitor to produce color graphics and other displays in color. Color, vertical sync, horizontal sync, and intensity signals can be controlled from the external monitor. Use of color in displays is described in Section 16.

6. *Composite video connector.* This connector provides RS-170 video output to an external monitor or camera.

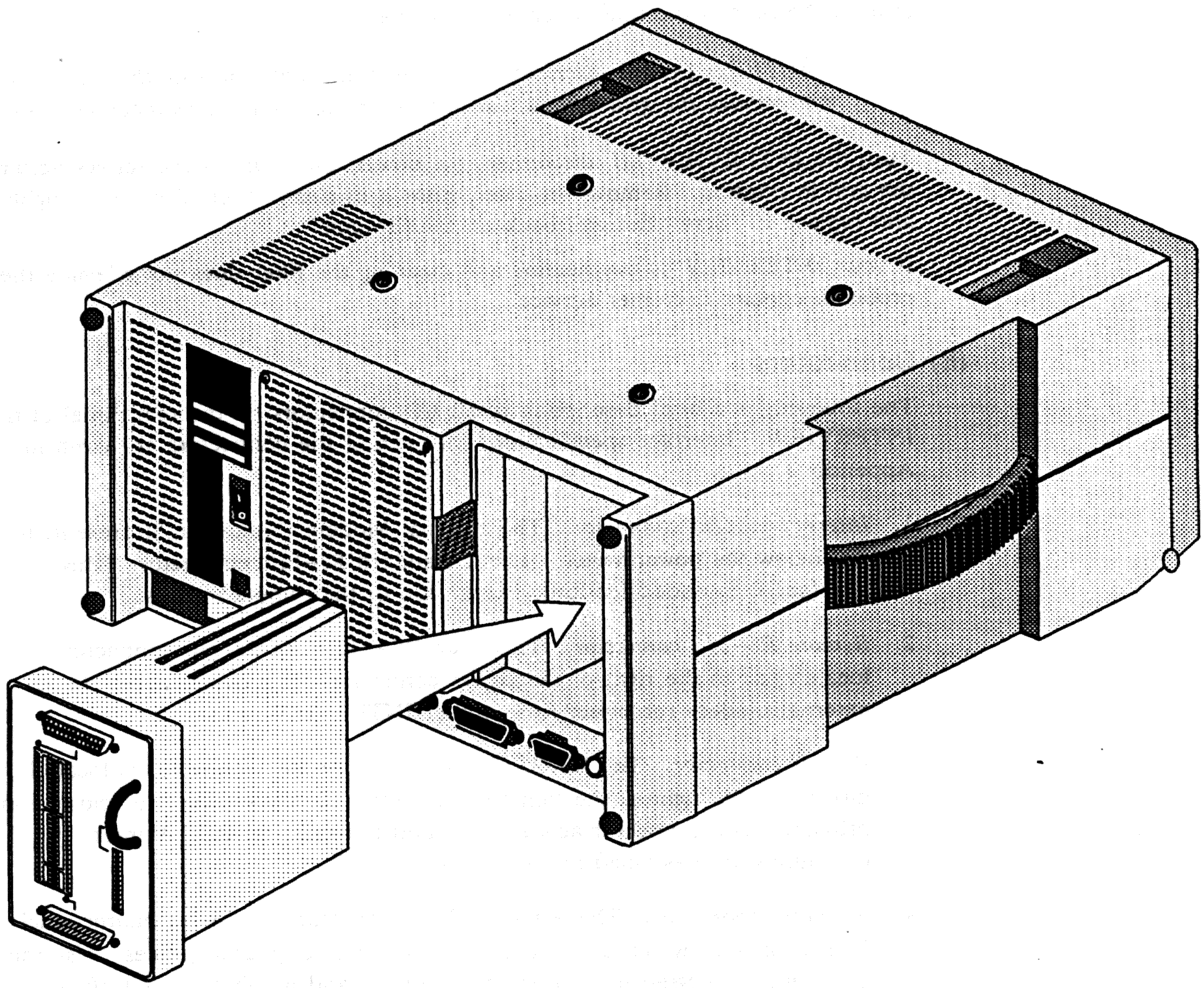


Figure 1-8 The right rear panel accommodates interchangeable Test Interface Modules.

(F) The Test Interface Module

The empty receptacle to the right of the rear panel (see Figure 1-6) accommodates interchangeable Test Interface Modules (TIM's). Whenever the INTERVIEW monitors a data line or emulates a DTE or DCE, the correct TIM must be installed. The RS-232/V.24 Test Interface Module is standard with any unit in the INTERVIEW series. V.35, RS-449, X.21, RC-8245 (RS-485), ISDN, T1, and G.703 test interfaces are available as options. Most Test

Interface Modules are equipped with two connectors, a TO DTE and a TO DCE connector. Figure 1-8 shows an RS-232 module being inserted into the unit. Connect to the data line as described in Section 1.10.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

NOTE: It is possible to monitor data previously recorded on disk, whether or not any TIM or the correct TIM is installed.

1. *Software control of TIM connectors.* When **Mode:** MONITOR or AUTOMON is the program selection, the INTERVIEW passively monitors data through either (or both) TO connectors on the Test Interface Module.

   When the INTERVIEW is operating in EMULATE DCE or BERT DCE modes, the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector. When **Mode:** EMULATE DTE (or BERT DTE) is the program selection, the INTERVIEW transmits and receives data through the TO DCE connector. The interface specifications for each Test Interface Module are given in Appendix I.

   Break-out switches on each Test Interface allow any pin to be patched. See Section 10.3 for an explanation of the RS-232 breakout switches.

2. *Test interface LED's.* There are four LED's on the Test Interface Module. Two, labeled EMULATE DTE and EMULATE DCE, indicate the operating mode of the unit. When EMULATE DCE is red, the TO DTE connector is active; when EMULATE DTE is red, the TO DCE connector is active. When the INTERVIEW is monitoring or auto-monitoring, both EMULATE LED's are black.

   The two LED's above the U/A input on the patch panel track the voltage level on the lead patched to U/A. The red LED above the U/A panel is lit to indicate space voltage (positive voltage above a minimum threshold). When the green LED above this panel is lit, it indicates a mark voltage (negative voltage within a specified acceptable range). For intermediate voltages, the U/A LED's are off (see Figure 1-9).

   CAUTION: Power off the INTERVIEW before installing or removing a TIM.

Remember to change the front panel overlay each time that you change the TIM.

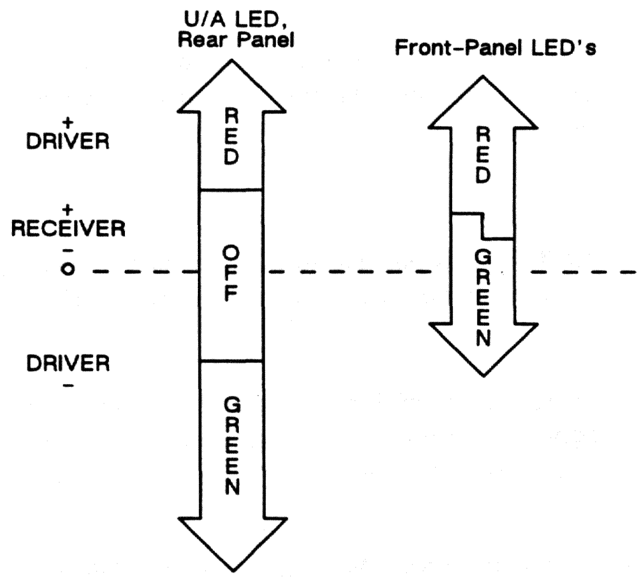


Figure 1-9 Color phases in green-red LEDs.

1.6 Storage Capacity

(A) RAM

RAM capacity for line data in the screen buffer is 64 Kbytes—a maximum of 32 Kbytes of characters plus 32 Kbytes of attributes for character data. EIA leads and time ticks are stored in RAM with the characters, if these options were selected on the Front-End Buffer menu (see Section 7.1). Each byte devoted to EIA leads and time ticks reduces the number available for characters. Bit-image RAM is 256 Kbytes in the 7000 and 7200 *TURBO* and 1 Mbyte in the 7500 and 7700 *TURBO*. (Bit-image RAM may be increased. See Section 11.4.)

(B) Microfloppy Diskettes

Each diskette has a 1.4 Mbyte storage capacity (formatted); thus, total diskette capacity is 2.8 Mbytes.

(C) Winchester Disk

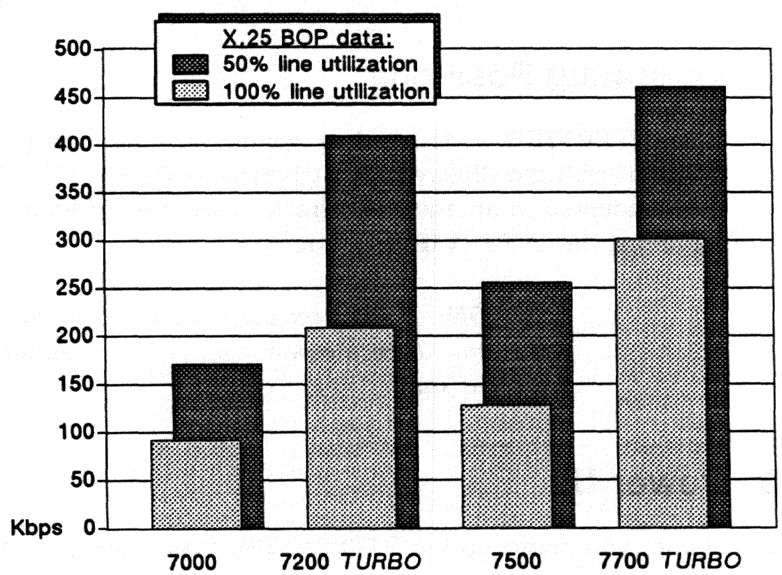
The Winchester Disk has a storage capacity of 20 Mbytes in the 7500 and 44 Mbytes in the 7200 *TURBO* and 7700 *TURBO*. The 20-Megabyte hard disk is available as an option in the INTERVIEW 7000.

(D) Maximum Data Rates

Maximum rates for data recording are as follows:

- Recording to bit-image RAM
  (full-duplex, 100% line use): 2.048 Mbits per second
- Bit-image recording to 20-Mbyte hard disk
  (full-duplex, 100% line use): 256 Kbits per second
- Bit-image recording to 44-Mbyte hard disk
  (full-duplex, 100% line use): 384 Kbits per second
- Recording to microfloppy
  (full-duplex, 100% line use): 64 Kbits per second

Figure 1-10 shows maximum rates for data analysis for the various units in the INTERVIEW 7000 Series. The speed your INTERVIEW actually achieves may vary. Factors which will influence data-analysis rates are line speed, percentage of line utilization, average frame length, the layer packages and user program loaded, suppression of idle, and the time-stamp resolution. Refer to Section 2.8 on how to optimize the INTERVIEW's speed of operation.



Notes: The margin of error is 5% on the utilization and speed measurements. These figures were generated using software revision 7.00.

Figure 1-10 Continuous real-time rates for display of raw data.

1.7 Clock

Data clocking is provided by a set of high-frequency crystals. The various data speeds that can be selected are listed in Appendix C.

The INTERVIEW is also equipped with a time-of-day clock which provides readings of time (hours, minutes, seconds), day, month, and year. Time may be used as an INTERVIEW program condition. Refer to Section 15 for instructions on setting the time-of-day clock. Refer to Sections 21 and 27 for a description of Time as a program condition.

1.8 Operating Environment

The INTERVIEW is designed to operate in an atmospheric temperature ranging from 50 to 90 degrees Fahrenheit (10 to 32 degrees Celsius). At these temperatures, the unit can operate in (uncondensed) humidity ranging from 30 to 90 percent.

CAUTION: Avoid dropping the unit.

Avoid getting the unit wet.

Do not operate the unit with the fan covered.

Avoid operating the unit immediately after exposure to drastic changes in temperature and humidity.

Avoid placing the INTERVIEW on a radiator or near a source of heat.

1.9 Operating Positions

The INTERVIEW is designed to operate on a desktop (Figure 1-1) or in a standing position, with the display facing upwards (Figure 1-11). The unit may also be shelf-mounted in an equipment rack or cabinet. Allow for adequate air flow when mounting the INTERVIEW in a rack.

CAUTION: To protect the hard disk, do not move the unit with the power on. Turn the power off first to position the hard disk in a protected state.

1.10 Power Up

Before you power up the INTERVIEW, make sure you have performed the preliminary steps listed below.

(A) Install the Test Interface Module

Check the rear panel to be certain that you are using the correct Test Interface Module before you test any data. A Test Interface Module is shown in Figure 1-8 and described in Section 1.5(F).

CAUTION: Never install or remove a TIM unless the INTERVIEW is powered off.

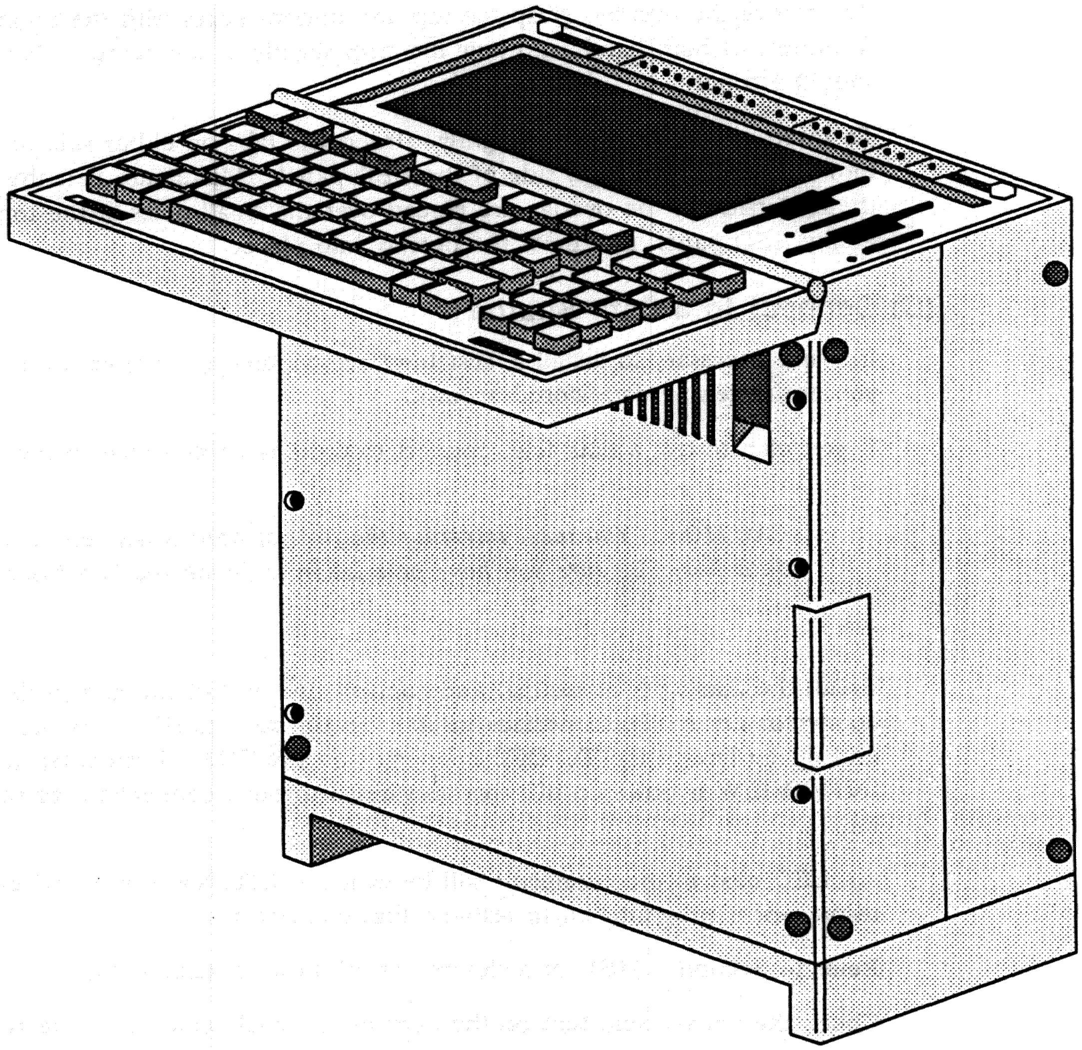


Figure 1-11 **The INTERVIEW may be operated on a desk top or in a standing position.**

Remove the Test Interface Module by pressing the button to the left of the module with the thumb of your left hand. Hold the button in as you pull firmly on the TIM handle with the thumb and forefinger of your right hand.

Install the Test Interface Module right-side-up in the receptacle provided at the right of the rear panel. Press firmly on the top and bottom of the module until it is secured and the button to the left clicks into place.

(B) Insert the Correct TIM Overlay

Be certain that the overlay over the front-panel LED's matches the Test Interface Module installed.

To remove the overlay, grasp the top and bottom edges with the thumb and forefinger of both hands and bow the strip slightly in the center. The overlay should slip out.

To insert an overlay, bow it slightly. Insert the tabs on either side of the overlay into the notches on each side of the LED panel. Make sure that the holes on the underside of the overlay are placed over the small posts at the top of the empty LED panel, and press the overlay into place.

(C) Connect to a Data Source

It is not necessary to install a Test Interface Module or connect to a data line if you are reviewing data stored on disk.

If you plan to test a data line, connect to the line as described below.

> *CAUTION: You must interrupt the flow of data when you connect to a data line. Be sure you have permission to break the line before doing so.*

Break the data line for testing, and connect one end of the line to the TO DTE connector on the Test Interface installed in the rear panel. Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

An LED next to the connector will be lit if the INTERVIEW is actively testing—or is programmed to test—on that connector.

Refer to Section 1.5(F) for a description of TIM connector functions.

Check the voltage selection on the card in the small window on the rear panel.

If the voltage is incorrect, refer to Section 1.5(B) for instructions.

(D) Open the Keyboard

Place the INTERVIEW on a stable surface. Support the back of the keyboard with one hand. Unlatch the keyboard by pushing the blue latches on the top of the unit all the way back. Then lower the keyboard to operating position.

(E) Power On

Connect the female end of the power cord provided to the back of the unit; connect the other end to a standard power outlet. Depress the side of the power switch marked "1." A Start Up screen similar to that in Figure 2-1 or Figure 2-2 should appear. Refer to Section 2 for a discussion of the Start-Up screen, system initialization, and general operations.

2 General Operation

This section discusses the general operation of the INTERVIEW and covers such topics as updating system software, configuring the menus, starting and stopping a test program, locating errors detected when the test is compiled, using both the pre-existent trigger setup menus and the free-form spreadsheet to create test programs, and using the INTERVIEW's analysis features.

For a hands-on introduction to the INTERVIEW, see *30 Minutes to Programming the INTERVIEW 7000*, ATLC-107-951-101.

2.1 Power Up

As you power up the INTERVIEW, perform the preliminary steps listed below. The procedures for each step are described in Section 1 on Hardware.

- Install the Test Interface Module.
- Select the correct voltage.
- Open the keyboard.
- Insert the proper TIM overlay.
- Install the initialization disk if you are not booting from hard disk.
- Connect a power cord and turn power on.
- Connect to a data source.

(A) Self Tests

When you turn on the unit, you initiate a series of self tests: first, the CPM Module DRAM, then the MPM Module DRAM, and finally, the MPM to CPM connections. Any self-test errors will be reported on this screen. Refer to the Appendices for an explanation of error messages. You may abort the self tests by pressing PROGRAM. (However, we recommend that you allow the tests to run their course.)

Once the self test cycle is complete or once you have aborted the tests, the INTERVIEW begins to initialize its software. The message BOOTING appears on the screen. The INTERVIEW 7000 has no hard disk (unless it has been added as an option) and will boot up from a system floppy disk. This process is described in Section 2.2.

The XDRAM module (if present) will also be tested. Depending on the unit's firmware version, self-testing for XDRAM either follows MPM Module DRAM testing or occurs after the unit has booted up.

When self tests are complete, a Start Up screen similar to that in Figure 2-1 or Figure 2-2 may appear. Notice that the number of processors in your unit, the software and firmware versions, the options installed, and the Test Interface Module in place when you powered on all appear on this screen.

If you have a file named *user_intrf* in the */usr* directory on the hard disk, the program in *user_intrf* will be compiled and run as soon as boot-up is complete, bypassing the Start Up screen as shown below. See Section 2.2(B).

The Start Up screen will appear only briefly if you have a file named *default* in the */usr* directory of your boot-up disk. If you do not press PROGRAM within five seconds of power-up, the program in *default* will be compiled and run. See Section 2.2(C).

```
                ** INTERVIEW  7700  TURBO **

        DISKS: FLOPPY 1  FLOPPY 2  HARD DISK(44M)

        PROCESSORS: 4

        SELF TEST ERRORS: NONE

Press:
[PROGRAM] to enter the menu page
[RUN]     to run the default program

Software  Version:  7.02
Firmware  Version:  6.00

OPTIONS:

TIM: RS-232/V.24

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Telenex Corporation
```

Figure 2-1 Power-up screen, INTERVIEW 7700 *TURBO*.

```
                ** INTERVIEW  7000 **

        DISKS: FLOPPY 1  FLOPPY 2

        PROCESSORS: 2

        SELF TEST ERRORS: NONE

Please insert system disk and press any key
```

Figure 2-2 Power-up screen, INTERVIEW 7000.

2.2 Initializing System Software (Booting Up)

(A) Insert System Disk

If you have an INTERVIEW 7000, you will see a slightly different start-up screen. A message instructing you to insert the system disk should appear (see Figure 2-2). Once you have powered on the unit and this message appears, insert the system disk (DSK-951-001-1.X) into either drive as shown in Figure 2-3. (Insert the metal head of the disk first. Keep the metal hub on the back of the disk facing away from the screen. The disk should lock in place, and the button to the right should pop out.) Then press any key to cause the INTERVIEW 7000 to complete its own initialization. The LED immediately to the right glows to indicate the active drive (in this case, the drive from which the system is being initialized). Do not remove the system disk until the LED has stopped glowing. Then it is safe to press the button next to the drive and eject the disk. A message will inform you when the 7000 is ready for operation.

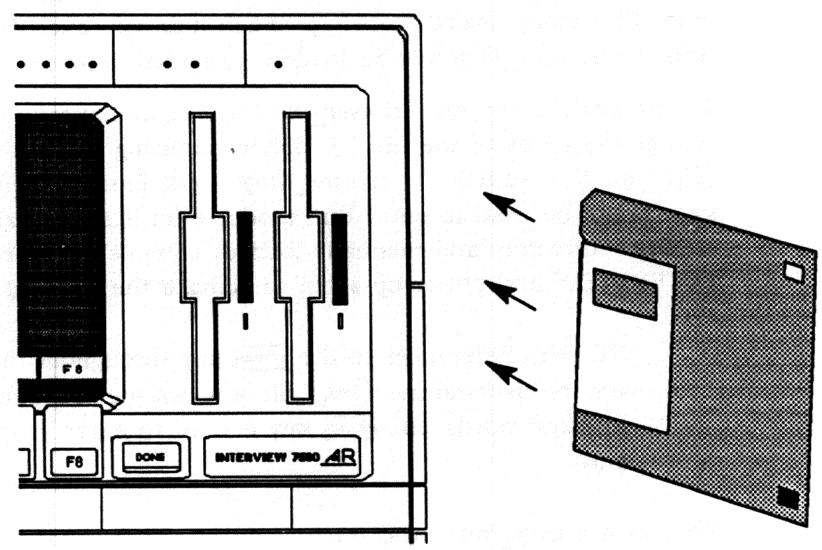


Figure 2-3 Insert microfloppy disks as shown.

The INTERVIEW 7200 *TURBO*, 7500, and 7700 *TURBO* normally do not require a system disk, since all initialization software is installed on the Winchester hard disk. If you need to install new system software from a floppy disk, refer to subsection 2.3.

> NOTE: We recommend that you make a copy of system software to use as your boot disk. Use the Duplicate Disk command on the Disk Maintenance screen as explained in Section 12.4(D). Then store your original floppy in a safe place.

(B) Creating a User Interface

Regardless of which disk drive you use for boot-up, FD1, FD2, or HRD, the *HRD/usr* directory—and only that directory—is searched during power-up for a file named *user_intrf*. If the file is located, the unit will automatically load, compile, and run the program as soon as boot-up is complete. Each time the operator presses [PROGRAM], the program in *user_intrf* will be loaded, compiled, and run again. Use this feature when you want to bypass the INTERVIEW's menus and create your own user interface for specific applications.

> *CAUTION: Avoid saving emulation programs in* user_intrf. *Booting up and automatically running an emulation program may result in an inadvertent break of the line.*

To enter Program mode, press [SHIFT]-[PROGRAM] or [CTRL]-[PROGRAM]. Perform any Program-mode operation you wish: make selections on menus, execute File or Disk Maintenance commands, or create a Protocol Spreadsheet program. To enter Run mode again, press [RUN]. Each time you execute the [PROGRAM] key during Run mode, *user_intrf* will be loaded, compiled, and run.

To prevent the program in *user_intrf* from automatically running upon power-up, change the name of the file. Simply capitalizing the first letter in the file name *(User_intrf)* is sufficient. If *user_intrf* is not found during power-up, the [PROGRAM] key cannot be used to enter Run mode, even if *user_intrf* is saved to the *HRD/usr* directory and manually loaded, compiled, and run. Turn off the INTERVIEW and power up again to activate the user-interface feature.

> NOTE: References to the [PROGRAM] key throughout this manual assume that the *user_intrf* file was not located during power-up. In other words, the [PROGRAM] key is used to enter Program mode only.

To create a *user_intrf* program:

1. Configure the menus to the selections you want.
2. Use Protocol Spreadsheet softkey entries or C regions on the spreadsheet to develop your user-interface program. All of the C structures, variables, and routines available to the INTERVIEW user are explained in Part II of this manual, *Advanced Programming*.
3. Press [SAVE] to call up the File Maintenance screen.
4. Check the hard disk for any existing user-interface program. Press [F3] for **Command:** CHANGE DIR. Select **Drive:** HRD. After **Name:** type in */usr* and then press [XEQ]. Check for a file named *user_intrf*.

Unless the old file is write-protected, any program already stored under this filename will be overwritten when you save your new file. To keep the old file for later reference, save it to a new name (its contents will have to be loaded manually). For a detailed discussion of file-maintenance commands, see Section 13.

5. Select **Command:** SAVE. Select **Type:** OBJECT or PROGRAM. Then select the hard disk.

   NOTE: The more complex a program is, the longer it takes to compile. To eliminate compilation each time you use the PROGRAM key, therefore, we recommend that you save *user_intrf* as an object file.

6. In the **Name:** field, type in the filename */usr/user_intrf*. Only this name can be used. (Program or object files saved to any other name or directory must be loaded manually.)

7. Execute the **SAVE** command by pressing XEQ.

8. *user_intrf* will appear in the Directory Listings when *HRD/usr* is the current directory. (The name of the current disk appears as a prefix to the absolute pathname of the current directory. The name of the current directory appears on the fourth line of the File Maintenance screen.)

9. You may alter the *user_intrf* program again at any time by saving a new program to the same filename.

(C) Running the Default Program

When the INTERVIEW boots up, the */usr* directory on the boot-up disk is searched for a file named *default*. Once the start-up screen (Figure 2-1 or Figure 2-2) appears, the program in *default* (if it exists) will be compiled and run automatically after five seconds, or immediately if you press RUN. You may prevent the default program from running by pressing PROGRAM before the five-second timeout expires.

Develop a default program to suit your particular needs. One application of the default program might be defining a new set of default menu selections.

> *CAUTION: Avoid saving emulation programs in* default. *Booting up with a default emulation program may result in an inadvertent break of the line.*

Upon boot-up all menu selections in the INTERVIEW are set to certain values. You may change these default selections if you wish by utilizing the default program. Follow these steps:

1. Configure the menus using the default selections you want.

2. Press [SAVE] to call up the File Maintenance screen.

3. Check your disk for any existing default program. Press [F3] for **Command:** CHANGE DIR. Select the boot disk you want to use. After **Name:** type in */usr* and then press [XEQ]. Check for a file named *default*.

   Unless the old file is write-protected, any set of defaults already stored under this filename on the disk you have selected will be overwritten when you save your new default file. To keep the old file for later reference, save it to a new name (its contents will have to be loaded manually), or use a different disk for your new defaults. For more assistance, refer to Section 13.

4. Select **Command:** SAVE. Select **Type:** PROGRAM, SETUP, or OBJECT. Then select the disk from which the system will be initialized.

5. In the **Name:** field, type in the filename */usr/default*. Only this name can be used as the new set of defaults. (Program files saved to any other name or directory must be loaded manually.)

6. Execute the SAVE command by pressing [XEQ].

7. The name of the file you have saved will appear in the Directory Listings when */usr* is the current directory and the selected disk is the current disk. (The name of the current disk appears as a prefix to the absolute pathname of the current directory. The name of the current directory appears on the fourth line of the File Maintenance screen.)

8. You may alter these defaults again at any time by saving a new default program to the same filename.

9. Be sure that you initialize the INTERVIEW from the disk which contains *default*. The unit will load, compile, and run the default program automatically (unless you press [PROGRAM]). The Run-mode screen displayed will be the one selected in the Display Setup menu in *default*. Likewise, all other menus will reflect your customized defaults.

   Refer to Section 13 for more information on the filing system or file maintenance commands.

2.3 Installing New System Software on Hard Disk

From time to time, you may need to install new system software on the hard disk of the INTERVIEW 7200 *TURBO*, 7500, and the 7700 *TURBO*. Use the Duplicate Disk command from the Disk Maintenance utility. (See Section 12.4(D) for more information on this command.) The steps are as follows:

1. Write-protect the master copies of the new system and user disks. Slide the plastic tab so that you can see through the rectangular write-protect hole.

   NOTE: There should also be a second rectangular hole which does not have a sliding tab. If you have any 3.5 inch disks which do not have this second hole, they are not compatible with the INTERVIEW.

2. Insert the new system floppy disk (DSK-951-001-1.X) into Floppy Drive 1 (FD1), the left-hand floppy drive.

3. From the Main Program menu, press F7 to access the Utilities, then F3 for Disk Maintenance. Select the softkey labeled DUPDISK to bring up the Duplicate Disk command screen.

4. Select From Disk Number: FD1 and To Disk Number: HRD on the command screen. Then press XEQ. The system will prompt you to insert a disk. Since the system disk is already in FD1, press the F1 softkey (GOAHEAD). When the duplication is completed, the system will prompt you again to insert the next disk. Remove the system disk from FD1 and insert the user floppy disk (DSK-951-001-2.X) for duplication. Press F1.

   The only files overwritten on the hard drive will be the system software files in the */sys* directory and files from the */usr/layer_pkgs* directory. These files comprise the new system software.

5. Once copying is complete, take the master copy of the user disk out of Drive 1, and store it and the master copy of the system disk in a safe place.

   NOTE: We recommend that you make a working copy of the new software on floppy disks which can be kept with the INTERVIEW.

6. Turn off the power switch for the unit, and wait ten seconds. Then turn the power on again to reboot the INTERVIEW. Following the self-test, the unit should boot without error. The new software version should appear on the screen. If there are errors or the unit will not reboot, repeat Steps 2 through 6. If problems persist, contact Customer Service.

2.4 Backing Up the Hard Disk

Periodic back-up of the hard disk is strongly recommended.

1. Install a formatted diskette in Drive 1. This disk should not contain operating system software. For formatting instructions, see Section 12.4(A).

2. Go to the File Maintenance screen. (From the Main Program menu, press F6.) Use the File Maintenance Copy command to copy any files you wish from the hard disk to floppy.

   NOTE: Do not copy files of type SYS or any files from the */sys* directory or the */usr/layer_pkgs* directory to the backup disk. These files reside on the master copies of your system and user software disks.

3. Once copying is complete, take the backup disk out of Drive 1 and write-protect it. Slide the plastic tab so that you can see through the rectangular write-protect hole. Store the disk in a safe place.

Select from the following methods if you need to recopy files from the backup disk to the hard disk. *Keep in mind that files on the hard disk with the same name as those on the floppy will be overwritten.*

- Copy files or directories one at a time using the File Maintenance Copy command.

- Copy the root directory from the floppy to the root directory of the hard disk. The name to enter for the root directory—once you have selected the correct origin or source drive in the rotating field—is simply the slash character, /.

- Use the Dupdisk command on the Disk Maintenance screen to duplicate the contents of the backup disk on the hard disk.

  NOTE: Do not recopy files from the */sys* directory, files whose type is SYS, or files from the directory */usr/layer_pkgs*. If you need to reinstall these files, use the master copies of system and user software disks to avoid inadvertently overwriting more recent software version files with older ones.

2.5 The Menus

The INTERVIEW is used to monitor data as it is received through a data line or to playback and monitor data as it was recorded from the line. The INTERVIEW may also be set up to emulate one side of a communication, sending data and responding to the data it receives. A series of menus are used to set the unit for the data you expect to receive or send and the type of analysis you wish to perform. These menus are categorized on the main Program menu, from which they are accessible by function key.

(A) The Program Menu

Press PROGRAM to see the Program menu. Notice that the Software and Firmware Versions are posted at the top of the screen. They are always available to you when you return to this menu.

```
                              ** Program Menu **
Software Version: 7.02                              Firmware Version: 6.00
 SETUP   Test Setup Screens:
           Line Setup          BCC Setup                   BERT Setup
           Display Setup       Front End Buffer
           Record Setup        Interface Control
 TRIGS   Triggers - Conditions & Actions
 SPDSHT  Protocol Spreadsheet
 STATS   Statistics Results:
           Tabular Display     Graphics Display            BERT Results
 LAYER   Layer Setup & Protocol Configuration
 FMAINT  File Maintenance Functions
 UTIL    Utilities:
           Disk Maintenance    Time/Date Setup
           Printer Setup       Miscellaneous Utilities

Select Program Function
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
 SETUP    TRIGS    SPDSHT   STATS    LAYER    FMAINT   UTIL
```

Figure 2-4 Main Program menu.

Think of the Program menu as the top level for every menu selection. Each time you prepare the INTERVIEW for the communications environment, you will start with the Program menu and use the function keys to move down into the menus.

All setup, trigger, and programming menus are accessible from this main menu. Assuming the file named *user_intrf* was not located in the */usr* directory of the hard disk during power-up, use PROGRAM at any time, from another menu, or from Run mode, to return to the Program menu. See Section 2.2(B) for a discussion of *user_intrf*.

(B) Configuring Menus

You may configure menus in any order you wish; however, we suggest you configure the Layer Setup screen before programming on the Protocol Spreadsheet or the Display Setup screen, since the selections available to you are governed by the protocols loaded on the Layer Setup screen.

All options on a particular menu are summarized as a diagram which appears in this manual at the beginning of the section which covers that menu. Programming options available in each protocol package are discussed in a section pertinent to the protocol and layer.

To move from the main Program menu to any sub-menu listed, use the function keys. The labels on the screen guide you through each step. For example:

- Access the Layer Setup screen from the main Program menu by pressing [F5].
- Access the Disk Maintenance screen from the main Program menu by pressing [F7] for utilities, then [F3] for Disk Maintenance.

Other uses of the function keys are described in Section 3 and in sections pertinent to the various sub-menus.

Once you have reached the menu you want, the function keys lead you through selections, down to the smallest level of detail. You may also use cursor keys [↑] and [↓] to move up and down through the menu fields. [←] and [→] move the cursor across a menu from field to field.

If you wish to return to the last screen, press [PREV PAGE]. Should you wish to review the menus you have configured, this key takes you back one screen at a time until you reach the main Program menu. Of course, you may press [PROGRAM] at any time to start again from the top of the menus. When you are ready, press [RUN] to start a testing session, no matter what menu is displayed.

Read Section 3 for a further discussion of these and other keys.

(C) The Setup Menus

The menus in the setup group (listed at the top of the Program menu) are used to specify how data is sent, received, recorded, and displayed.

The Line Setup screen allows you to designate the role which the INTERVIEW is to play in testing—whether it is to monitor passively or participate in an active dialogue as DTE or DCE. Menu settings also determine the source of the data and the data clock as well as the characteristics of the data stream you expect to receive or send. These characteristics include the scheme for character encoding/decoding and the format in which blocks of data are sent and received (i.e., synchronous, asynchronous, bit-oriented, or isochronous). The Line Setup screen is described in Section 4.

The Display Setup screen provides alternative types of display to aid in analysis. On this screen, designate how you want data to appear. (Data may be displayed as a stream of bytes alone or in conjunction with lead transitions; summarized in a protocol trace or customized trace format; or tracked on one of two statistical displays.) Then, as you require different types of analysis, use function keys to change from one type of display to another while testing, without returning to the menu. The Display Setup screen and the different types of displays are described in Section 5.

The Record Setup screen defines recording conditions for data acquisition tracks on disk; or for RAM (RAM capacity is 256 Kbytes in the 7000 and the 7200 *TURBO*; 1 Mbyte in the 7500 and 7700 *TURBO*). This screen does not influence the data stored in the character buffer. Storage of data in the screen's character buffer can be controlled from the Protocol Spreadsheet using the Capture command. The Record Setup screen is described in Section 11.

Data and control-lead signals entering the INTERVIEW or generated internally are routed from the receivers through a front-end buffer (FEB) before being presented to the screen and to the trigger program. Data bits are buffered automatically in the FEB. The buffering of other events—control leads, idle bits, and time ticks—can be enabled or disabled on the Front-End Buffer Setup menu, explained in Section 7.

The BCC Setup Menu controls and displays the values of the INTERVIEW's block-check parameters. For more information on block checking, refer to Section 8.

The INTERVIEW can transmit and analyze Bit Error Rate Tests (BERT). Once you have selected the BERT mode on the Line Setup menu, select appropriate parameters on the BERT Setup menu. See Section 9.

(D) The Trigger Setup Menus

The next three groups of menus, Triggers, Spreadsheet, and Statistics, are programming menus which you use to establish interactive dialogues, create test scenarios, and make and display measurements.

> NOTE: BERT testing is handled separately, on the BERT Setup screen. See Section 9.

The 16 identical Trigger Setup screens are a limited set of test conditions and actions grouped in a standard menu format. The set of conditions offered on these screens are described in Section 21. Trigger Setup actions are described in Section 22. The Protocol Spreadsheet provides a wider range of conditions and actions which vary, according to the layer and the protocol you are programming. Conditions and actions available on the spreadsheet are covered in Sections 27 and 28 and in sections dedicated to each layer protocol.

Trigger Setup screens and the Protocol Spreadsheet may be used together as described in Section 19. Counters and timers of the same name may be shared between the two, as can the flag bits from the Trigger Setup screens, which are accessed as flags on the spreadsheet under the name **trig_flags**.

(E) The Protocol Spreadsheet

The Protocol Spreadsheet, a more flexible programming tool with more options that the Trigger Setup screens, is initially a blank menu. Legal programming options are presented as function key labels at the bottom of the screen. Create your program by pressing the necessary function keys. Your entries will be posted on the screen. As you make entries, the function keys reflect the new options enabled.

You may also type your program directly onto the screen, as long as you observe syntax and use exact keywords (as they are posted on the screen; *not* as they are abbreviated in function key labels.) Programming options and errors will still be tracked.

Syntax errors are indicated by strike-throughs when you have completed an entry. (If you are typing onto the spreadsheet, completing an entry usually means pressing the space bar, pushing [DONE] or [RETURN], or moving the cursor to a different location.)

1. *The spreadsheet pattern.* The Protocol Spreadsheet expects a certain pattern of entries. To gain access to the set of trigger conditions and actions at each layer, you must first identify what layer you are programming, then what test you are developing, and finally the name of the state which will contain the triggers you create. Once you have named the state, press the function key for CONDITIONS:. At this point, actual programming options will appear. When you complete the Conditions portion of a trigger, press [DONE] and then press the function key for ACTIONS: to display possible trigger actions. Use the NEXT_STATE: action to indicate movement to another state. The NEXT_STATE: action must be followed by a state name. It can move to any state within the test; the NEXT_STATE: NEXT action moves the test to the following state on the spreadsheet. Programming concepts related to these selections are described in Sections 19, 20, and 24.

   Here is an example of the spreadsheet pattern you will see repeatedly:

   ```
   LAYER: 1
      TEST: example
         STATE: begin
            CONDITIONS: One or more conditions appear here.
            ACTIONS: One or more actions appear here.
             NEXT_STATE: second

            (NEXT_STATE will not follow every trigger. Also, it may replace
             ACTIONS)
   ```

2. *Additional spreadsheet capabilities.* Constants may be used on the spreadsheet to represent repeated values or text, and they may be placed so

that they apply to all or part of a program. Constants are explained in Section 25. C programming language can be introduced at any location on the spreadsheet to create new testing conditions and actions and generally increase program flexibility. C is introduced in Section 56.

3. *Increasing the spreadsheet buffer*. INTERVIEWs with an XDRAM board (OPT-951-23-1) installed *may* have a spreadsheet buffer five times larger than those units without XDRAM. This option makes possible significantly larger Protocol Spreadsheet programs. If a file named *xdram_rcrd* resides in the */sys* directory of the boot-up disk during power-up, however, XDRAM will be dedicated to another purpose. See Section 11.4(A).

(F) The Statistics Screens

The INTERVIEW has two different statistics menus, one in tabular form, the other in bar-graph format. Both are accessible by softkey while you are analyzing data. The value of counters and timers named in triggers can be tracked in statistical screens, once their names have been entered on the corresponding menus. Current, last, minimum, maximum, and average values are tabulated. Values for several counters and timers may be totaled by an accumulator. Bar graphs can be scaled and color-keyed. Refer to Sections 17 and 18 for information on statistics menus and displays.

(G) The Layer Setup Screen

Before you program the Protocol Spreadsheet, you are advised to load the protocols you intend to use. Protocols are selected and loaded from the Layer Setup screen. Your selections, once loaded, determine the set of program conditions and actions which appear on the spreadsheet.

With most protocols, a secondary screen loaded with the protocol allows you to modify common parameters for the protocol.

For more information on the Layer Setup screen, see Section 6.

(H) The File Maintenance Screen

The File Maintenance screen is the user's interface with the filing system. The menu facilitates saving and loading programs, renaming or deleting files. It allows you to consult the contents of any directory, create a new directory, and write-enable or write-protect a file. From this menu, you may structure your own filing system according to your needs.

> **NOTE:** The files pertaining to the operating system and menu selections are stored primarily in the */sys* directory, with some files stored in the */usr* directory. These files should not be deleted or moved. You are otherwise free to manipulate the filing system as you wish.

Section 13 explains file and directory pathnames, how to set up a file hierarchy, how to move through the filing system, and how to use the various maintenance commands.

(I) The Utilities Menus

The last group of menus listed on the Program menu are the utility menus, used to manage peripherals: disk, printer, the internal time-of-day clock, and color monitor.

Consult the time or modify it on the Time/Date Setup screen. The time and date which appear here are used in time-stamping data blocks and user files. See Section 15 for details on this screen.

The Disk Maintenance menu allows you to allocate disk space for data and programs, to transfer data from one storage medium to another, and to duplicate the contents of one disk onto another. Section 12 describes disk maintenance commands and their use in detail.

The Miscellaneous Utilities screen provides mapping of black and white to color enhancements for external monitors. Once the mapping is completed, these enhancements may be placed under trigger control for the production of highlighted data. Refer to Section 16 for further information on this screen.

2.6 Running a Test Program

Press [RUN] to compile and execute a test program. As the program is compiled, a message appears at the top of the screen to indicate the phase that the compiler is in. The longer and more complex the program, the greater the compile time that is required. The preparations being made in each phase are briefly outlined below.

(A) Test Preparation

1. *Phase 1.* Trigger Setup screens are converted to the Protocol Spreadsheet format, the Protocol Spreadsheet is converted to C, and the C Preprocessor directives are acted upon.

   NOTE: Compilation time is somewhat faster if all triggers are programmed directly on the Protocol Spreadsheet.

2. *Phase 2.* The Program is compiled.

3. *Phase 3.* The number of processors and the configuration of the equipment (into which the program is to be loaded) are determined, and internal packages to support the user's program are structured. Also during this phase, linkable-object files referenced on the Protocol Spreadsheet are found and the compiled code in them combined with the compiled spreadsheet program.

4. *Phase 4.* Resources are allocated for each separate task in the program.
5. *Phase 5.* The run–time operating system is generated.
6. *Phase 6.* All code is linked.
7. *Phase 7.* A memory image of the code which can be run by the processors is built.

(B) Rerun Without Recompiling

After a program has compiled once, it will enter Run mode "immediately" (within 2 seconds) after [RUN] is pressed in subsequent executions of the program—assuming that no substantive changes have been made in the program in between the two runs. Substantive changes may be defined as those changes not to menus and fields listed in Table 2-1. That is, changes to fields covered in Table 2-1 will not necessitate a recompile and will not prevent the unit from entering Run mode immediately.

Any changes to the Trigger Setup menus or to the Protocol Spreadsheet will be considered substantive and will necessitate a new compile.

Changes to the tabular or graphic statistics screens will not cause the program to recompile. If a counter or timer is added to the screen, however, it will not update until the program is recompiled. You can force a recompile by holding down [CTRL] and pressing [RUN].

(C) Errors Detected When A Program Is Compiled

Trigger programs and spreadsheet programs with syntax errors or other errors will not compile successfully and will prevent the unit from executing the test program.

If an error is detected during the compiling phases (after you have pressed [RUN]), the user is returned automatically to the Protocol Spreadsheet.

While a program is being compiled, errors are flagged and diagnostic information is stored. This information is made available to the user when the unit is returned to Program mode. A diagnostic message for the first error found is automatically displayed at the top (second line) of the Protocol Spreadsheet screen. The cursor is automatically moved to the error.

Press GO-ERR once more to move to the next error. For each error, a diagnostic message is displayed. The search for errors stops at the end of the file and the message "No more errors" is displayed.

GO-ERR also calls up diagnostic information on trigger–menu errors.

Error messages are listed in Appendix A of this manual.

Table 2-1
Fields That Can Be Changed Without Causing Recompile

Menu	Field
Line Setup	Disk No (recorded data must be same *type*) Block No Clock Source Speed NRZI MIL
Display Setup	Display Mode Type RTS/CTS? CD? DTR/DSR? C/I? Layer (Protocol or User Trace; not Program) Statistics Type
Record Setup	Disk No Initial Cond Stop At
Front-End Buffer Setup	Idle Suppress DTE DCE
T1 Transmit Setup	(all fields)
T1 Data Path Setup	(all fields)
T1 Line Setup	(all fields)
T1 Signal Channel Setup	Signal Channel Number
G.703 Transmit Setup	(all fields)
G.703 Data Path Setup	(all fields except Signalling Type and related fields)
G.703 Line Setup	(all fields)
ISDN Interface Setup	(all fields)
Tabular Statistics	(all fields)
Graphical Statistics	(all fields)
File Maintenance	(all functions except LOAD)
Date/Time Setup	(all functions)
Printer Setup	(all fields except Redirect Run Mode Output)
Disk Maintenance	(all functions)
Misc Utilities	(all fields)

(D) Recoverable Errors During Run Mode

The following error messages indicate *recoverable* MPM memory failures:

MPM -- Processor Fault
MPM -- Divide Fault
MPM -- Bus Error
MPM -- Stack Fault
MPM -- Memory Fault

Do not turn off the INTERVIEW when any one of these errors is displayed in Run mode. Instead, press [PROGRAM] and check your program, since these messages indicate programming problems that cannot be displayed as syntax errors but which do prevent your test from running properly. Consult Appendix A1 for an explanation of these messages. Once you have revised the test, try running it again. If you cannot resolve the problem, save a copy of the program and contact Customer Service.

2.7 Data Flow

Figure 2-5 diagrams the movement of data between the various functional components of the INTERVIEW. The diagram provides "clues" to many of the operating characteristics of the unit. For example:

- The front-end buffer (FEB) lies squarely in between the line interface and (1) the recording medium and (2) the program logic. This means that control leads may or may not be recorded and may or may not be seen by the triggers—depending on the FEB setup (Section 7).
- Line data may be recorded directly to disk as bit-image data, recorded to bit-image RAM and then transferred to disk, or captured as character data in the display buffer and transferred to disk.
- Once control leads and time ticks (that is, the original timing values) are recorded alongside character data, they are locked in. Since the FEB is not on the playback path for character data, FEB selections do not apply.
- Bit-image data, however, does pass through the FEB during playback. Except for the **Idle Suppress** field, FEB selections apply. This means that control leads and time ticks, if recorded with the data, *must* be enabled in order for the program logic to detect them. (For playback of bit-image data, the **NRZI** selection on the Line Setup menu also does not apply.)
- Only data on disk may be played back.
- Front-panel green-red LED's are never disabled for line data and never blink for recorded data.
- Not only characters but also leads and time ticks, if enabled in the FEB setup, are captured automatically in the display buffer (that is, the screen buffer or character RAM).

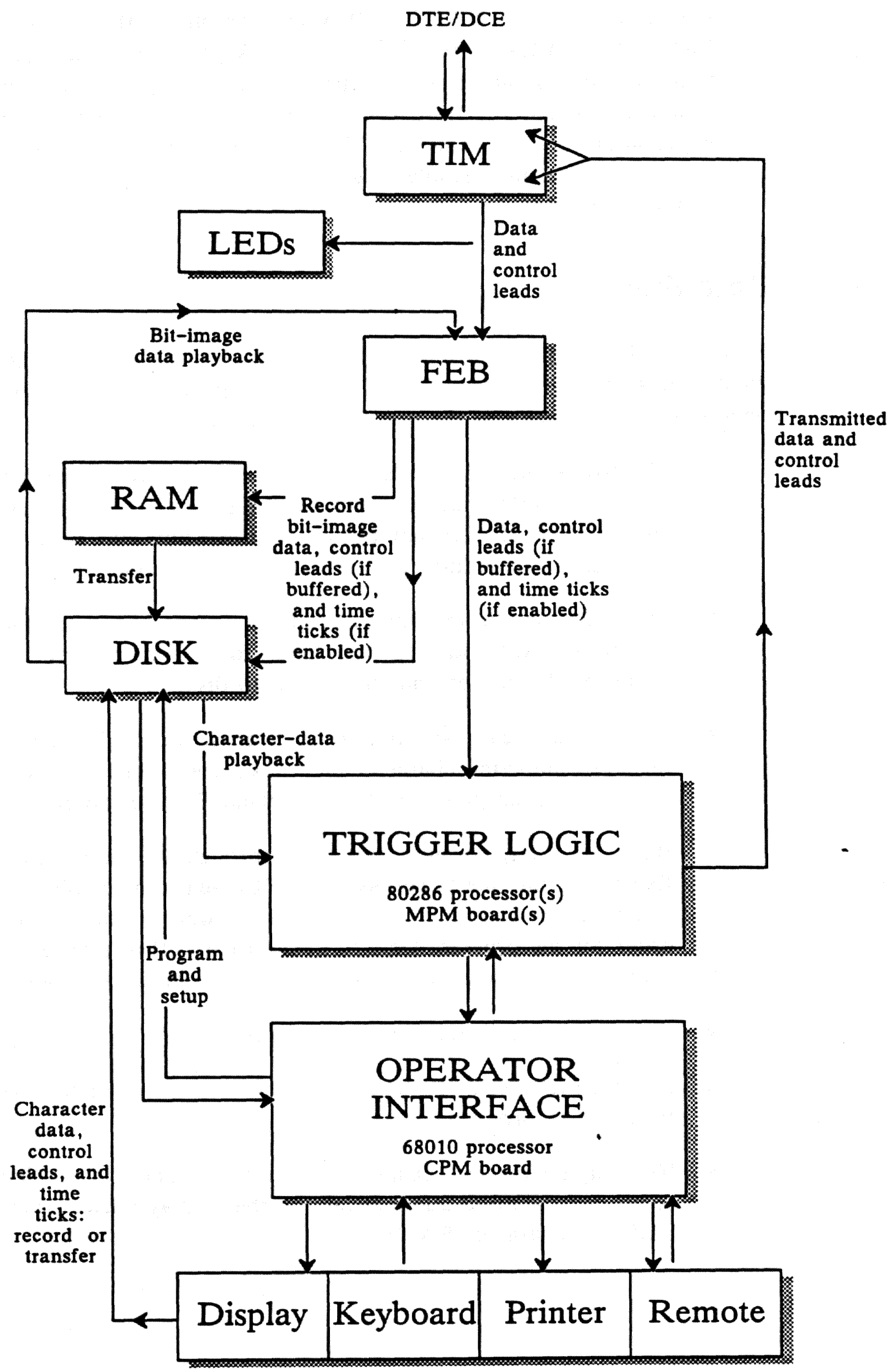


Figure 2-5 INTERVIEW 7000 Series functional diagram.

2.8 How to Correct Common Problems

(A) Unit enters Run mode even though I press the Program key.

A file called *user_intrf* was located in the */usr* directory of the hard disk during boot-up. In this situation, the program in *user_intrf* is automatically loaded, compiled, and run each time the [PROGRAM] key is pressed. Press [SHIFT]–[PROGRAM] to enter Program mode, or rename *user_intrf* and power-up again. See Section 2.2(B).

(B) Unit does not execute Run: Protocol Spreadsheet returns to screen instead.

An error was detected during the compiling phases (after you pressed [RUN]). See Section 2.6(C).

(C) My program does not run, and instead I get a message about an "unresolved reference."

Your program is asking the compiler for a send routine that is not available in Monitor mode. Switch to an Emulate mode, or modify the program. For programs with C coding, this message usually means that a routine has not been declared or defined.

(D) Protocol Spreadsheet program which was just loaded shows syntax error strikethroughs which weren't there before.

Missing softkey selections and pervasive strike-through's on the Protocol Spreadsheet indicate that the correct Layer Personality Package has not been loaded. To correct the problem, return to the Layer Setup screen, insert disks if necessary, and check Personality Package and drive selections. Then press [XEQ] to load the packages manually.

(E) EIA trigger condition does not come true, even though the front-panel LED indicates a status that makes the condition true. For example, an EIA RTS ON condition is not coming true, even though the RTS LED is bright red.

EIA status is not detected by the triggers if **Buffer Control Leads: NO** is the selection on the Front-End Buffer Setup menu. See Section 7.

If the data is being played back from disk and the FEB Setup menu was not configured to buffer control leads at the time the data was recorded, the leads are no longer available for triggering.

Front-panel LEDs *always* reflect line status, never the status of recorded leads.

Note also that an EIA condition that is the only condition on a trigger menu (or the only condition associated with an action or set of actions on the Protocol Spreadsheet) is *transitional*. It is only true when it changes to true. To check the current *status* of an EIA lead regardless of transitions, pair the EIA condition with a don't-care character condition (see Section 21.4) or with an ENTER_STATE condition on the Protocol Spreadsheet. See Section 27.3(A).

(F) Lead lines on the data-plus-leads display are not transitioning, even though the front-panel LEDs for the same control leads are blinking.

The leads on the data-plus-leads display are also enabled/disabled by the Buffer Control Leads field on the FEB Setup menu. See (E), directly above.

(G) My "current" timers seem to be incrementing on the Tabular Statistics screen, but the other statistical columns always show 0, even when I take statistical samples.

The "current" column is derived from a millisecond "clock on the wall," while the statistical values may be calculated on the basis of time ticks that occur at one-second intervals. Your timer samples may be less than .5 seconds, in which case they are rounded to zero.

Check the FEB Setup menu, and solve the problem in either of two ways. Turn Time Ticks off, and the statistical columns will use the wall clock. Or change the Tick Rate from 1 second to 10 milliseconds or smaller (down to 10 microseconds).

(H) I am trying to send a transmit string from a trigger menu (or from Layer 1), but my data does not appear on the screen.

When you are having trouble transmitting, always go to the Line Setup menu and look at the **Clock Source** field first. You must have clock to transmit, whether internal or supplied by an external DCE.

Another frequent problem is receiver synchronization. When you try to transmit, does the front-panel LED for your transmit lead (TD or RD) blink rapidly? If it does, then you are transmitting successfully, but your receivers may not be synchronizing with the data.

Check the **Sync Char** field on the Line Setup menu. Also be sure that the sync pattern is part of your transmit string. You must supply these characters yourself.

(I) I have loaded in X.25 packages at Layer 2 and Layer 3, and I am trying to send a data packet from Layer 3; but my data does not appear on the screen.

The INTERVIEW is a *layered* emulator. The significance of this is that Layer 3 and higher layers (in Emulate modes) have no direct access to the physical layer, Layer 1. In practice this means that a RCV condition at Layer 3 *does not see packets on the line*. It only sees packets that are delivered up from Layer 2 by a *user program* at that layer.

Similarly, a **SEND** action at Layer 3 does not in itself send a packet out onto the line. A **SEND** action merely delivers the packet to Layer 2—provided that Layer 2 has indicated its readiness to receive data from above.

The following program is not any sort of complete Layer 2 emulation. It is the *minimum* program that must be entered at spreadsheet Layer 2 in order for a Layer 3 program to have access to the data line. Once this Layer 2 program is entered, Layer 3 can send packets out onto the line and receive packets from the line.

```
LAYER: 2
  STATE: datalink
     CONDITIONS: DL_CONNECT REQ
     ACTIONS: DL_CONNECT CONF
     CONDITIONS: DL_DATA REQ
     ACTIONS: SEND INFO " ((DL_DATA)) "
     CONDITIONS: RCV INFO
     ACTIONS: GIVE_DATA
```

The elements of this program are discussed in Section 30, OSI Primitives on the Protocol Spreadsheet, and in the programming example in Section 33.9.

(J) I'm trying to load a program, but instead I get an error message about loading a layer package.

When a program or object file is loaded from the File Maintenance screen, the system must be able to locate any layer personality package that the program requires. If the necessary layer package cannot be found, the file will not be loaded.

> NOTE: Optional applications programs are available for the INTERVIEW 7000 Series. Make sure that necessary layer packages are accessible when you load these programs.

In the INTERVIEW 7500, 7200 *TURBO*, and 7700 *TURBO*, all layer packages are always accessible since they reside in the */usr/layer_pkgs* directory on the hard disk. In the INTERVIEW 7000, layer packages are located in the same directory on the user disk (DSK-951-001-2.X). See Section 6. Place the user disk in the other floppy disk drive and try loading the program (or object) file again.

(K) My INTERVIEW is overheating.

Collected dust and dirt on the fan filter may be blocking the flow of air into the unit. Follow the instructions in Section 1.5(D) on cleaning the fan filter. If the problem persists, contact Customer Service.

2.9 Optimizing High-Speed Operation

It is a simple fact that the more tasks there are to accomplish, the longer it takes to complete them—time is a relative factor. This is also true of the INTERVIEW. When line rates are relatively high, it may be best to strip your program of extraneous tasks which would slow down the unit.

(A) Record

One option is to record the data for playback and analysis at a slower rate.

Three sets of program selections for optimizing high-speed recording of data follow. All three versions assume that you are not loading in any program that will look at the TD or RD data, BCC, frames, packets, or EIA leads. All three versions record the data so that it can be run against more complex programs later on.

The fastest version records data without displaying the character data to the screen. The next version records data at maximum speed while still displaying data. The third version records data with personality packages loaded in the unit so that a protocol trace is displayed in real-time.

1. *Recording without displaying character data.* The first set of programming selections records all of a data line (including idle and time ticks) in bit-image data format. This is the fastest of the three recording scenarios.

   Beginning with the default screens, make the following selections:

   SETUP: LINE:

   Sync Char: delete both sync characters

   DISPLAY:

   Display Mode: NO DISPLAY

   RECORD:

   Capture Memory: user choice

   Data To Record: BIT IMAGE

   Stop at: user choice

   FEBUFF:

   Buffer Control Leads: YES or NO

   Time Ticks: OFF or ON with 1 second to 1 millisecond selected

   Using 1 millisecond time ticks, the maximum normal recording speeds for each of the disk types on the Record setup screen are as follows:

Single Floppy Disk	64 Kbps
Multiple Floppy Disks	56 Kbps
20-Mbyte Hard Disk	256 Kbps
44-Mbyte Hard Disk	384 Kbps
RAM	256 Kbps

TRIGGERS:

For SYNC format, the following triggers will keep the unit out of sync; the unit works at optimum speed when it is not in sync. Enter these conditions and actions on a Trigger Setup screen:

CONDITION: DTE 1 OF ☒ ("don't care")
ACTION: OUT_SYNC BOTH
CONDITION: DCE 1 OF ☒ ("don't care")
ACTION: OUT_SYNC BOTH

NOTE: When line rates approach the maximum recording speed, consider using high-speed RAM recording. See Section 11.4(A).

2. *Recording while displaying character data.* The second scenario records data at optimum speed while still preserving the character display.

Beginning with the default screens, make the following selections:

SETUP: LINE/RECORD:

Capture Memory: user choice for type of DISK
(do not select RAM recording)

FEBUFF:

Suppress the idle line pattern under **Idle Suppress** using the following patterns:

BOP: DTE : $^T{}_E$
DCE : $^T{}_E$
SYNC: DTE : $^F{}_F$
DCE : $^F{}_F$

On the Front End Buffer screen, turn off **Buffer Control Leads** and **Time Ticks**:

Buffer Control Leads: NO
Time Ticks: OFF

LAYER:

Do not load any layer personality packages.

TRIGGERS AND PROTOCOL SPREADSHEET:

Do not load in any program that will look at the received data, BCC, or EIA leads.

3. *Recording while displaying character data or protocol trace.* The third setup version records data at maximum speed with layer personality packages loaded.

   Beginning with the default screens, check the following selections:

   SETUP: LINE/RECORD:

   Capture Memory: user choice for type of DISK (do not select RAM recording)

   FEBUFF:

   Suppress the idle line pattern under **Idle Suppress** using the following patterns:

BOP:	DTE	: 7E
	DCE	: 7E
SYNC:	DTE	: FF
	DCE	: FF

   On the Front End Buffer screen, turn off **Buffer Control Leads** and **Time Ticks**:

   Buffer Control Leads: NO
   Time Ticks: OFF

   LAYER:

   When running SS7 layer personality packages, load Layer 1 Compression package.

   TRIGGERS and PROTOCOL SPREADSHEET:

   Do not load in any program that will look at the received data, BCC, frames, packets, or EIA leads.

(B) Monitor

If you want to monitor the data in real time, but still optimize speed, select **Time Ticks:** OFF and **Buffer Control Leads:** NO on the FEB Setup menu.

(C) *TURBO*

The INTERVIEW 7200 *TURBO* and the 7700 *TURBO* can monitor data at high rates. To achieve the maximum operation speed, however, the active spreadsheet program should not: 1) load in any personality package; 2) look at (TD or RD) data, BCC's, (EIA) leads, frames, or packets; or 3) include OSI or other conditions which require a frame to be passed up to higher layers.

This means that the following Layer 1, line-related C variables should not be referenced:

Event Variables:	Non-Event Variables:
fevar_rcvd_char_rd	*rcvd_char_rd*
fevar_rcvd_char_td	*rcvd_char_td*
fevar_gd_bcc_rd	*current_eia_leads*
fevar_gd_bcc_td	*previous_eia_leads*
fevar_bd_bcc_rd	*l1_tick_count*
fevar_bd_bcc_td	*rd_modifier*
fevar_abort_rd	*td_modifier*
fevar_abort_td	
fevar_eia_changed	

Other C variables at higher layers are either specific to various protocol packages or have meaning only if a frame has been passed up the layers. In either case, they should not be referenced in your spreadsheet program.

3 Keyboard

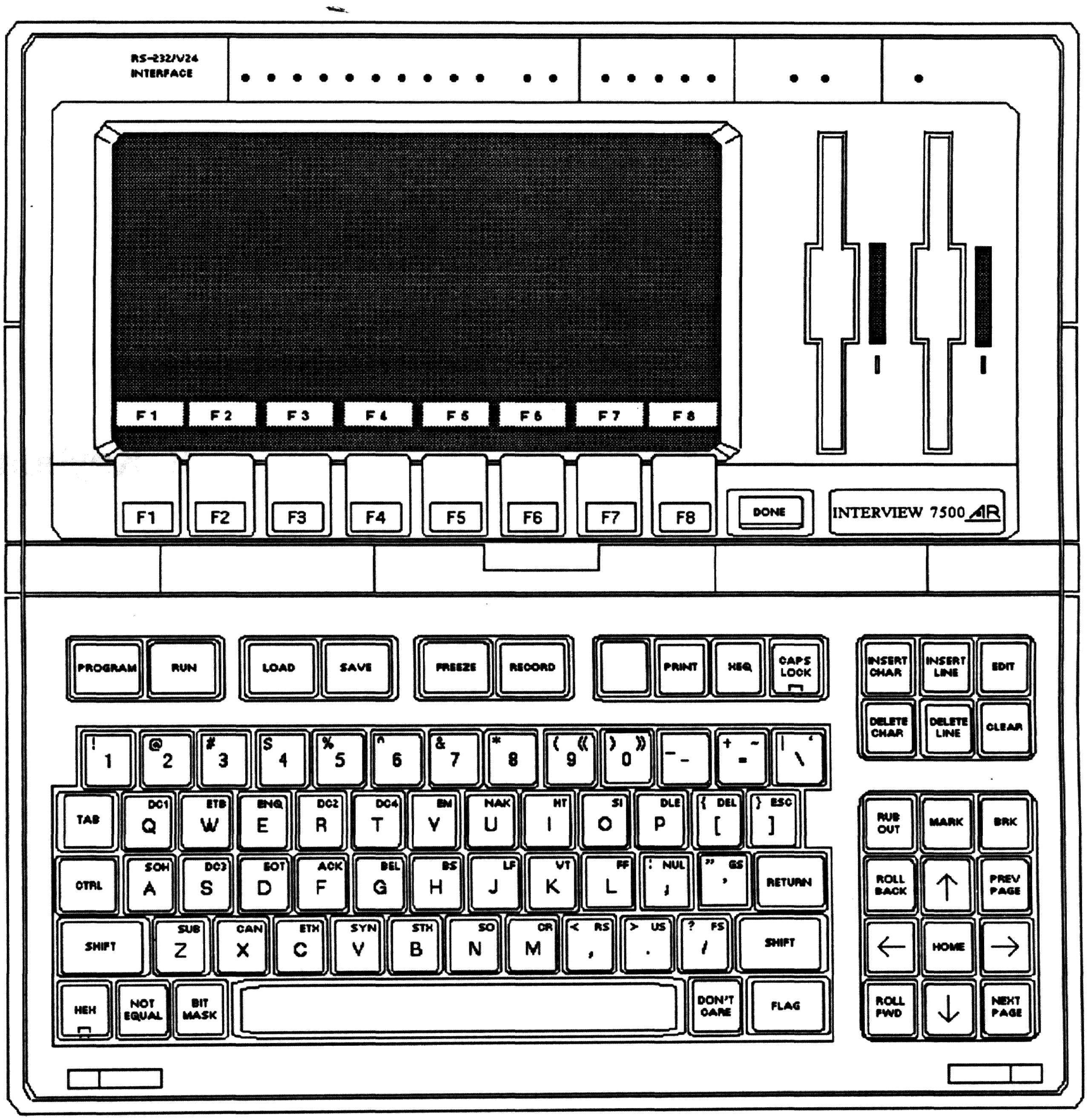


Figure 3-1 The INTERVIEW keyboard.

3 Keyboard

3.1 Hard Keys and Softkeys

The ninety-four keys of the INTERVIEW include nine keys (eight variable or *soft*keys and a DONE key) that are positioned not on the keyboard itself but rather above the keyboard on the front panel, just below the monitor. The softkeys are placed directly below their (changing) screen legends, in order that the user will not have to take his eye off the screen to locate one of these keys.

In Program mode, softkeys can move the cursor around menu screens and change selections in menu fields. On the Protocol Spreadsheet screen, softkeys are an alternative to direct keyboard entry: programming levels from layer down to specific conditions and actions are softkey-selectable. In Run mode, the softkeys serve as an extended keyboard for functions such as changing the display (from data to protocol trace or to a statistics graphic, for example).

The keyboard itself consists of an ASCII keyboard and several special-function keypads, including a cursor keypad and an editing keypad that is used to modify all entries on the Protocol Spreadsheet screen as well as text entries on various menu screens. The ASCII keyboard includes five special, non-ASCII characters arranged on either side of the space bar that are used primarily to enter nonstandard characters in search strings.

Most keyboard functions are explained in detail elsewhere in the manual. The editing keypad, for example, is covered in Section 26, Editor. The present section is intended primarily to indicate the range of keys available when the operator has placed the unit in Program, Run, or Freeze mode.

3.2 Programming Keys

Table 3-1 is a brief listing of some of the frequently used programming keys. The keyboards in Figure 3-2 and Figure 3-3 indicate all of the keys that are valid in Program mode.

Table 3-1

Frequently Used Programming Keys

[PROGRAM]	In Program mode, always returns to the master menu from any other menu or screen. (In Run mode, either returns to master menu or loads, compiles, and runs program in */HRD/usr/user_intrf*. See Section 2.2(B).)
[↑] [↓] [←] [→]	Move cursor from field to field.
[ROLL FWD] [ROLL BACK]	Change rotating-field selections.
[DONE]	Completes an entry and tabs to next field.
[HOME]	Moves cursor to beginning of menu screen.
[PREV PAGE]	Goes back up to previous menu in program-menu tree.
[XEQ]	Loads and saves files; loads in protocol packages; executes other commands.
[INSERT CHAR] [DELETE CHAR] [CLEAR] [RUB OUT]	Edit text entries.

(A) ASCII Keys

The set of ASCII keys is used in Program mode to provide names for files and directories, to identify counters, timers, accumulators, and programming flags, to type in operator-defined messages called prompts and traces, to enter search and transmit strings on trigger menus, and to enter text on the spreadsheet screen. The ASCII character that appears on the screen is always the character shown on the keycap, with shifted characters shown at the top left corner of the keycap and control characters shown at the top right.

It is important to note, however, that there may be a difference between the display of keyboard input in Program mode versus Run mode. In Program mode, a particular keystroke ([CTRL] pressed in conjunction with [-], for example) will always produce the same character ("-") in a data-entry field. In Run mode, a particular code-translate chart will be consulted and the character ("-" in our example) may not belong to the code set and therefore may be missing on the chart. Such a character cannot be trapped, transmitted, or displayed in Run mode: it is "untranslatable" (see Note, Appendix D1). Run-mode encoding of keyboard input is given in Appendix D1, Keyboard-to-Hex Translation.

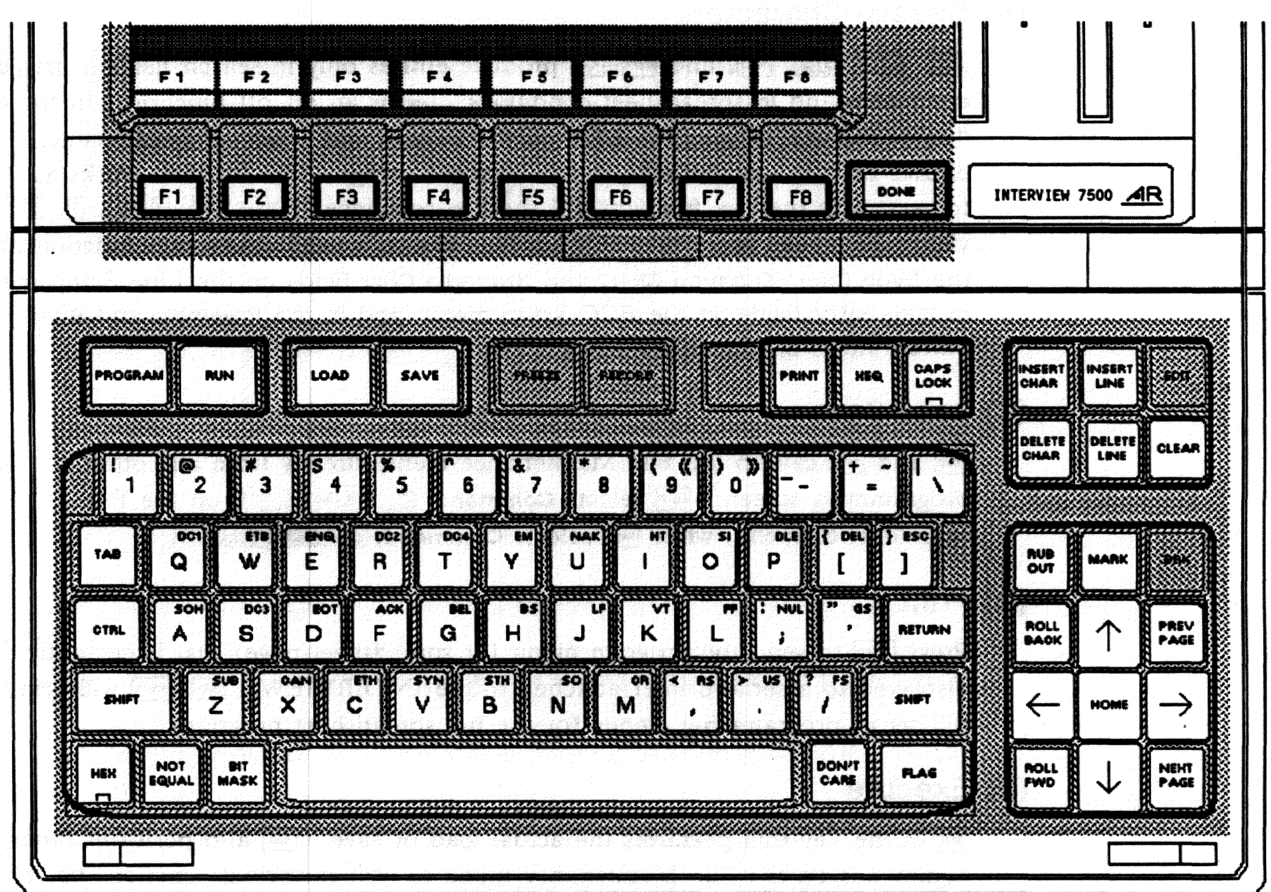


Figure 3-2 Menu-screen keys.

Two characters on the ASCII keyboard are part of the spreadsheet programming language but do not belong to any standard code set. They are 《 and 》. These characters are produced by the combination of [CTRL] and [9] or [0] and can be entered only on the Protocol Spreadsheet, and in the **Xmit:** field on Trigger Setup menus. They are never transmitted.

For examples of how these double-parens are used, see Section 25, Constants, and Section 29, Strings.

Three standard ASCII characters have special meaning on the Protocol Spreadsheet. The double-quotation mark (") opens or closes a text list or string: see Section 29, Strings. The backslash (\) is an escape character. And the ASCII space produced by the space bar indicates the completion of a "keyword" (or "token") and normally changes the rack of programming softkeys along the bottom of the screen.

[RETURN] does not produce an ASCII control character in the INTERVIEW. It is always a cursor-movement key. Press [CTRL]-[M] to enter the ␍ character.

(B) Special Characters

[NOT EQUAL], [BIT MASK], [DON'T CARE], [FLAG], and [SHIFT]-[FLAG] produce entries only in search fields in trigger conditions and in spreadsheet conditions. [HEX] is an on-off function. In the "on" condition it lights the LED on the keycap and produces hexadecimal entries both in search fields and in transmit strings. The function works as follows: with the hex function off, the key sequence [A], [A], [HEX], [7], [F], [7], [F] yields the screen entry of A A 7F 7F. Hex is also a valid data-entry function in the **Sync Char, Outsync Char,** and **Xmit Idle Char** fields on the Line Setup menu, in text-entry fields on the BCC Setup menu, and in the **Preamble** and **Sync Pattern** fields on the BERT Setup screen.

(C) Load/Save

[LOAD] and [SAVE] call up the File Maintenance menu directly from any other programming screen. [LOAD] selects **Command:** LOAD on the File Maintenance menu, while [SAVE] selects **Command:** SAVE.

(D) Print

Press [PRINT] to send the program menu (or spreadsheet page) that is currently displayed to a serial printer attached to the INTERVIEW. [CTRL]-[PRINT] will print the full set of programming menus (or the full spreadsheet program).

(E) Execute

[XEQ] is the key that performs the actual load or save. [XEQ] also performs other commands on the File Maintenance menu as well as various functions on the Disk Maintenance, Date/Time Setup, and Layer Setup screens. On the Protocol Spreadsheet, [XEQ] may be used to perform a "write" operation from the screen to a file, or a "read" operation from a file to the screen. See Section 26, Editor.

(F) Mark

[MARK] has a special function on the File Maintenance Screen. When you have cursored down to a particular file in the File Maintenance directory, [MARK] selects that file for the next operation. Several files may be "marked" prior to the execution of a command. The [MARK] key also unmarks rows in the directory that have been marked already.

[MARK] has a "program tab" function on the Protocol Spreadsheet: see (J), below.

(G) Editing Keys, Menu Screens

The editing keys that operate within text-entry fields on menu screens are shown in Figure 3-2. [INSERT CHAR] inserts a space at the cursor position. A character can then be typed over the space. [DELETE CHAR] deletes the character that is under the cursor. Characters in the same field to the right of the cursor move left to fill the column vacated by the deleted character. [CLEAR] removes the entire data entry.

[RUB OUT] deletes the character just to the left of the cursor position. The cursor moves left as successive characters are deleted. Use [RUB OUT] to correct a typographical error on the most recent keystroke (or the last several keystrokes).

[CTRL]–[CLEAR] restores the default selections for the entire menu screen.

On the multipage tabular and graphic statistics screens, [INSERT LINE] adds a blank statistics row above the cursor. [DELETE LINE] removes the row that has the cursor.

(H) Editing Keys, Spreadsheet Program

These keys are shown in Figure 3-3. The operation of [DELETE CHAR] and [RUB OUT] is the same as on menu screens, except that here the use of these keys is not restricted to particular fields.

[INSERT LINE] adds a blank line above the cursor. [DELETE LINE] removes the line that has the cursor. [CLEAR] erases the cursor character and everything to the right of the cursor on a given line. [EDIT] enables/disables the spreadsheet editor. Refer to Section 26, Editor, for editing softkeys and their functions.

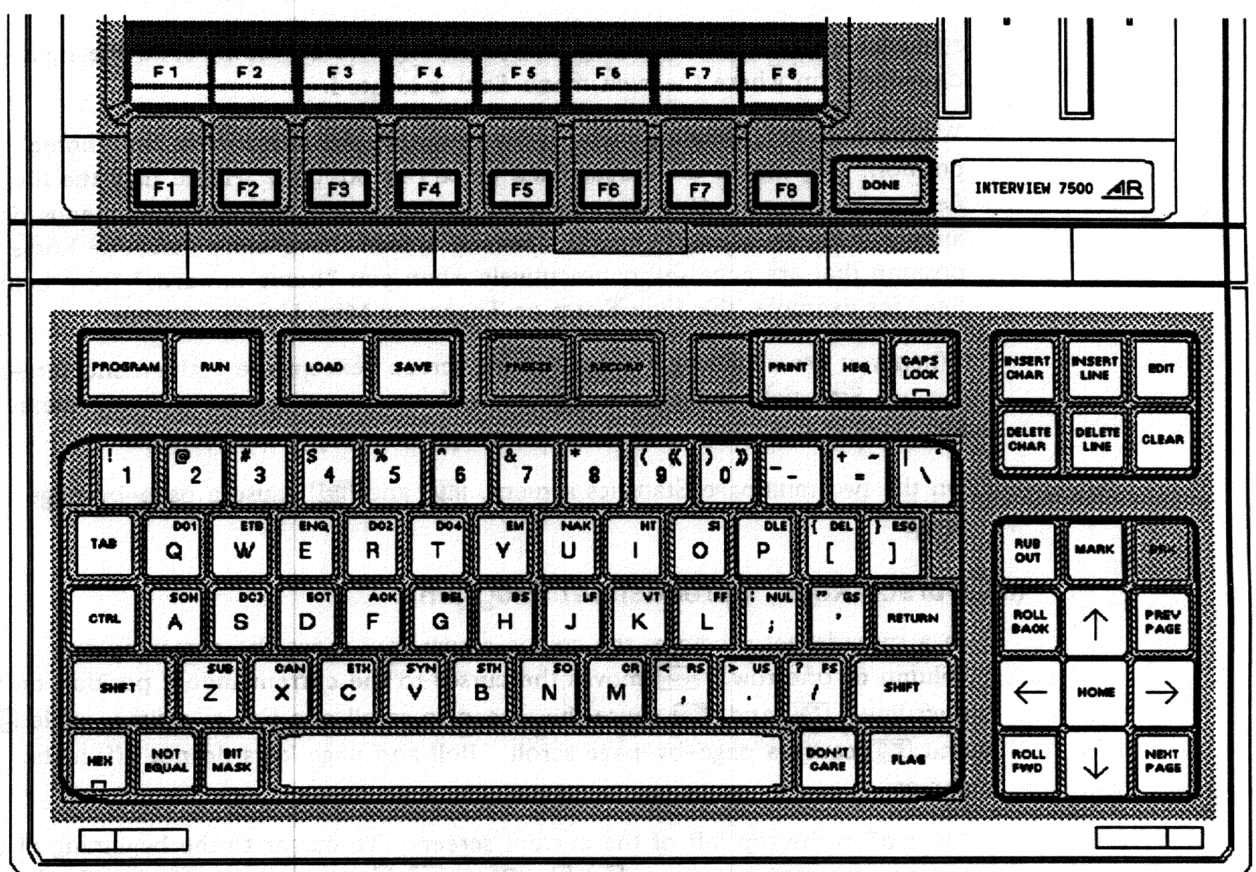


Figure 3-3 Spreadsheet keys.

There is a separate insert *mode* in the spreadsheet editor. This mode is invoked by two keys, [INSERT CHAR] and [INSERT LINE]. When the mode is enabled, the word <Insert> appears at the top left of the spreadsheet screen. In insert mode, the operator types in a block of data while succeeding text is pushed forward with every keystroke.

Press [INSERT CHAR] a second time to exit *insert* mode and return to *overstrike* mode.

> NOTE: [INSERT LINE] is not an alternate-action key that toggles the spreadsheet from *insert* to *overstrike* mode. Only [INSERT CHAR] accomplishes this function.

(I) Cursor Keys, Menu Screens

See the bottom right of Figure 3-2. [↑] and [↓] move the cursor from line to line on programming menus (including triggers). [SHIFT]-[↑] moves the cursor to the first field in the menu. [SHIFT]-[↓] places the cursor in the last field in the menu. [→] and [←] move the cursor from field to field on the same line. In text-entry fields, they move nondestructively right and left over text that has already been entered. [ROLL FWD] and [ROLL BACK] rotate the selections at the cursor position.

[RETURN] and [DONE] are field oriented. They move the cursor down or to the right, depending on where the next menu field is located.

Whenever a programming menu is first entered, the cursor is in the "home" position. [HOME] moves the cursor back up to this position. Home may the the first field on the menu. Or it may be a softkey rack that selects among menus or among fields on a lengthy menu. Several screens have more than one home position that are accessed consecutively when you "home upwards" from below. See, for example, the Line Setup or Trigger or Misc Utilities screens.

When you are accessing a programming screen (except the main-menu screen or the two Statistics menus), the [PREV PAGE] key will return you to your previous menu. You may use this key to backtrack through several previous screens.

On the two multipage Statistics screens, [PREV PAGE] and [NEXT PAGE] cause a page-by-page scroll.

(J) Cursor Keys, Spreadsheet Program

In a spreadsheet program, the cursor-arrow keys move the cursor by one column or one row. [RETURN] moves the cursor to the current indent position on the next line. [ROLL BACK] and [ROLL FWD] cause the screen to scroll one line at a time, while [PREV PAGE] and [NEXT PAGE] cause a page-by-page scroll. Roll and page keys do not affect the cursor.

"Home" is the top left of the current screen. To cursor to the beginning of the spreadsheet program, press [SHIFT]-[↑]. Press [SHIFT]-[↓] to go one line below the last line of the program.

To cursor to the beginning of a given line, press [CTRL]-[←]. To "express" the cursor to the end of the data-entry on a line, press [CTRL]-[→].

To cause the cursor to skip forward from keyword (or "token") to keyword, press [SHIFT]-[→]. [SHIFT]-[←] causes a reverse skip.

Any cursor movement across keyword boundaries will change the softkey-option rack along the bottom of the screen.

[MARK] may be used as a kind of "program tab" to mark a place in the Protocol Spreadsheet where the cursor will automatically revert on command. With the cursor in a position you will want to return to quickly and conveniently, press [MARK] followed by a number key—[2], for example. Then go ahead and move the cursor any distance in either direction from the marker.

When you wish to return to the "mark 2" position, press [SHIFT]-[MARK] followed by [2]. Up to ten numbered cursor-markers may be reserved in the spreadsheet program.

(K) Softkeys and [DONE]

Depending on which menu field has the cursor, all selections are mapped to softkeys at various times. On menu fields, the [DONE] key has the same function as [RETURN]: it moves the cursor to the next field. So there is a way to move around the menu and make selections without using the cursor-arrow and other keyboard keys.

When the operator is using softkeys to enter a spreadsheet program, he uses [DONE] to mean, "Escape to the previous (higher) level of programming." Figure 3-4 illustrates how two depressions of the [DONE] key can take the program from a specific EIA condition all the way to the highest level of softkeys.

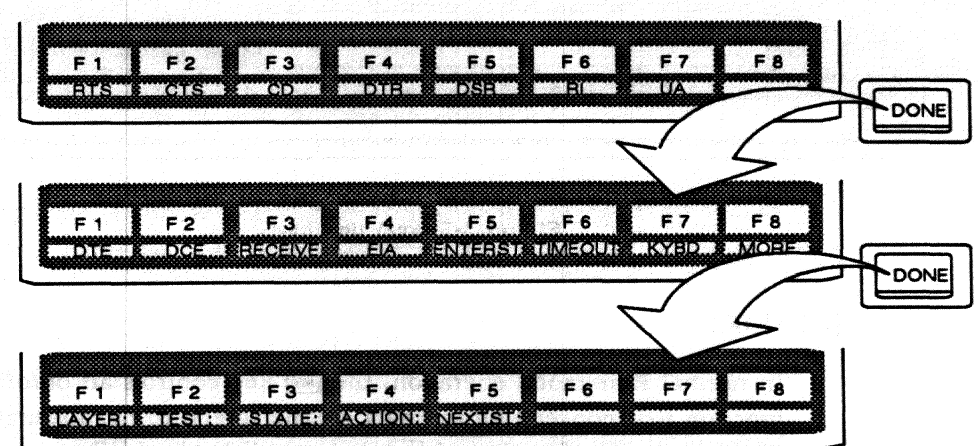


Figure 3-4 Moving to a higher rack of softkeys on the Protocol Spreadsheet.

3.3 Real-Time Keys

The keyboard in Figure 3-5 indicates the keys that are valid in Run mode when the data is displayed in real time (rather than frozen). In addition to the keys highlighted in this figure, the C programmer may use the variable *keyboard_any_key* to monitor input from every key except [EDIT], [CAPS LOCK], [DONE], and softkeys [F1] through [F8]. See Section 69, Other Library Tools.

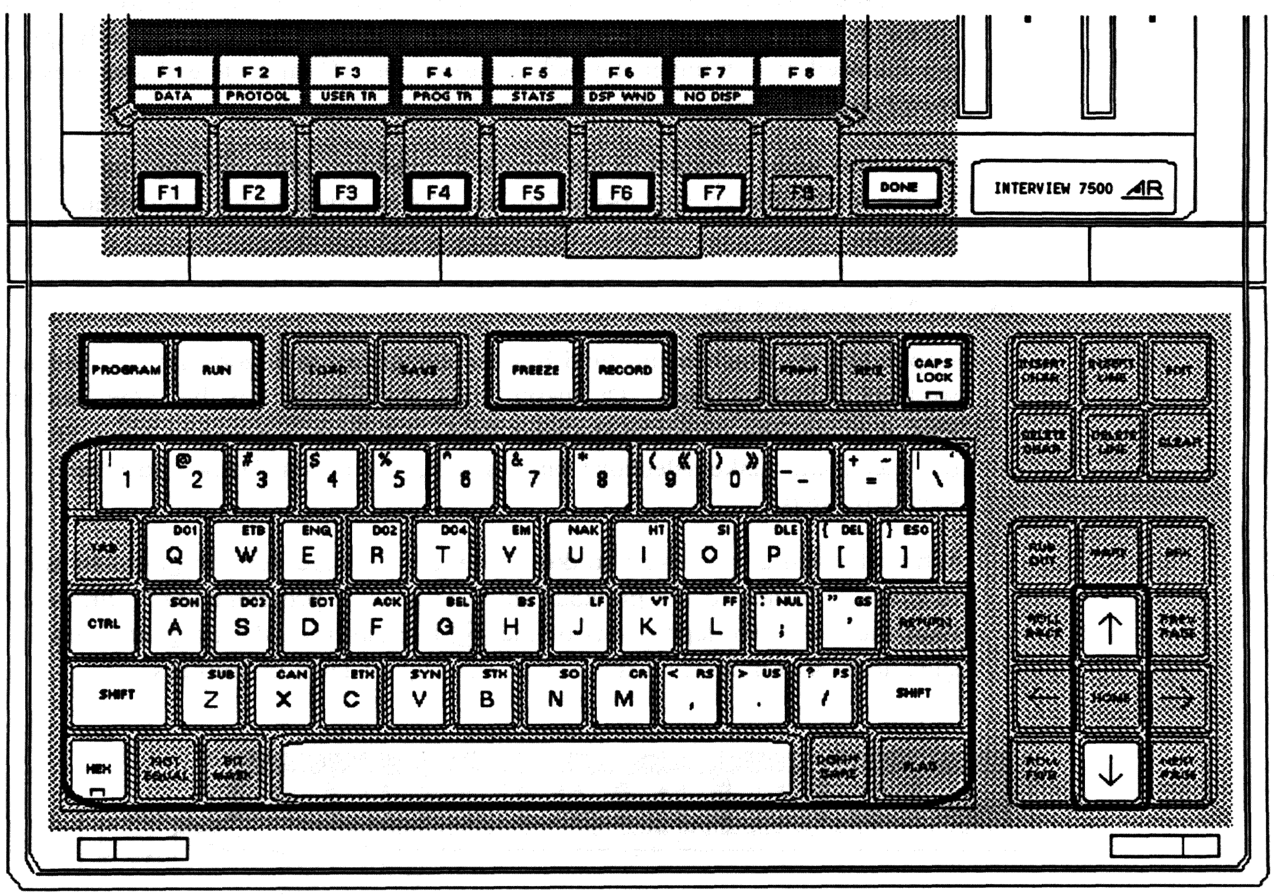


Figure 3-5 Real-time keys.

(A) Hex

In normal Run-mode operation, the [HEX] key controls an on/off decoding function that converts all the data on the screen to hexadecimal. Note that the screen-decoding function of [HEX] does not light the LED on the keycap. Only the data-entry function turns on the LED.

(B) Freeze

[FREEZE] controls an on/off function that freezes the screen display. For line data, program activity and bit-image recording continues. Character recording will not continue since the display buffer (character RAM) is frozen.

A similar freeze function can be activated when a **Capture:** BOTH OFF action is performed by a trigger. The difference is that while the manual (keyboard) freeze permits you to scroll through the data buffer, trigger freeze does not.

(C) Record

For line data, [RECORD] controls a manual start/stop function that records data according to the parameters selected on the Record Setup menu. For disk data, press [RECORD] to suspend/resume playback.

> NOTE: Although playback is immediately suspended when you press [RECORD], the screen display continues until the character buffer's contents are fully displayed. (For bit-image data, the FIFO must empty.) At slower playback speeds, you may notice a slight delay before the display actually freezes.

Notice the record/playback status field next to the block number field in the status area of the Run-mode display screens. See Section 5.2. The initial status indicator displayed in this field is determined by Line and Record Setup selections. See Sections 4.2 and 11. It is subsequently controlled via the [RECORD] key.

(D) Cursor Keys

When a multipage Statistics display (tabular or graphic) is presented in Run mode, [ROLL BACK] and [ROLL FWD] cause the rows of values (or bars) to scroll up or down one line at a time, while [PREV PAGE] and [NEXT PAGE] cause a page-by-page scroll.

[↓] and [↑] serve two purposes. When the Run-mode display screen is the Display Window, [↓] and [↑] are under the programmer's control. (Refer to Section 69, Other Library Tools, for information on keyboard variables and the *send_key* routine.) For example, these keys could be used to move from field to field on a menu created in the Display Window. For all other Run-mode screens, [↓] and [↑] control the playback speed of data from a disk. [↓] slows the data speed by half, while [↑] doubles the current speed.

(E) Softkeys

In Run mode, the softkeys will change the display selection. Selectable display modes include character data, character data plus control-lead timing, protocol trace, program trace of state-to-state movement and of user-entered messages called "traces," an application-specific "display window," and statistical tabulation or graphic display of counters and timers.

There is also a Run-mode softkey selection called NO DISP. This suppresses the writing of data to the screen (though not to the screen buffer). See Section 5.11 for an explanation of this display mode.

3.4 Freeze-Mode Keys

The keyboard in Figure 3-6 indicates the keys that are valid in Run mode when the data display has been frozen.

In addition to the keys highlighted in Figure 3-6, the C programmer may use the variable *keyboard_any_key* to monitor input from every key except [EDIT], [CAPS LOCK], [DONE], and softkeys [F1] through [F8]. See Section 69, Other Library Tools.

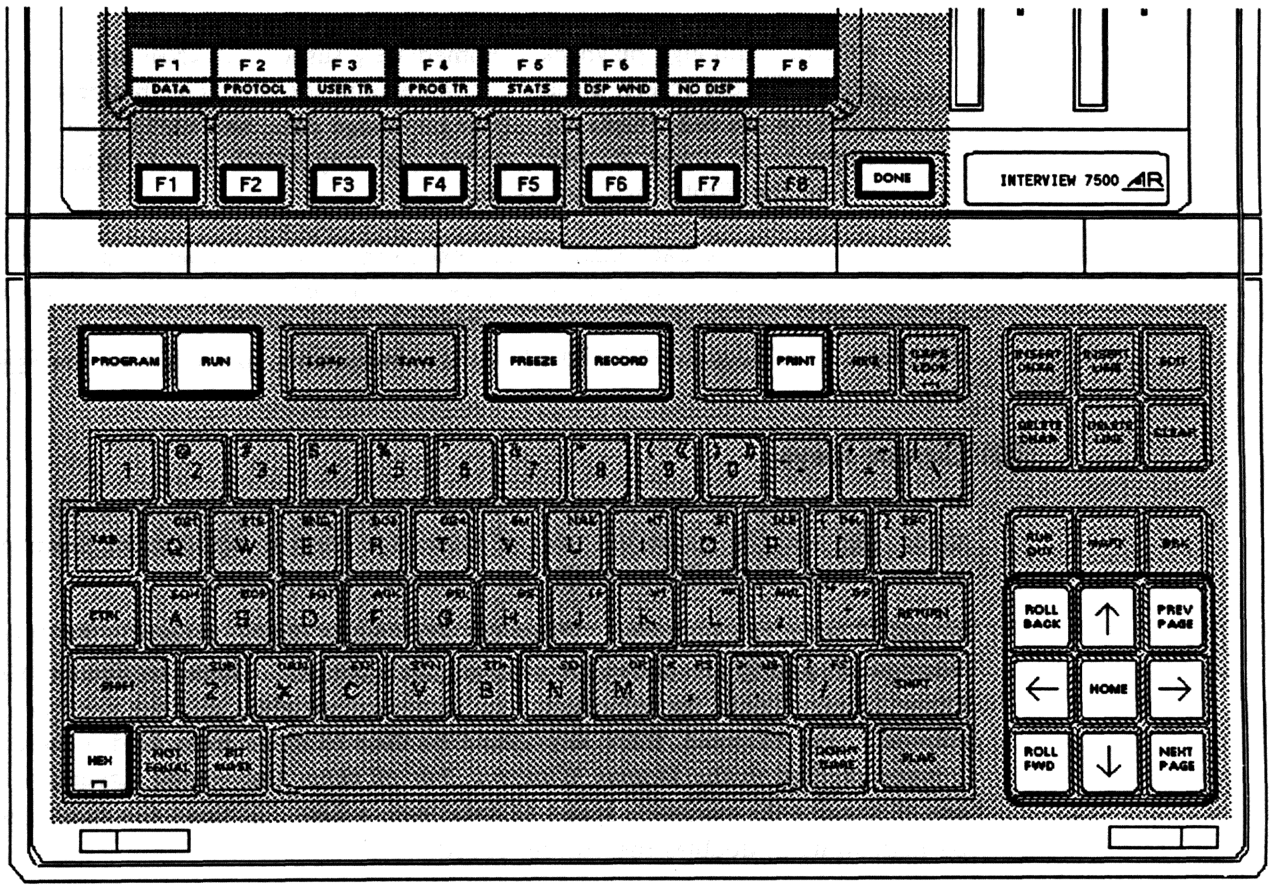


Figure 3-6 Freeze-mode keys.

(A) Hex

In Freeze mode, [HEX] controls an on/off decoding function that converts all the data on the screen to hexadecimal.

(B) Freeze

[FREEZE] will also unfreeze a frozen display. For disk data, it will resume playback and program activity.

(C) Record

The recording of live data can be stopped and started even while the display is frozen. The [RECORD] key will not resume playback of disk data that was frozen via the [FREEZE] key.

(D) Print

Press [PRINT] to send the current frozen screen to a serial printer attached to the INTERVIEW. [PRINT] together with [CTRL] will send the entire data buffer.

(E) Cursor Keys

The cursor keys work on the frozen data buffer the same way they work on the spreadsheet screen. Cursor-arrow keys move the cursor by one column or one row. [ROLL BACK] and [ROLL FWD] cause the screen to scroll one line at a time, while [PREV PAGE] and [NEXT PAGE] cause a page-by-page scroll. Roll and page keys do not affect the cursor.

[HOME] will move the cursor to the first (and oldest) character in the character (screen) buffer. When [HOME] is pressed together with [CTRL], the screen and cursor move to the last (or newest) character in the buffer.

When a multipage Statistics display (tabular or graphic) is presented in Freeze mode, [ROLL BACK] and [ROLL FWD] cause the rows of values (or bars) to scroll up or down one line at a time, while [PREV PAGE] and [NEXT PAGE] cause a page-by-page scroll.

(F) Softkeys

All softkeys are valid in Freeze mode and serve the same functions as in real time.

4 Line Setup

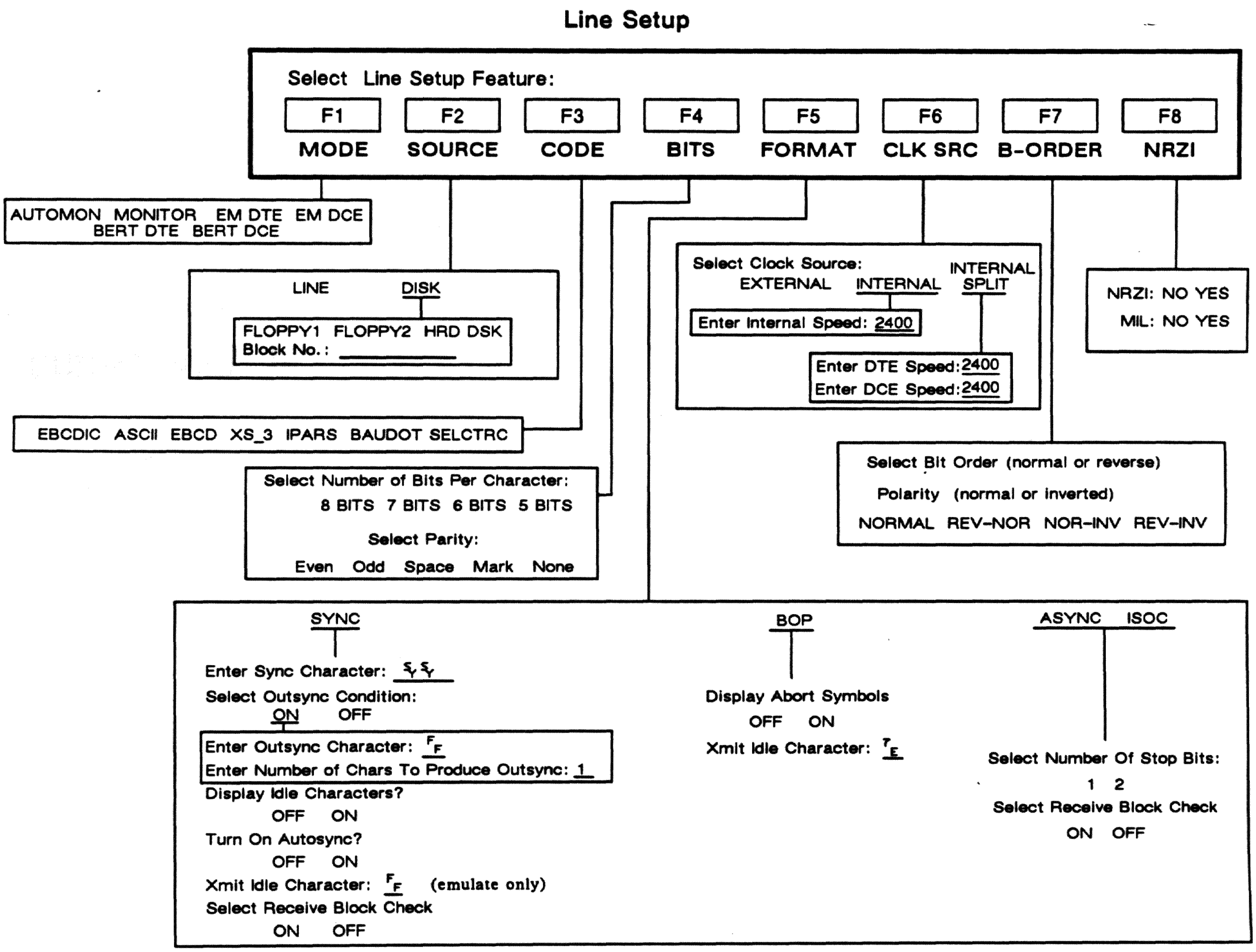


Figure 4-1 Line Setup menu.

4 Line Setup

The Line Setup menu is the configuration menu for line parameters such as data format (synchronous or start-stop), code, clock, bit order, and bit polarity. The data may be received at a modular test interface, generated internally, or played back from disk. Figure 4-1 shows the fields and selections on this menu.

The Line Setup menu is on the left half of the Line Setup screen. Press PROGRAM, then F1, F1, to access this screen.

4.1 Mode

The first field on the Line Setup menu is **Mode**. In this field you select the type of operation you intend to perform with the INTERVIEW.

Available modes are Automonitor, Monitor, Emulate DTE, Emulate DCE, BERT DTE and BERT DCE.

Select AUTOMONITOR (the default mode) if you are not certain of the line characteristics. When you press RUN, the unit will test samples of line data, autoconfigure, and begin to monitor. Once the unit is configured, change the mode to MONITOR. This is to prevent the unit from autoconfiguring every time you go into Run mode.

To use Automonitor, you must also select **Source:** LINE. **Source:** DISK does not provide data samples for the unit to test. In this instance, it cannot autoconfigure.

Select **Mode:** MONITOR if you intend simply to monitor data, and you wish to enter the configuration parameters yourself. The INTERVIEW is a passive monitor (that is, it does not regenerate signals). Once the unit's DTE and DCE connectors are attached to the data line, the unit will not interfere with data transmissions when it is in Automonitor or Monitor mode. Select **Mode:** MONITOR also when you want to play back data from a disk.

> NOTE: Before data can be played back or the line monitored, all transmit actions must be cleared from the trigger menus, and all SEND actions and RECEIVE or RCV conditions must be deleted from the Protocol Spreadsheet. These conditions and actions are for emulate mode only.

EMULATE DTE. Make this selection for interactive testing of a modem or testing of a DTE *across* modems. Break the data line from the DTE and connect the modem to the TO DCE interface on the interface module at the rear of the INTERVIEW.

Note on synchronous and BOP operation: The INTERVIEW can transmit using internal clock (SCTE) when it is emulating a DTE; but in order to display its own transmit data as well as receive data, it must be connected to a modem or other DCE device that is providing SCT and SCR clock.

If you are emulating DTE and external clock is not available for synchronous or BOP operation, select **Clock Source:** INTERNAL and patch SCTE to SCT.

EMULATE DCE. This mode is for direct, local testing of a DTE (such as a terminal, PAD, or front end). Break the data line from the modem and connect the DTE to the TO DTE connector on the interface module at the rear of the unit.

BERT DTE. In this mode you will run the BERT test that is configured on the BERT Setup screen, using the TD lead to transmit and RD to receive and analyze.

BERT DCE. In this mode you will run the BERT test that is configured on the BERT Setup screen (Section 9), using the RD lead to transmit and the TD lead to receive and analyze.

4.2 Source

This selection field determines the source of the data to be monitored or tested.

LINE is the default selection. In Monitor or Automonitor mode when LINE is selected, the INTERVIEW will monitor data received at either of the line-interface connectors on the interface module at the rear of the unit.

In Emulate DTE mode when LINE is selected, the INTERVIEW will transmit on pin 2 (TD) and expect to receive data on pin 3 (RD). In Emulate DCE mode, the unit will transmit on pin 3 (RD) and monitor pin 2 (TD).

Part of any disk may be set aside for the recording of live data. Line data may be recorded directly to disk, recorded to RAM and then transferred to disk, or captured in the screen buffer (RAM) and transferred to disk. To record to disk or RAM, use the fields of the Record Setup menu on the Line Setup screen (see Section 11, Record Setup). Capture in the screen buffer (character RAM) is discussed in Section 22.9.

For data to be available for playback, it must reside on a disk. Therefore, data stored in bit-image RAM or screen buffer RAM must be transferred to disk using the Data Transfer command. See Section 12.4(C).

On the Line Setup menu, the **Source:** DISK selection allows data that has been recorded to the data-acquisition track to be played back for testing and display. Selecting DISK brings up two new fields. Choose from FD1 (FLOPPY1), FD2 (FLOPPY2), and HRD (HRD DSK) in the **Disk No.** field.

Enter the starting block number in the **Block No.** field. Valid entries are 0 to 99999. If you do not enter a value, the value will default to zero. Block 0 means that playback will start from the beginning of the data source, regardless of the actual block number. All other entries represent actual block numbers.

> NOTE: It is not necessary to enter leading zeroes in this field. For example, you may enter 10 instead of 00010.

When DISK is the source selection, a record/playback field (on the top line in the status area) on Run-mode screens will indicate whether playback is in progress or has been suspended. If playback is ongoing, a "P" appears next to the block-number field. If you suspend playback by pressing RECORD or using a program action, "S" will be displayed. The record/playback field will be blank if a disk is not present in the selected drive or when the end of the data—acquisition tracks is reached. This field will also be blank if you enter a starting block number on the Line Setup menu that a) precedes the block number at which data actually begins, or b) exceeds the block number at which data actually ends. Change your entry to zero.

> NOTE: An "R" in the record/playback field indicates that line-data recording is in progress. See Section 11.

4.3 Code

The standard **Code** selections are EBCDIC, ASCII, EBCD, XS_3, IPARS, BAUDOT, and SELECTRIC. Default is EBCDIC.

Appendix D1 gives keyboard-translation tables for all the codes that are standard in the INTERVIEW. These tables indicate the hex byte that is transmitted (or searched for) and the actual character displayed in Run mode as a result of a given keystroke (unshifted, shifted, or control) made while the cursor is in a data-entry field.

Note the difference between Run-mode display and Program-mode display of keyboard input. In Program mode, a particular keystroke (CTRL pressed in conjunction with -, for example) will always produce the same character ("-") in a data-entry field. In Run mode, a particular code-translate chart will be consulted and the character ("-" in our example) may not belong to the code set and therefore may be missing on the chart. Such a character cannot be trapped, transmitted, or displayed in Run mode: it is "untranslatable" (see note, Appendix D1).

Appendix D2 gives an input-to-display translation table for all of the standard codes. Next to each hexadecimal value (input) is the ASCII-keyboard character or control character (display) in each of the various codes. "Input" refers to bytes, both received and transmitted, in hexadecimal notation before they are converted to characters and displayed on the monitor.

4.4 Bits

Identify the number of information bits for the selected code in the **Bits** field. Do not include the parity bit. Options are 8, 7, 6, and 5.

4.5 Parity

In the **Parity** field select the type of parity used in the system being tested. The choices are NONE, EVEN, ODD, SPACE, and MARK. The parity bit is additional to the information bits.

A data character received with a parity error will appear on the display with a bar through it.

> **NOTE:** 8-Bit odd or 8-bit even parity is a functional choice, but eight bits plus mark or space parity is not a valid selection.

4.6 Format

The **Format** selection field allows you to program the INTERVIEW correctly for the protocol to be monitored. The selection in the **Format** field determines many of the selection subfields that follow.

(A) Sync Selections

Selecting SYNC for **Format** results in the group of subfields shown in Figure 4-2. Choose SYNC for Bisync format.

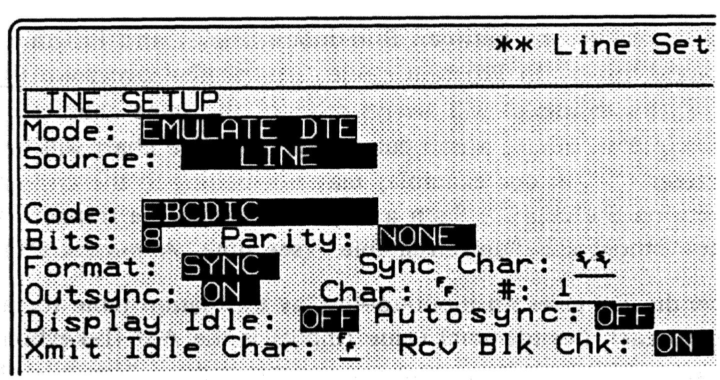


Figure 4-2 **There are eight subfields under *Format: SYNC*.**

1. *Sync characters.* **Sync Char** is a data–entry field that determines the synchronization pattern for synchronous data protocols. When the receivers are looking for synchronization, every occurrence of the sync pattern results in a [S] (sync) symbol on the data display. Refer to **Outsync** and **Autosync**, below, for the conditions under which the receivers *look for sync*.

   The synchronization characters default to ${}^{S}_{Y}{}^{S}_{Y}$. Adjustments for your parity selection are automatic. For example, ${}^{S}_{Y}$ in odd–parity ASCII is ${}^{1}_{6}$ but in even–parity ASCII the INTERVIEW converts ${}^{S}_{Y}$ to ${}^{9}_{6}$. For most cases, therefore, you will not have to make any entry in the **Sync Char** field.

   IPARS and XS_3 are exceptions in that the control character ${}^{S}_{Y}$ does not occur on their translation tables. If ${}^{S}_{Y}$ is entered as a sync character for these two codes, it is treated like any other untranslatable character and converted to SPACE or NULL, inappropriate for synching.

   For IPARS, the hexadecimal value ${}^{3}_{F}{}^{3}_{E}$ should be entered manually in the **Sync Char** field (see Figure 4-3). In the case of XS_3, the correct sync pattern is ${}^{3}_{5}{}^{3}_{5}$.

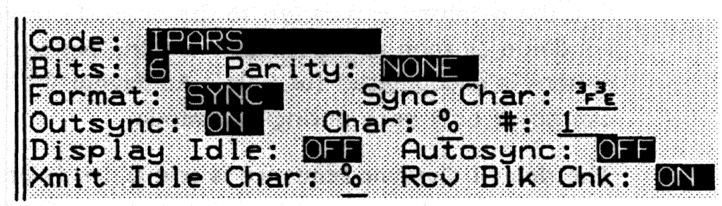


Figure 4-3 Different codes have different sync parameters.

   The correct synchronization patterns for the various standard codes in the INTERVIEW are listed in Table 4-1. Any other one– or two–character sequence may be entered, using alphanumeric keys, control characters, or hexadecimals.

   The character entered will be adjusted for parity unless **Parity:** NONE has been selected or unless the entry has been made in hexadecimal. *For hexadecimal entries no parity adjustment is made. You must adjust hexadecimal entries yourself to take parity into account.* (Do not adjust parity for the default hexadecimal sync characters in IPARS or XS–3).

   To enter a one–character synchronization pattern, position the cursor in the **Sync Char** field and depress [CLEAR]. This will clear the field. Enter the desired character.

Table 4-1

Synchronization Parameters for Standard Codes

Code	Info Bits	Parity	SY1 SY2
EBCDIC	8	None	32 32
ASCII	7	Odd	16 16
		(Space	16 16)
		(Even or Mark	96 96)
EBCD	6	Odd	3D 3D
		(Space	3D 3D)
		(Even or Mark	7D 7D)
XS-3	6	Odd	35 35
IPARS	6	None	3F 3E
SELECTRIC	6	Odd	--

2. *Outsync.* When the unit enters Run mode in synchronous format, the receivers are always *out of sync, looking for sync.* After initial synchronization, the receivers stop looking for sync. **Outsync: ON** means that the receivers can *return* to the original outsync, looking-for-sync condition as soon as a particular outsync pattern is encountered. Unless this pattern is encountered (or unless **Autosync: ON** is selected), synchronization can occur only once during Run mode.

   The default **Outsync** sequence is one % (pad) or hex FF character. Any character may be entered in the **Char** field. The # field is a decimal field. It allows you to specify how many times the character must occur consecutively (from one to 255 times) before outsync will take effect. In transparent text, there is a possibility that legitimate data FF will occur. Also, the block-check character may occasionally mimic the outsync character. Normally these problems are solved by turning outsync off (and autosync on) or by increasing the number of outsync characters to 2.

3. *Display idle.* **Display Idle: OFF** prevents display and buffer-storage of idle characters from the time the receivers go out of synchronization until they see the synchronization pattern again. If you select **ON**, the idle characters will be displayed on the monitor and also saved in the data buffer.

4. *Autosync.* When **Autosync** is **ON**, the receivers will resynchronize every time they see the selected synchronization pattern, *even if they are in sync already.* When autosync is enabled, the logic constantly tests for the one- or two-character pattern on a bit-by-bit basis. When a match is found, it becomes the new reference point for character framing.

This is a useful selection when data does not have a unique outsync character (as when a transmitter idles the sync character, for example). Autosync is also useful where one block of data follows another by less than a full character interval. Autosync will detect the synchronization pattern and adjust to it even though it is skewed in relation to the previous sync.

As long as autosync is off, there is no danger of accidental synching in the middle of a block of data, since receivers that are already in sync do not look for sync. While autosync is on, accidental synching may happen when a sequence of bits in the data mimics the sync pattern. You may reduce the chance of random synching in the middle of a block of data by always using a two-character synchronization pattern whenever autosync is turned on.

In normal synchronous operation, outsync is on and autosync is off. Once the receivers go out of sync, the receiver logic tests for the one- or two-character sync pattern one bit at a time, just as when autosync is on. Enabling autosync means that the bit-by-bit search is conducted all the time, even when the receivers are already in sync.

5. *Block-check overlays.* **Rcv Blk Chk** is a subfield of **Format:** SYNC, ASYNC, and ISOC. This field is discussed in Section 8, Block Checking.

6. *Transmit idle character.* The **Xmit Idle Char** field is valid for both SYNC and BOP formats. It allows you to specify what idle-line condition will be applied by the INTERVIEW in Emulate modes. Alphanumeric, control, or hexadecimal characters may be entered in this field. The default idle-line condition for SYNC format is steady mark (hex FF).

(B) Bit-Oriented Protocols

Format: BOP selects bit-oriented protocols that use 7E framing and zero-insertion. Examples are X.25, X.75, and SDLC.

In BOP protocols, the synchronization flag pattern, conditions for outsync, and block-check calculation are always defined. Any fields on the Line Setup menu that pertain to synchronization and block-checking disappear when BOP is the **Format** selection. The subfields under **Format:** BOP are **Display Abort** and **Xmit Idle Char**. See Figure 4-4.

```
Code: ASCII
Bits: 8   Parity: NONE
Format:  BOP
Display Abort: OFF
Xmit Idle Char: 7E
```

Figure 4-4 **Synchronization and frame-check parameters are automatic (and therefore not selectable) under *Format: BOP*.**

1. *Display abort.* The seven 1-bits in a row that signal an "Abort" to BOP receivers can occur during $^{T}{}_{E}$ idle as well as in the middle of a frame. Since these idle aborts are not aborted frames but merely indicate missing zeroes in the $^{T}{}_{E}$-idle bitstream, you may want to suppress the display of these "glitches" by selecting **Display Abort:** OFF. This is the default selection. **Display Abort:** OFF does not pertain to aborted *frames*, which will be displayed in any case.

2. *Transmit idle character.* This field is valid for both SYNC and BOP formats. See under SYNC, above. The default idle character for BOP format is the $^{T}{}_{E}$ flag. Press [HEX], [7], [E], (not [FLAG]) to enter this idle character. Only $^{T}{}_{E}$ or $^{F}{}_{F}$ idle is valid for BOP.

(C) Start-Stop Format

For start-stop data, choose **Format:** ASYNC or ISOC. Then you may choose either 1 or 2 **Stop Bits**, as shown in Figure 4-5. ASYNC is the correct **Format** selection for data that has start/stop-bit framing if both digital devices rely on internal clock. If clock is provided on the interface for one of the devices (isochronous operation), select **Format:** ISOC.

```
Code: ASCII
Bits: 8    Parity: NONE
Format: ASYNC
Stop Bits: 1
Rcv Blk Chk: ON
```

Figure 4-5 Async receivers go out of sync when a selectable number of stop bits are received.

4.7 Clock Source

Clock Source and **Speed** apply to data in any format. Selections for **Clock Source** are EXTERNAL, INTERNAL, and INTERNAL SPLIT. If **Format:** ASYNC has been selected, the clock source *must be internal* (or internal-split). Async means that there is no clock on the interface leads, and the INTERVIEW will not look for external clock nor recognize the clock signals if they are there.

Note on synchronous and BOP operation: The INTERVIEW can transmit using internal clock (SCTE) when it is emulating a DTE; but in order to display its own transmit data as well as receive data, it must be connected to a modem or other DCE device that is providing SCT and SCR clock.

If you are emulating DTE and external clock is not available for synchronous or BOP operation, select **Clock Source:** INTERNAL and patch SCTE to SCT.

INTERNAL SPLIT allows you to monitor or emulate in *asynchronous* systems that have different baud rates for Receive Data and Transmit Data, and to emulate a modem on dual-speed, *synchronous* lines. When INTERNAL SPLIT rotates into the selection field, speed settings for both DTE and DCE appear below it. See Figure 4-6.

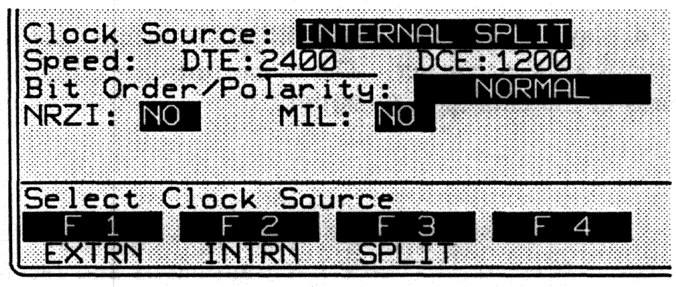


Figure 4-6 Internal clock may be split into DTE and DCE speed settings.

If you are monitoring or emulating a DTE on a dual-speed, synchronous line, the proper clock-source selection is EXTERNAL, since the modem is already supplying both clocks.

4.8 Bit-Order/Polarity

Bit Order/Polarity: NORMAL means that both the bit order and the bit polarity are "normal." REVERSE-NORM means that the bit order is reversed while the polarity is normal. Other selections are NORM-INVERT and REV-INVERT.

Normal bit order means that when a character is encoded into binary for transmission (or decoded from binary for display), the first bit transmitted (or received) will correspond to the rightmost bit in the INTERVIEW's hexadecimal value for that character and code. The code-conversion for every hexadecimal value is given in Appendix D2, Hex-to-Display Translation Tables.

When reverse bit order is selected, the hexadecimal display for each byte does not change; but now the first bit to be transmitted and received will be the leftmost bit in the binary version of the hexadecimal. (Leftmost, that is, except for the parity bit. For obvious reasons, the parity bit always is the last bit transmitted.) Reverse bit order is appropriate for certain standard codes such as IPARS and EBCD (which then becomes REV EBCD).

Usually the rightmost bit for the hex bytes on a translation table is the least-significant bit, but not always: the right-hand bit is the most-significant bit in two older IBM code sets, EBCD and SELECTRIC. But whatever the code set, normal bit order establishes a correspondence between the rightmost bit on the hexadecimal table and the first bit transmitted or received.

For normal bit polarity, the INTERVIEW's RS-232/V.24 transmitters define logic 1 as more negative than -3 V and logic 0 as more positive than +3 V. When you invert the bit polarity by selecting **Bit Order/Polarity:** NORM-INVERT or REV-INVERT, logic 1 becomes +3 V and logic 0 switches to -3 V. Logical inversion changes the voltages for bits in data characters ($^{S}_{Y}$, the ASCII sync character, becomes ---+-++- instead of +++-+--+) but the inversion does not affect voltages for start/stop-bit framing and mark idle. The start bit still signals the transition from negative to positive voltage. Stop bit and idle are still negative voltages, but now they are read as logic 0 instead of logic 1.

Note that the display LEDs above the INTERVIEW monitor always shine red when the voltage level is +3 V or greater. This is true for data leads as well as control leads, regardless of the data logic (polarity).

4.9 NRZI

When **NRZI:** YES is selected, INTERVIEW transmitters and receivers use the Non Return to Zero (Inverted) mode of signal sense. In this mode, logic 0 is defined not as a plus-voltage threshold, but rather as any transition from plus to minus or from minus to plus. Logic 1 is defined as an absence of transition.

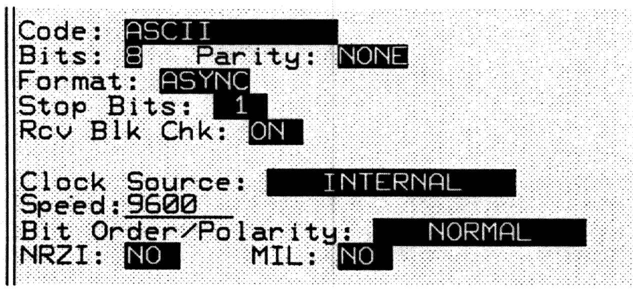
> NOTE: Since the hardware that accomplishes NRZI formatting is not on the playback path for disk data, **NRZI:** YES must be selected when the original line data enters the FEB. The **NRZI** selection will have no effect during playback, whether the data was recorded in character or bit-image format.

4.10 MIL

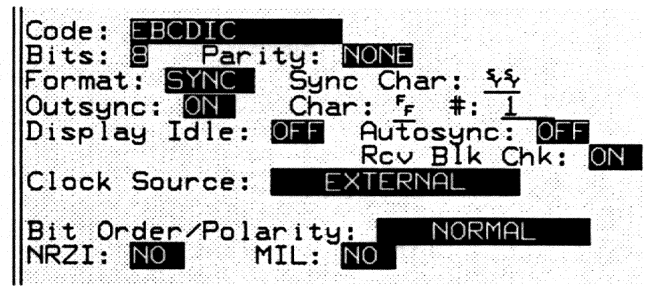
MIL: YES designates MIL-188 operation, which inverts all signals on the data leads (including idle). In MIL operation there is no need to invert bit polarity. Note that MIL operation does not convert the voltage *levels* to MIL-188 specifications.

4.11 Sample Line Setups

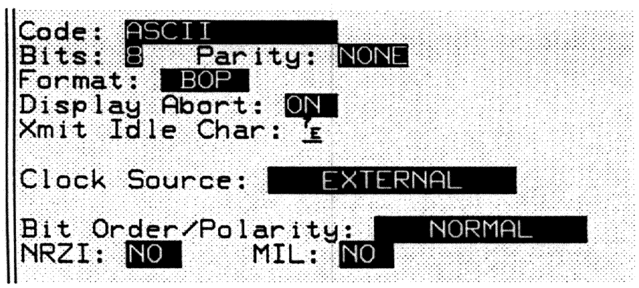
Figure 4-7 shows typcial Line Setup configurations for various protocols.



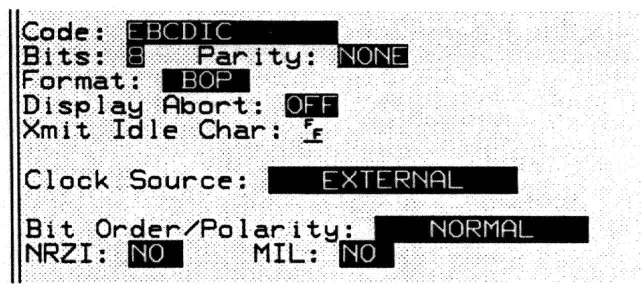
ASYNC



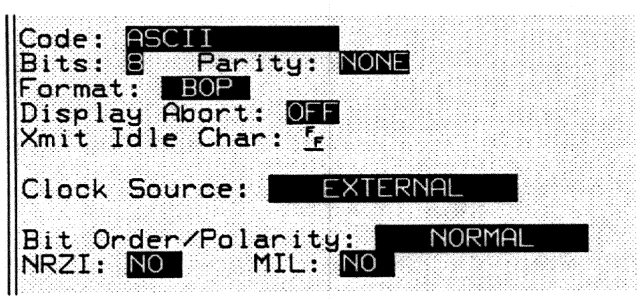
BISYNC



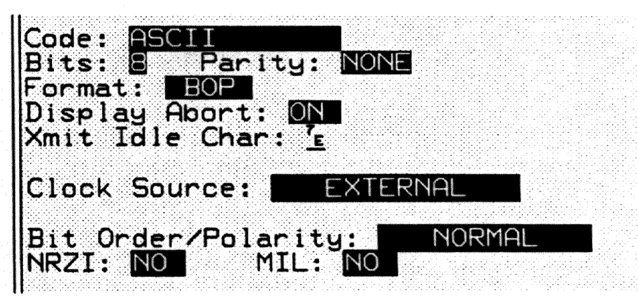
X.25



SNA



ISDN



SS#7

Figure 4-7 Sample Line Setup configurations for the following protocols: *X.25*, *SNA*, *ASYNC*, *BISYNC*, *ISDN*, and *SS#7*.

5 Run–Mode Display

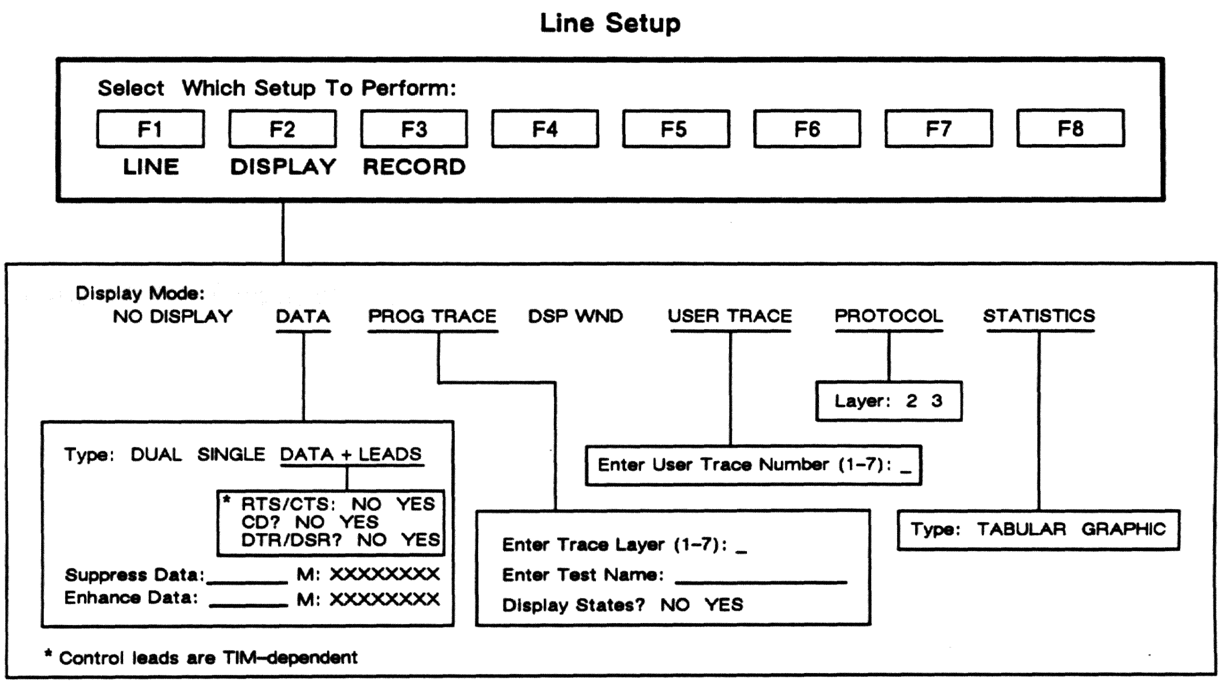


Figure 5-1 The Display Setup menu.

5 Run–Mode Display

Press [RUN] to compile and execute a test program. The compilation phases are discussed in Section 2.5.

If AUTOMON is the **Mode** selected on the Line Setup menu, the compilation will be delayed until the unit has configured its line setup parameters automatically.

5.1 Auto Configure

When the operator presses [RUN] with **Mode:** AUTOMON (the default mode) selected on the Line Setup menu, an Auto Configure program is loaded in that displays the screen in Figure 5-2. A Status field appears at the bottom of the screen, identifying the stage in the auto-configure procedure. The first stage is a clock-sampling phase that is reflected in the Status field as Capturing Sample #1. Once clock source and clock speed have been determined, these parameters are posted to the screen (see Figure 5-2) and the autolearn process moves to its second phase, Capturing Sample #2.

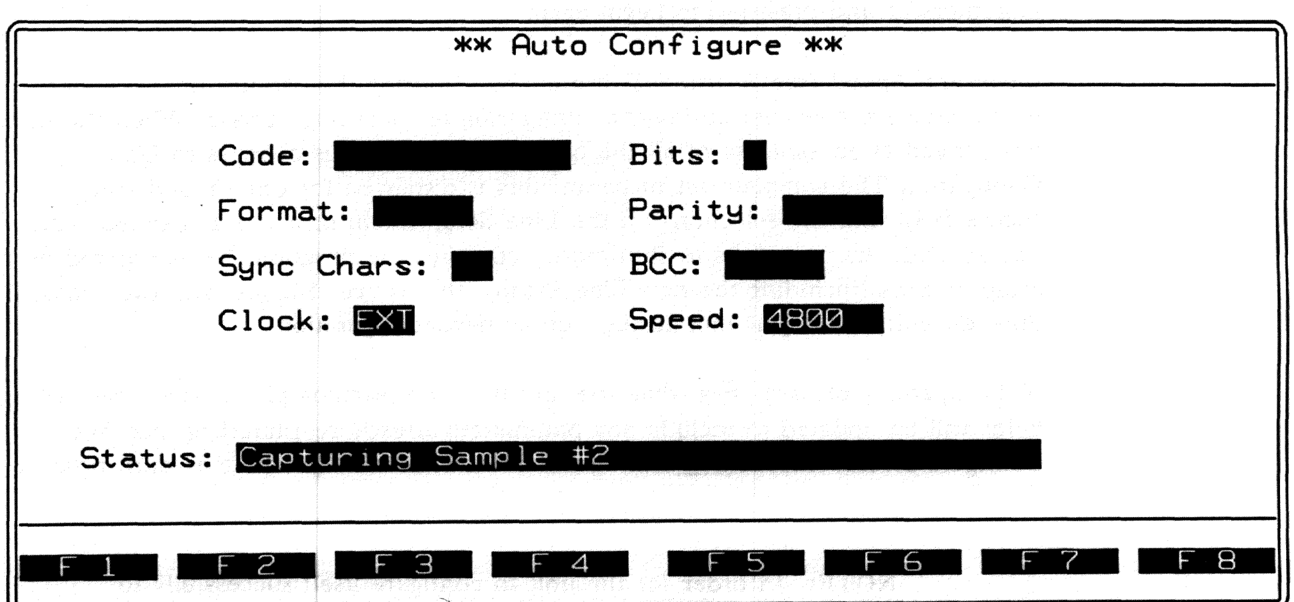


Figure 5-2 ***Clock*** **and** ***Speed*** **are analyzed during the capture phase.**

The unit remains in this stage from 1 to 6 seconds, depending on the data speed—one second for data captured at 19.2 Kbits per second or higher, a longer duration for captures at lower speeds. When the sample period ends, the sample is evaluated for its suitability as the basis for a new configuration.

If the sample is adequate—if it contains a high enough number of "meaningful transitions" and meets other similar criteria—the unit enters its configuring phase and arrives quickly at an estimate of all the line-setup parameters.

The unit does not try to configure itself if the first sample does not meet the criteria for adequacy. Rather it returns to sampling data, this time Capturing Sample #3; and so on until a good data sample is found.

> **NOTE:** If an autoconfiguration is attempted on a line with no data or clock, the data-sampling will go on indefinitely. If the operator presses [PROGRAM] and checks the Line Setup menu, he will find the **Clock Source** field set at INTERNAL and the **Speed** at 168000 bits per second. This is the first (highest) internal clock speed that is tested. Without data, the software will have had no reason to reject this speed and try the next lower one.

The initial data sample is very important. If at any time you wish to restart the autolearn process and try for a "better" initial data sample, press [PROGRAM] to terminate Automonitor and press [RUN] to begin again.

Clock and **Speed** (see Figure 5-2) are analyzed during the capture phase. Other parameters are analyzed during the configuring or "learning" phase. When the unit has arrived at an estimate of all the parameters, the Status changes to Unit Configured. The complete set of parameters is displayed for one second (see Figure 5-3), and the selections on the Line Setup menu screen are updated. After one second, the unit shifts to Run mode, compiles the program that is entered on the setup screens (including the new Line Setup), the Trigger Menus, and the Protocol Spreadsheet, and begins monitoring with its new configuration.

If the operator presses [PROGRAM] while the unit is in the learning phase, the Line Setup fields will be updated to include any parameters already registered on the Auto Configure screen. Pressing [RUN], however, will always initialize the autolearn process.

> **NOTE:** In order for the unit to configure itself successfully to monitor synchronous data, the sync characters should be preceded by two or more idle-time characters.

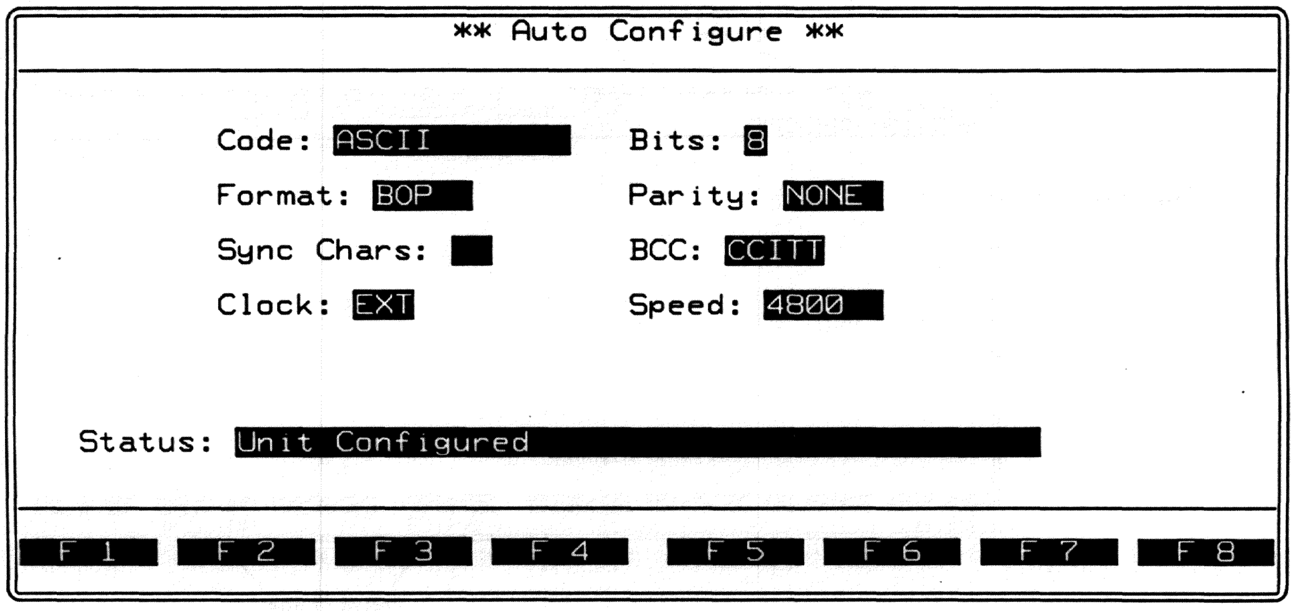


Figure 5-3 The entire set of parameters is displayed when autoconfiguration is completed.

The INTERVIEW's Automonitor mode has been designed to be (1) fast, and (2) 90% accurate. To satisfy the first criterion, the software acts on two assumptions: first, that the protocol is a fairly typical one; and also that the data sample is typical. (For example, an X.25 line without traffic cannot be distinguished from an SDLC line that also merely is idling 7E flags. In the absence of valid data, the Automonitor logic will not configure the unit.) Automonitor is designed as a tool for setting up a piece of test equipment properly, to be used with other tools. These tools include the Line Setup menu and the operator's own knowledge and experience.

5.2 Entering Run Mode

Figure 5-4 shows the screen of the INTERVIEW after Run mode has been entered. In any display mode, the *data* screen has three basic divisions.

The top two lines of the screen are status lines that provide setup information including test mode (monitor, emulate, or BERT), data source (line or disk), disk drive (hard, floppy 1, floppy 2—when source is disk), block number (for data recording or playback), record/playback status ("R"ecording line data, "P"laying back disk data, or "S"uspended record/playback), date and time, code, number of data bits, parity, synchronization format (synchronous, BOP, or async/isoc), and sync pattern if the format is synchronous. (The second line of the status area is also the prompt line.)

The bottom three lines of the screen are given to softkey prompts and a group of softkey functions that control the actual mode of display as long as the unit is in real–time or frozen Run mode. The remaining sixteen lines display test data or user–generated messages in a mode selected by the user.

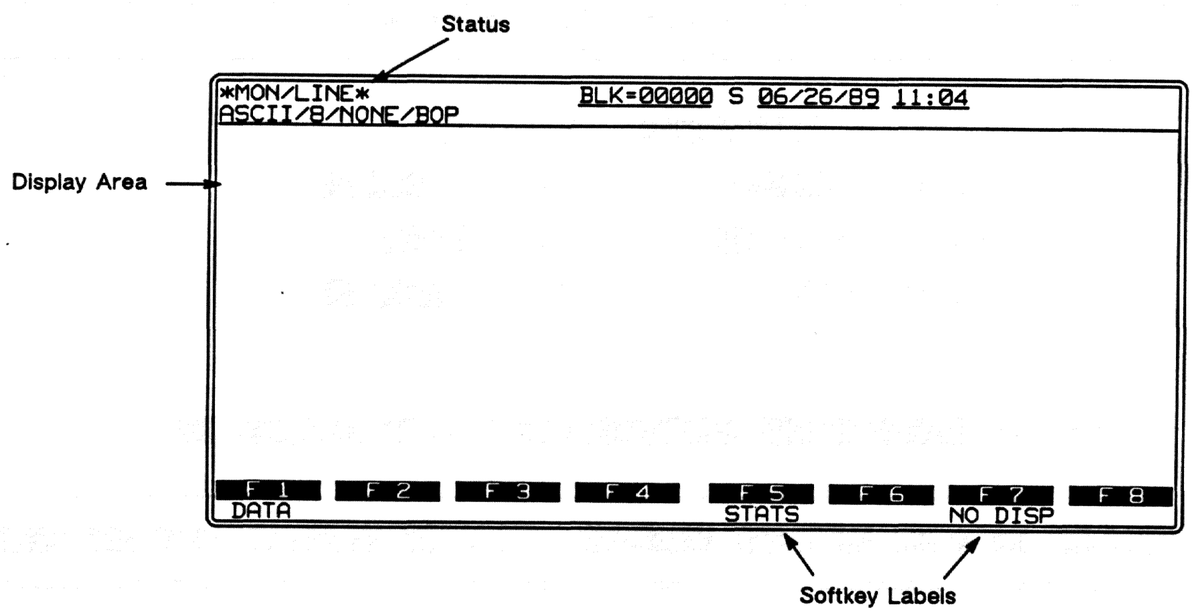


Figure 5-4 The three divisions of the data screen.

During programming, the user selects the display mode on the Display Setup menu (Figure 5-1), the top right sector of the Line Setup screen. In Run mode, the softkeys will change the display selection. Selectable display modes include character data, character data plus control-lead timing, protocol trace, program trace of state-to-state movement and of user-entered messages called "traces," and statistical tabulation or graphic display of counters and timers.

All data and statistics displays are available at *all* times during Run mode. Other special displays, Program Trace for example, are conditionally present. Figure 5-5 shows the two consecutive racks of softkeys that make the various data displays accessible to the user. To return to the first softkey rack, press [DONE].

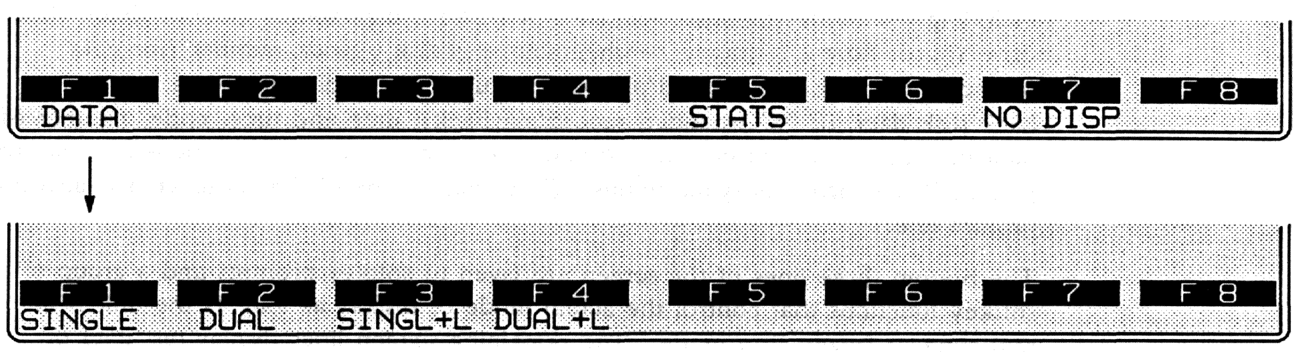


Figure 5-5 Two banks of softkeys give access to data display modes during a run.

There is also a **Display Mode** selection called NO DISPLAY. This suppresses the writing of data to the screen (though not to the screen buffer). See Section 5.11 for an explanation of this display mode.

The final **Display Mode** selection on the Display setup menu will be the first display mode presented to the screen in Run mode. All other available display modes can then be accessed in real time via Run-mode softkey.

Certain Display Setup menu selections cannot be changed in real time via softkey. Under **Display Mode:** DATA, regardless of the **Type** field selection, the **Suppress** and **Enhance** entries remain in effect during Run mode. When you choose **Type:** DATA+LEADS as the display mode, control-lead subfields appear. Only the control leads you select with a YES will be displayed during Run mode. Under **Display Mode:** PROG TRACE, you will see the subfield **Display States**. You may not change your selection for this field during Run mode.

5.3 Selecting Character-Data Display

Character data may be displayed in single or dual lines, with or without control-lead transitions. All four combinations of data leads and control leads are selectable on the lower rack of softkeys in Run mode. See Figure 5-5.

The **Type** of data display is also a selection field on the Display Setup menu. See Figure 5-6. The DATA softkey (Figure 5-5, top) enables the last **Type** option selected, even if that selection was dormant—not visible—on the Display Setup menu when the user pressed [RUN]. Other **Type** options can be accessed from the secondary rack of softkeys (Figure 5-5).

Fields on the Display Setup menu also accommodate lists of characters to be suppressed or enhanced.

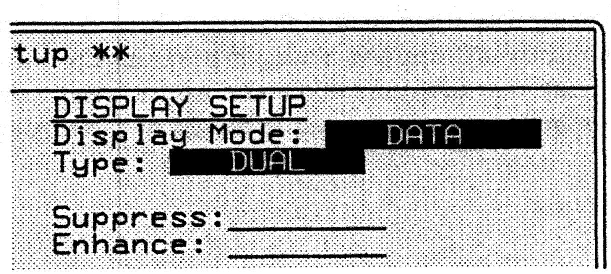


Figure 5-6 *Type* is a subfield under *Display Mode: DATA.*

(A) Single/Dual

In single-line display (Figure 5-7), DCE (RD) data and DTE (TD) data are displayed alternately on the same line. They are easily distinguishable because DCE data is always underlined. Single-line is the display mode that is most economical of screen-buffer space.

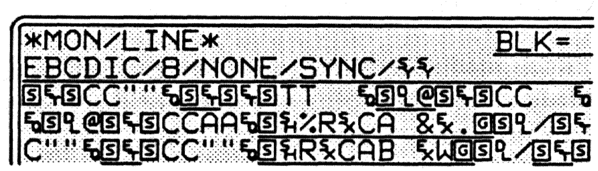


Figure 5-7 **Single line display.**

In dual-line display (Figure 5-8), DTE (TD) data begins on the first data line. DCE (RD) data (always underlined) is shown on alternating lines beginning with the second data line. When one of the data leads is idle, time correlation with the other lead is maintained by this time-fill symbol: . See Figure 5-8.

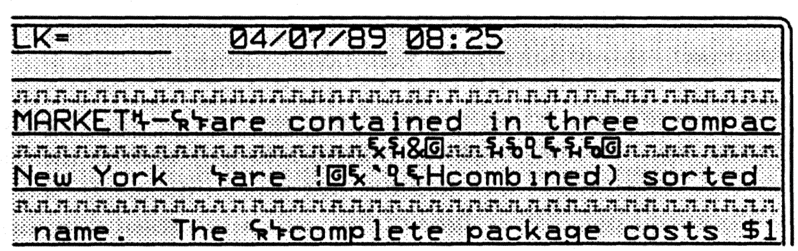


Figure 5-8 **Dual line display.**

Select DUAL whenever the communications are full duplex. Single-line display is not appropriate when data is flowing in both directions simultaneously. The single-line display will preserve timing relationships to within one character time, with the result that the data will be less easy to read. See Figure 5-9, where an RD (underlined) message is interrupted by alternating TD characters.

In both single and dual display, fresh data is written to the screen beginning at the top left and moving to the right before retracing horizontally, and down to the bottom of the screen before retracing vertically. At a given moment during real-time display, there are always two blank lines on the screen. These two lines move just ahead of the freshest data and continuously overwrite the oldest data.

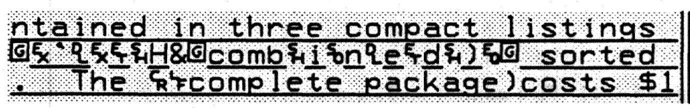


Figure 5-9 Avoid single-line display for full duplex data.

(B) Data Plus Leads

By pushing the softkey labeled SINGL+L or DUAL+L (Figure 5-5), the user can monitor not only two data leads, but also a timing pattern for up to five control leads. A display of single-line data plus all five leads is illustrated in Figure 5-10. The two states of the timing pattern can be defined in visual terms as low/high, in "handshake" terms as off/on, and in electrical terms as minus/plus voltage.

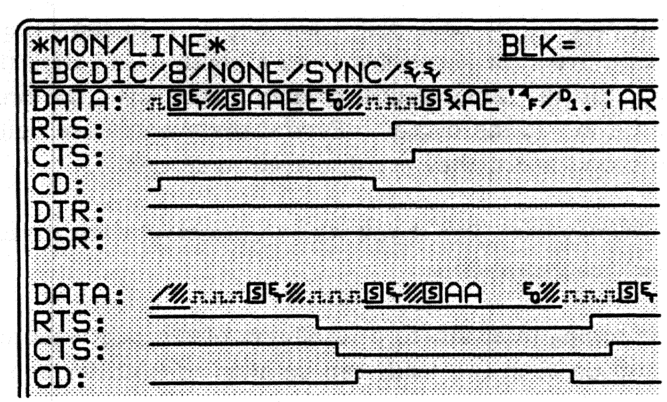


Figure 5-10 Control-lead transitions are displayable.

Control leads are selected for display on the Display Setup menu. EIA leads available for screen monitoring are RTS-CTS (selectable as a pair), DTR-DSR (also selectable only as a pair), and CD (carrier detect). See Figure 5-11 for the selection subfields under **Type:** DATA+LEADS .

If control leads are not set to be buffered on the Front-End Buffer Setup screen, control-lead status will not be available for data-plus-leads display and triggering. See Section 7.1(B) on buffering control leads.

```
DISPLAY SETUP
Display Mode:    DATA
Type: DATA+LEADS
RTS/CTS? N CD? N DTR/DSR? N
Suppress:________
Enhance: ________
```

Figure 5-11 Five control leads are selectable under *Type: DATA+LEADS*.

A full set of leads is written to the bottom of the sixteen-line display area only if it fits completely. A full set is one or two lines of TD/RD data (with RD underlined) and a state-and-timing line for each of the control leads specified previously on the Display Setup menu. If a set is six lines and only four display lines remain on the screen, the entire set is displayed at the top of the next screen.

If the set is comprised of six lines (one data line and one line each for five control leads), two full sets of lines will be written to each successive screen. If a full set equals three lines, five sets will be written per screen.

The purpose of the data-plus-leads display is to show the *sequence* of events. Two data bytes (or a data byte and a control-lead transition) are never displayed in the same vertical column. Otherwise, the order of their occurrence would be lost to the display. Even if the events were detected a millisecond or a microsecond apart, they are displayed in sequence.

Turn **Display Idle:** ON if you wish to preserve a visual record of time intervals between lead transitions.

Precise timing intervals, to a resolution of ten microseconds, between lead and data and between two leads can be attained both for live and recorded data with a simple trigger program that uses timers. Timer increments are discussed in Section 7, FEB Setup, and Section 17, Tabular Statistics.

(C) Suppress

A data-entry field labeled **Suppress** appears on the Display Setup menu along with **Display Mode:** DATA. For single- or dual-line display mode, you may choose up to eight characters to be suppressed from the screen display. The suppressed characters will not appear on the screen or be available in the character buffer for playback. They will, however, be considered by the triggers, included in counting and timing where applicable, and recorded if bit image data is being recorded.

The characters to be suppressed are entered directly from the keyboard and may include:

- Upper- and lower-case alpha characters and numerals;
- Control characters;
- Hexadecimal entries;
- Flag bytes (BOP format only);
- One bit mask;
- All characters not equal to a given character or bit mask.

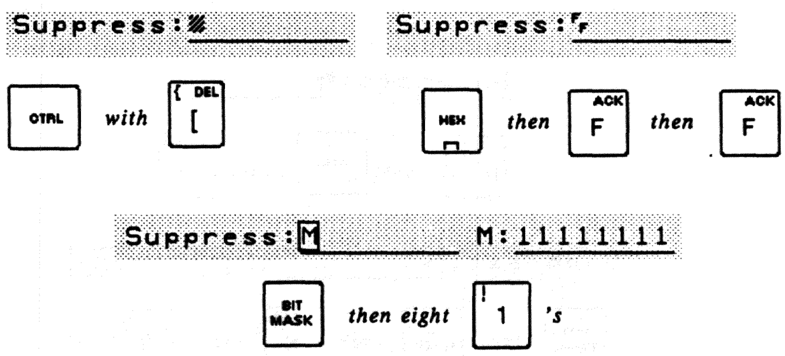


Figure 5-12 ***FF*** **idle can be suppressed as a character, a hexadecimal, or a bit mask.**

Figure 5-12 shows three different ways to suppress idle FF on the data display. The idle character may be entered as an ASCII character, a hexadecimal, or a bit mask. Use HEX to turn on the hexadecimal function for all hex entries. Press BIT MASK to bring up a string of X's that you may overwrite with ones or zeroes.

Figure 5-13 shows the **Suppress** field when 7E flags are suppressed. Note that the FLAG key must be used for this entry. If literal 7E is entered with hex turned on, the logic will not read this as a flag, but instead as data (zero-stuffed) 7E.

You can use the NOT EQUAL key-function in the **Suppress** field to *display only* a specific character (or set of characters represented by a bit mask). Press NOT EQUAL followed by one ASCII character, hex character, or bit mask. The suppressed character will appear in the **Suppress** list with a horizontal bar through it to indicate "not equal."

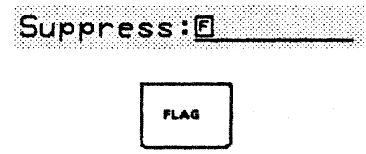


Figure 5-13 The *flag* key must be used to suppress *7E* flags.

Figure 5-14 gives two examples of the Suppress Not Equal ("display only") function. The top entry is used to display only the X-OFF (DC3) character. The Not Equal Bit Mask on the bottom will display four possible bytes only: $^{1}_{1}$ or $^{9}_{1}$ (DC1 in ASCII code) and $^{1}_{3}$ or $^{9}_{3}$ (DC3).

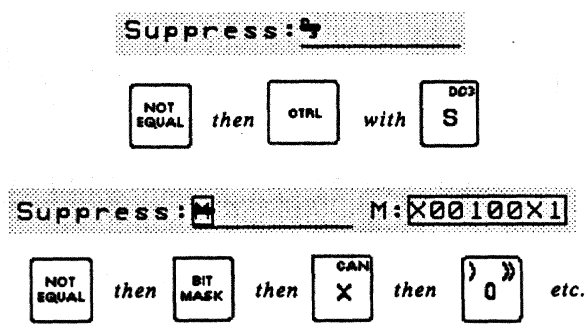


Figure 5-14 Display *only* X-OFF (top); display *only* X-ON/X-OFF (bottom).

When two or more Not Equal entries are combined in the **Suppress** field, only the listed not-equal characters are displayed. Refer to Section 21.3(I).

(D) Enhance

A data-entry field labeled **Enhance** appears on the Display Setup menu when the **Display Mode** is DATA. The enhancement that results on the data display is blinking reverse video, dark lettering inside a light rectangle. Up to eight characters may be enhanced, including ASCII-keyboard characters, control characters, hexadecimals, and one bit mask.

Figure 5-15 shows a bit mask that enhances control characters in EBCDIC code. (Control characters are the only EBCDIC characters with zero-zero as the two high-order bits.) Beneath the bit mask is a data sample in which screen-formatting orders (always control characters) within the 3270-data stream have been enhanced.

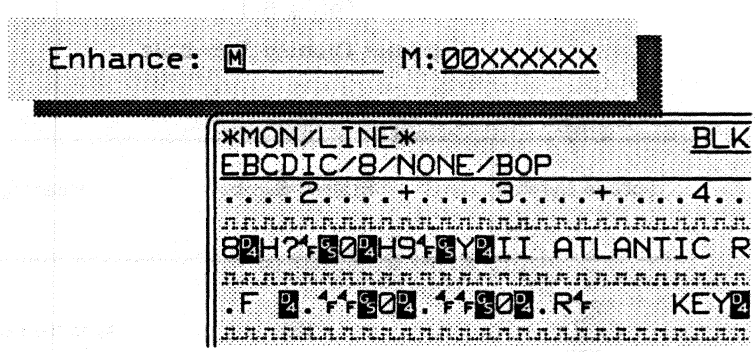


Figure 5-15 **This bit mask enhances EBCDIC control characters only.**

5.4 Special Features of Data Display

When character data is displayed on the INTERVIEW monitor, the bit stream is first divided into bytes according to the format (synchronous, bit-oriented, or start-stop) that the operator has selected on the Line Setup menu. Then the bytes are converted to displayable characters according to the code selected on the same setup menu. See Appendix D2 for the various byte-to-character translations. When a byte does not occur on the particular code-translation table and therefore cannot be decoded as a character, it is presented to the screen as a hexadecimal. All bytes are displayable, in hexadecimal at least.

In synchronous formats, display is suppressed automatically *before* synchronization and *after* outsync. Idle is usually suppressed, as a result of the receivers going out of sync; but idle display can be enabled on the Line Setup menu. In BOP (bit-oriented) formats, mark idle is suppressed automatically and cannot be displayed. FE flags are not normally suppressed but they may be designated for suppression in the **Suppress** field on the Display Setup menu.

(A) Special Characters

Table 5-1 shows the special non-ASCII, non-hex characters that appear on the data display. [G] and [B] are overlays that cover the last-received byte in the block-check (or frame-check) calculation. [A] is an overlay that *covers* the last full character received before a BOP abort, defined as seven consecutive one-bits anywhere inside a frame. The [F] symbol represents a FE flag, the literal (nonzero-stuffed) sequence 01111110 anywhere in the BOP bitstream. [S] stands for "sync." It indicates that the receivers have identified the sync pattern in the synchronous bitstream and locked on it as a new reference for character framing.

Table 5-1
Special Display Symbols

Screen Symbol	Printed Symbol	Meaning
S	[S]	synchronization
F	[F]	BOP flag
G	[G]	good BCC or FCS
B	[B]	bad BCC or FCS
A	[A]	BOP abort
⁙	...	fill

(B) Hexadecimal Translation

In real-time or frozen Run mode, press [HEX] to display every data character on the screen as a hexadecimal. The hex translation is applied to the entire character buffer and not merely to characters written to the screen subsequent to the depression of the [HEX] key.

The hex display is an on/off function: press [HEX] again to restore normal decoding to the data. The LED on the cap of the [HEX] key lights up for hexadecimal data-entry, not display.

Hexadecimal notation divides each byte into two quartets or "nibbles." Figure 5-16 indicates the order in which the nibbles are transmitted/received when normal bit order is indicated on the Line Setup menu.

Note that the actual order of transmission of nibbles is not the order that we see when we read hexadecimal data casually from left to right: 2, 1, 4, 3, 6, 5, etc. Many protocol fields are designed around the *apparent* order of the nibbles rather than the actual order. The twelve-bit logical channel number, for example, in an X.25 packet-header is composed of twelve bits that are not contiguous in the bitstream but appear to form contiguous nibbles in hexadecimal display.

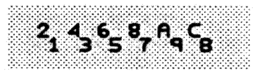


Figure 5-16 **Hexadecimal series with digits indicating normal order of "nibble" transmission.**

(C) Trigger Hex

Hexadecimal translation can be turned on and off by a trigger action on a Trigger Menu or on the Protocol Spreadsheet. Trigger hex is useful when you want to display some data in hex and some in translated characters.

In X.25, for example, frame and packet headers are bit–oriented and are more meaningful when they are displayed in hexadecimal. Once you are past the packet header in a normal (not "qualified") data packet, the data is character–oriented and the hexadecimal enhancement should be turned off. Figure 5-17 shows a display in which trigger hex has been used selectively on BOP data to convert protocol characters to hexadecimal. See Section 33.8 for the short trigger program that is controlling the display in Figure 5-17.

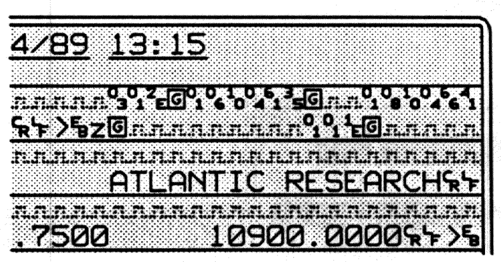


Figure 5-17 **A set of four triggers is turning hex translation *on* for protocol characters and *off* for user data.**

(D) Binary Expansion

By pressing [FREEZE] with character data on the screen, the operator freezes the display and activates the automatic character expander. Now the cursor appears on the monitor, under the control of the cursor–arrow keys. On the second line of the screen at the far right, the character at the cursor position is expanded in binary, with the DTE expansion slightly to the left and the DCE expansion on the right. Figure 5-18 shows a simultaneous DTE and DCE expansion.

The rightmost bit in the binary expansion is the first bit received or transmitted when normal bit order has been selected on the Line Setup menu. The four right–hand bits compose the right–hand (lower) nibble in the hex byte that is expanded.

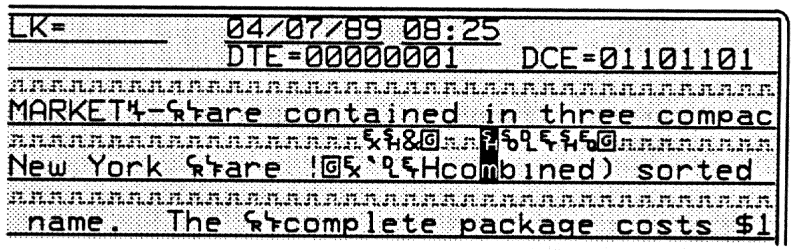


Figure 5-18 In Freeze mode, cursor characters are expanded in binary at the top right corner of screen.

5.5 Protocol Trace

The Display Setup menu and the softkeys associated with Run mode can present data to the user in forms other than raw character form. One of these alternate displays is a protocol trace. A protocol trace is enabled when a protocol "personality package" is loaded into the system from a disk via the Layer Setup screen. See Section 6.1, Personality Packages. Figure 5-19 shows sample data from a protocol analysis for X.25 Layer 3.

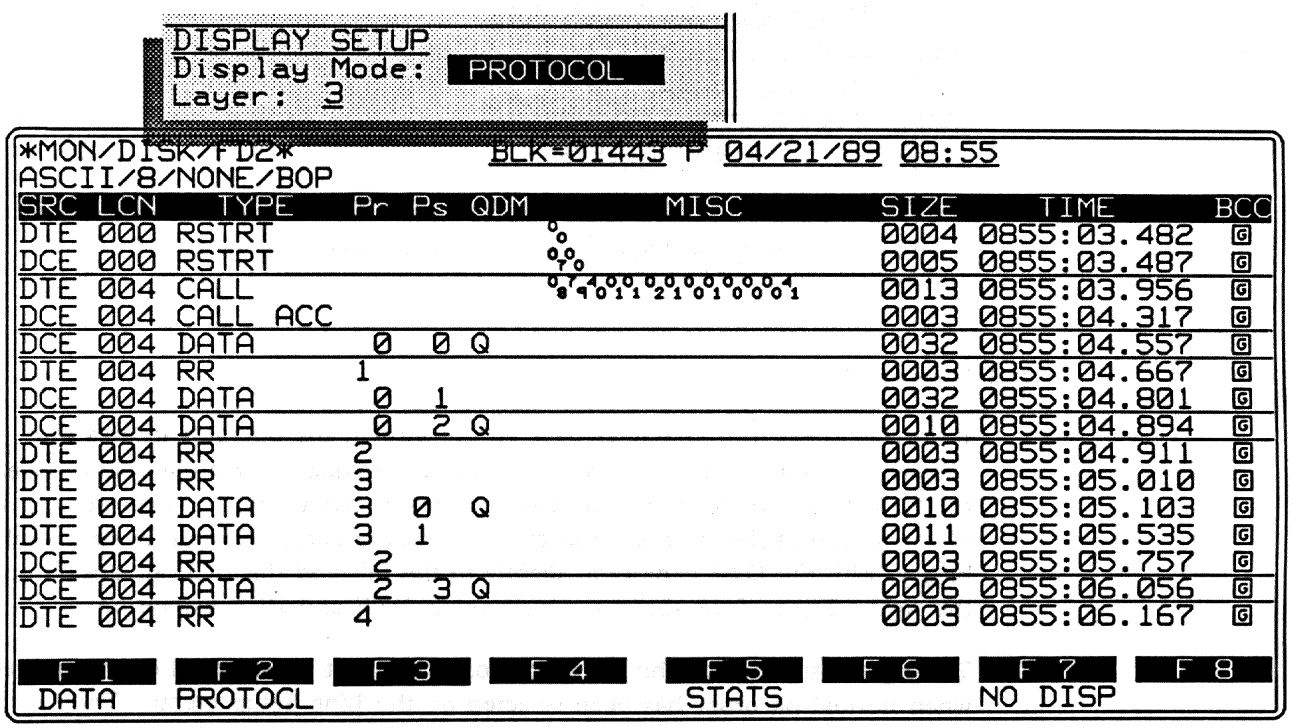


Figure 5-19 Protocol analysis for X.25 Layer 3.

To display the data in Figure 5-19, the operator first loaded in the X.25 Layer 3 package on the Layer Setup screen. Then he selected **Display Mode:** PROTOCOL and **Layer:** 3 on the Display Setup menu. When the INTERVIEW entered Run mode, the Layer 3 analysis was the active display mode.

If another display mode had been selected on the Display Setup menu, the Layer 3 analysis still would have been accessible after RUN was pressed. The PROTOCOL and **Layer** selections merely designate the display mode entering a run. They do not limit the display options during the run.

To access the Layer 3 protocol trace during Run mode, press **PROTOCL** on the first rack of softkeys. See Figure 5-20.

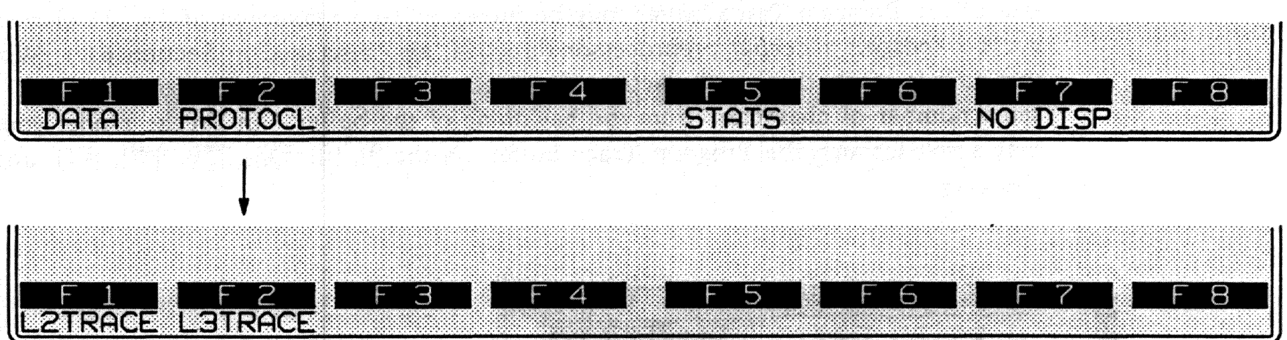


Figure 5-20 To access Layer 2 and Layer 3 protocol traces, press *PROTOCL*.

The location of the **L2TRACE** softkey depends on the layer packages loaded. When a Layer 2 package is loaded without a Layer 3 package, **L2TRACE** will appear on the first rack of softkeys. See Figure 5-21.

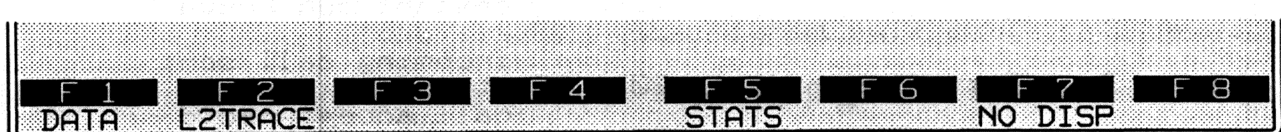


Figure 5-21 When a Layer 2 package is loaded without a Layer 3 package, *L2TRACE* will appear on the first rack of softkeys.

If both Layer 2 and Layer 3 packages are loaded, **L2TRACE** and **L3TRACE** appear on the second rack of Run-mode softkeys, as shown in Figure 5-20.

5.6 Program Trace

Program Trace is another mode of data presentation. See Figure 5-22. The Run-mode softkey **PROG TR** is present if you enter a **TRACE** spreadsheet action, if you write to the trace buffer *prog_trbuf* in C (see Section 61 for an explanation of trace routines in C), or if you select **Display States: YES** on the Display Setup menu.

As a program moves from state to state within the various tests and layers, the INTERVIEW maintains a log of user-assigned state and test names and user-entered messages called "traces." When the Program Trace is accessed (entering Run mode or via softkey) the sixteen data lines are dedicated to this log of states and traces. Unless its size is increased, the Program Trace buffer maintains a maximum of 4096 characters, equivalent to four full screens when every character space is used. (The size of the Program Trace buffer may be increased to a maximum of 16,381 elements via the *#pragma tracebuf* preprocessor directive, also discussed in Section 61.) When this limit is reached, new characters written to the end of the buffer force out the same number of characters from the beginning of the buffer. In Freeze mode, you may scroll through the Program Trace buffer via the [↑], [↓], [ROLL FWD], [ROLL BACK], [PREV PAGE], [NEXT PAGE], and [HOME] keys.

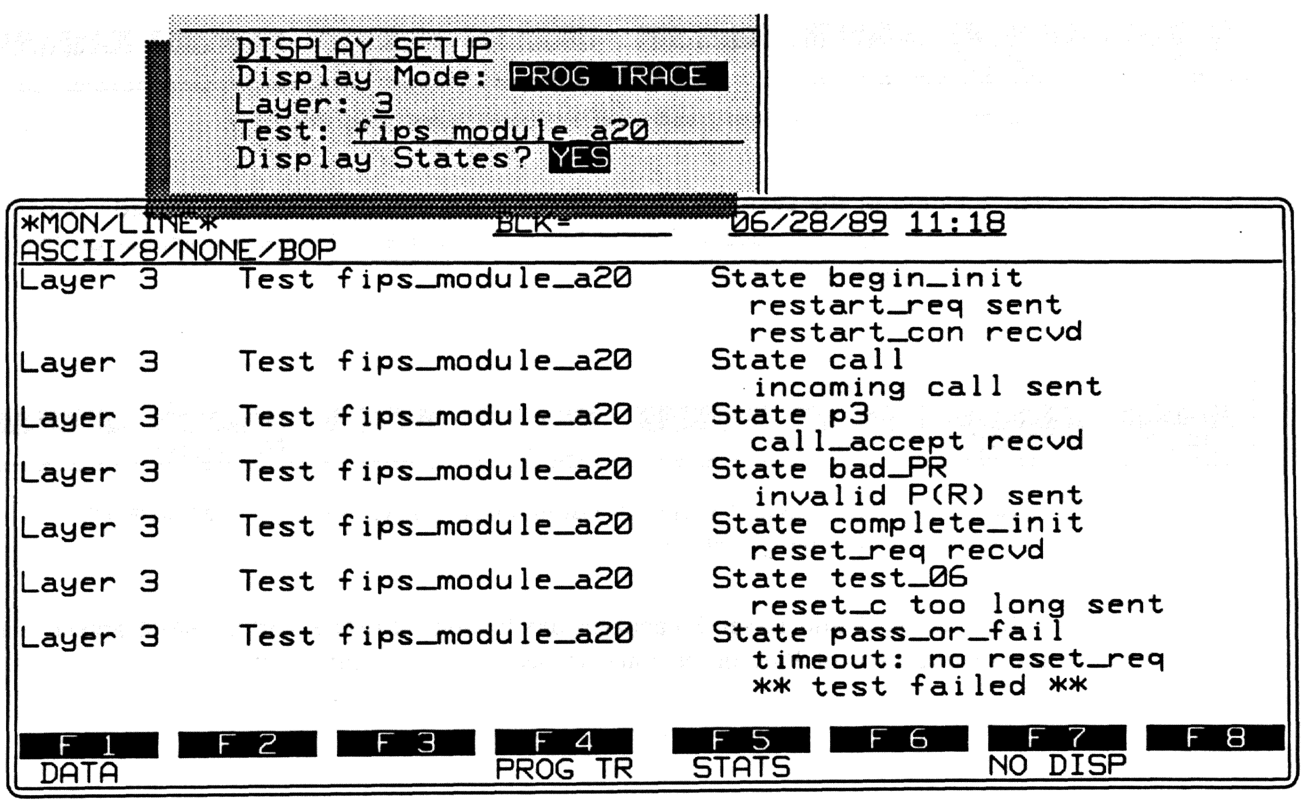


Figure 5-22 The user may select a specific layer and test for a Program Trace.

(A) Layer, Test, and State

States are the third level from the top in the programming hierarchy on the Protocol Spreadsheet screen. Inside of states are *triggers*, comprised of *conditions* and *actions*. Above states are *tests*. At the top of the hierarchy are *layers*, corresponding to OSI protocol layers. See Section 20, The Layered Program Model.

Numerous layers and numerous tests per layer can be active concurrently in the INTERVIEW. The Program Trace can be set up to track state-to-state movement only in a particular **Layer** and **Test** identified by the operator on the Display Setup menu. Figure 5-22 gives the Display Setup necessary for the Program Trace shown. In the default setup, the **Layer** and **Test** fields are blank. In this configuration, the Program Trace will track all tests and layers.

Traces are trigger actions in Protocol Spreadsheet programs (see Section 27, Layer-Independent Conditions and Actions). They are simply user-entered ASCII data strings, identical to prompts except in their mode of display: traces are posted one to a line in the sixteen-line Program Trace display, while prompts appear on the second status line in all data-display modes (including the Program Trace). At a given moment during real-time display, there is always one blank line on the screen. This line moves just ahead of the freshest trace message and (once the trace buffer is full) continuously overwrites the oldest one.

State names can be included in the Program Trace via the **Display States: YES** selection on the the Display Setup menu (Figure 5-22). You will find the state log highly useful for locating dead ends, states that the test can enter but cannot exit due to a programming glitch. Traces are debugging tools, also. Inside a dead-end state they can inform you whether a particular condition that you are expecting is coming true.

Traces also allow you to keep a record of selected protocol events—to design your own protocol analysis. Figure 5-23 shows a user-designed trace for X.29 and X.3 protocols. Unlike prompts, traces are not immediately overwritten by other traces, so they are highly useful when you are trying to track protocol events that occur in quick succession. In Freeze mode, you may use the cursor keys to scroll through the Program Trace buffer.

```
*MON/LINE*                    BLK=          06/28/89 11:18
ASCII/8/NONE/BOP
DCE
SET
  PAD Recall
    LF
  Data Forwarding
    CR
  Idle Timer Delay
    No data forwarding on timeout
  Ancillary Device
    Data transfer (X-ON)
  Service Signals
    Other than prompt (std form)
  Action On Break
    Int
    Ind Brk
    Discard output
 F 1     F 2     F 3     F 4      F 5      F 6     F 7      F 8
DATA                    PROG TR  STATS            NO DISP
```

Figure 5-23 Program Trace for X.29 PAD parameters.

(B) Line and Percentage

When you press FREEZE, the second status line at top of the screen changes. Two new fields, LINE and PERC, replace the code, parity and format indications. These fields provide information about the location of the cursor within the data written to the trace buffer. As you scroll through the buffer via the cursor keys, the values in both fields change. LINE indicates the line number of the current cursor position in the data. PERC reflects the percentage of the data in the trace buffer past which the cursor is located.

5.7 Statistics Display

There are two statistics displays in the INTERVIEW, tabular and graphic. Both of these displays can be accessed by softkey at any time during Run mode. Figure 5-24 shows the softkeys for TABULAR and GRAPHIC statistics displays.

```
  F 1      F 2      F 3      F 4
TABULAR  GRAPHIC
```

Figure 5-24 The two types of statistics display are accessible in Run mode on the second rack of softkeys.

When statistics are displayed in tabular form, horizontal rows in the table are labeled with user–assigned names. Each name represents a counter, a timer, or a set of counters or timers combined for statistical purposes in an "accumulator." The first column next to the name contains the current *value* of a counter or timer. (Accumulators neither count nor time and therefore have no current value.) The values in the next four tabular columns (Last, Minimum, Maximum, Average) are derived from *previous* current values and are updated each time the counter or timer is sampled (read and reset). The tabular display is illustrated in Figure 5-25.

```
*MON/LINE*                 BLK=          06/28/89 11:18
ASCII/8/NONE/BOP
```

Name	Current	Last	Minimum	Maximum	Average	Unit
hostfrm	106	16	2	256	84.03	
goodfrm		16	2	256	85.22	
badfrm		11	11	11	11.00	
abort						

Figure 5-25 The tabular display.

In the graphic display, the values that are shown as numbers on the tabular display—up to 48 of them, sixteen on the screen at any given time, selected by the user out of 400 possible values on the scrolling tabular screen—are represented as horizontal bars. See Figure 5-26. The two statistics screens are discussed in detail in Section 17, Tabular Statistics, and Section 18, Graphic Statistics.

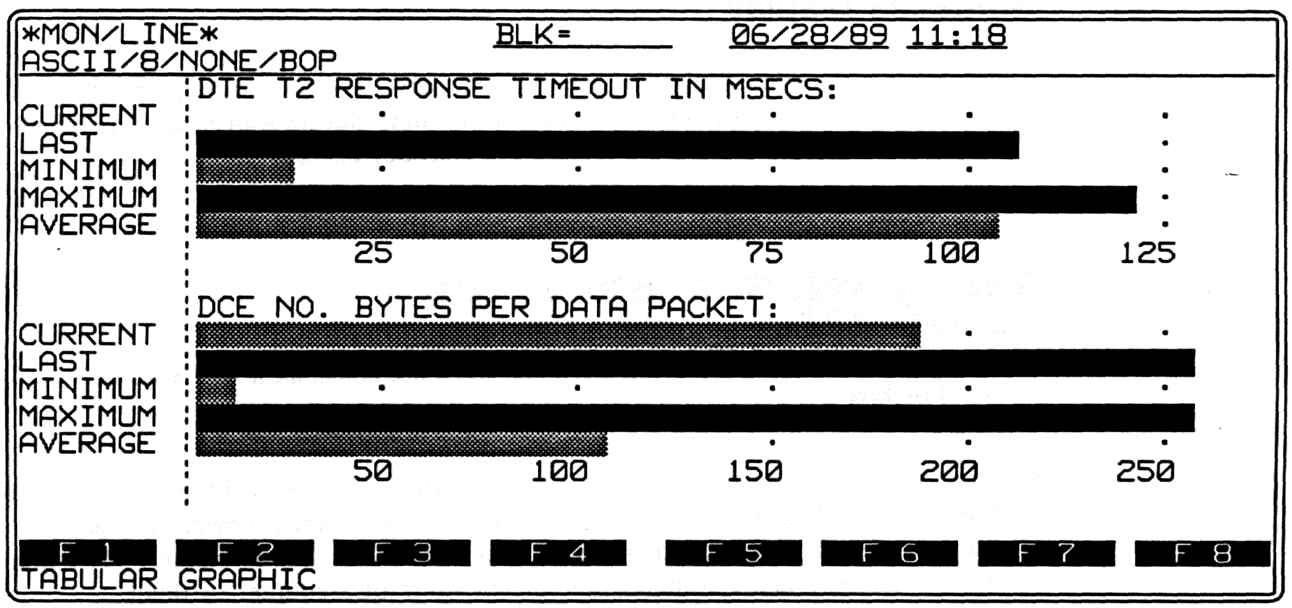


Figure 5-26 The graphics display.

5.8 Display Window

Figure 5-27 shows the Display Setup menu when **Display Mode:** DSP WND is selected. Display Window displays and preserves one screen, including the prompt line, of user-entered messages. When the end of the display screen is reached, the previous messages are overwritten, beginning at row one (the line below the prompt line). Messages are presented to the Display Window primarily via C display routines. See Section 61 for an explanation of these routines.

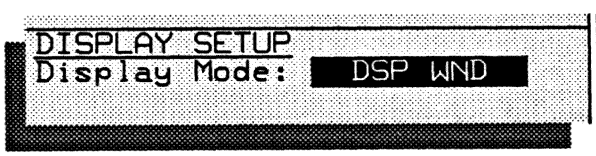


Figure 5-27 Display Window is a selection under *Display Mode*.

The Display Window lends itself to table or menu creation. The cursor may be positioned anywhere in the sixteen-line display area of the screen, or on the prompt line. Entries to a table, for example, may be updated by repositioning the cursor to a certain location. Also, the Run-mode use of ⇩ and ⇧ in the Display Window can be programmed via the keyboard variables and the *send_key* routine explained in Section 69, Other Library Tools. (For other Run-mode screens, these keys control the playback speed of disk data.) For example, use ⇩ and ⇧ to move from field to field on a menu created in the Display Window. Figure 5-28 shows a Display Window created by the SNA Statistics application program (OPT-951-19-1).

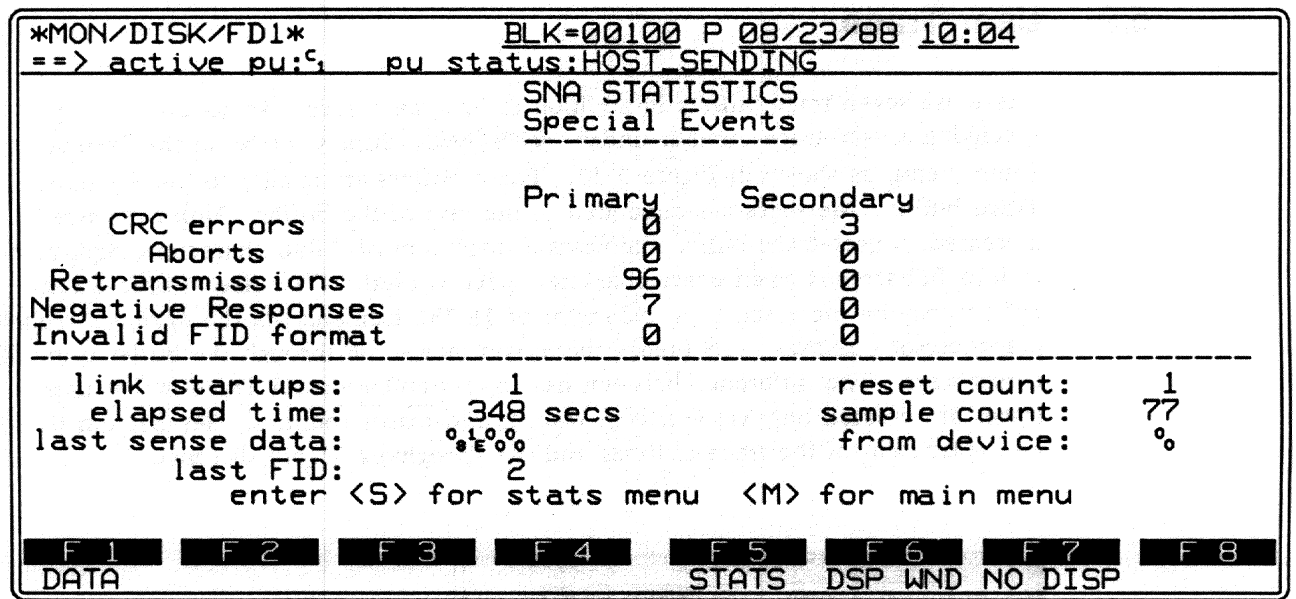


Figure 5-28 Display Window is useful for tables, as in this SNA Statistics example.

The DSP WND token, when present, is located on the first rack of Run-mode softkeys, as shown in Figure 5-29.

> **NOTE:** In the absence of display routines (or softkey prompts) in a spreadsheet program, the Run-mode DSP WND token will not appear on any softkey rack. In this instance, if you select DSP WND as the display mode on the Display Setup menu, the Display Window will be the initial screen during Run mode, but it will be blank. If you move to a different display screen, you will not be able to return to the Display Window.

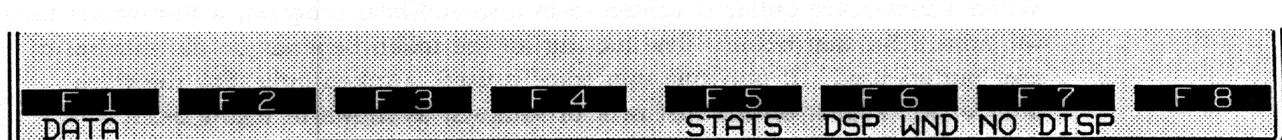


Figure 5-29 Including display routines or *PROMPT* actions in a program causes the *DSP WND* token to appear in Run mode.

5.9 User Trace

There are seven trace buffers in addition to Program Trace. Select any one by specifying a user-trace number under USER TRACE display mode on the Display Setup menu, as shown in Figure 5-30. These buffers are similar to the Program Trace buffer. Messages are appended to the end of the buffer. Unless its size is increased, a user-trace buffer maintains a maximum of 4,096 characters, equivalent to four full screens when every character space is used. (The size of user-trace buffers may be increased to a maximum of 16,381 elements via the *#pragma tracebuf* preprocessor directive.) In Freeze mode you may scroll through the buffer using the cursor keys. The difference between user traces and Program Trace is that user traces are created only via C *tracef, tracec,* and *traces* routines. See Section 61 for an explanation of the trace routines and the *#pragma tracebuf* directive.

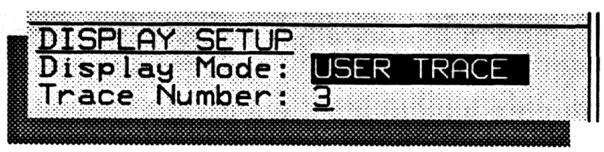


Figure 5-30 **The initial display in Run mode will be user trace number three.**

> **NOTE:** In the absence of spreadsheet-program uses of user traces, a Run-mode trace token will not appear on any softkey rack. In this instance, if you select USER TRACE as the display mode on the Display Setup menu, the specified user trace will be the initial screen during Run mode, but it will be blank. If you move to a different display screen, you will not be able to return to any user trace.

When a user-trace buffer is written to in a spreadsheet program, a Run-mode token will appear for that buffer. The location of the token depends on the number of user buffers used. If only one user trace is used, a token indicating the trace number will appear on the first rack of softkeys, as shown in Figure 5-31.

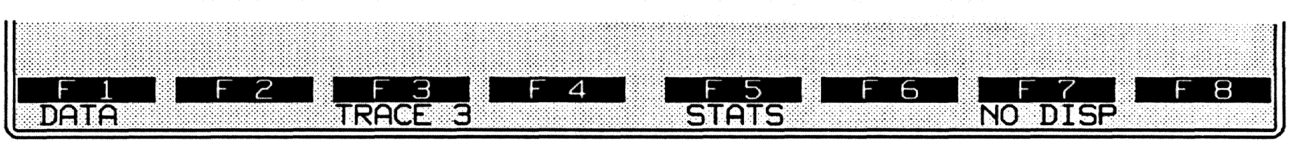


Figure 5-31 **When only one user trace is used, its token appears on the first rack of softkeys.**

If more than one user trace is written to, a USER TR token on the first rack provides access to the next rack containing tokens for all used buffers. See Figure 5-32.

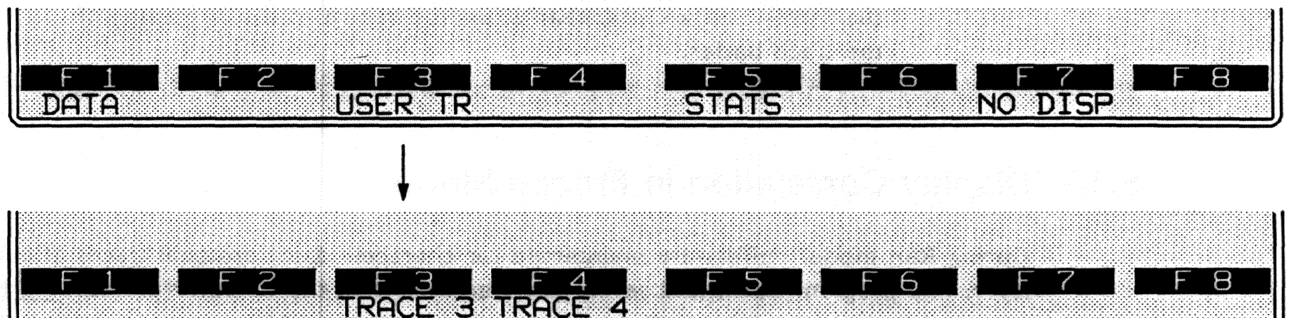


Figure 5-32 To access trace buffers when more than one has been written to, press *USER TR*.

Figure 5-33 shows a trace created via C *tracef* routines. Note the fields in reverse video, one of the attributes available to the user with *tracef* and *displayf*. Attributes are not available with softkey TRACE and PROMPT actions. Another advantage of the user (*tracef*) trace is that it can use the screen more economically. Where the softkey TRACE action assigns each message to a new line, *tracef* does not automatically generate a new line. A series of *tracef* messages may be written across the width of the screen. More information can be stored on a single screen.

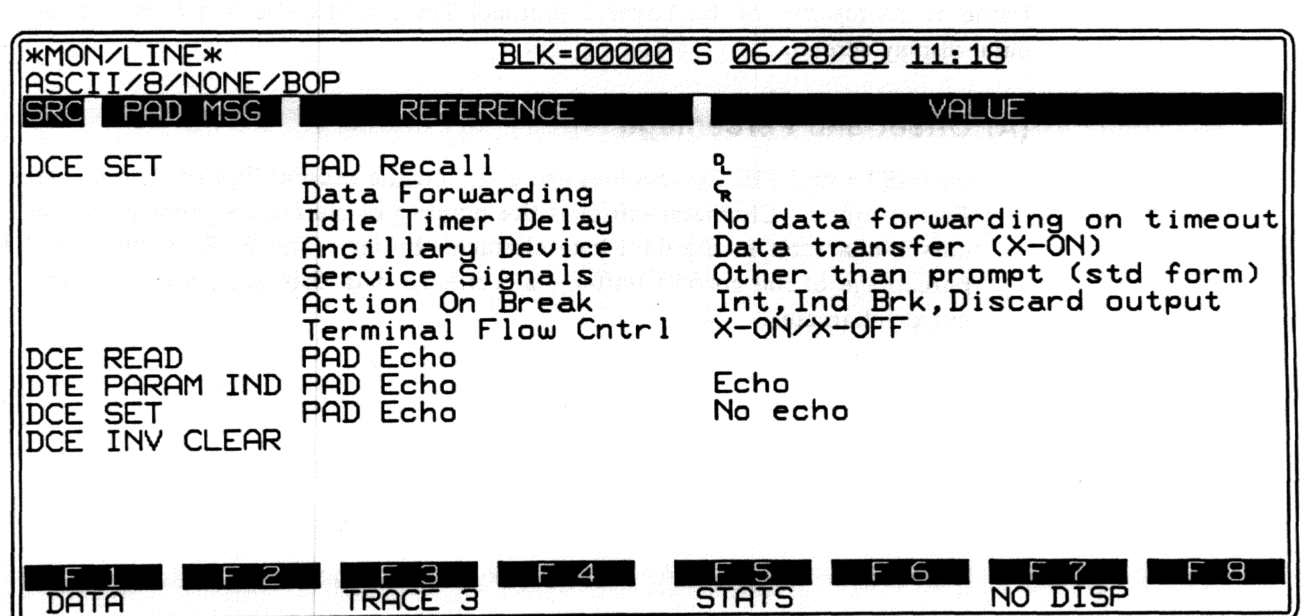


Figure 5-33 X.29/X.3 trace generated via C *tracef* routines.

NOTE: The heading displayed in reverse image in Figure 5-33 is written to the first line of the trace buffer. It is not a constant screen heading like those in the Protocol Traces. When you scroll forward through the buffer, the heading will disappear from the screen. It will reappear when you return to the beginning of the trace buffer.

5.10 Display Correlation in Freeze Mode

During Run mode, buffers are maintained for character data, protocol traces at each layer, one program trace, and seven user traces. When the operator presses [FREEZE] to stop the display, all of the buffers used are accessible by softkey and may be scrolled through. Certain buffers are correlated. The Layer 3 Protocol Trace buffer correlates to the Layer 2 Protocol Trace buffer. Either Protocol Trace buffer correlates to the 64-Kbyte character-data buffer. "Correlate" means that the packet displayed at the top of the Layer 3 Protocol Trace is contained in the frame displayed at the top of the Layer 2 Protocol Trace. This frame will begin—i.e., will be positioned in the upper left corner of—the corresponding data-display.

Figure 5-34 shows three Freeze-mode displays that relate to the same sample of raw data. The top display is a Layer 3 X.25 trace, the middle is a Layer 2 X.25 trace, and the bottom display is dual-line data. The operator uses the cursor-arrow, roll, and page keys to move freely around the buffers in Freeze mode. For example, when he presses a softkey to change the display from L2TRACE to DATA, the INFO frame at the *top line* of the Layer 2 Protocol Trace is also the first frame on the data-display screen.

(A) Offset and Percentage

OFFSET= and PERC= readings are given on the second line of data displays in Freeze mode. Character-offset is the number of characters *previous to* the cursor-character in the 64-Kbyte character buffer. The PERC value tells the percentage of the current buffer that contains data that was previous to the cursor character.

At two bytes of code and attributes per character, the character buffer holds an optimum number of 32,768 (or 32 K) characters. This translates to 32 screens of data in single-line display. Note, however, that if the Front-End Buffer Setup menu is configured to buffer time ticks or EIA leads (Section 7), the maximum number of characters in the character buffer will be reduced.

MON/LINE BLK=00000 S 06/24/89 14:20
ASCII/8/NONE/BOP

SRC	LCN	TYPE	Pr	Ps	QDM	MISC	SIZE	TIME	BCC
DCE	01F	DATA	4	6			0128	1420:08.382	G
DTE	01E	DATA	0	0			0003	1420:08.701	G
DCE	001	DATA	0	0			0003	1420:08.810	G

MON/LINE BLK=00000 S 06/24/89 14:20
ASCII/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	03	INFO	7	3	0	0131	1420:08.382	G
DTE	03	RR	4		0	0000	1420:08.475	G
DTE	01	INFO	4	7	0	0006	1420:08.701	G
DCE	01	RR	0		0	0000	1420:08.799	G
DCE	03	INFO	0	4	0	0006	1420:08.810	G
DTE	03	RR	5		0	0000	1420:08.903	B

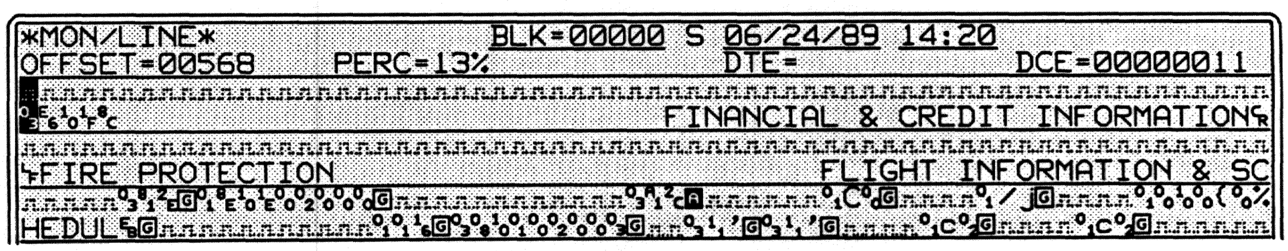


Figure 5-34 The first packet on the Layer 3 screen (top) correlates with the first frame on the Layer 2 screen (middle) and also with the first character-data frame (bottom).

When the character buffer is full, it wraps to the beginning and new characters overwrite the oldest characters. The character buffer is likely to wrap much sooner than any of the trace buffers. There may be instances when a protocol element (a frame, for example) is shown on the trace display but the data version of the same element has been overwritten in the character buffer.

5.11 No Display

If **Display Mode:** NO DISPLAY is the selection on the Display Setup menu, a blank screen will be displayed when the unit enters Run mode. The screen will remain blank until one of the display-mode softkeys (DATA, STATS, and so on) is depressed. Unlike Freeze mode, this mode does not prevent the writing of data to the screen buffer (also referred to in this manual as the "character buffer"). If you enter Run mode in No-display mode and then press a data softkey, all data will be present in the buffer (unless it is old data that has been overwritten).

The NO DISPLAY selection can be used to maximize efficient capture of data at very high speeds.

6 Layer Setup

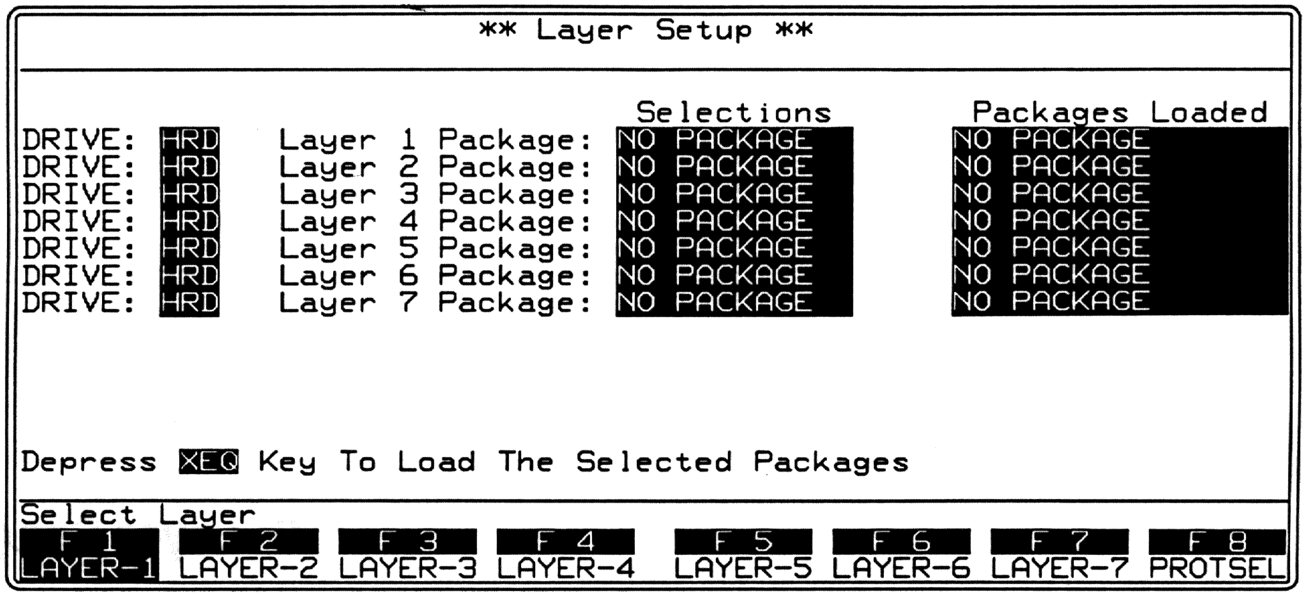


Figure 6-1 Default Layer Setup screen.

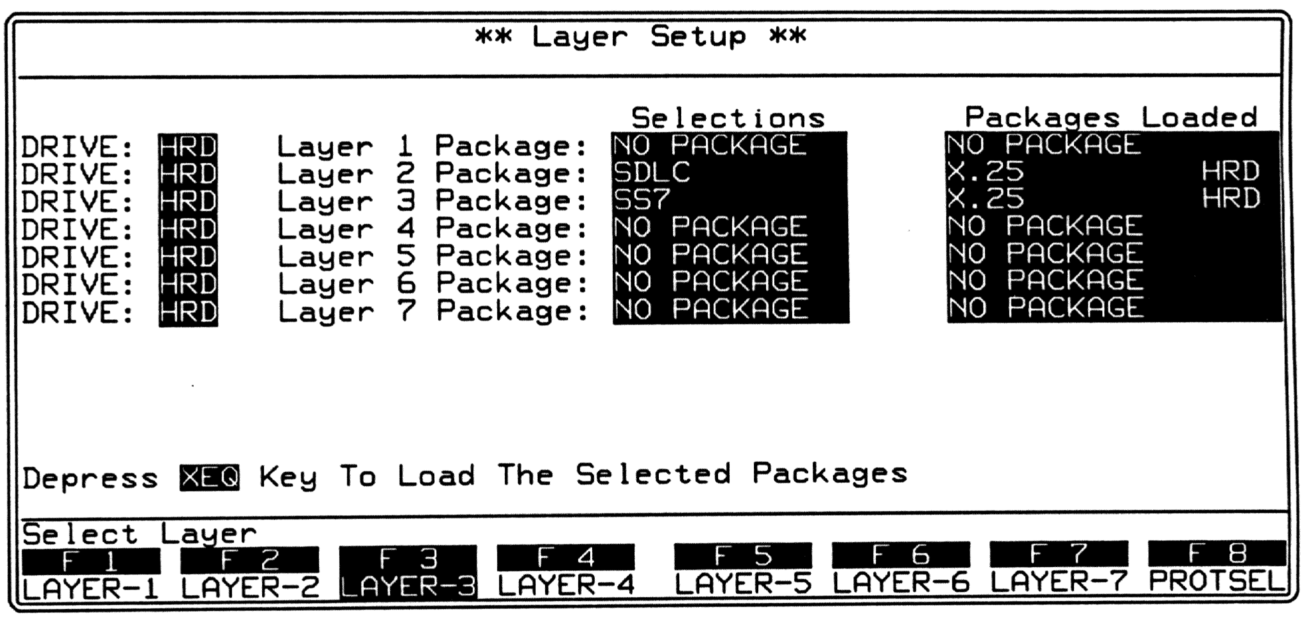


Figure 6-2 A Configured Layer Setup screen.

6 Layer Setup

The Layer Setup screen is directly accessible from the Main Program menu. A default Layer Setup screen is shown in Figure 6-1 and a configured Layer Setup screen in Figure 6-2.

Most protocols available to the user also have certain definable parameters. These parameters are grouped on the Protocol Configuration screen described later in this section.

6.1 Personality Packages

The INTERVIEW provides layer-specific protocol packages called Personality Packages. These packages contain automatic selections for trigger conditions and actions. Automatic selections appear on the Protocol Spreadsheet once the Personality Package is loaded.

The Layer Setup screen gives the user access to the Personality Packages residing on disk in his system. Personality Packages are identified on the Layer Setup screen by protocol name and are categorized by layer and by the disk on which they reside. Since protocols are selectable by layer, it is possible to "mix and match" them.

A rotating field on the Layer Setup screen is assigned to each OSI layer. In the field, the user may choose from available protocols. The protocol chosen (displayed) in each field and then loaded will be the one used for monitoring and emulating that layer in Run mode.

6.2 Selecting and Loading Protocols

Two disks are supplied with the INTERVIEW or with software upgrades. The system disk (DSK-951-001-1.X) may be used for boot-up. The personality packages reside in the */usr/layer* directory of the user disk (DSK-951-001-2.X). The same directory on the hard disk also contains the personality packages.

If your boot drive is one other than the hard drive (either floppy drive 1 or 2), place the user disk in the boot drive. Press [CTRL]-[CLEAR] to read the disk. Available personality packages will appear as softkey selections at appropriate layers.

For convenience, the OSI layers appear on the screen from lowest to highest. Access a layer in one of two ways: by moving the cursor up and down the **Drive** column with the [↑] and [↓] keys; or by pressing the function key for the appropriate layer when the prompt above the function keys reads "Select Layer." The **Drive** field for that layer blinks.

When you have selected a layer, press the appropriate function key or press [ROLL BACK] or [ROLL FWD] to display the options for the source drive. A rotating field at the left identifies the active drive for each Layer. Once you have selected a drive (Hard Disk is selected for each layer in Figure 6-2), it is the only drive from which the Personality Packages for that layer can be loaded.

Only the names of the Personality Packages for the selected drive appear in the **Selections** column. Select the correct drive, then press [DONE] or [→] to move to **Selections**. Pressing the function key for a protocol or pressing the [DONE] key moves you to the rotating field for the next layer.

In the **Selections** column, display all the protocols you wish to use in Run mode. (If you don't want any protocol loaded at a certain layer, leave "NO PACKAGE" in its **Selections** field.) Then press the [XEQ] key. This loads all selected protocol packages from disk. Once the process is complete, the names of loaded protocols appear in the column labeled **Packages Loaded** on the right of the screen.

> **NOTE:** Protocols used should be compatible with the data format you have selected on the Line Setup screen (see Section 4). For example, if you are using SDLC, X.25, or SS#7 at Layer 2, you must have selected Bit-Oriented Protocol (BOP) as the Format.

6.3 The Protocol Configuration Screen

Typically, a protocol available on the setup screen has its own submenu, the Protocol Configuration screen, accessible from the Layer Setup screen. The contents of each protocol's configuration screen are explained in a section devoted to that protocol and layer.

(A) Accessing the Screen

Once the protocols you will be testing are loaded, you may call up the Protocol Configuration screen, in turn, for each protocol. Press PROTSEL. (You may always access the PROTSEL softkey by first pressing [HOME].) Then select a layer by pressing the appropriate function key. This takes you immediately to the configuration screen for that protocol. If, for example, you are using X.25 at Layer 2, you will see the screen shown in Figure 6-3.

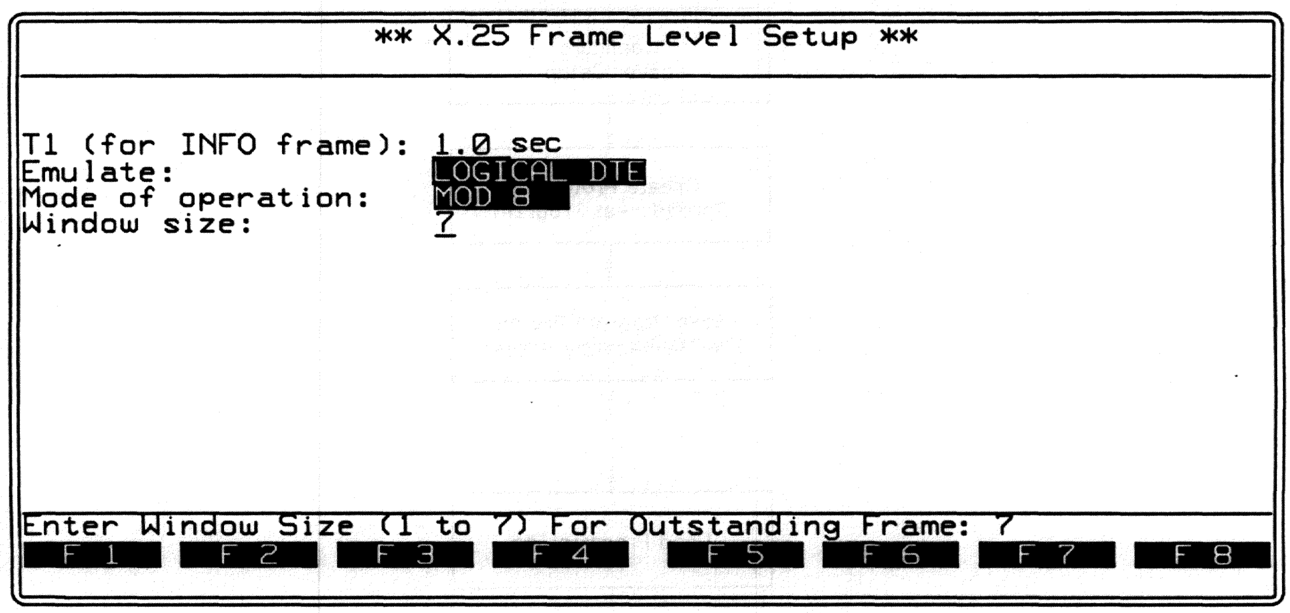


Figure 6-3 Most protocols have definable parameters, selected on a separate screen accessed from the Layer Setup screen.

Make appropriate parameter selections. Return to the Layer Setup screen, if necessary, by pressing the [PREV PAGE] key. If you have additional parameters to set, press [F8] (PROTSEL) and select another layer to call up the new parameters screen.

(B) Default Parameters

Default parameters, loaded with each personality package, are displayed on the Protocol Configuration screen until you modify them. You can always recall these defaults to the screen by displaying the appropriate parameters menu and pressing [CTRL]–[CLEAR].

6.4 Saving the Layer Setup Screen

You can save a configured Layer Setup screen and load it later so that you don't have to make selections on the screen each time you use the equipment. This is done by configuring the Layer Setup screen and then saving it along with all other screens as part of a program file (see Figure 6-4). (A program file is saved and loaded from the File Maintenance screen as explained in Section 13.) When loaded into the unit, a program file overwrites all screens.

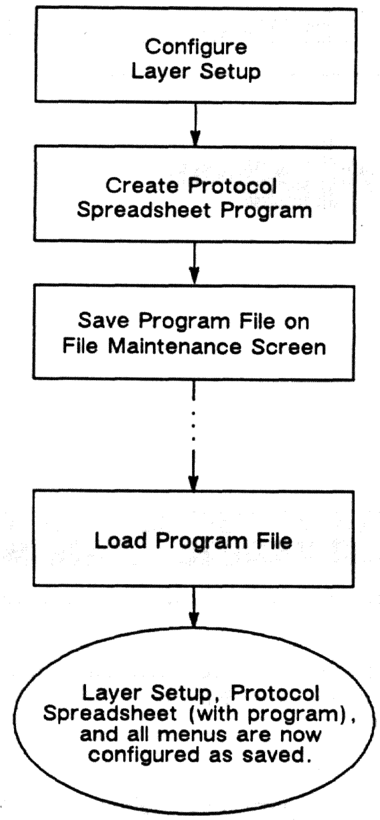


Figure 6-4 **Saving and loading the Layer Setup screen.**

To use a program file with personality packages, simply load the file in any drive. All drives will be searched, in the following order: boot drive, F1, F2, hard disk. (Of course, the boot drive is F1, F2, or hard disk.) This order is important when unique names have not been used. The first occurrence of the specified protocol package will be used. All protocol packages previously resident in the INTERVIEW will be replaced automatically, as long as the INTERVIEW can access the protocol packages specified in the program file. The personality package need not appear in the same drive from which it was originally loaded.

If the INTERVIEW does not find the Personality Package on any drive, nothing will be loaded. Missing softkey selections and pervasive strike-through's on the Protocol Spreadsheet also indicate that the correct Layer Personality Package has not been loaded.

To correct the problem, reload the program and packages. Return to the File Maintenance screen, insert the user disk containing the personality packages if necessary, and press [XEQ].

7 FEB Setup

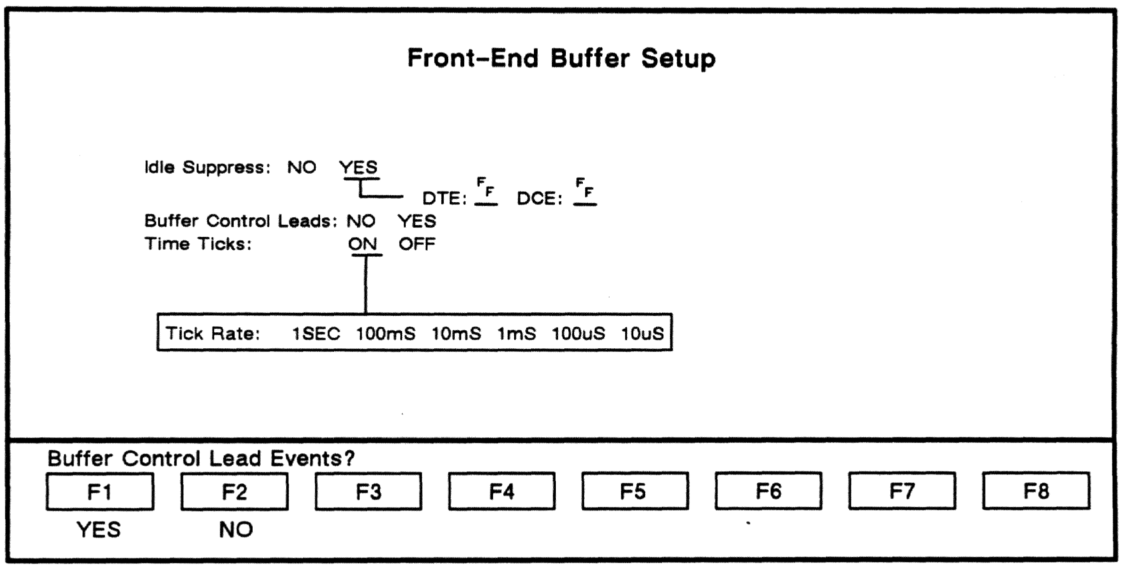


Figure 7-1 Selections on the Front-End Buffer Setup screen.

7 FEB Setup

Data and control-lead signals entering the INTERVIEW or generated internally are routed from the receivers through a front-end buffer (FEB) before being presented to the screen and to the trigger program. Since it holds onto data longer during times of peak processing, the FEB may shorten or lengthen slightly the time interval between signal "events." Buffering will not necessarily affect timer measurements, however, since the FEB has a mechanism that recreates real time to an accuracy of ten microseconds for all time-related measurements that the unit performs.

The mechanism of time-recreation is the time tick, counted and encoded in the FEB and decoded during processing. Time ticks are encoded in recorded data whether in bit-image or character format. Very precise timing measurements are available for data in either format when it is played back.

Time ticks are enabled and their rate selected on the Front-End Buffer Setup screen. Figure 7-1 is an overview of this menu.

Time ticks may also be disabled on the FEB Setup screen. When they are turned off, timing measurements are always based on an internal "clock on the wall" that gives timings to the millisecond. During playback, such timings will be influenced by "local conditions" such as playback speed, idle suppression, etc.

> **NOTE**: The "clock on the wall" is the timing mechanism used in other INTERVIEWs such as the COMSTATE series and the 4600, and many users will feel comfortable in turning time ticks off and relying on the wall clock for all normal operations.

7.1 Buffering Idle, Control Leads, and Ticks

Data bits are buffered automatically in the FEB. The buffering of other events—control leads, idle bits, and time ticks—can be enabled or disabled on the Front-End Buffer Setup menu.

Suppressing events in the FEB means intercepting them directly from the line so that they are not passed to the screen or to the program. Suppressing control leads means, for example, that neither EIA trigger conditions nor the data-plus-leads display will be available in real time or playback. Suppressing idle means that idle characters are not displayed even when **Display Idle:** ON is selected on the Line Setup menu. Suppressing time ticks means that timers lose some precision, especially when recorded data is being played back. The advantage of these suppressions is that when the user does not care about EIA leads or idle characters or playback timings, he can dispense with them in order to save processing time and also memory space in RAM or on disk.

(A) Suppressing Idle

Idle characters from the line can be suppressed in the FEB before they consume valuable space in RAM and on disk. Figure 7-2 shows the selection subfields that allow suppression of separate idle characters for DTE and DCE, as, for example, when a host idles ^T_E while multidropped terminals are idling ^F_F. If **Idle Suppress:** YES is selected on the Front-End Buffer Setup screen, nothing can be done in the **Display Idle** field on the Line Setup menu to restore the lost idle characters.

Once recorded, idle characters are locked into the data. Since the hardware that suppresses idle is not on the playback path for disk data, the **Idle Suppress** selection on the FEB setup does not apply. You can still suppress idle from the display via the **Display Idle:** OFF selection on the Line Setup menu or the **Suppress** field on the Display Setup menu.

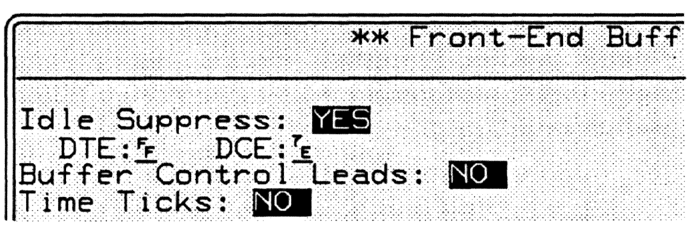


Figure 7-2 **The FEB menu allows suppression of separate idle characters for DTE and DCE.**

Although they are expensive to record, idle characters can be useful, chiefly to preserve idle time in between data transmissions when recorded data is sent to the screen display. Idle time also is preserved in time ticks if they are enabled; but while they do drive timers, these ticks do not drive the screen display. Figure 7-3 illustrates how idle time may be used to advantage on the screen.

In this figure, the data sample on the top was recorded with idle suppressed, the bottom sample with idle buffered. The time between RTS *on* and CTS *on* was the same in both samples, but only the display that included idle characters retains a picture of the handshake interval.

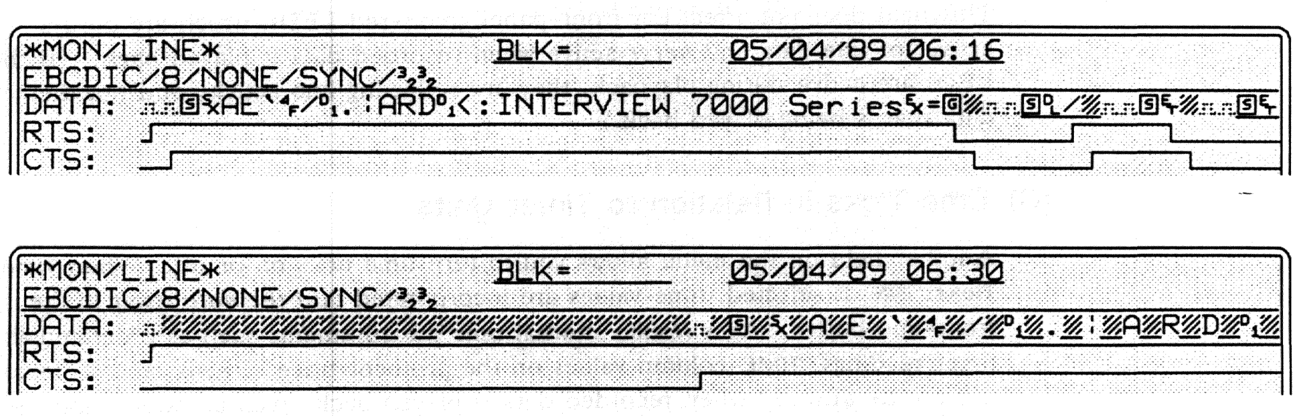


Figure 7-3 In the lower example, idle has *not* been suppressed in the FEB or in the line setup. Note that the interval between RTS *on* and CTS *on* is clearly preserved.

(B) Buffering Control Leads

The next field on the Front-End Buffer Setup screen is **Buffer Control Leads:** NO or YES. See Figure 7-4. Buffering control leads means that control-lead status will be available for data-plus-leads display and triggering. See Section 5.3(B) for a description of the data-plus leads display mode. Data-plus-leads will also be available during playback of bit-image or character data, whether or not this mode of display was used when the data was first recorded.

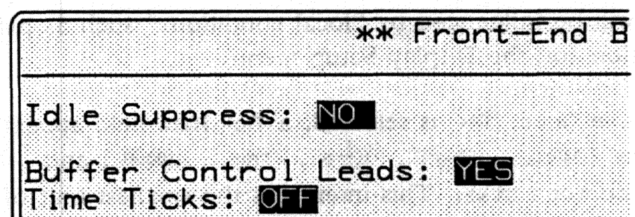


Figure 7-4 Control-lead status, time ticks, and idle characters can be buffered or suppressed in the FEB.

During data recording, a **Buffer Control Leads:** YES selection means that control leads will be recorded with the data. Once control leads are recorded alongside *character* data, they are locked in. Since the FEB is not on the playback path for character data, FEB selections do not apply during playback. (See Figure 2-5.) *Bit-image* data, however, does pass through the FEB during playback. Except for the **Idle Suppress** field, FEB selections apply. This means that control leads *must* be enabled in order for the program logic to detect them.

This field does not affect the front-panel green-red LEDs, which are *always* active for line data and *never* active when recorded data is played back. (If the LEDs are active during playback, they are reflecting line activity and not the data that is being played back.)

(C) Time Ticks in Relation to Timer Units

Another field on the menu allows you to turn time ticks on or off. When **Time Ticks:** ON is selected, time values are incorporated *into the data itself* in the front-end buffer. As a result, internal time measurements such as programmable timer readings, TIME-column values on the protocol-trace screens, and so forth, will not be affected when recorded data is played back, even at varying speeds.

> NOTE: Once time ticks are recorded alongside *character* data, they are locked in. Since the FEB is not on the playback path for character data, FEB selections do not apply during playback. (Refer again to Figure 2-5.) *Bit-image* data, however, does pass through the FEB during playback. Except for the **Idle Suppress** field, FEB selections apply. This means that time ticks *must* be enabled in order for the program logic to detect them.

If **Time Ticks:** OFF is selected, time values will not be incorporated into the data and timing measurements will always be based on an internal "wall" clock in the INTERVIEW that gives timings to the millisecond. During playback, such timings will be influenced by "local conditions" such as playback speed, idle suppression (on the Display Setup menu), etc.

When **Time Ticks:** ON is selected, a **Tick Rate** field appears just below it with six selections, 1SEC, 100mS, 10mS, 1mS, 100uS, and 10uS. Tick rate is the interval between ticks. This interval is the smallest unit of measurement attainable by the INTERVIEW's timers.

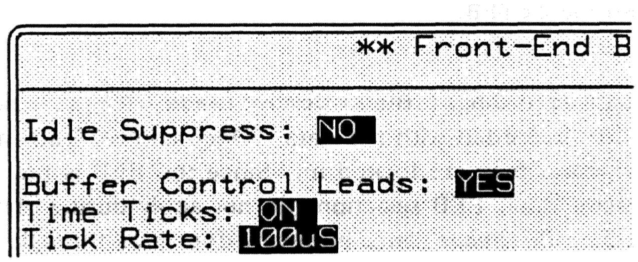


Figure 7-5 The user specifies the degree of timing precision when he selects the *tick rate*, the intervals at which time-ticks are stored with the data.

Ticks are indivisible. A **Unit** of time selected on a statistics screen should not be smaller than the tick rate on the FEB–setup screen. Figure 7-6 shows a mismatch between units on one screen and ticks on the other. **Unit:** MILLI-SECS is selected for a timer on the Tabular Statistics screen; but because the **Tick Rate** entry on the FEB–setup screen is 1SEC, the timer will advance in units no smaller than one thousand milliseconds (or one second). SECONDS would have been a more appropriate unit for this timer.

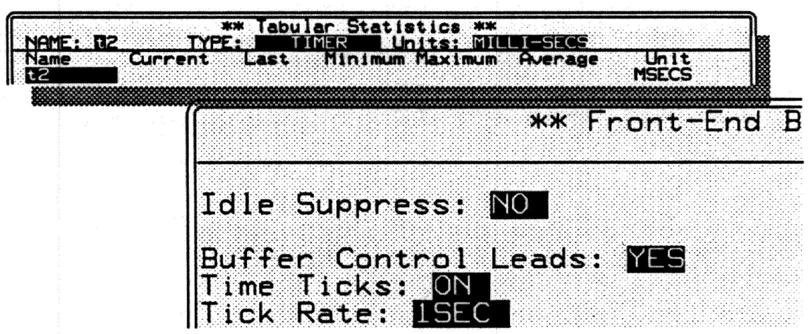


Figure 7-6 This is a mismatch: the **Unit** of time on the statistics screen should not be smaller than the tick rate on the FEB screen.

8 Block Checking

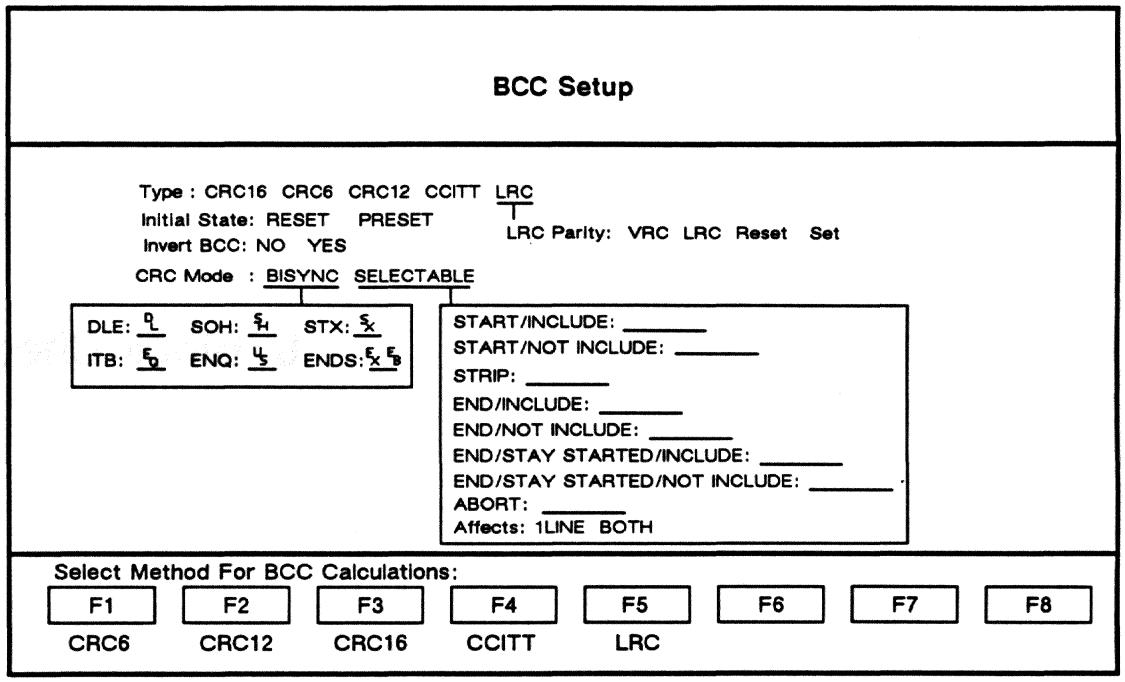


Figure 8-1 Fields and selections on BCC Setup screen.

8 Block Checking

The INTERVIEW is capable of a variety of standard and nonstandard block-check calculations (BCCs). These calculations can be appended to the INTERVIEW's own transmissions and they also can be used for comparison with BCCs in the line data. The results of the comparison are displayed on the unit's monitor as special symbols representing good and bad BCCs. (A "good" BCC in the line data is one that agrees with the INTERVIEW's own internal calculation.) The result of a BCC evaluation can also be used to satisfy a trigger condition.

8.1 BCC Symbols

The internal BCC that the INTERVIEW compares with a BCC in the line data and then displays as a special symbol on the data screen is enabled in a field on the Line Setup menu. This field is named **Rcv Blk Chk** and is shown in Figure 8-2. When **Rcv Blk Chk:** ON is selected, the unit evaluates as "good" or "bad" the BCCs in all properly framed data blocks. The last byte in the data BCC is then overwritten on the INTERVIEW monitor with G or B. Figure 8-3 shows a BCC symbol written over the second character of a line BCC that has been judged bad.

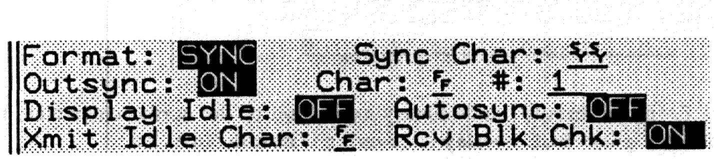


Figure 8-2 A field on the Line Setup menu enables block checking on all data "received" to screen and triggers.

It should be noted that the BCC-appending function and the BCC-evaluating function are separate, and that the **Rcv Blk Chk** field enables BCC *evaluation* in all data, including the INTERVIEW's own transmissions. The data block in Figure 8-3 was transmitted by the INTERVIEW. It is simply a fox message framed by S_X and E_X and preceded by sync characters. The transmit trigger that generated the message specified "no BCC" to be appended to the data (see Section 8.3), so E_X is followed by idle ▒ (pad) characters. But since **Rcv Blk Chk** is enabled, the unit treats the first two idle characters as BCC and evaluates them accordingly.

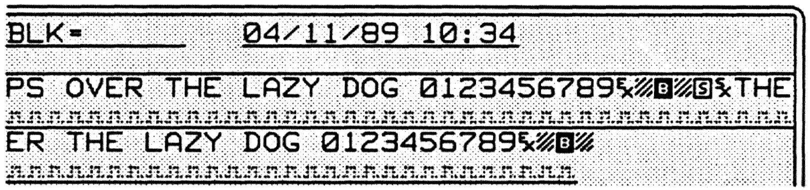


Figure 8-3 A special symbol overlays the final character in a bad BCC.

For non-BOP data, there are two ways to look underneath the [G] or [B] overlay to get a glimpse of the concealed final block-check character. One way is to select **Rcv Blk Chk: OFF**. Then the complete block-check calculation monitored by the INTERVIEW is displayed on the screen, with no special symbol overlaying the final BCC character.

The second way to uncover the hidden block-check character is to look at the binary expansion of the character in Freeze mode. In Figure 8-4, the operator has pressed [FREEZE] and then moved the cursor over the good-BCC symbol. In Freeze mode, the binary expansion of any character that comes under the cursor (including a concealed block-check character) is given at the top right of the screen.

When you look at the binary expansion of a BOP BCC-overlay, disregard the two least-significant (rightmost) bits. The third bit from the right is the real least-significant bit in the second BCC byte. The two high-order bits of the frame-check sequence simply are not made available for viewing by the BOP hardware.

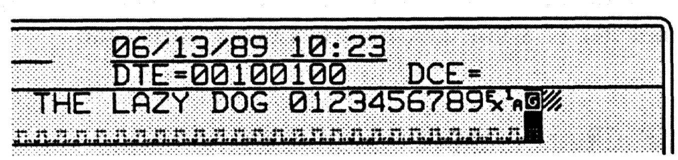


Figure 8-4 From the Freeze-mode binary expansion of the cursor character, it is easy to tell that the the good-BCC overlay is covering a hexadecimal *24*.

For BOP formats, **Rcv Blk Chk** does not appear on the Line Setup menu. Block-check evaluation is automatically *on* for BOP.

In BOP format only, block-check evaluation includes an abort symbol, [A]. Bisync devices signal an abort by sending ^E_Q in the middle of a text block, but BOP devices send no such control character—they merely idle mark for seven bit-times to indicate an aborted frame. The INTERVIEW uses the [A] symbol to stamp these seven consecutive 1-bits clearly as an abort.

Control over the type of block check and the many parameters associated with the type is afforded on the BCC Setup screen. The selections on this screen are laid out in Figure 8-1.

The BCC Setup screen does not operate for BOP. This format has a well-defined block-check sequence that is not alterable in the INTERVIEW.

8.2 BCC Conditions

Good and bad BCCs (and aborts in BOP format) can be used as trigger conditions. Figure 8-5 shows a GD BCC condition on a trigger menu. And here is an example of a BDBCC condition in a Protocol Spreadsheet test for Layer 1:

```
LAYER: 1
  TEST: bcc
    STATE: bad_bcc
        CONDITIONS: RECEIVE BAD_BCC
        ACTIONS: COUNTER bad_bcc INC
```

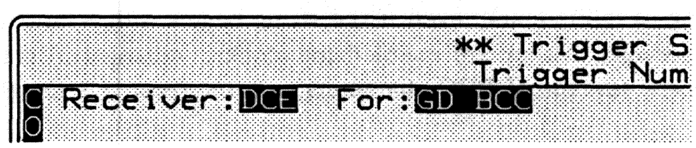


Figure 8-5 **Good and bad BCCs can be used as trigger conditions.**

Figure 8-6 is a string condition with a further condition added: Wait for E(nd) O(f) F(rame), the literal meaning of which is "wait for a good BCC." None of the triggers in these examples can come true unless block-check evaluations are enabled on the Line Setup menu. This enabling is automatic in BOP format. In other formats, **Rcv Blk Chk**: ON must be selected as a line-setup parameter.

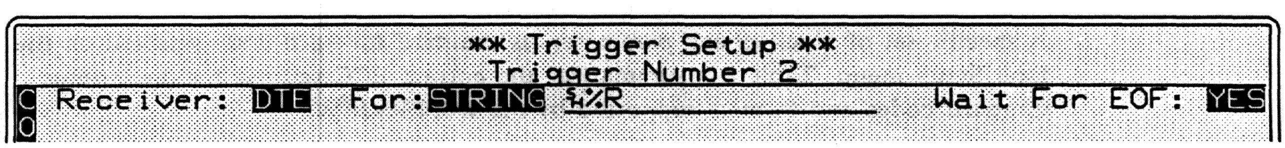


Figure 8-6 ***Wait For EOF*** **following a** ***Receiver*** **condition means "wait for a good BCC."**

8.3 Transmitted BCC

Block-check calculations that the INTERVIEW appends to messages and transmits out onto the line are enabled in the **BCC** field on trigger menus and in similar entries on the spreadsheet. **BCC** is a subfield under **Xmit** on trigger-action menus (see Figure 8-7). On the spreadsheet, transmitted BCC is a subselection under **SEND**: every time you transmit ("send") a message you have a choice of appending a good BCC, a bad one, an abort (BOP only), or nothing (not applicable to BOP).

```
            Buffer Full:     NO
            Keyboard:        NO
-------------------------------
good block check.ᴱx          BCC: GOOD
```

Figure 8-7 A transmitted BCC may be selected on the *actions* half of a trigger menu.

Please note that **BCC: GOOD** or **BAD** following a transmit string does not mean that a BCC will always follow. In bisync, the INTERVIEW will append BCCs only to text strings that are *properly framed*—as, for example, by $^{S}_{X}$ and $^{E}_{X}$ (or $^{E}_{B}$). If you are sending a bisync poll or ACK or $^{E}_{T}$ or some other nontext message, your selection in the **BCC** field will have no significance.

BCC: NONE means that the INTERVIEW will go directly from transmitting the transmit string to idling mark, even if the string begins with $^{S}_{X}$ and ends with $^{E}_{X}$ or $^{E}_{B}$. The unit's receivers, if they are enabled for block checking and if they stay in sync for the requisite number of BCC characters, will interpret this no-BCC as a bad BCC (Figure 8-3).

In BOP format, the sudden shift from data to mark idle is an abort. The third BCC selection in BOP triggers therefore is called **ABORT** instead of **NONE**. The receivers put up the appropriate ■ symbol when they see the seventh mark bit.

Good BCCs are transmitted in accordance with the parameters in effect on the BCC Setup menu. See Section 8.5.

8.4 Standard BCC Parameters

A specific set of block-check parameters is standard for each code selected on the Line Setup menu. Table 8-1 summarizes the correct BCC settings for the various standard codes and formats supported by the INTERVIEW.

The actual equations used by the INTERVIEW in block-check calculations are defined in Table 8-2.

Changes to the BCC Setup menu remain on the menu when you change line-setup formats.

Table 8-1
Standard Block-Check Parameters for Sync or Async/Isoc Formats

Code	Type	BCC starts following	BCC aborts/resets on	BCC ends with
EBCDIC	CRC-16	${}^{S}_{H}$ or ${}^{S}_{X}$	${}^{E}_{Q}$ or next bit after BCC	${}^{E}_{B}$, ${}^{E}_{X}$
ASCII	LRC	${}^{S}_{H}$ or ${}^{S}_{X}$	${}^{E}_{Q}$ or next bit after BCC	${}^{E}_{B}$, ${}^{E}_{X}$
IPARS	CRC-6	SY2 (${}^{3}_{E}$)	SY1 (${}^{3}_{F}$) or next bit after CRC	EOM-PB (${}^{3}_{D}$) EOM-1 (${}^{0}_{D}$) EOM-C (${}^{1}_{D}$) EOM-U (${}^{2}_{D}$)
BAUDOT	LRC	--	--	--
EBCD/ SELECTRIC	LRC; *Xmit:* LRC parity=LRC *Recv:* ignores parity bit	*Xmit:* sync *Recv:* bid (#)	${}^{E}_{T}$ on either side resets BCC for both sides	${}^{E}_{B}$
XS-3	LRC	${}^{4}_{0}$	--	${}^{5}_{S}$ (not included in BCC)

Table 8-2
Block Check Polynomials

BCC Type	Block Check Polynomial
CRC-16	$X^{16} + X^{15} + X^{2} + 1$
CRC-CCITT	$X^{16} + X^{12} + X^{5} + 1$
CRC-12	$X^{12} + X^{11} + X^{3} + X^{2} + X + 1$
CRC-6	$X^{6} + X^{5} + 1$

(A) BOP Format

For Bit-Oriented Protocols, the INTERVIEW defaults to the BCC calculations standard for BOP. The parameters for these calculations cannot be changed on the BCC Setup screen. Any changes to this screen while the unit is set up for BOP will not be executed until another format (such as ASYNC) is selected. The changes will remain on the BCC Setup menu when you change formats.

(B) Sync and Start-Stop Formats

When a format other than BOP is selected on the Line Setup menu, the unit must be set up for BISYNC or SELECTABLE **CRC Mode** depending on the code selected on the Line Setup menu. The various correct configurations for SYNC or start-stop formats (ASYNC and ISOC) are detailed below.

1. *EBCDIC or ASCII code.* Both EBCDIC and ASCII require **CRC Mode:** BISYNC, but EBCDIC uses a sixteen-bit CRC-16 calculation while ASCII uses an eight-bit LRC check. You may redefine the values of the BCC control characters using alternate control characters, standard alphanumerics, or hexadecimal characters. You may also indicate that the control character does not exist by leaving the field blank. See Section 8.6 on bisync CRC-mode operation.

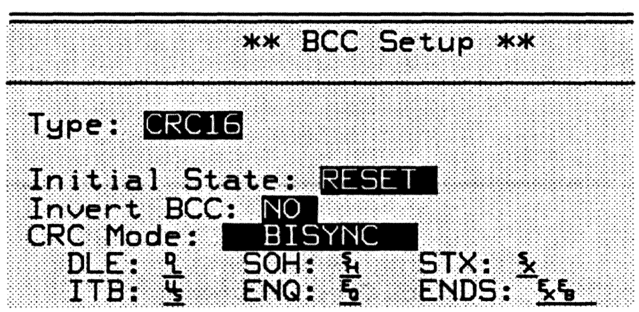


Figure 8-8 BCC setup for EBCDIC.

2. *IPARS.* Selecting **Code:** IPARS in sync or async (or isoc) format requires the BCC parameters shown in Figure 8-10. IPARS requires **CRC Mode:** SELECTABLE and uses CRC6 to calculate BCCs. Any of the BCC parameters may be changed to meet specific applications.

3. *BAUDOT.* Since Baudot does not normally support block checking, there are no standard settings.

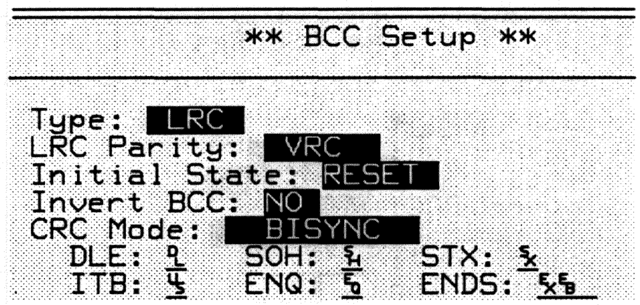


Figure 8-9 BCC setup for ASCII.

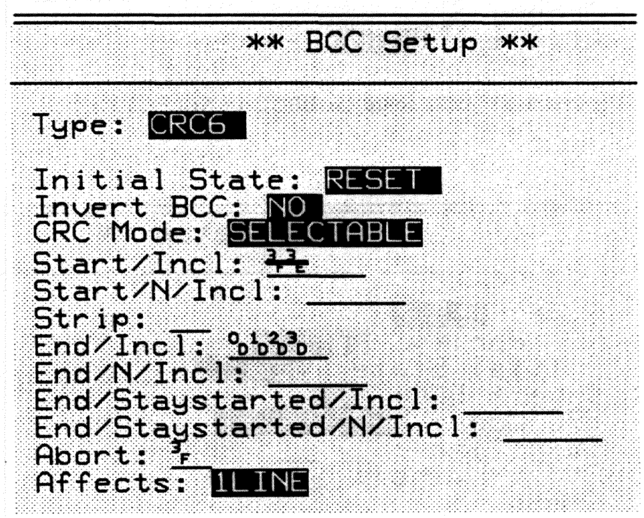


Figure 8-10 BCC setup for IPARS.

4. *EBCD, XS-3, or SELECTRIC.* Selecting EBCD or SELECTRIC code for SYNC or for either of the start-stop formats will require the BCC parameters shown in Figure 8-11. The XS_3 parameters are shown in Figure 8-12. All three codes require SELECTABLE CRC mode and use an LRC check to determine BCCs. Any of the BCC parameters may be changed to meet specific applications.

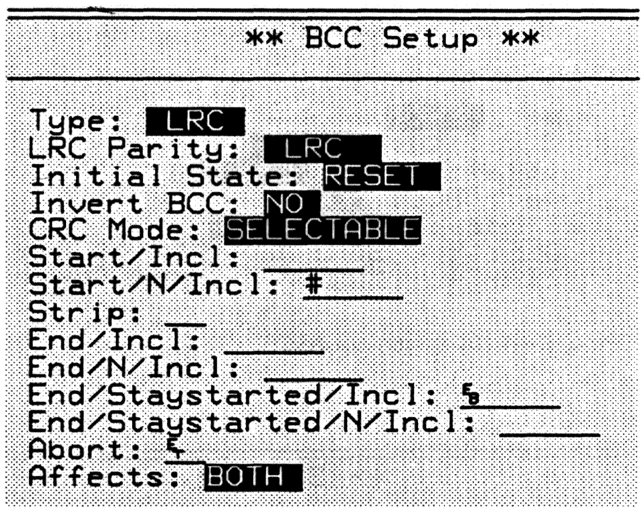


Figure 8-11 BCC setup for EBCD or SELECTRIC.

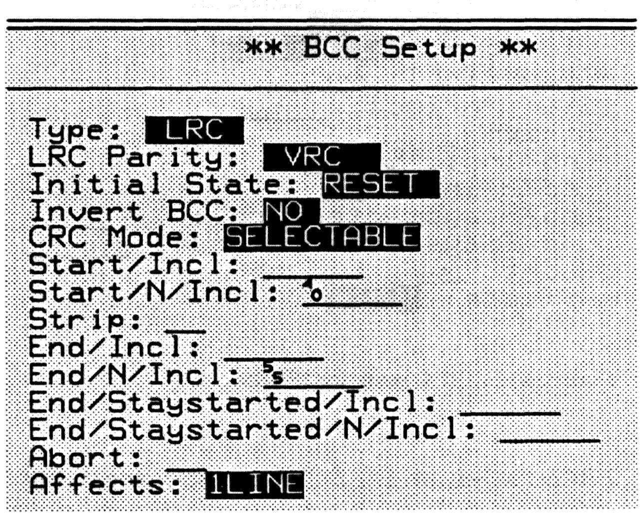


Figure 8-12 BCC setup for XS-3.

8.5 BCC Setup Menu Fields

The BCC Setup Menu controls and displays the values of the INTERVIEW's block check parameters. The full set of parameters is shown in Figure 8-1. The meanings of the BCC Setup parameter fields are found in Table 8-3.

Entries on the menu may be made in either alphanumerics, control characters, or hexadecimals. In the **START/INCL** field only, characters may also be entered in the not-equal format. See, for example, the IPARS setup in Figure 8-10.

Use control characters instead of hexadecimals where possible, since hexadecimals commit you to a particular parity that may change later on. An ASCII $^{S}_{X}$, for example, is hex $^{0}_{2}$ or $^{8}_{2}$ depending on the parity selected on the Line Setup menu. If you enter $^{0}_{2}$ in the **STX** or **START/N/INCL** field on the BCC Setup screen, the software will recognize $^{S}_{X}$ only in odd-parity ASCII data. An entry of $^{S}_{X}$, on the other hand, will adjust for whatever parity is enabled on the Line Setup menu.

Table 8-3
BCC Setup Menu Fields

Type	Indicates method of BCC calculation selected. Polynomial expansions of each CRC type are listed in Table 8-2.
LRC Parity	Displayed when *Type: LRC* is selected. Identifies how the parity bit in the BCC character is calculated. *LRC* = parity bit in BCC character the result of an LRC on the parity bits within the message *VRC* = parity bit the result of a VRC on the BCC character *RESET* = parity bit always 0 *SET* = parity bit always 1
Initial State	Sets initial state of block check character. *RESET* = all 0's. When *Type* is *LRC*, this selection yields an *even* longitudinal check. *PRESET* = all 1's. When *Type* is *LRC*, this selection yields an *odd* longitudinal check.
Invert BCC	*YES* produces an inverted BCC by changing 1's to 0 and 0's to 1.
CRC Mode	Allows choice between *BISYNC* and *SELECTABLE* CRC modes.
BISYNC control character fields	Data-entry fields displayed for *BISYNC* CRC mode only. Allow you to select the characters that control block-checking. Default is standard set of bisync control characters. Alphanumeric, hexadecimal, and control characters are legal.
START/INCL	Displayed when *SELECTABLE* is chosen. Identifies the character(s) on which the INTERVIEW initiates BCC accumulation, and includes the character(s) in the accumulation. For this field only, characters may be entered in either normal or not-equal format.

Table 8-3 (continued)

START/N/INCL	Displayed when *SELECTABLE* is chosen. Identifies the character(s) on which the INTERVIEW initiates BCC accumulation, and does not include the character(s) in the accumulation.
STRIP	Displayed when *SELECTABLE* is chosen. Identifies character(s) to be stripped from BCC accumulation.
END/INCL	Displayed when *SELECTABLE* is chosen. Identifies the character(s) on which the INTERVIEW ends BCC accumulation, and includes the character(s) in the accumulation. Initiates processing of BCC. Returns to START state when processing is complete (see Figure 8-14).
END/N/INCL	Displayed when *SELECTABLE* is chosen. Identifies the character(s) on which the INTERVIEW ends BCC accumulation, and does not include the character(s) in the accumulation. Initiates processing of BCC. Returns to START state when processing is complete (see Figure 8-14).
END/STAYSTARTED/INCL	Displayed when *SELECTABLE* is chosen. Identifies the character(s) on which the INTERVIEW ends BCC accumulation, and includes the character(s) in the accumulation. Initiates processing of BCC. Returns to ACCUMULATE state when processing is complete (see Figure 8-14). This function is performed by the $^{I}_{B}$ (Intermediate Block-check or ITB) character in bisync.
END/STAYSTARTED/N/INCL	Displayed when *SELECTABLE* is chosen. Identifies the character(s) on which the INTERVIEW ends BCC accumulation, but does not include the character(s) in the accumulation. Initiates processing of BCC. Returns to ACCUMULATE state when processing is complete (see Figure 8-14).
ABORT	Displayed when *SELECTABLE* is chosen. Identifies character(s) on which the INTERVIEW aborts BCC accumulation and returns to START state (See Figure 8-14). This function is performed by $^{E}_{Q}$ in bisync. Note that the abort *function* does not generate an abort *overlay* on the screen. The user may enhance the abort character in the *Enhance* field on the Display Setup menu. See Section 5.3(D).
Affects	This field pertains to the *ABORT* character on the preceding line. The choices are *1LINE* or *BOTH*. The abort character may cause only the side of the line sending the character to reset its BCC; or it may have this affect on both sides. $^{E}_{T}$ in EBCD/SELECTRIC is an example of a character that resets BCC on both sides.

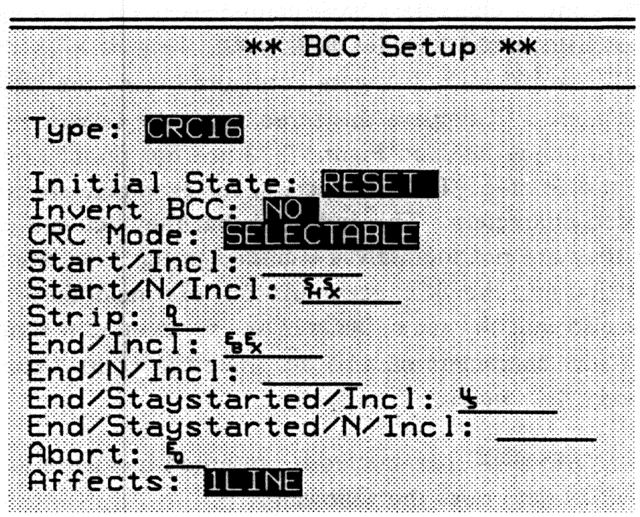


Figure 8-13 A valid BCC for nontransparent bisync can be configured "manually" using *SELECTABLE* parameters.

8.6 BISYNC vs. Selectable CRC Mode

The INTERVIEW supports an expanded subset of IBM's "Binary Synchronous Control Procedures" (BISYNC) that covers a wide variety of BISYNC-type applications including Burroughs, Honeywell, Univac, ISO-1175, and others.

Figure 8-8 shows the menu subfields under **CRC Mode:** BISYNC. In these subfields you may specify the values of the six BISYNC control characters (DLE, ITB, SOH, ENQ, STX, and ENDS) which appear on the BCC Setup menu with default character values already assigned (see Figure 8-8).

The BISYNC configuration has one important advantage, however, in that it implements full DL transparency. When **CRC Mode:** BISYNC is employed, the appearance of DL SX will enable a transparent mode in which all control characters except DL are accumulated as data characters while their control functions are ignored. SELECTABLE mode offers no similar mechanism for treating control characters as data. The SELECTABLE setup in Figure 8-13 will work, therefore, only as long as the bisync data is not transparent.

Most of the bisync control characters have counterparts on the *other* set of BCC parameters, accessed under **CRC Mode:** SELECTABLE. Figure 8-13 shows how a standard bisync BCC would look if it were configured using the SELECTABLE subfields on the BCC Setup screen. Compare this screen with the bisync screen in Figure 8-8. Note that the names of the fields in Figure 8-13 are functionally descriptive. Start–Of–Header and Start–of–TeXt characters, for example, are really **START/Not/INCL**uded characters. This indicates that they activate block–check accumulation but they are not themselves included in the calculation. $^{E}{}_{B}$ and $^{E}{}_{X}$, on the other hand, which end the BCC accumulation, *are* included in the block–check calculation. Note also that the set of SELECTABLE parameters is more complete, and that thirty–four distinct characters may be designated as control characters compared to eight in the BISYNC fields.

A state diagram of SELECTABLE parameters is presented in Figure 8-14. In this diagram, process–BCC state does the following:

- Calculates and displays BCC result.
- Reinitializes BCC remainder.
- If end character was a STAYSTARTED character, returns to accumulate state.
- Otherwise, returns to start state.

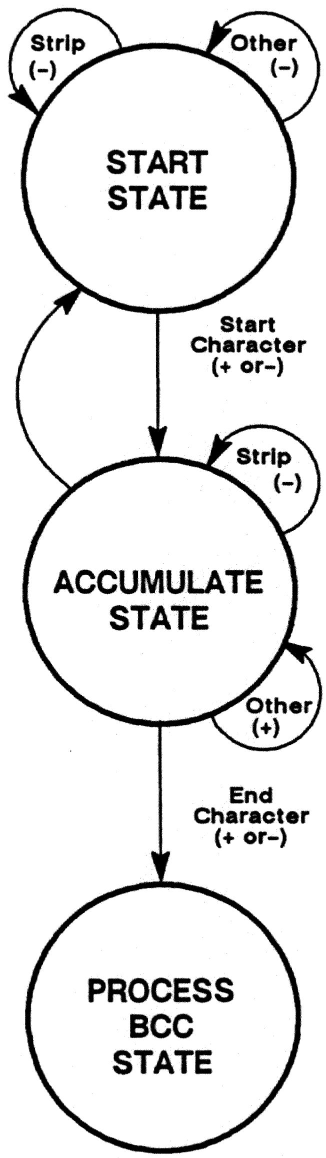


Figure 8-14 State diagram for CRC **Mode:** ***selectable.*** (+) means the character is included in BCC calculation; (-) means the character is not included.

9 Bit Error Rate Testing

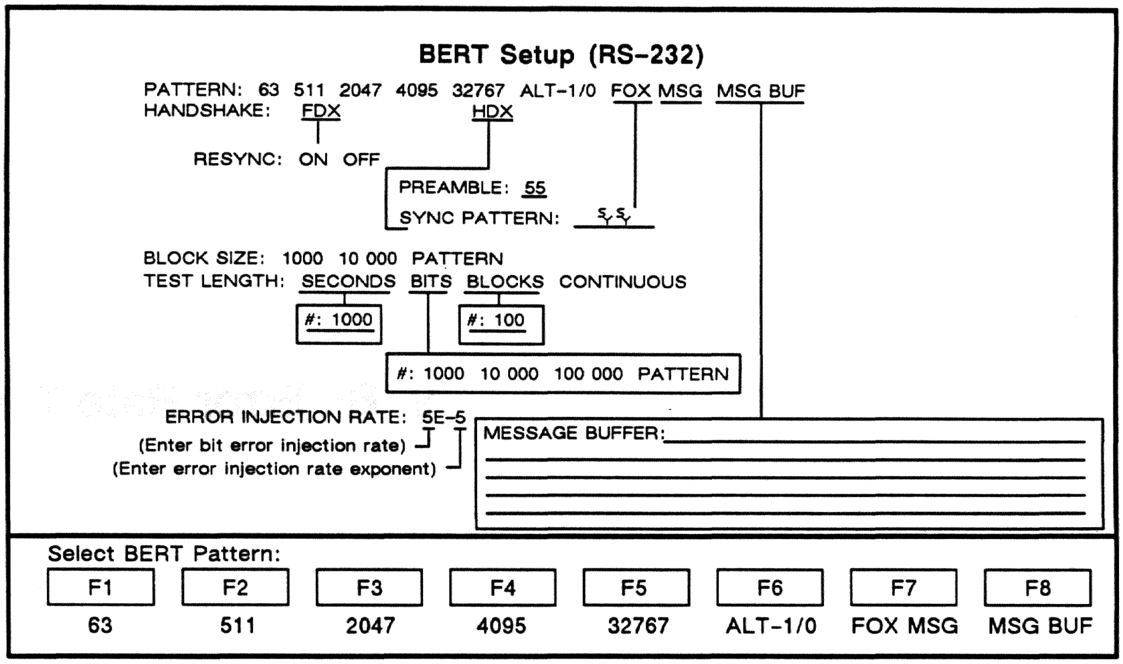


Figure 9-1 Menu selections on the BERT Setup screen.

9 Bit Error Rate Testing

The INTERVIEW can transmit and analyze Bit Error Rate Tests consisting of five different pseudorandom bit patterns, a series of alternating 1's and 0's, a canned fox message, and a user–assigned message of up to 259 characters. The INTERVIEW can send and analyze BERT patterns in synchronous or asynchronous format over transmission facilities that are full duplex or half duplex.

9.1 Pseudorandom Bit Patterns

BERT data may be transmitted and analyzed in pseudorandom patterns of 63, 511, 2047, 4095, or 32767 bits. The algorithm for each pattern is diagrammed in Figure 9-2.

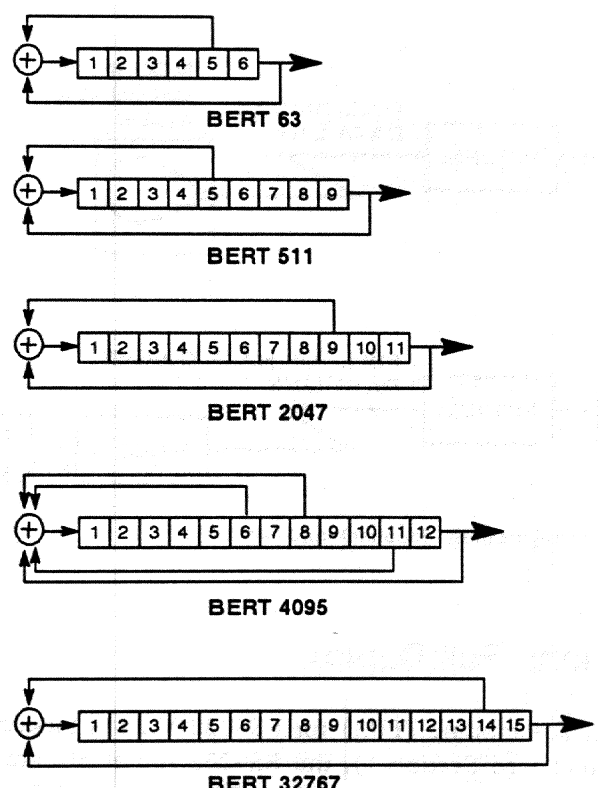


Figure 9-2 BERT algorithms.

9.2 Test Configurations

Tests can be configured for one tester or two.

A standard one-tester configuration places the remote modem (remote from the INTERVIEW) in a loopback condition. See Figure 9-3. The INTERVIEW generates the BERT data and analyzes the data upon its return over the transmission line. This is the easiest test to configure, since the INTERVIEW's BERT analyzer automatically looks for the same pattern of data that the unit generated.

When another BERT generator is used at the remote site, each tester analyzes the data generated by the other. See bottom of Figure 9-3. There is no looping of data. Both testers must generate data that matches bit for bit. Selections on the Line Setup and BERT Setup screens let the user control the pattern of information bits, the number of information bits allotted to a character, the stop bits used along with a start bit to frame each character (async only), and the sync characters necessary for locating (and relocating) the beginning of a fox or user-defined pattern.

The two-tester configuration can be thought of as two separate one-way tests. From the point of view of each tester, the transmitted BERT data is superfluous. The data that is received and analyzed is the test data.

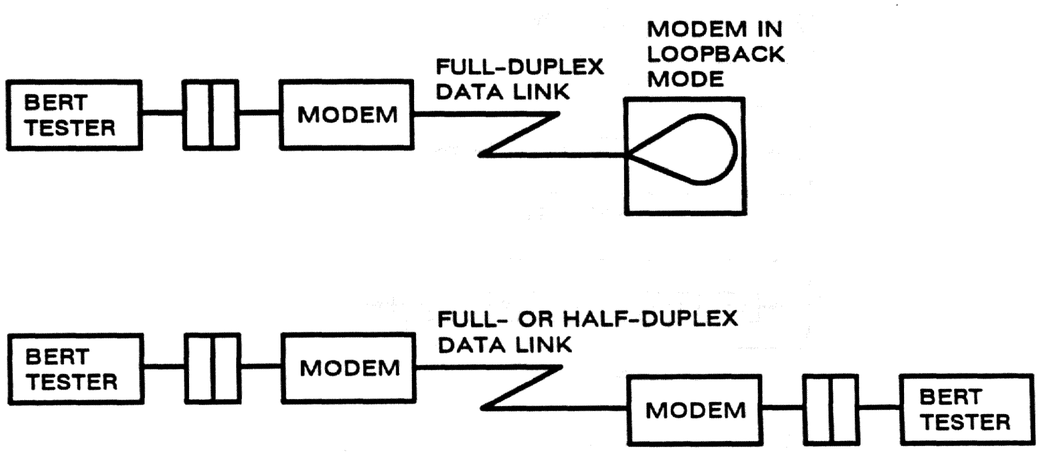


Figure 9-3 Two test configurations: loopback and two-tester.

9.3 BERT Operation: Full Duplex

When the test-interface module (TIM) for RS-232/V.24 is locked in place in the slot at the rear of the unit (see Section 1), the RS-232 subset of parameters on the BERT Setup screen is enabled automatically. On the RS-232 Interface Control menu, **RTS**, **CTS**, and **CD** all should be set to **ON** for full-duplex operation.

In the **Mode** field on the Line Setup menu, select either **BERT DTE** or **BERT DCE**. BERT is used most commonly to test modems and transmission links, so the normal attitude of the INTERVIEW will be **Mode:** **BERT DTE**. See Figure 9-4.

CAUTION: As soon as the INTERVIEW is run in either of its BERT modes, it will interfere with any active communications on the interface. Be sure that it is all right to break the line and transmit test data on it.

Note on synchronous and BOP operation: The INTERVIEW can transmit using internal clock (SCTE) when it is emulating a DTE; but in order to display its own transmit data as well as receive data, it must be connected to a modem or other DCE device that is providing SCT and SCR clock.

If you have selected **Mode:** **BERT DTE** and external clock is not available for synchronous or BOP operation, choose **Clock Source:** **INTERNAL** and patch SCTE to SCT.

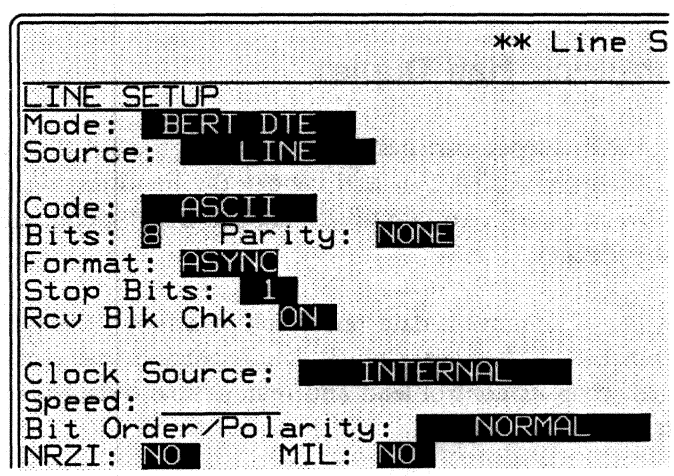


Figure 9-4 **The fields on this Line Setup menu—except for *Source*, *Rcv Blk Chk*, and *NRZI*—also are BERT parameters.**

Once you have selected the BERT mode, press [PROGRAM], [F1], [F5], to enter the BERT Setup parameters menu (Figure 9-5). Select **Handshake:** **FULL DUPLEX** in the second field on this menu. When you have completed your other selections in these parameter fields (see Section 9.5), press [RUN]. In full-duplex testing, whenever you execute a run the INTERVIEW will begin to operate both as a BERT generator and analyzer.

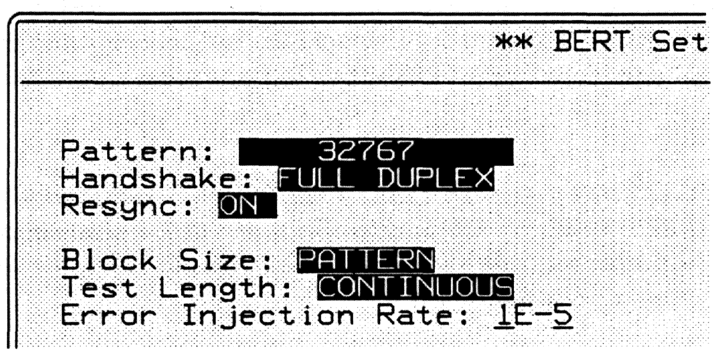


Figure 9-5 BERT Setup screen.

The unit will begin transmitting immediately. The transmission will consist of the bit pattern chosen on the BERT Setup menu according to the format entered on the Line Setup menu.

The INTERVIEW also begins immediately to perform a BERT statistical analysis on all received data. If you press [F3], **RESET**, while the pattern is being transmitted, the pattern will not be interrupted but the statistical counters will clear. See Section 9.7(E).

9.4 BERT Operation: Half Duplex

To operate over half-duplex transmission lines, go to the RS-232/V.24 Interface Control screen (press [PROGRAM], [F1], [F2]) and change the handshaking control leads (**RTS**, **CTS**, and **CD**) from ON to SWITCH. On the BERT Setup menu, select **Handshake:** HALF DUPLEX.

During the test you will transmit data one block at a time. (See Section 9.5(F) for a definition of "block.") After every block of information that it transmits, the INTERVIEW will drop its control lead and relinquish the data link while the remote tester transmits a block.

On the Line Setup menu, select **Mode:** BERT DTE. Then press [PROGRAM], [F1], [F5], to enter the BERT Setup screen. When you have made your selections in these BERT-menu fields (see Section 9.5), press [RUN].

CAUTION: As soon as the INTERVIEW begins running in either of its BERT modes, it will interfere with any active communications on the interface. Be sure that it is all right to break the line and transmit test data on it.

When the INTERVIEW operates in half duplex, it does not transmit and receive BERT data at the same time. When you send the Run command to start the test, the unit is in the "receive and analyze" mode. Once it has received a complete block of data, it will shift to "generate" mode and transmit *one* block automatically.

In this situation, both ends are waiting; press [F5], START, to **initiate** the sending-receiving cycle with a transmission.

9.5 BERT Setup Screen

(A) Pattern

With the cursor in the **Pattern** field, press [ROLL FWD] and [ROLL BACK] to rotate between a series of alternating 1's and 0's, a canned fox message, a user-assigned message of up to 259 characters, and five different pseudorandom bit patterns. The INTERVIEW both transmits and expects to receive this pattern while it is in BERT Mode.

When MESSAGE BUFFER is selected in this field, the pattern will consist of the contents of the 259-byte message buffer represented by five data-entry lines toward the bottom of the BERT Setup menu.

Do not run the 1010 pattern if you have selected ASYNChronous (or ISOChronous) start-stop framing on the Line Setup menu.

(B) Handshake

In this field, select **Handshake:** FULL DUPLEX or HALF DUPLEX. The selection will determine whether preamble and sync characters can be appended to the data (half duplex) and whether the resync function can be enabled (full duplex only). In Run mode, the full-duplex pattern will run continuously for the duration of the test, while the half-duplex test will be transmitted one block at a time before turnaround. This field configures the test sequence, not the interface. The interface must be configured on the Interface Control screen in accordance with Table 9-1.

Table 9-1
Full- or Half-Duplex BERT
(RS-232/V.24 Interface Control screen)

	RTS	CTS	CD
Full duplex:	on	on	on
Half duplex:	switch	switch	switch

(C) Resync

Use the resync function to prevent one missed bit-time from skewing an entire test. **Resync:** ON is valid only when the screen is configured for full duplex. This selection allows you to go out of test-sync after a fault has been detected (see Section 9.9(G), Number Of Faults) and back into synchronization after a short interruption. When out of sync, the receiver stops analyzing bits and counting errors and waits for synchronization to turn the analyzer on again.

Resync: ON avoids a bit-error rate approaching fifty per cent for pseudorandom patterns over a long error count. (The analyzer will "guess" right fifty per cent of the time even if it is out of sync with the incoming test data.)

Table 9-2

BERT Pattern (BERT Setup screen)

PATTERN:	BERT ALGORITHM (63, 511, 2047, 4095, 32767)	ALT-1/0 (synchronous only)	FOX/MSG BUF
Handshake:	Full or half duplex	Full or half duplex	Full or half duplex
Resync on:	Algorithm (full duplex) or sync chars (switched)	1010 (full duplex) or sync chars	one or two sync chars
Preamble char:	selectable (switched line-use only)	selectable (switched line-use only)	selectable (switched line-use only)
Sync chars:	1st pattern-byte selectable, switched line-use (half duplex) only	selectable, switched line-use (half duplex) only	selectable
Block size:	1 Kbit, 10Kbit, or pattern	1 Kbit or 10 Kbit	1 Kbit, 10 Kbit, or pattern
Test length:	selectable # of seconds or blocks; 1 K, 10 K, 100 K, or pattern # of bits; or continuous	selectable # of seconds or blocks; 1 K, 10 K, 100 K, or pattern # of bits; or continuous	selectable # of seconds or blocks; 1 K, 10 K, 100 K, or pattern # of bits; or continuous
Error Injection Rate:	selectable	selectable	selectable

For a pseudorandom pattern, resync means going out of sync and performing the algorithm on two bytes of data in order to predict the third byte. Since the algorithm may be performed at any point in the cycle, there are no sync characters.

For the fox pattern or the user-defined message buffer, resync means going out of sync when a fault occurs and looking bit by bit for the sync pattern entered in the **Sync Pattern** field on the BERT Setup (not the Line Setup) menu.

In half-duplex BERT testing, **Resync:** ON is not available. The analyzer goes out of synchronization at the end of each block when the line turns around, but never in the middle of a block.

A fault in half duplex means that synchronization was missed entirely for a block. The analyzer stays out of sync until the next line turnaround.

On a noisy circuit, a fault may not imply that the analyzer has lost synchronization with the incoming BERT pattern. In spite of a high error rate, the test should remain in sync. Select **Resync:** OFF to prevent the analyzer from going out of sync and suspending its error count while waiting to resynchronize.

(D) Preamble

This selection is enabled when the BERT Setup menu is configured for half duplex only. One or two bytes selectable by the user can be prefixed to the sync pattern in half duplex tests. The default entry in this field is two bytes of $^{5}{}_{5}$, a character with an alternating pattern of 0 and 1 bits. After line turnaround, a modem can use this pattern from a remote DTE to put its bit clock into phase with the new carrier.

Since preamble characters always follow carrier turnaround and precede synchronization, they are not checked by the BERT analyzer for error.

Pressing CLEAR to blank this field will prevent the preamble pattern from being transmitted.

(E) Sync Pattern

Sync characters have a special role in BERT testing. Because they provide message synchronization as well as character sync, BERT analysis requires sync characters in line setups where they would not normally occur—in asynchronous fox-pattern testing, for example. To cover these special applications, the BERT Setup screen is provided with its own **Sync Pattern** field. The **Sync Char** field on the Line Setup menu is inoperative during BERT tests.

1. *Sync characters in fox or user-defined tests.* Default is $^{S}{}_{Y}$$^{S}{}_{Y}$ in the four-character **Sync Pattern** data-entry field. Alphanumerics, control

characters, and hexadecimals are legal. Entry of one, two, three, or four characters is legal. A blank field is treated as default: $^{S}_{Y}{}^{S}_{Y}$.

In full-duplex BERT tests, sync characters precede each fox message or user-defined message. In normal synchronous data transmission, sync characters help the receivers locate character boundaries. In BERT tests they do more: they help the analyzer find message boundaries. For this reason, sync characters precede fox and user messages in asynchronous tests as well as synchronous.

In a full-duplex fox or user test with few errors, the sync pattern is transmitted repeatedly but used only once by the analyzer. After initial synchronization, the analyzer stays in sync and does not look for the sync pattern. The sync characters that precede each successive message in the test are treated as data and checked for bit errors.

In half-duplex BERT, the sync characters precede every transmission in fox and user tests. They are not repeated in mid-transmission. They never are treated as data.

BERT testing can be tricky when two different brands of tester are being used, especially when a data pattern is being tested. Even fox messages will vary with different testers. Some use STX-ETX, some say "JUMPED . . . DOGS" instead of "JUMPS . . . DOG," and so on. Design a MESSAGE BUFFER test to mirror the fox message of the other tester. Use the **Sync Pattern** field for the first character (or more) of the fox message ("$^{S}_{X}$," for example, or "T") in cases where the other tester does not send $^{S}_{Y}{}^{S}_{Y}$. Then continue the message on the first line of the **Message Buffer.** Figure 9-6 shows how the **Sync Pattern** field is used in conjunction with the message buffer to design a customized fox pattern.

```
                         ** BERT Setup **

 Pattern: MESSAGE BUFFER
 Handshake: FULL DUPLEX
 Resync: ON
 Sync Pattern: SxT
 Block Size: PATTERN
 Test Length:    BLOCKS    #: 100
 Error Injection Rate: 5E-5

 Message Buffer:  HE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
        0123456789Ex

Msg Text: HE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789Ex
  F 1    F 2    F 3    F 4    F 5    F 6    F 7    F 8
```

Figure 9-6 If the other tester does not send *sy sy*, synchronize on the first two characters he does send.

2. *Pattern-synchronization in pseudorandom tests.* For a pseudorandom pattern in full duplex, the **Sync Pattern** field does not apply. Since the algorithm may be performed at any point in the cycle, there are no sync characters.

   Synchronization for half-duplex pseudorandom tests is more complicated. The first few bits received after the line turns around are important bits to be tested. Both the transmitting and receiving testers must agree in advance on the point in the algorithmic series where the half-duplex test will begin.

   Here the **Sync Pattern** field is used not for standard sync characters but rather to identify the point in the pseudorandom pattern where the test will begin after each line turnaround. This special use of the **Sync Pattern** field allows the operator to program the INTERVIEW for compatibility with half-duplex testers from other manufacturers.

   To program a synchronization point into a half-duplex test, the user must know the eight bits that precede the point and the eight bits that follow. For example, suppose that the eight bits preceding a sync point in a 2047-bit test are 10100001.

   NOTE: In the notation above, the first bit transmitted is the rightmost. This is consistent with the presentation of binary patterns in all INTERVIEW screen-displays and documents. This right-to-left ordering of bits is well suited to binary-to-hexadecimal and binary-to-ASCII/EBCDIC conversions; but the usual presentation of bits in the BERT literature is left to right.

Since this binary pattern corresponds to the hexadecimal number A1, the user would move the cursor to the **Sync Pattern** field and enter A1 in the first data-entry position. Suppose also that the eight bits following the sync point (and therefore the first eight bits transmitted after line-turnaround) are 01001000 (hex 48). The user enters 48 in the second position of the **Sync Pattern** field. Figure 9-7 shows the full pattern-sync entry.

48 will be the first character transmitted in the half-duplex 2047-bit test. Since some algorithms are based on strings longer than eight bits (see Figure 9-2), the preceding character (A1) was included in the **Sync Pattern** field; but this character is not transmitted.

When it is receiving and analyzing, the test synchronizes on the character in the second position in the **Sync Pattern** field (48 in our example). If there is an error in one of these first eight bits, synchronization will be missed and the test will record a "fault." See Number Of Faults, Section 9.9(G). Following the sync character, erroneous bits are recorded as BIT ERRORS.

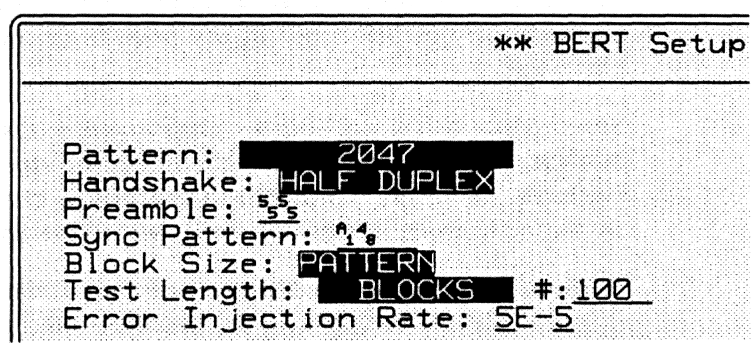


Figure 9-7 Pseudorandom tests in half duplex require pattern-synching.

In certain cases, two bytes of sync may be insufficient to begin a half-duplex pseudorandom test. The 32767 pattern, for example, requires fifteen bits to calculate the sixteenth bit and succeeding bits. If **Bits:** 8 is selected on the Line Setup screen, a two-byte entry in the **Sync Pattern** field is sufficient. But if a smaller bit-number is selected, two hex characters in the **Sync Pattern** field will not represent the number of bits that the algorithm requires to continue.

In such cases, use the four places in the **Sync Pattern** field (in conjunction with the bit number in the Line Setup) to construct a pattern that is at least as long as the algorithmic series (see Figure 9-2). The last character in the pattern will be the first byte transmitted and analyzed.

3. *Default pattern–sync.* There are two default sets of half–duplex sync points in the INTERVIEW. These are outlined in Table 9-3. BERT testers that use set #1 include the TREND *Data Tester 100* series. NAVTEL's *Datatest II Plus* uses default set #2.

   To operate with sync–point set #1, enter ${}^{S}{}_{Y}$ ${}^{S}{}_{Y}$ in the **Sync Pattern** field. To operate with set #2, clear the field (press CLEAR). If fewer than two characters are entered in the **Sync Pattern** field, the unit will default to set #2. Remember that the default sets are enabled only when **Handshake:** HALF DUPLEX is selected.

Table 9-3
Half–Duplex BERT: Default Synchronization Points

Pattern	1st 8 Data Bits Transmitted	Preceding 8 Bits in Pattern	Entry in Sync Chars Field
Set #1			
63	${}^{A}{}_{3}$	${}^{0}{}_{8}$	${}^{S}{}_{Y}$ ${}^{S}{}_{Y}$ or ${}^{0}{}_{8}$ ${}^{A}{}_{3}$
511	${}^{9}{}_{6}$	${}^{A}{}_{1}$	${}^{S}{}_{Y}$ ${}^{S}{}_{Y}$ or ${}^{A}{}_{1}$ ${}^{9}{}_{6}$
2047	${}^{9}{}_{6}$	${}^{B}{}_{D}$	${}^{S}{}_{Y}$ ${}^{S}{}_{Y}$ or ${}^{B}{}_{D}$ ${}^{9}{}_{6}$
4095	${}^{5}{}_{7}$	${}^{A}{}_{1}$	${}^{S}{}_{Y}$ ${}^{S}{}_{Y}$ or ${}^{A}{}_{1}$ ${}^{5}{}_{7}$
32767	${}^{9}{}_{6}$	${}^{F}{}_{F}$	${}^{S}{}_{Y}$ ${}^{S}{}_{Y}$ or ${}^{F}{}_{F}$ ${}^{9}{}_{6}$
Set #2			
63	${}^{B}{}_{C}$	${}^{A}{}_{3}$	no chars or ${}^{A}{}_{3}$ ${}^{B}{}_{C}$
511	${}^{9}{}_{6}$	${}^{A}{}_{1}$	no chars or ${}^{A}{}_{1}$ ${}^{9}{}_{6}$
2047	${}^{4}{}_{8}$	${}^{A}{}_{1}$	no chars or ${}^{A}{}_{1}$ ${}^{4}{}_{8}$
4095	${}^{5}{}_{7}$	${}^{A}{}_{1}$	no chars or ${}^{A}{}_{1}$ ${}^{5}{}_{7}$
32767	${}^{9}{}_{6}$	${}^{F}{}_{F}$	no chars or ${}^{F}{}_{F}$ ${}^{9}{}_{6}$

(F) Block Size

A block can be the length of a cycle or message (PATTERN), or 1000 or 10000 bits rounded to the nearest byte. A block is a component of a test: complete tests often are measured in blocks.

> *CAUTION: The definition of a block varies from standard to standard and from BERT tester to BERT tester. Some standards*

define a block as the pattern length while others specify 1,000 bits. The user must ascertain and then select the proper definition.

When a FOX MESSAGE or MESSAGE BUFFER pattern is chosen, PATTERN means one fox message or one message buffer. The PATTERN selection is not valid for the ALT 1010 pattern: a block in this pattern always is a set number of bits.

When a pseudorandom pattern is chosen, the message is one cycle of the pattern. The shortest pseudorandom block is 63 bits, while the longest block is 32,767 bits.

In half-duplex BERT, each transmission is one block. The line turns around following each block. After turnaround, the test continues.

(G) Test Length

Tests are measured in blocks, bits, or seconds. They can also be CONTINUOUS.

The **Test Length:** BLOCKS selection brings up a four-digit # field that accepts entries from 1 to 9999. The shortest pseudorandom block is 63 bits, so the shortest pseudorandom test that is one block long is also 63 bits. The longest test measured in blocks will be 9999 times the longest pattern (32,767), or 327,637,233 bits.

The **Test Length:** SECONDS field also brings with it a # field, with five places for numbers from 1 to 99,999. The maximum number of seconds comes to slightly more than twenty-seven and three-quarter hours.

If **Test Length:** BITS is selected, a # field appears with these rotating selections: 1000, 10000, 100000, and PATTERN.

(H) Automatic Error Injection

Errors can be injected in a bit pattern automatically at a preselected rate. (They may also be injected manually from the keyboard: see Section 9.7 below.) The **Error Injection Rate** field defaults to 5E-5, equivalent to 5 errors per 100,000 bits. The two fives are variables in this formula. The first five is the error rate and can be overwritten with numbers in the range of 0-9. The second five is the **negative exponent** and can be changed to any number in the range of 2-9.

Read the "E-" in the formula as *per 10-to-the-exponent bits*. For example, 1E-2 means $1/10^2$ or 1 error per 100 bits. 0E-6 means $0/10^6$ or no errors per 1,000,000 bits, equivalent to zero. Using 0 as the first variable is equivalent to injecting *no* errors and, in effect, disabling the field.

The highest automatic–error rate selectable would be 9E–2 or $9/10^2$ or 9 errored bits per 100 bits. The lowest rate of injected errors would be 1E–9 or $1/10^9$ or 1 error per 1 billion bits.

9.6 Transmission Format: Line Setup Menu

Certain selections on the Line Setup menu will affect the pattern of bits transmitted during a BERT test. The screen is illustrated in Figure 9-4.

(A) Code

If your BERT pattern is a fox message or a user–defined message that contains alphanumerics, the **Code** that you select on the Line Setup menu will affect the pattern of bits in your test. If your test involves sync characters, remember that the bit pattern for ␖␖ is different for ASCII and EBCDIC.

Testers on either side of a transmission link should be configured for the same code.

(B) Bits

Select the number of information bits. This field is invalid for pseudorandom and alternating 1/0 BERT patterns in SYNC format. In all other BERT configurations, characters are formed according to the bit–number specified here.

(C) Parity

For 5, 6, or 7 information bits in async or isoc format, you may select the type of parity. (For 8 information bits, even, odd, or no parity is available but not mark or space.) The parity bit is additional to the information bits.

The BERT test transmits and checks parity. It calculates parity on the data bits it *expects* to receive, not the actual data bits. This is to prevent an errored data bit from causing a parity error and being counted twice as a result.

(D) Format

Choose **Format:** SYNC , BOP , ASYNC , or ISOC .

1. *Sync*. If **Format:** SYNC is selected on the Line Setup menu and a pseudorandom (or alternating 1/0) pattern is the BERT Setup selection, the pattern will be transmitted bit for bit without synchronization or character–framing. The Line Setup selection fields from **Code** down to (but not including) **Bit Order/Polarity** are invalid.

   If a character–oriented (fox or message–buffer) pattern is selected on the BERT Setup screen, the precise bit pattern will be determined partly by the

Code, Bits, and **Parity** selections on Line Setup. The fields from **Format:** SYNC down to **Bit Order/Polarity** are invalid for BERT, however. Sync characters are entered on the BERT Setup screen. See Section 9.5(E).

2. *BOP*. This softkey is nonfunctional. The selections default to the same as if **Format:** SYNC were selected.

3. *Async*. If **Format:** ASYNC is selected on the Line Setup menu, stop bits (ones) and a start bit (zero) will be added after every fifth, sixth, seventh, eighth, or ninth bit in the BERT pattern, depending on the **Bits** and **Parity** selections on Line Setup. This start/stop-bit framing applies to pseudorandom patterns as well as to character-oriented patterns.

   Do not run the alternating 1/0 pattern if you have selected asynchronous (or isochronous) start/stop-bit framing on Line Setup.

4. *Isoc*. This is a cross between async and sync. It uses asynchronous start/stop-bit framing; but unlike async, internal clock (if selected) will transmit clock pulses on the clock lead(s) for use by the other device on the interface.

(E) Clock

If clock is to be supplied by a modem during the test, you can select **Clock:** EXTERNAL . If no external clock is to be supplied, select INTERNAL or INTERNAL SPLIT and the correct speed or speeds.

> **Note on synchronous and BOP operation:** The INTERVIEW can transmit using internal clock (SCTE) when it is emulating a DTE; but in order to display its own transmit data as well as receive data, it must be connected to a modem or other DCE device that is providing SCT and SCR clock.
>
> If you are have selected **Mode:** BERT DTE and external clock is not available for synchronous or BOP operation, choose **Clock Source:** INTERNAL and patch SCTE to SCT.

(F) Bit Order/Polarity

The pattern of bits in sync and async tests will be affected by the selection in the **Bit Order/Polarity** field only if a character-oriented (fox or message-buffer) pattern is selected on the BERT Setup screen.

Table 9-4
Sync or Async BERT (Line Setup screen)

FORMAT:	SYNC	ASYNC	ISOC
Mode:	BERT DTE or BERT DCE	BERT DTE or BERT DCE	BERT DTE or BERT DCE
Code:	EBCDIC, ASCII, EBCD, XS-3, IPARS, SELECTRIC	EBCDIC, ASCII, EBCD, XS-3, IPARS, SELECTRIC	EBCDIC, ASCII, EBCD, XS-3, IPARS, SELECTRIC
Bits:	8, 7, 6, or 5	8, 7, 6, or 5	8, 7, 6, or 5
Parity:	none	none, even, or odd; mark or space (except 8 bits)	none, even, or odd; mark or space (except 8 bits)
Stop bits:	N/A	1 or 2	1 or 2
Clock source:	external, internal, or internal split	internal or internal split	external, internal, or internal split
Speed:	selectable (except external)	selectable	selectable (except external)
Bit order/polarity:	normal, rev-nor, nor-inv, rev-inv	normal, rev-nor, nor-inv, rev-inv	normal, rev-nor, nor-inv, rev-inv

9.7 Run Mode: Keyboard Control

Whenever you press [RUN], the INTERVIEW will begin to operate as both a BERT generator and analyzer.

It will begin immediately to transmit the bit pattern chosen on the BERT Setup menu according to the format entered on the Line Setup menu. The pattern will repeat until the test ends: see Test Length, Section 9.5(G).

(A) Freezing the Test

The pattern can be interrupted from the keyboard. Pressing [PROGRAM] or [FREEZE] will drive the analyzer out of sync and stop the counters. Freeze mode retains the latest results display on the screen (Figure 9-8). Hitting [FREEZE] a second time will unfreeze the analyzer and resume the count from the frozen readings.

(B) Restarting the Test

The [FREEZE] key restarts a frozen test.

To restart a test while it is running, use the [F1] softkey, labeled RESTART. This restart also reinitializes the synching process. To clear and restart the counters, press [F3], RESET. Softkey selections in Run mode are illustrated in Figure 9-8.

Hitting [PROGRAM] and [RUN] will also restart everything—test, synching process, and counters.

(C) Manual Errors

You may introduce errors into the BERT transmission one at a time via softkey. One errored bit will be sent each time the operator presses [F1] (INJ1ERR).

(D) Automatic Error Injection

Automatic error-injection can be turned on and off by softkey. Press [F2], ERR INJ, to toggle this function. See Section 9.5(H), for an explanation of error rates.

(E) Clearing the Results Screen

To clear the counters without losing sync, press [F3], RESET.

(F) Restarting the Test Function

The test function length was determined on the BERT Setup screen to be measured in blocks, bits, or seconds, or to run continuously. Pressing [F4], RESTART, restarts the test and reinitializes the synching process.

(G) Disabling Transmission

You may prevent the BERT pattern from being transmitted while the INTERVIEW analyzes a received pattern. If the unit is in BERT DTE mode, move the breakout switch for pin 2 on the test-interface module (TIM) to the open position. If the unit is in BERT DCE mode, open pin 3 instead.

9.8 Run Mode: Status Line

The status line of the Run-mode BERT display, shown in Figure 9-8, identifies the BERT test and the parameters chosen on the Line Setup menu. The INTERVIEW is using these parameters both to transmit and to analyze. Figure 9-8 shows a BERT 511 test in EBCDIC code; with 8 information bits, no parity, and full duplex pattern; and in synchronous mode.

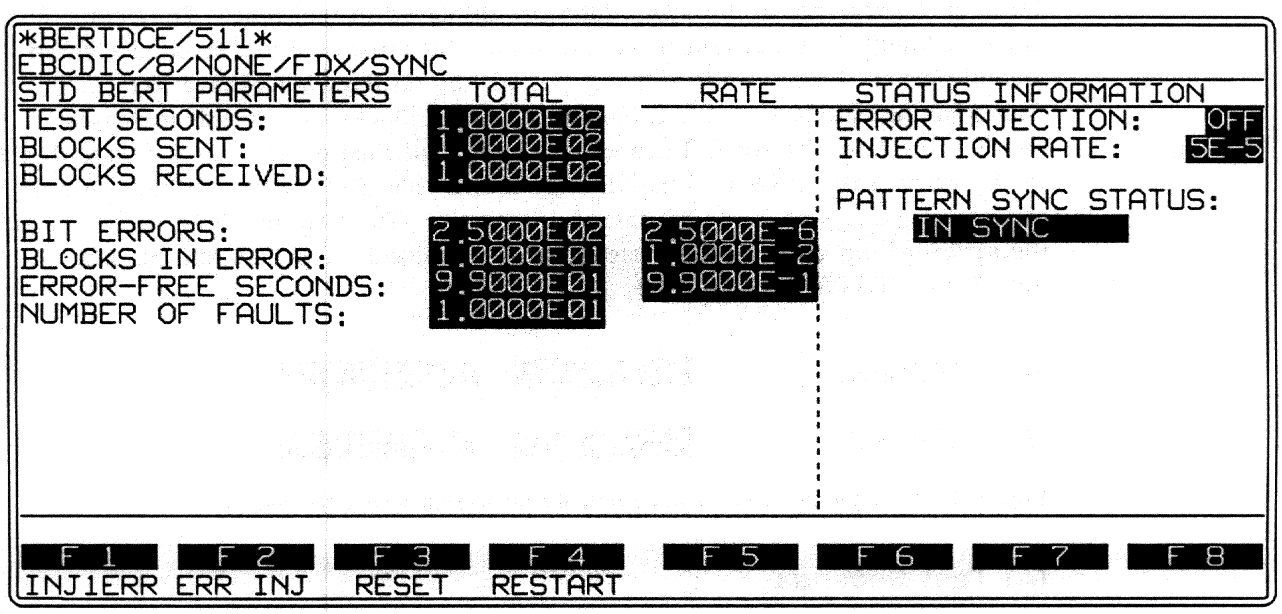


Figure 9-8 The BERT Results screen displays setup status, receiver-sync status, error injection rate, seven counters, and three rate calculations.

9.9 Run Mode: Statistical Display

BERT counters increment to $2^{64} - 1$, or approximately 1.8 times 10^{19}. For practical purposes these counters are unlimited.

Each counter enters Run mode at 0.0000E00. The top of Figure 9-9 shows the block counter on the verge of rolling over to a new exponential value. The bottom of the figure shows the effect of the next block received: the exponent has incremented so that the counter is being updated on every tenth count instead of every one. The counter will be updated next when ten new blocks have been received.

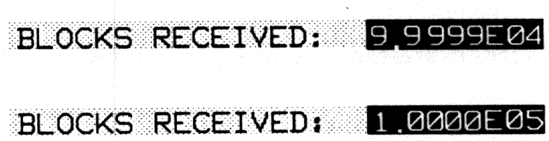


Figure 9-9 This is a before-and-after illustration of the block counter receiving its 100,000th block.

Three of the counters have Rate displays adjacent to them. See Figure 9-8. These rates are to be read in the same way you would read an entry in the **Injection Rate** field on the BERT Setup menu (see Section 9.5(H)): 9.0000E-3 means 9 times

$1/10^3$ or 9 errors per 1,000 bits. Rates are displayed in real time. They enter Run mode at 0.0000E-0 and remain at zero until a bit error or block error or errored second occurs. Once an error rate is posted, the displays will behave like decrementing counters: while the number of bits, blocks, or seconds increases steadily, the rate of error will decrease. The top of Figure 9-10 shows a Rate display for bit errors that stands at 1.0000E-4 or 1 error per 10,000 bits. When the next bit arrives, unless it is an error the rate will decrease. The bottom of the figure shows the action of the display as the rate of error decreased: 1 per 10,000 became 9.9999 per 100,000 (9.9999E-05).

```
BIT ERRORS:          1.4000E01   1.0000E-04

BIT ERRORS:          1.4000E01   9.9999E-05
```

Figure 9-10 As the rate of error decreases, the minus-exponent grows larger.

(A) Test Seconds

This counter is incremented once for every second the test runs.

(B) Blocks Sent

The current number of blocks sent is recorded here. A block is defined in Section 9.5(F).

(C) Blocks Received

This shows the current number of blocks received. If this count is not incrementing, the INTERVIEW is not synching on a pattern and the PATTERN SYNC STATUS field on the lower right of the BERT statistical display screen should say OUT OF SYNC.

(D) Bit Errors

The bit sequence received is compared with that expected in accordance with the parameters chosen on the Line Setup menu and the BERT Setup screen. The count of received bits that do not match the expected pattern is displayed here. This counter value in relation to total bits is given in the Rate column at the right of the counter, expressed in errors per exponent of 10.

(E) Blocks In Error

The number of blocks in which one or more bit errors have occurred is recorded. A rate calculation of this value to total blocks received is given to the right of the counter in real time.

> **NOTE:** If two testers are being used, verify that both are defining block size in the same way. See Section 9.5(F).

(F) Error-Free Seconds

This counter will increment when the Test Seconds counter increments until one or more errors have been found during the last second. The rate of this counter value compared to total seconds is given to the right of the counter in real time.

(G) Number Of Faults

"Fault" has different meanings for full and half duplex. In full duplex, a fault is recorded whenever an error is detected in more than 25 percent of the bits received over a certain period of time (approximately 16 bits in 64 contiguous bits). This percentage is considered sufficient to indicate that a bit time has been missed.

In full duplex, if **Resync:** ON has been selected on the Transmit Mode menu the INTERVIEW's receiver will resynchronize every time a fault is found.

In half duplex, a fault occurs when the analyzer sees bit transitions that indicate a new block of BERT data but fails to recognize the sync pattern or the sync character.

(H) Error Injection

The status of Error Injection may be ON or OFF; it is toggled manually by the ERR INJ softkey. In Run mode it is turned on and off by the F2 softkey.

(I) Injection Rate

This status field simply reports the error-injection rate that the user has entered on the BERT Setup menu.

(J) Receiver

BERT analysis begins when the receiver synchronizes on incoming data. The **PATTERN SYNC STATUS** line on the results screen reports on receiver status. At all times during a BERT run, the line displays one of two messages, IN SYNC or OUT OF SYNC.

Once synchronization is established, the receiver can go out of sync only if **Resync:** ON is selected. During the out-of-sync condition, data is not analyzed for error.

When the resync function is turned off, the IN SYNC condition, once established, will remain in effect until the test ends. This setup is appropriate for relatively brief tests on noisy circuits.

9.10 Loopback at the Transmitting INTERVIEW

The INTERVIEW can analyze its own BERT transmission without being connected to the data interface. This is a good way for you to become familiar with the BERT test procedure before you apply it to a system.

With the interface disconnected, power up the unit and select **Mode:** BERT DCE on the Line Setup menu. Then select a configuration compatible with the specifications in Table 9-2 and Table 9-3. Select internal clock.

Press [RUN]. You will see only the first two counters, Test Seconds and Blocks Sent, incrementing. This is the way the Run-mode display will appear when you are sending the BERT pattern to another BERT analyzer. No statistical analysis is being done because the BERT analyzer is not seeing the transmitted pattern. The report on Receiver status is OUT OF SYNC.

Press [PROGRAM]. On the breakout box on the test-interface module (TIM), patch TD to RD. Press [RUN]. This time you will see the first three counters incrementing: Test Seconds, Blocks Sent, and Blocks Received. The receiver is now IN SYNC. The INTERVIEW's BERT analyzer can see its own transmission but it is unlikely that it will find any errors in its own data.

Use the [F1] key to introduce errors into the transmission. Observe the next three counters and the rate measurements alongside them. The [F1] key will not introduce a fault.

Run another test into which you have injected automatic errors. An **Error Injection Rate** entry of 1E-5 on the BERT Setup screen will produce one errored bit for every 100,000 bits and a bit-error rate of 1.0000E-5.

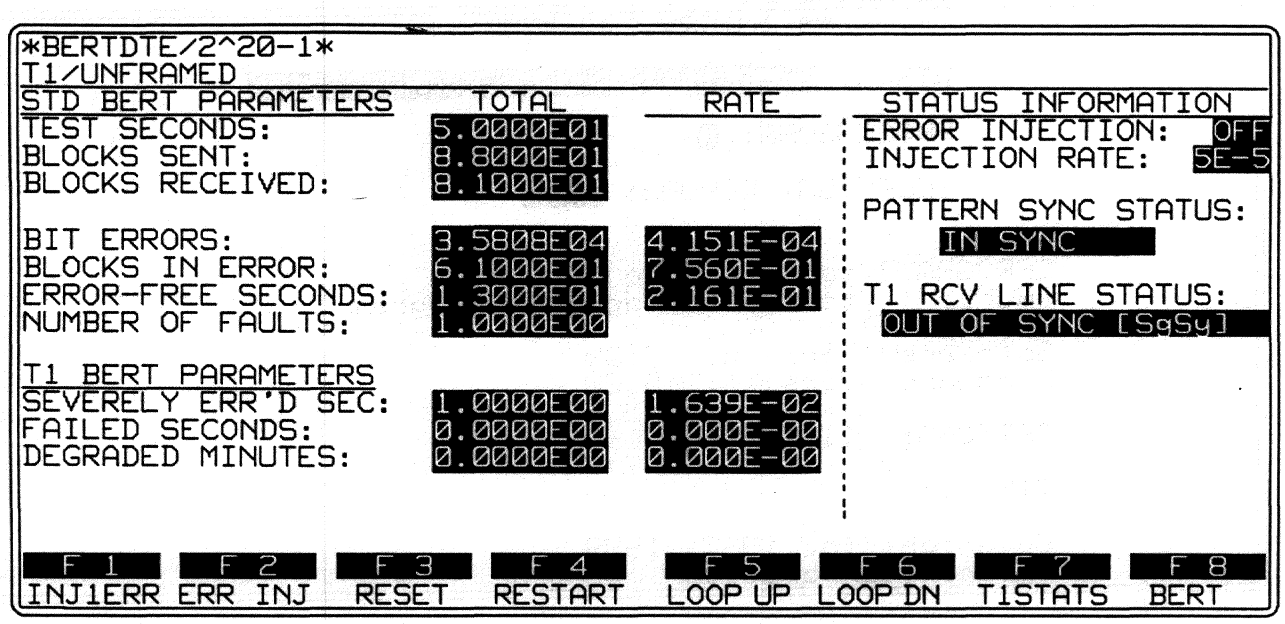


Figure 9-11 T1 BERT Statistics screen.

9.11 T1 BERT

The INTERVIEW can perform both framed and unframed BERT tests on T1 transmissions. An individual channel may also be BERT tested. Tests may be performed in a simple loopback configuration or in conjunction with another INTERVIEW or BERT tester. For further discussion of test configurations, refer to Section 9.2.

A T1 BERT display (see Figure 9-11) tracks test results in Run mode. In addition to T1 BERT testing, statistics are gathered on the quality of the T1 circuit whenever the T1 TIM is installed. These statistics are displayed and constantly updated on a separate screen, which is accessible from the BERT statistics screen during run time. Regular T1 statistics and modifiable selections that pertain to these statistics are described in Section 49.

(A) The T1 BERT Option

T1 BERT capabilities are available as part of the overall T1 option, which consists of a factory-installed multiplexer board and a removable Test Interface Module. If you have T1 BERT installed, Option 11-1 will be displayed on the start-up screen of the INTERVIEW when you turn it on. The TIM posted on the same screen must be T1 (see example in Figure 9-12).

```
                    ** INTERVIEW  7500 **

         DISKS: FLOPPY 1  FLOPPY 2  HARD DISK

         PROCESSORS: 4

         SELF TEST ERRORS: NONE

     Press:
     [PROGRAM]  to enter the menu page
     [RUN]      to run the default program

     Software   Version:  7.00
     Firmware   Version:  5.00

     OPTIONS:   11-1

     TIM: T1

     Copyright (c) 1987, 1989
     Telenex Corporation
```

Figure 9-12 Power-up screen, INTERVIEW 7500.

(B) Preparing for T1 BERT Testing

Setting up for T1 BERT requires installation of the correct Test Interface Module, proper cabling, and making menu selections. In addition to the selections made on the BERT Setup screen, certain selections must be checked on the Line Setup screen and the T1 FEB Setup screen.

1. *Install the T1 TIM.* T1 testing can be done only when the T1 TIM, described in Section 49.2, is in place. Before powering up the INTERVIEW, install the T1 TIM as described in Section 1.10.

2. *Cable the T1 TIM.* With the power switch still OFF, connect to a data source as described in Section 49.2(A). When the TIM is in place and cabling is complete, power on the unit.

   Several types of cable may be used for T1 testing. The cable type and its length must be specified on the Line Setup screen, along with other items discussed in the next paragraph.

3. *Configure the Line Setup screen.* Before you run a T1 test, you must configure the Line Setup screen for the type of testing you wish to do. Select **Mode:** BERT DTE if you are operating as a DTE and testing a remote Channel Service Unit (CSU) or a transmission link. Select **Mode:** BERT DCE to test a CSU in local loopback mode.

CAUTION: When the INTERVIEW operates in broadband or normal channel transmit mode, it interrupts the regular exchange of data on the circuit for the duration of the test. Be certain you have permission to test the circuit before you proceed.

NOTE: Clocking of T1 data is not provided by the standard data clock. As a result, the **Clock** selection on the Line Setup screen is overridden. An applicable clock selection is provided on the T1 Interface Control screen and is described in Section 49.5.

NOTE: Channel BERT selections pertaining to half duplex operation are not applicable to T1 BERT.

Make other Line Setup selections as described in Section 9.3.

```
                       ** Interface Control **

T1 Line Setup                         T1 Data Path Setup
Receiver Gain: 0 db                   Framing Mode: D4
Termination: BRIDGED                  Data Path: 64K DATA CHANNEL
Cable Type: MAT                       Channel Number: 01
Cable Length: 0-220                   Yellow Alarm: F-BIT 12 = 1
                                      Sync Procedure: ALL F-BITS
                                      Sync Length: 10 bit
                                      B8ZS Coding: NO

T1 Transmit Setup                     Record Framing Bits: YES
Transmit Mode: NORMAL
Idle Select: 7F                       T1 Signal Channel Setup
Line Clock Select: INTERNAL           Signal Channel Number: 24
                                      Signal Channel Idle Char: 7E
                                      Sig Channel Polarity: NORMAL

Select Setup To Perform:
 F 1     F 2     F 3     F 4      F 5     F 6     F 7     F 8
 LINE    XMIT    PATH    SIGNAL
```

Figure 9-13 Interface Control Screen for T1 Protocol.

4. *Configure the T1 Interface Control screen.* Select the channel to be tested as the **Data Path** and **Channel Number** on the Interface Control screen (see Figure 9-13). T1 framing, syncing, code format, alarm procedures, and cable length are also controlled on the Interface Control screen. The **T1 Signal Channel Setup** fields pertain only to dual-channel T1 Primary Rate ISDN.

Transmit Mode in the T1 Transmit Setup selections pertains only to Channel BERT testing. Only one of the 24 available T1 channels is BERT–tested at one time. This selection determines what will be transmitted to the other channels which are not under test. The choices are NORMAL and DROP–AND–INSERT.

In NORMAL transmit mode, the standard milliwatts pattern of all 1's is transmitted on the 23 remaining channels.

In DROP–AND–INSERT transmit mode, all received channels pass through the INTERVIEW unchanged, with the exception of the channel under test. The specified channel BERT pattern is inserted into this channel in place of the original data.

Use drop–and–insert transmit mode when the INTERVIEW is operating in BERT DCE mode in order to test a T1 mux (using another INTERVIEW to emulate the user DTE).

Use drop–and–insert transmit mode when the INTERVIEW is operating in BERT DTE mode to test Channel Service Units and phone lines.

For more information on normal or drop–and–insert transmit mode, refer to Section 49.5(E).

Make selections on the T1 Interface Control screen as described in Section 49.5.

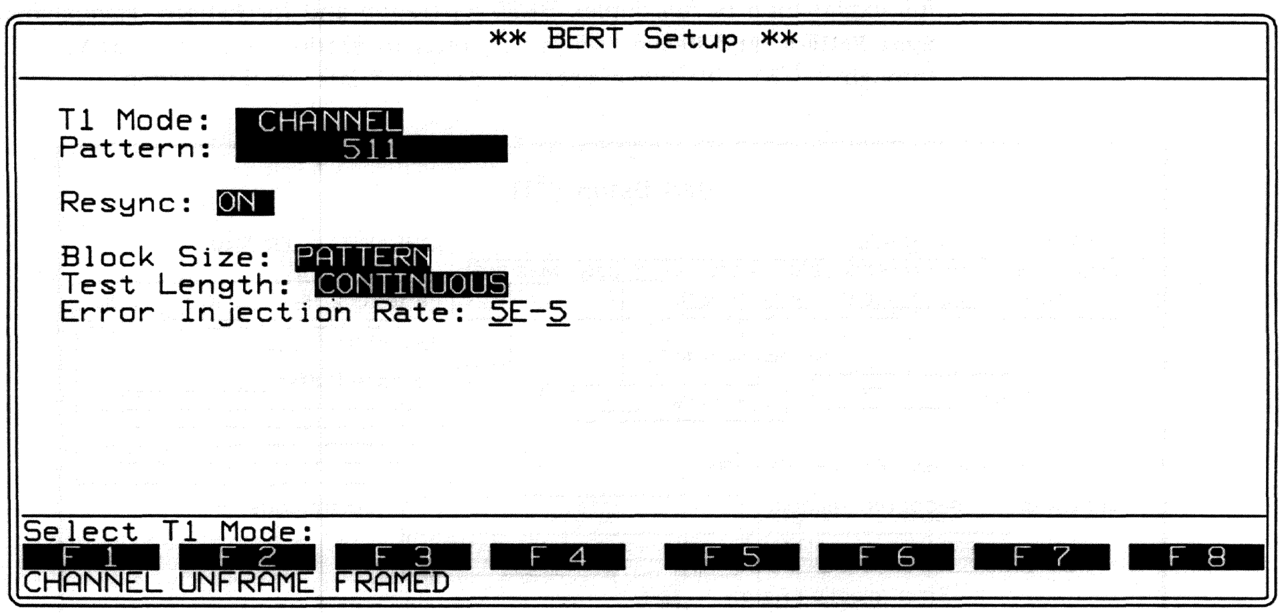


Figure 9-14 The T1 BERT Setup screen.

(C) T1 BERT Setup Screen

The default T1 BERT Setup screen is shown in Figure 9-14. For a full set of options available on this screen, refer to Figure 9-15. As illustrated in Figure 9-15, there are three modes available for T1 BERT testing. These are CHANNEL, UNFRAMED, and FRAMED.

Channel mode is used for single channel testing and may be done transparently (when drop-and-insert mode is used) so that transmissions on other channels experience minimal interruption.

> **NOTE:** At the instant that you begin running a test which employs the INTERVIEW in drop-and-insert transmit mode, on-going transmissions on all T1 channels on the circuit will be momentarily disrupted. This is true even though the INTERVIEW is already connected into the circuit. The interruption is minimal, however, and is not likely to produce a framing error or resynchronization.

Unframed and framed modes, on the other hand, are "broadband" BERT tests; that is, all channels on the T1 circuit are involved in the test.

1. *Channel mode.* T1 channel mode is similar to *full-duplex* RS-232 BERT testing, with the exception that **Block Size** selections are much larger. For a

full explanation of full duplex BERT operation and for **Pattern, Handshake, Sync Pattern,** and **Resync** selections, refer to Sections 9.3 and 9.5(A) through 9.5(F). T1 block sizes are described later in this section.

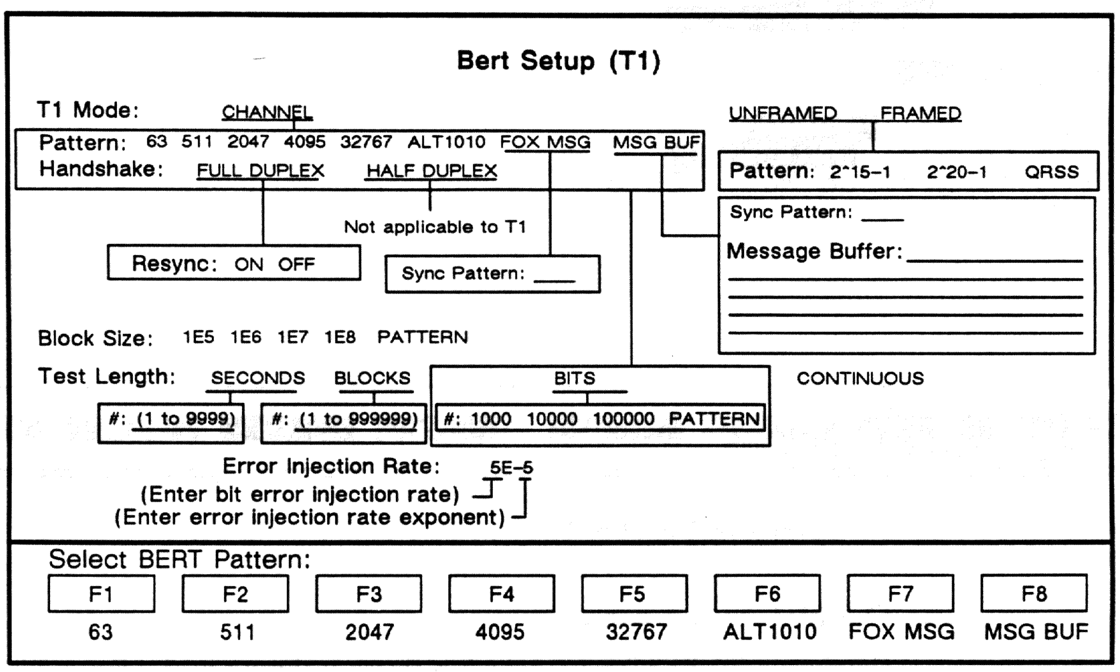


Figure 9-15 T1 BERT menu options.

2. *Unframed T1 BERT mode.* This mode sends the BERT pattern in every T1 bit position. Channel and framing conventions are ignored. When unframed BERT is the T1 mode, three **Pattern** selections are available. These selections are discussed in subsequent paragraphs.

3. *Framed T1 BERT mode.* This mode provides framing bits according to the convention chosen by the user (i.e., D4 or ESF; see discussion in Section 49). These bits are inserted in between (not written over) the BERT pattern during transmission, which means that error injection during the BERT test will never cause a framing error. When framed BERT is the T1 mode, the same three patterns available with unframed T1 BERT may be used (see the discussion in the next paragraph).

4. *Pattern.* The patterns shared by framed and unframed BERT differ from the patterns available with channel BERT. Channel BERT patterns are described in Section 9.5(A).

   For framed and unframed T1 BERT, the three selections in the **Pattern** field are $2^{15}-1$ (which is equivalent to the 32767 pattern and simulates the output of a 15-bit shift register); $2^{20}-1$ (which simulates the output of a 20-bit shift register); and QRSS (or Quasi-Random Signal Source, which is similar to the $2^{20}-1$ pattern but observes the 1's density prescribed for transmission by suppressing any string of 15 or more 0's.)

5. *Block size.* A block is a component of a test: complete tests may be measured in blocks. In T1 channel BERT, **Block Size:** PATTERN selections are the same as for RS-232 BERT (see Section 9.5(F)); otherwise, the **Block Size** selection is a certain number of bits. Blocks measured in bits (as described in the next paragraphs) are larger for T1 channel BERT than are RS-232 blocks.

   For framed or unframed T1 BERT, a block can be the length of a cycle as indicated by one of the three **Pattern** selections or a certain number of bits.

   T1 block sizes measured in bits are 100,000 (1E5); 1,000,000 (1E6); 10,000,000 (1E7); and 100,000,000 (1E8).

   CAUTION: The definition of a block varies from standard to standard and from BERT tester to BERT tester. Some standards define a block as the pattern length while others specify 1,000 bits. The user must ascertain and then select the proper definition.

6. *Test length.* Tests are measured in blocks or seconds; or they may be CONTINUOUS. In Channel BERT, they may also be measured in bits.

   The **Test Length:** BLOCKS selection brings up a four-digit # field that accepts entries from 1 to 9999. If PATTERN has been selected in the **Block Size** field, the length of the test may be determined by multiplying this figure by the number of bits in the selected test pattern.

   The **Test Length:** SECONDS field also brings with it a # field, with five places for numbers from 1 to 99,999. The maximum number of seconds comes to slightly more than twenty-seven and three-quarter hours.

   The **Test Length:** BITS selection brings up a field that accepts entries of 1000, 10,000, 100,000 or a pattern. If PATTERN has been selected in the **Block Size** field, the length of the test is the number of bits in the selected test pattern.

7. *Error injection rate.* Errors can be injected in a bit pattern automatically at a preselected rate. Refer to Section 9.5(H) for more information on the pre-determined injection rate. Errors may also be injected manually, one-at-a-time, from the keyboard as explained in Section 9.11(E).

```
*BERTDTE/2^20-1*
T1/UNFRAMED
STD BERT PARAMETERS        TOTAL        RATE        STATUS INFORMATION
                                                    ERROR INJECTION:      OFF
TEST SECONDS:            1.0000E02                  INJECTION RATE:       5E-5
BLOCKS SENT:             1.0000E02
BLOCKS RECEIVED:         1.0000E02                  PATTERN SYNC STATUS:
                                                           IN SYNC
BIT ERRORS:              2.5000E02   2.5000E-6
BLOCKS IN ERROR:         1.0000E01   1.0000E-2      T1 RCV LINE STATUS:
ERROR-FREE SECONDS:      9.9000E01   9.9000E-1            NORMAL[]
NUMBER OF FAULTS:        1.0000E01

T1 BERT PARAMETERS
SEVERELY ERR'D SEC:      1.0000E01   1.0000E-8
FAILED SECONDS:          0.0000E00   0.0000E00
DEGRADED MINUTES:        0.0000E00   0.0000E00

   F 1      F 2      F 3      F 4       F 5      F 6      F 7      F 8
INJ1ERR  ERR INJ   RESET   RESTART  LOOP UP  LOOP DN  T1STATS   BERT
```

Figure 9-16 Sample T1 BERT Statistics screen in Run mode.

(D) T1 BERT Statistics Screen

As long as a BERT emulation mode has been selected on the Line Setup screen and the T1 hardware options are installed, the T1 BERT Statistics display appears on the screen. An example of the display is shown in Figure 9-16.

The top of the screen shows which side of the line the INTERVIEW is emulating, indicates whether channel, unframed, or framed testing is being done, and gives additional information on test selections.

Certain test status information is tracked at the far right of the screen. The **ERROR INJECTION** field indicates whether or not the operator has turned on automatic injection rate by pressing the appropriate function key during run-time. The **INJECTION RATE** field indicates the programmer's entry for automatic error injection on the T1 BERT Setup screen (see Section 9.5(H)). The **PATTERN SYNC STATUS** (as opposed to the line syncing status) field indicates whether the BERT pattern is in or out of sync (see discussion in Section 9.9(J)). The **T1 RCV LINE STATUS** field reflects the **T1 LINE CONDITIONS** information given on the regular T1 Statistics screen (see Section 49.6(O)).

The remainder of the screen provides constantly updated test statistics. Values for BERT parameters (far left of screen) are posted in highlighted boxes in the center of the screen. In addition to total values, rates (that is, total occurrences divided by **TEST SECONDS**) are given in a highlighted box to the right of the totals. All values are measured starting from the last time [RUN], **RESET**, or **RESTART** was pressed.

1. *Test seconds*. This indicates the time elapsed since [RUN], **RESET**, or **RESTART** was pressed.

2. *Blocks sent*. This value represents the number of blocks which the INTERVIEW has transmitted. Blocks are recognized according to the block size (in terms of bits) or the pattern (one block per complete pattern) as selected in the **Block Size** and **Pattern** fields on the T1 BERT screen.

3. *Blocks received*. This is the number of blocks received from the remote end. These blocks are measured according to the same criteria as the number of blocks sent.

4. *Bit errors*. This value represents the number of individual bits received in error. The number of bits in error divided by the total bits received is posted in the **RATE** column.

5. *Blocks in error*. This value indicates the number of blocks received in which one or more bits were found to be in error. The rate which appears to the right is the total blocks in error divided by total blocks received.

6. *Error–free seconds*. This value is the number of **TEST SECONDS** during which no bit error, framing error, CRC error, or bipolar violation was recorded. The rate given to the right is total error–free seconds divided by total **TEST SECONDS**.

7. *Number of faults*. This is the number of times that the number of bits in error has exceeded 25% for at least 1/50th of a second.

8. *Severely errored seconds*. This is the number of individual seconds during which any of the following occurred: 320 or more Out of Frame conditions or CRC errors (see description in Section 49.6(H) and 49.6(I)); or the bit error rate was worse than 1E–3; that is, 1 X 10^{-3} power. (Ten or more consecutive Severely Errored Seconds constitute a Failed Signal State.)

9. *Failed seconds*. This is the duration of a Failed Signal State in seconds. The tenth consecutive Severely Errored Second is the first Failed Second. A failed signal state lasts until 10 consecutive seconds are *not* Severely Errored Seconds. Thus, there will always be at least 10 failed seconds recorded at one time.

10. *Degraded minutes*. This is the number of minutes during which the bit error rate exceeds 1E–6.

(E) Run-time Function Keys for T1 BERT

The function keys shown in Figure 9-17 appear at the bottom of the T1 BERT Statistics display when the INTERVIEW is running a T1 BERT test. You may access the T1 Statistics screen and the regular BERT screen, both of which are active while a T1 BERT test is in progress, by pressing the appropriate function key. Alternate screens have the same rack of function keys and so allow you to return to the original display.

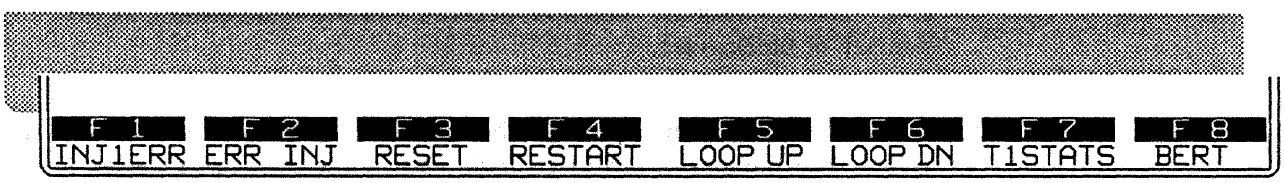


Figure 9-17 Run-time function keys available when performing a T1 BERT test.

1. *Inject one error.* The function key labeled INJ1ERR injects a single bit error into the INTERVIEW's T1 BERT transmission. If this key is used when error injection is on (see next paragraph), the single error is simply added to the automatic error rate.

2. *Error injection at pre-determined rate.* The function key labeled ERR INJ is an alternate-action function key which turns off the automatic error injection; or turns it back on and inserts errors into the T1 BERT transmission at the rate selected on the T1 BERT Setup screen. (See Section 9.5(H) for a description of the selection.) Error injection is off when the INTERVIEW enters Run mode. The **ERROR INJECTION** field at the far right of the screen tells you whether automatic error injection is currently on or off.

3. *Reset.* The function key labeled RESET sets the value of all timers and counters, including T1 counters, to zero. The BERT test continues, however.

4. *Restart.* The function key labeled RESTART is used to initiate T1 BERT testing again, once it has stopped at the point determined by the Test Length selection on the T1 BERT Setup screen. All counters and timers, including T1 counters, and elapsed time (TEST SECONDS) continue from wherever they stopped.

5. *Loop up.* The function key labeled LOOP UP sends a Loop-up command (for a duration of 5.5 seconds) to the remote CSU. This command allows

any pattern of data to be transmitted to the remote CSU for any length of time desired. Assuming that the remote CSU is functioning properly, all data will be looped back on the corresponding return lead thereafter.

NOTE: It is not necessary to send the Loop-up command, however, when the INTERVIEW is troubleshooting the line while remotely connected to another BERT tester.

CAUTION: Do not activate the Make lead on the T1 TIM when a T1 BERT test is in progress. Since the Loop-up signal has already been sent, generating a second Loop-up signal risks locking up all equipment under test and the INTERVIEW in a continuous data loop.

CAUTION: Do not activate the Break lead on the T1 TIM when a T1 BERT test is in progress, since this will interrupt the test in progress. The Loop-down signal can be generated from the T1 BERT screen as explained in the next paragraph.

6. *Loop down.* The function key labeled LOOP DN sends a Loop-down command to the remote CSU (for a duration of 5.5 seconds). This command takes the remote end out of loopback, so that it is capable of responding normally to received data rather than echoing it back without interpretation.

```
*BERTDTE/2^20-1*
T1/UNFRAMED
```

T1 STATISTICS	DTE	RATE	DCE	RATE
TEST SECONDS:	1.0000E03			
FRAMES RCVD:	8.0000E05		0.0000E00	
BPV'S RCVD:	1.2300E02	1.2550E-5	0.0000E00	0.0000E00
BPV-FREE SECS:	9.8000E02	9.8000E-1	0.0000E00	0.0000E00
FRAMING ERRORS:	0.0000E00	0.0000E00	0.0000E00	0.0000E00
CRC ERRORS:	0.0000E00	0.0000E00	0.0000E00	0.0000E00
ESF ERRORS:	0.0000E00	0.0000E00	0.0000E00	0.0000E00
CARRIER LOSSES:	0.0000E00	0.0000E00	0.0000E00	0.0000E00
SYNC LOSSES:	0.0000E00	0.0000E00	0.0000E00	0.0000E00
SYNC LOSS TIME:	0.0000E00	0.0000E00	0.0000E00	0.0000E00
ERROR-FREE SECONDS:	9.8000E02	9.8000E-1	0.0000E00	0.0000E00

T1 LINE CONDITIONS	DTE	DCE
CURRENT [PREVIOUS]	NORMAL [ ]	NORMAL [ ]

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
INJ1ERR	ERR INJ	RESET	RESTART	LOOP UP	LOOP DN	T1STATS	BERT

Figure 9-18 The T1 Statistics screen is an alternate run-time screen during T1 BERT testing.

7. *T1 statistics display*. The function key labeled T1STATS changes the INTERVIEW screen to the regular T1 statistics display (see example in Figure 9-18). The contents of this display are described in Section 49.

8. *Regular BERT display*. The function key labeled BERT changes the INTERVIEW screen to the regular BERT statistics display (see example in Figure 9-8). The contents of the regular BERT display are described in Section 9.9. Press the function key labeled BERT again to return to the T1 BERT statistics screen.

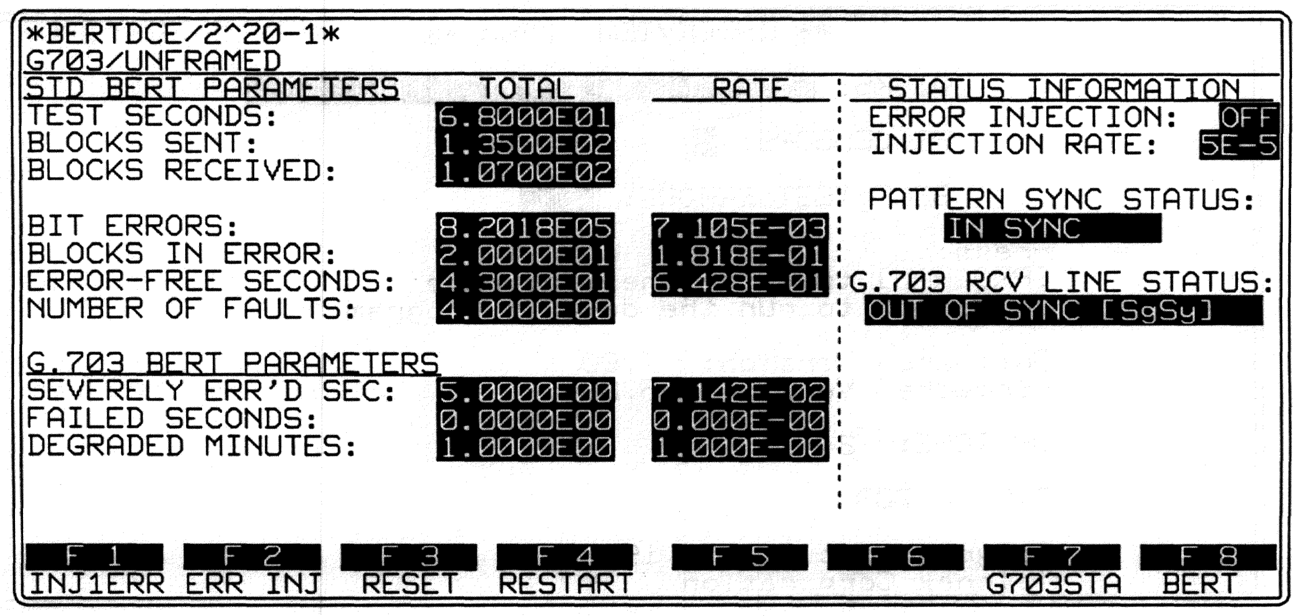


Figure 9-19 G.703 BERT Statistics screen.

9.12 G.703 BERT

The INTERVIEW can perform both framed and unframed BERT tests on G.703 transmissions. An individual channel may also be BERT tested. Tests may be performed in a simple loopback configuration or in conjunction with another INTERVIEW or BERT tester. For further discussion of test configurations, refer to Section 9.2.

A G.703 BERT display (see Figure 9-19) tracks test results in Run mode. In addition to G.703 BERT testing, statistics are gathered on the quality of the G.703 circuit whenever the G.703 TIM is installed. These statistics are displayed and constantly updated on a separate screen, which is accessible from the BERT statistics screen during run time. Regular G.703 statistics and modifiable selections that pertain to these statistics are described in Section 50.

(A) The G.703 BERT Option

G.703 BERT capabilities are available as part of the overall G.703 option, which consists of a multiplexer board and a removable Test Interface Module. If you have G.703 BERT installed, Option 24-1 will be displayed on the start-up screen of the INTERVIEW when you turn it on. The TIM posted on the same screen must be G.703 (see example in Figure 9-20).

```
                    ** INTERVIEW  7500 **

          DISKS: FLOPPY 1  FLOPPY 2  HARD DISK

          PROCESSORS: 4

          SELF TEST ERRORS: NONE

      Press:
      [PROGRAM] to enter the menu page
      [RUN]     to run the default program

      Software  Version:  7.00
      Firmware  Version:  5.00

      OPTIONS:  24-1

      TIM: G.703

      Copyright (c) 1987, 1989
      Telenex Corporation
```

Figure 9-20 Power-up screen, INTERVIEW 7500.

(B) Preparing for G.703 BERT Testing

Setting up for G.703 BERT requires installation of the correct Test Interface Module, proper cabling, and making menu selections. In addition to the selections made on the BERT Setup screen, certain selections must be checked on the Line Setup screen and the G.703 Interface Control screen.

1. *Install the G.703 TIM.* G.703 testing can be done only when the G.703 TIM, described in Section 50.2, is in place. Before powering up the INTERVIEW, install the G.703 TIM as described in Section 1.10.

2. *Cable the G.703 TIM.* With the power switch still OFF, connect to a data source as described in Section 50.2(A). When the TIM is in place and cabling is complete, power on the unit.

   Depending upon the connector used on the TIM, two types of cable may be used for G.703 testing and the **Line Impedance** field selections must match the ohm-value indicated on the TIM. For DE-9 connectors with twisted pair cabling, select 120 ohms line impedance; for BNC connectors with standard coax cabling, select 75 ohms line impedance.

3. *Configure the Line Setup screen.* Before you run a G.703 test, you must configure the Line Setup screen for the type of testing you wish to do. Select **Mode:** BERT DTE if you are operating as a DTE and testing a transmission link or testing toward the network. Select **Mode:** BERT DCE to test toward the multiplexer.

CAUTION: When the INTERVIEW operates in broadband or normal channel transmit mode, it interrupts the regular exchange of data on the circuit for the duration of the test. Be certain you have permission to test the circuit before you proceed.

NOTE: Clocking of G.703 data is not provided by the standard data clock. As a result, the **Clock** selection on the Line Setup screen is overridden. An applicable clock selection is provided on the G.703 Interface Control screen and is described in Section 50.5.

NOTE: Channel BERT setup selections pertaining to half duplex operation are not applicable to G.703 BERT.

Make other Line Setup selections as described in Section 9.3.

```
                         ** Interface Control **
                            G.703 / 2.048MBPS
Line Setup                              Data Path Setup
Coding Type: HDB3                       Data Path: 64K DATA CHANNEL
Line Impedance: 75 OHMS                 Channel Mode: SAME
Receiver Gain: 0 db                     Channel Number: 01
Termination: BRIDGED                    Enable CRC-4: NO
                                        Signalling Type: CAS
                                        Begin CAS MF W/Frame Contain-
Transmit Setup                           ing Frame Align. Signal: YES
Transmit Mode: NORMAL                   Extra Bits: 111
Line Clock Select: INTERNAL             National Bits: 11111
Xmit Signalling All 1's                 International Bit: 1
  (CCS Signalling Only): NO             CAS MF Sync Criteria: NORMAL
Xmit Distant MF Alarm                   CAS MF Resync Criteria: NORMAL
  (CAS Signalling Only): NO             Frame Resync Criteria: NORMAL
Xmit Remote Alarm: NO
Begin CAS Multiframe with Frame Containing FAS?
  F 1     F 2     F 3     F 4     F 5     F 6     F 7     F 8
  YES     NO
```

Figure 9-21 Interface Control Screen for G.703 Protocol in Emulate mode.

4. *Configure the G.703 Interface Control screen.* There are different selections on the Interface Control screen pertinent to each type of BERT mode: unframed, framed, or channel BERT.

a. *Unframed BERT.* The Line Setup selections on the G.703 Interface Control screen should be specific to the line to be tested. The rest of the fields on the Interface Control screen are not used in unframed BERT.

b. *Framed BERT.* The Line Setup selections on the G.703 Interface Control screen should be specific to the line to be tested. Those selections specific to the type of signalling selected (CAS or CCS) as well as those specific to CRC-4 errors and channel 0 should also match the line parameters. Other selections are not pertinent. When CAS is the signalling type, the user must not transmit BERT on channel 16 as it is used for signalling information. (Select **Include Ch16:** NO on the BERT Setup screen.)

c. *Channel BERT.* For Channel BERT, select the channel(s) to be tested via the **Data Path, Channel Mode,** and **Channel Number** fields on the Interface Control screen (see Figure 9-21). G.703 framing, syncing, code format, and alarm procedures are also controlled on the Interface Control screen.

Transmit Mode in the G.703 Transmit Setup selections pertains only to Channel BERT testing. One (or two, if **Channel Mode:** SPLIT is selected) of the 31 G.703 data-channels in CCS mode or 30 G.703 data-channels in CAS mode are available for BERT testing at one time. This selection determines what will be transmitted to the other channels which are not under test. The choices are NORMAL and DROP-AND-INSERT.

In NORMAL transmit mode, the standard idle pattern, Ds (hex D5), is transmitted on the remaining data channels. Channel 0, however, always sends framing bits and, if in CAS mode, channel 16 will send signalling information.

NOTE: Do not select **Include Ch16:** YES on the BERT Setup screen.

In DROP-AND-INSERT transmit mode, all received channels pass through the INTERVIEW unchanged, with the exception of the channel under test. The specified channel BERT pattern is inserted into this channel in place of the original data. If **Mode:** BERT DCE is selected, the INTERVIEW transmits the BERT pattern on RD and receives (verifies) on TD; if **Mode:** BERT DTE is selected, the INTERVIEW transmits the BERT pattern on TD and receives (verifies) on RD. If **Channel Mode:** SPLIT is selected, TD and RD are on different channels.

Use drop-and-insert transmit mode when the INTERVIEW is operating in BERT DCE mode in order to test a G.703 mux (using another INTERVIEW to emulate the user DTE).

Use drop-and-insert transmit mode when the INTERVIEW is operating in BERT DTE mode to test phone lines on the network.

For more information on normal or drop-and-insert transmit mode, refer to Section 50.5(E).

Make selections on the G.703 Interface Control screen as described in Section 50.5.

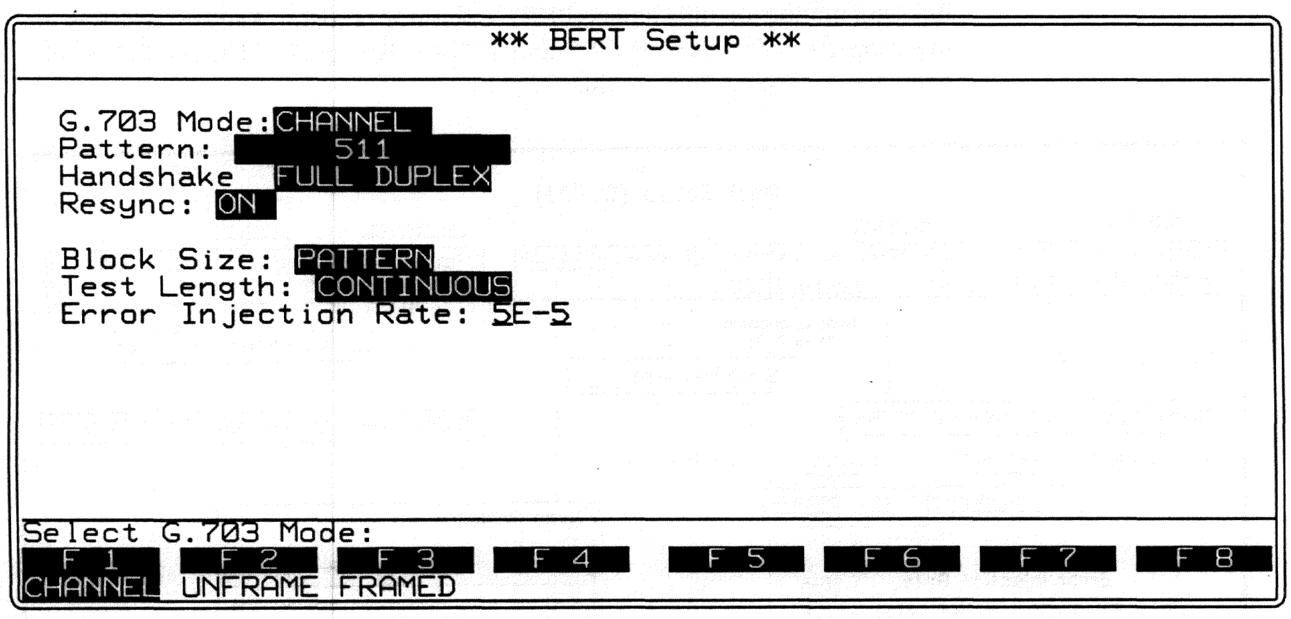


Figure 9-22 The G.703 BERT Setup screen.

(C) G.703 BERT Setup Screen

The default G.703 BERT Setup screen is shown in Figure 9-22. For a full set of options available on this screen, refer to Figure 9-23. As illustrated in Figure 9-23, there are three modes available for G.703 BERT testing. These are CHANNEL, UNFRAMED, and FRAMED.

Channel mode is used for single channel testing and may be done transparently (when drop-and-insert mode is used) so that transmissions on other channels experience minimal interruption.

NOTE: At the instant that you begin running a test which employs the INTERVIEW in drop-and-insert transmit mode, on-going transmissions on all G.703 channels on the circuit will be momentarily disrupted. This is true even though the INTERVIEW is already connected into the circuit. The interruption is minimal, however, and is not likely to produce a framing error or resynchronization.

Unframed mode, on the other hand, is a "broadband" BERT test; that is, all channels on the G.703 circuit are involved in the test. In Framed mode, all channels except the framing channels (0 and, if selected, 16) are included in the testing.

1. *Channel mode.* G.703 channel mode is similar to *full-duplex* RS-232 BERT testing, with the exception that **Block Size** selections are much larger. For a full explanation of full duplex BERT operation and for **Pattern** and **Resync** selections, refer to Sections 9.3 and 9.5(A) through 9.5(F). G.703 block sizes are described later in this section.

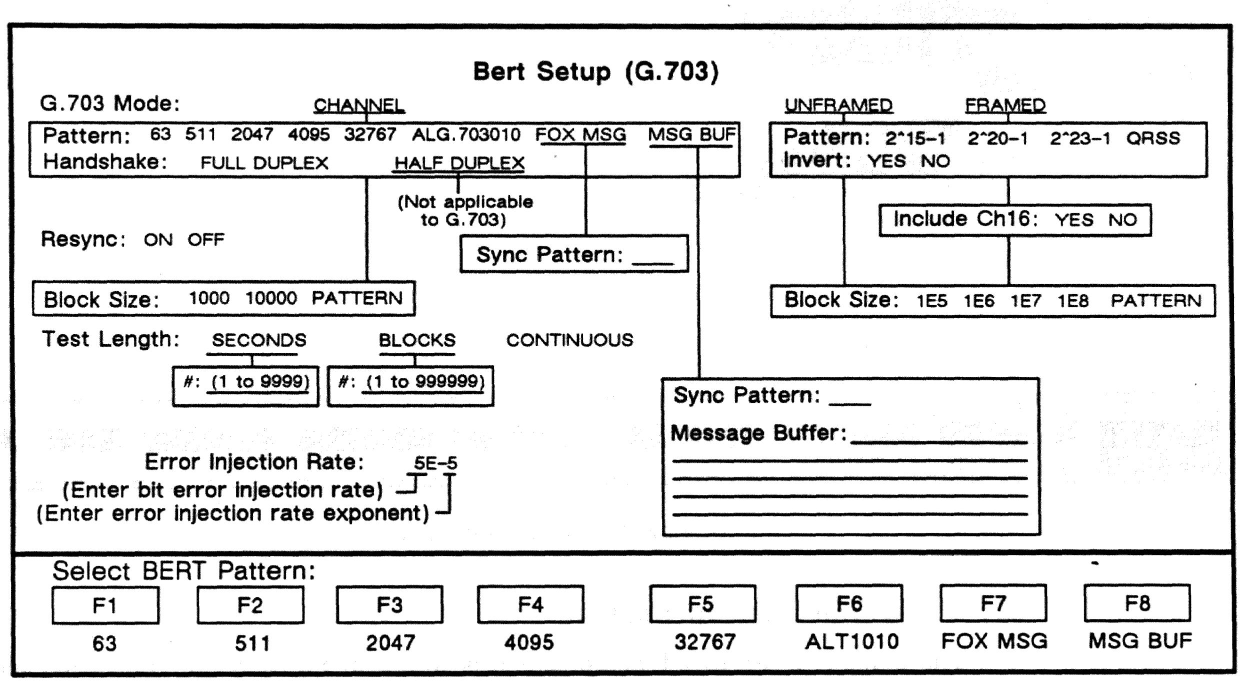


Figure 9-23 G.703 BERT menu options.

2. *Unframed G.703 BERT mode.* This mode sends the BERT pattern in every G.703 bit position, including channel 0. Channel and framing conventions are ignored. When unframed BERT is the G.703 mode, four **Pattern** selections are available. These selections are discussed in subsequent paragraphs.

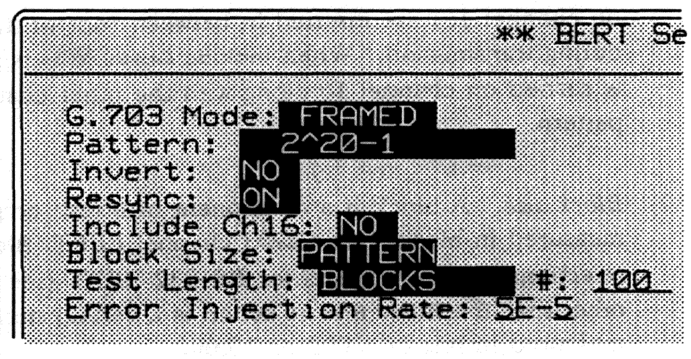


Figure 9-24 **When in *FRAMED* G.703 BERT mode, the *Include Ch16* field appears.**

3. *Framed G.703 BERT mode.* This mode provides framing bits according to the convention chosen by the user (i.e., CAS or CCS; see discussion in Section 50 and especially paragraph 6. below). These bits are carried on channel 0 and also on channel 16 in CAS mode; they are inserted in between (not written over) the BERT pattern during transmission, which means that error injection during the BERT test will never cause a framing error. When framed BERT is the G.703 mode, the same four patterns available with unframed G.703 BERT may be used (see the discussion in the next paragraph).

4. *Pattern.* The patterns shared by framed and unframed BERT differ from the patterns available with channel BERT. Channel BERT patterns are described in Section 9.5(A).

   For framed and unframed G.703 BERT, the four selections in the **Pattern** field are $2^{15}-1$ (which is equivalent to the 32767 pattern and simulates the output of a 15-bit shift register); $2^{20}-1$ (which simulates the output of a 20-bit shift register); $2^{23}-1$ (which simulates the output of a 23-bit shift register); and QRSS (or Quasi-Random Signal Source, which is similar to the $2^{20}-1$ pattern but observes the 1's density prescribed for transmission by suppressing any string of 15 or more 0's.)

5. *Invert.* This field appears when in either framed or unframed G.703 BERT mode. When **Invert: YES** is selected, a logical inversion of the BERT pattern occurs: 1's become 0's and 0's become 1's. Note that channel 0 is *not* inverted when in framed G.703 BERT mode; and if in CAS mode, channel 16 is not inverted as it contains the signalling bits for that mode.

6. *Include channel 16.* This field appears when in framed G.703 BERT mode. Do not select **Include Ch16: YES** when in CAS mode or else both the signalling bits and the BERT pattern will be sent on this same channel, resulting in a garbled BERT pattern. The signalling bits (which are carried

on channel 16) are inserted in between (not written over) the BERT pattern during transmission. When **Include Ch16:** YES is selected, the BERT pattern is carried on channel 16 along with the other channels and included in the pattern.

7. *Block size.* A block is a component of a test: complete tests may be measured in blocks. In G.703 channel BERT, **Block Size:** PATTERN selections are the same as for RS-232 BERT (see Section 9.5(F)); otherwise, the **Block Size** selection is a certain number of bits. Blocks are measured in bits of 1,000 or 10,000.

   For framed or unframed G.703 BERT, a block can be the length of a cycle as indicated by one of the four **Pattern** selections or a certain number of bits. G.703 block sizes measured in bits are 100,000 (1E5); 1,000,000 (1E6); 10,000,000 (1E7); and 100,000,000 (1E8).

   CAUTION: The definition of a block varies from standard to standard and from BERT tester to BERT tester. Some standards define a block as the pattern length while others specify 1,000 bits. The user must ascertain and then select the proper definition.

8. *Test length.* Tests are measured in blocks or seconds; or they may be CONTINUOUS.

   The **Test Length:** BLOCKS selection brings up a four-digit # field that accepts entries from 1 to 9999. If PATTERN has been selected in the **Block Size** field, the length of the test may be determined by multiplying this figure by the number of bits in the selected test pattern.

   The **Test Length:** SECONDS field also brings with it a # field, with six places for numbers from 1 to 999,999 (a maximum of over 11 days).

   The **Test Length:** BITS selection brings up a field that accepts entries of 1000, 10,000, 100,000 or a pattern. If PATTERN has been selected in the **Block Size** field, the length of the test is the number of bits in the selected test pattern.

9. *Error injection rate.* Errors can be injected in a bit pattern automatically at a preselected rate. Refer to Section 9.5(H) for more information on the pre-determined injection rate. Errors may also be injected manually, one-at-a-time, from the keyboard as explained in Section 9.12(E).

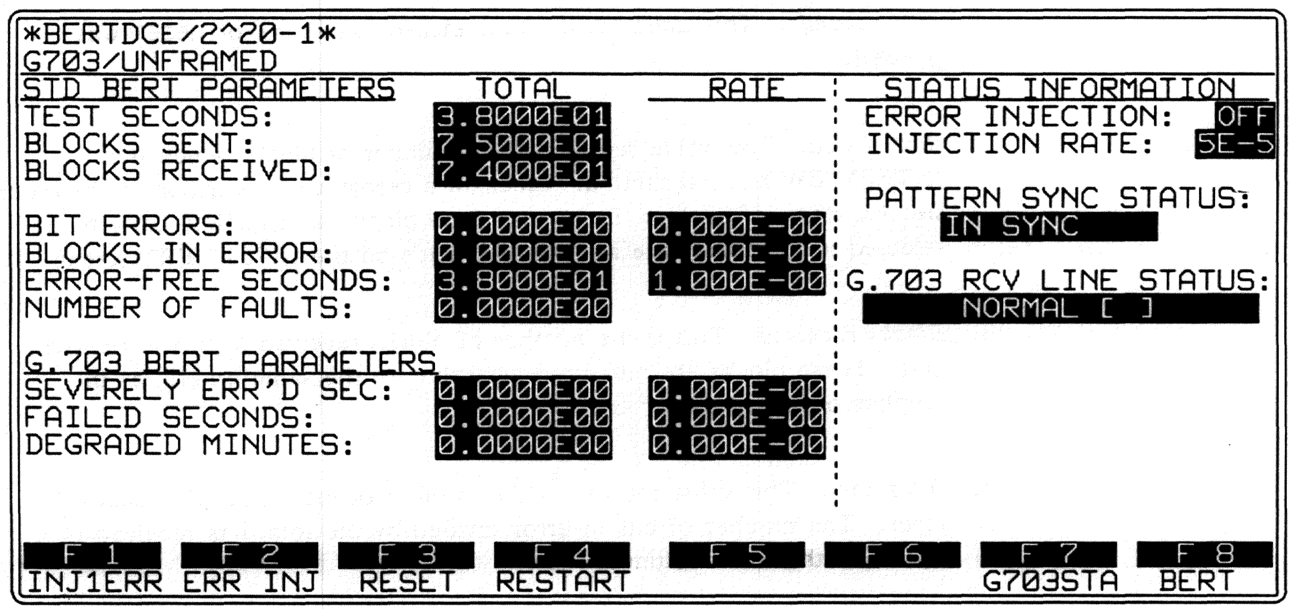


Figure 9-25 Sample G.703 BERT Statistics screen in Run mode.

(D) G.703 BERT Statistics Screen

As long as a BERT emulation mode has been selected on the Line Setup screen and the G.703 hardware options are installed, the G.703 BERT Statistics display appears on the screen. An example of the display is shown in Figure 9-25.

The top of the screen shows which side of the line the INTERVIEW is emulating, indicates whether channel, unframed, or framed testing is being done, and gives additional information on test selections.

Certain test status information is tracked at the far right of the screen. The **ERROR INJECTION** field indicates whether or not the operator has turned on automatic injection rate by pressing the appropriate function key during run-time. The **INJECTION RATE** field indicates the programmer's entry for automatic error injection on the G.703 BERT Setup screen (see Section 9.5(H)). The **PATTERN SYNC STATUS** (as opposed to the line status) field indicates whether the BERT pattern is in or out of sync (see discussion in Section 9.9(J)). The **G.703 RCV LINE STATUS** field reflects the **G.703 LINE CONDITIONS** information given on the regular G.703 Statistics screen (see Section 50.6(K)).

The remainder of the screen provides constantly updated test statistics. Values for BERT parameters (far left of screen) are posted in highlighted boxes in the center of the screen. In addition to total values, rates are given in a highlighted box to the right of the totals. All values are measured starting from the last time [RUN], **RESET**, or **RESTART** was pressed.

1. *Test seconds*. This indicates the time elapsed since [RUN] or **RESET** was pressed.

2. *Blocks sent*. This value represents the number of blocks which the INTERVIEW has transmitted. Blocks are recognized according to the block size (in terms of bits) or the pattern (one block per complete pattern) as selected in the **Block Size** and **Pattern** fields on the G.703 BERT screen.

3. *Blocks received*. This is the number of blocks received from the remote end. These blocks are measured according to the same criteria as the number of blocks sent.

4. *Bit errors*. This value represents the number of individual bits received in error. The number of bits in error divided by the total bits received is posted in the **RATE** column.

5. *Blocks in error*. This value indicates the number of blocks received in which one or more bits were found to be in error. The rate which appears to the right is the total blocks in error divided by total blocks received.

6. *Error-free seconds*. This value is the number of **TEST SECONDS** during which no bit error, framing error, CRC error, or bipolar violation was recorded. The rate given to the right is total error-free seconds divided by total **TEST SECONDS**.

7. *Number of faults*. This is the number of times that the number of bits in error has exceeded 25% for at least 1/50th of a second.

8. *Severely errored seconds*. This is the number of individual seconds during which the bit error rate was worse than 1E-3; that is, more than one errored-bit per 1,000 bits. (Ten or more consecutive Severely Errored Seconds constitute a Failed Signal State.)

9. *Failed seconds*. This is the duration of a Failed Signal State in seconds. The tenth consecutive Severely Errored Second is the first Failed Second. A failed signal state lasts until 10 consecutive seconds are *not* Severely Errored Seconds. Thus, there will always be at least 10 failed seconds recorded at one time.

10. *Degraded minutes*. This is the number of minutes during which the bit error rate exceeds 1E-6; that is, more than one errored-bit per 1,000,000 bits.

(E) Run–time Function Keys for G.703 BERT

The function keys shown in Figure 9-26 appear at the bottom of the G.703 BERT Statistics display when the INTERVIEW is running a G.703 BERT test. You may access the G.703 Statistics screen and the regular BERT screen, both of which are active while a G.703 BERT test is in progress, by pressing the appropriate function key. Alternate screens have the same rack of function keys and so allow you to return to the original display.

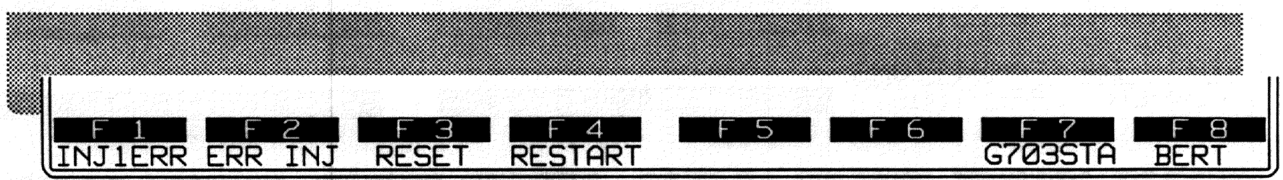


Figure 9-26 Run–time function keys available when performing a G.703 BERT test.

1. *Inject one error.* The function key labeled INJ1ERR injects a single bit error into the INTERVIEW's G.703 BERT transmission. If this key is used when error injection is on (see next paragraph), the single error is simply added to the automatic error rate.

2. *Error injection at pre–determined rate.* The function key labeled ERR INJ is an alternate–action function key which turns off the automatic error injection; or turns it back on and inserts errors into the G.703 BERT transmission at the rate selected on the G.703 BERT Setup screen. (See Section 9.5(H) for a description of the selection.) Error injection is off when the INTERVIEW enters Run mode. The **ERROR INJECTION** field at the far right of the screen tells you whether automatic error injection is currently on or off.

3. *Reset.* The function key labeled RESET sets the value of all timers and counters, including G.703 counters, to zero. The BERT test continues, however.

4. *Restart.* The function key labeled RESTART is used to initiate G.703 BERT testing again, once it has stopped at the point determined by the Test Length selection on the G.703 BERT Setup screen. All BERT counters, timers, and elapsed time (**TEST SECONDS**) continue from wherever they stopped.

```
*BERTDCE/QRSS*
G703/FRAMED/WITHOUT CH16

 G.703 STATISTICS       DTE          RATE         DCE          RATE
TEST SECONDS:        8.3000E01
FRAMES RCVD:         5.3000E05                 0.0000E00
BPV'S RCVD:          2.0000E00   1.428E-08     0.0000E00   0.000E-00
BPV-FREE SECS:       6.3000E01   7.619E-01     0.0000E00   0.000E-00
FRAMING ERRORS:      1.5000E01   2.743E-05     0.0000E00   0.000E-00

SYNC LOSSES:         5.0000E00   9.143E-06     0.0000E00   0.000E-00
SYNC LOSS TIME:      1.6399E01   1.952E-01     0.0000E00   0.000E-00
ERROR-FREE SECS:     6.1000E01   7.380E-01     0.0000E00   0.000E-00

G703 LINE CONDITIONS
 CURRENT [PREVIOUS]     NORMAL  [SgSy]         NOT MONITORED

  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
INJ1ERR  ERR INJ  RESET    RESTART                    G703STA  BERT
```

Figure 9-27 The G.703 Statistics screen is an alternate run-time screen during G.703 BERT testing.

5. *G.703 statistics display.* The function key labeled **G703STA** changes the INTERVIEW screen to the regular G.703 statistics display (see example in Figure 9-27). The contents of this display are described in Section 50.

6. *Regular BERT display.* The function key labeled **BERT** changes the INTERVIEW screen to the regular BERT statistics display (see example in Figure 9-8). The contents of the regular BERT display are described in Section 9.9. Press the function key labeled **BERT** again to return to the G.703 BERT statistics screen.

10 Standard Interface: RS–232

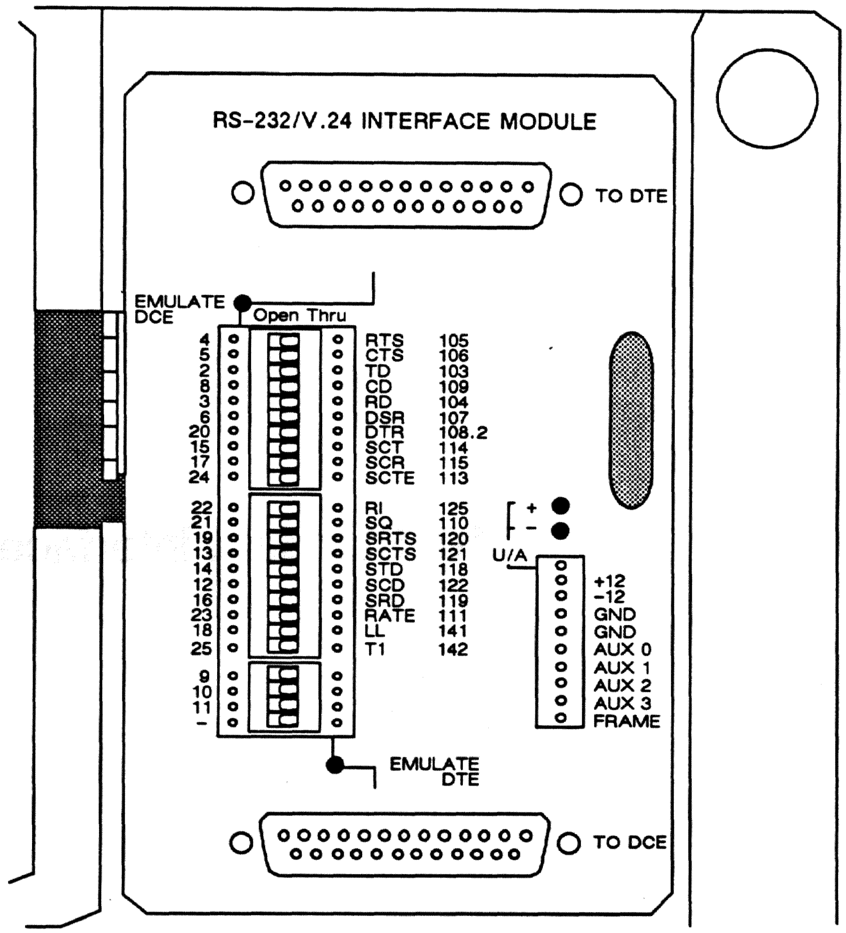


Figure 10-1 Breakout panel on RS-232/V.24 Test Interface Module (TIM).

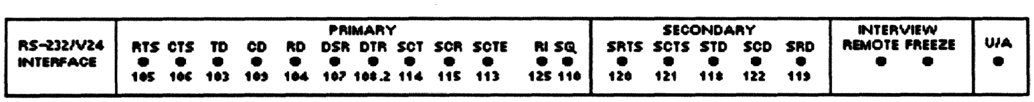


Figure 10-2 RS-232/V.24 Green-Red LED Overlay.

10 Standard Interface: RS-232

The INTERVIEW contains a universal logic interface that supports data rates into the megabits-per-second range. Physical interfaces that are adapted to the various data rates are provided in the form of test-interface modules (or TIMs).

TIMs currently available include RS-232/V.24, V.35, X.21, RS-449, RC-8245 (RS-485), T1, G.703, and ISDN. Each interface module provides *breakout* patching and switching for each lead.

TIMs are modular and simple to install. There are two steps to installing an interface module: 1) **With the unit powered off**, insert the TIM into the module slot at the rear of the unit and press until it latches; 2) apply the proper LED overlay in position on the front of the unit above the screen. The overlay is a flexible plastic strip with small tips on either end that fit into notches in the front panel. The overlay covers the front-panel green-red LEDs and gives them connector-specific identification.

Note that the test-interface module locks into place and a small blue release bar must be pressed to unlock it. The rear of the unit is illustrated in Section 1 of this manual.

Figure 10-1 and Figure 10-2 show the TIM and the LED overlay for the standard interface, RS-232. Once the RS-232 module is installed, the following EIA functions are enabled: seventeen leads can be monitored on the front-panel green-red LEDs; twenty-three RS-232 leads can be switched, patched, and tested on the breakout box on the module; up to five control leads can be selected for real-time screen display; seven leads can be monitored by menu and spreadsheet triggers; and five RS-232 leads and four auxiliary leads come under spreadsheet control in emulate modes. Also in emulate modes, five control leads, four auxiliary leads, six handshake timers, and two transmit delays can be regulated via an Interface Control menu screen.

10.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 10-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE indicator is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector. When **Mode:** EMULATE DTE is the program selection, the INTERVIEW transmits and receives data through the TO DCE connector. The EMULATE DTE indicator is red, and the EMULATE DCE indicator is off.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

10.2 Green–Red LEDs

The RS–232 LED overlay (Figure 10-2) identifies twenty LEDs. Seventeen of these represent RS–232 leads monitored at either of the line interfaces (TO DTE, TO DCE) on the test–interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated (off for EIA receivers being defined as less positive than +3 V relative to signal ground) and red when the lead is at or above the *on* threshold (+3 V).

Data and clock leads often transition quite rapidly. As a result, their LEDs typically show an orange color that is intermediate between red and green. Data–lead LEDs will vary in color with the type of data. FF–idle, for example, has no *on* transitions and appears as bright green. 7E–idle is *on* 25 percent of the time (that is, two bits out of every eight bits are *zero)* and glows with its own distinctive light–orange mixture.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE or phone–jack interface. (The remote–control feature is not implemented in the initial release of the INTERVIEW 7000 Series.)

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any signal that is patched to the UA–input jack on the module. See Figure 10-5. Any of the eight RS–232 leads that are not accounted for on the front overlay can be assigned to this LED by the user.

It is important to note that the front–panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data–plus–leads display; but playback data never drives the green–red LEDs.

10.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable–connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 10.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any RS–232 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

The lefthand column of patch jacks may be thought of as belonging to the DTE, in that signals applied to those pins are *always* visible to the receiver and the front–panel green–red LEDs when the unit is emulating DTE, whatever the condition of the breakout switches.

The righthand column of patch jacks pertains to the DCE: signals applied to these leads are always visible to the receiver and the front–panel LEDs when the unit is emulating DCE, whatever the condition of the breakout switches.

> NOTE: Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

(A) Paths Through the Breakout Switches

Figure 10-3 illustrates the position of the INTERVIEW's receivers and high–impedance monitors relative to the breakout and patching area when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.

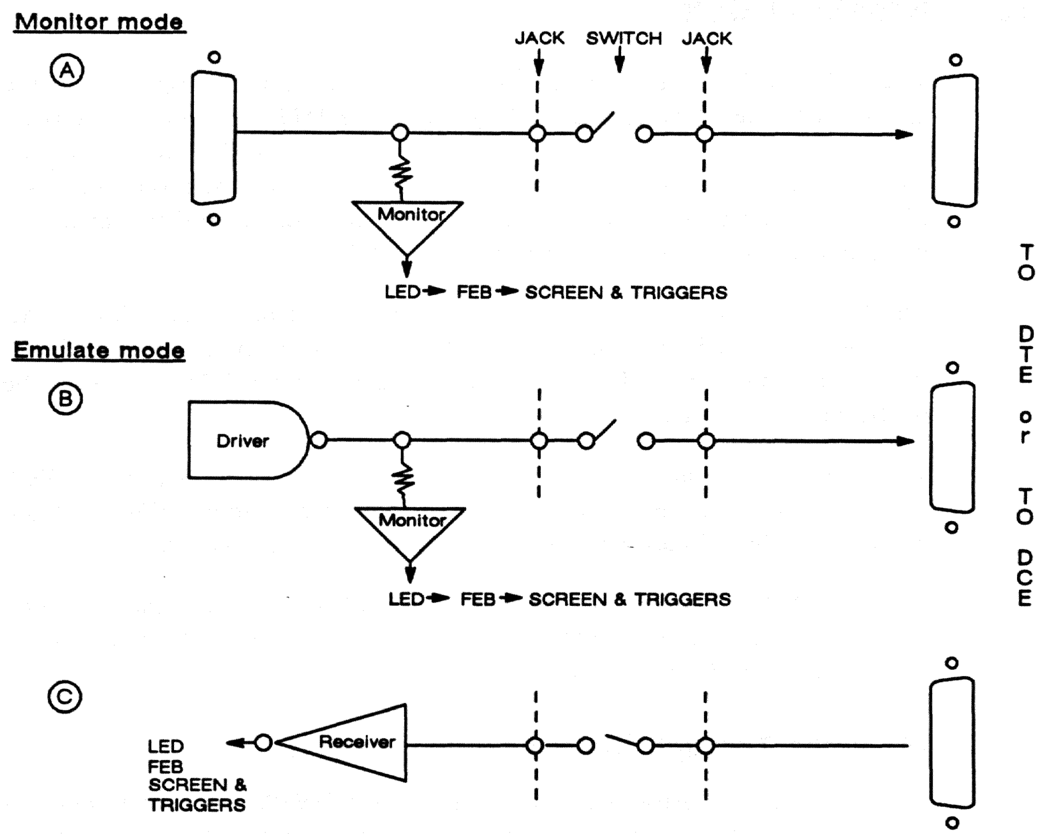


Figure 10-3 Position of patch jacks and breakout switches relative to monitors/receivers when unit is passively monitoring (A), driving signal in emulate mode (B), or receiving signal in emulate mode (C).

Monitor mode is shown at the top of the illustration. In this mode (example A), a signal is being transmitted left to right across the interface module while the INTERVIEW is monitoring passively. The breakout switch is open and the signal is prevented from reaching its destination, but the INTERVIEW monitor sees it. *In Monitor mode the INTERVIEW sees everything*, regardless of the position of the breakout switches.

The signal in the middle of the illustration in Figure 10-3 is being driven by the INTERVIEW. The breakout switch is open and the *on* signal is not reaching the cable connection to DCE or to DTE; but because the monitor is on the driver side of the switch, the front-panel LED is red and an *on* voltage level is shown on the data-plus-leads screen display.

The bottom signal in Figure 10-3 (example C) is being driven by the DTE or DCE at the cable interface. The signal is intended for an INTERVIEW receiver in an Emulate mode, but the breakout switch is open. Since the INTERVIEW's receiver for incoming signals always is "downstream" of the switch, the front-panel LED is green and neither the screen nor the program detect the *on* status.

Note also in connection with Figure 10-3 that there is a selection on the Front End Buffer (FEB) Setup menu that inhibits reception and display of all EIA activity except data (see Section 7). Figure 10-3 indicates the point at which EIA status is passed to the FEB in Emulate and Monitor modes. (Refer also to the functional block diagram in Figure 2-5.) Green-red LED display is *not* affected by FEB suppression of EIA leads, since, as the figure suggests, the path of the signals is through the receivers/monitors to the LEDs first, to the FEB next, and finally to the triggers and screen.

(B) Patching Example: Modem Eliminator

Figure 10-4 is an example of patching. Six patch cords have configured the breakout area into a modem-eliminator that allows two DTEs to converse across the interface module. Note that switches next to rerouted leads have been opened.

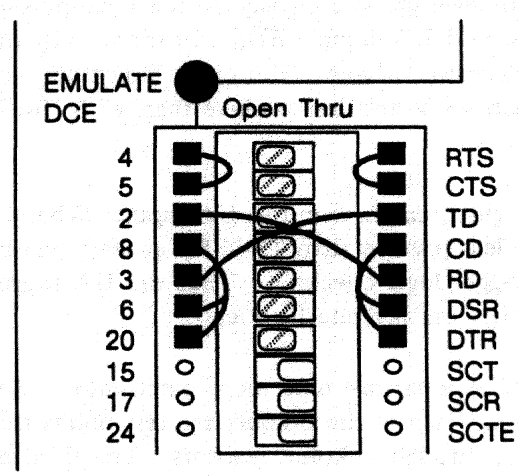


Figure 10-4 **Patch cords reroute data and control leads to allow two DTEs to communicate.**

(C) Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs indicate the voltage patched to the uppermost pin (Figure 10-5). This is the UA (user-assigned) input jack. If a signal patched to this input is +3 V (nominal) or more positive, the red + LED will go on. If the signal is -3 V (nominal) or more negative, the green - LED will light. Any signal patched to this input can be monitored by the INTERVIEW's triggers.

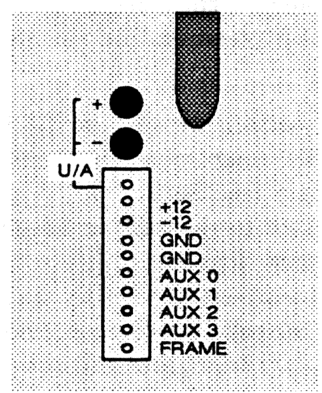


Figure 10-5 A separate column of patch jacks provides UA input and nine special output pins.

There are four kinds of lead-status indicators in the INTERVIEW: front-panel LEDs, lead-level graphic display on the data-plus-leads screen, triggers that test EIA status, and UA-input LEDs. Of these, *only the UA-input minus (-) LED indicates negative voltage*. The other indicators recognize two states only: more positive than +3 V and less positive than +3 V (with a slight allowance for hysteresis).

There is a glitch catcher on the UA input. Whenever the voltage is more positive or less positive than +3 V for at least one microsecond, it will be latched until the trigger logic checks it. Thus the UA trigger condition can be used to detect glitches on any interface lead.

Below the UA input are nine more patch jacks. See Figure 10-5. All are output jacks. Two of the outputs are test points that supply +12 V and -12 V, respectively, through 1-kohm resistors. The third and fourth pins are at signal ground.

The next four jacks allow you to patch the output of four auxiliary RS-232/V.24 drivers that are controlled by trigger actions on the Protocol Spreadsheet and by selections on the Interface Control menu (see Sections 10.5 and 10.6 below). These AUX outputs are useful if at some point in a program you want to turn on a signal that you don't actually control. You might be raising RTS, for example, and the modem is not giving you Clear to Send. Simply patch AUX0 to CTS on the TO DCE (right) side of the breakout switches; open the switch for CTS; and drive AUX0 via trigger. (The AUX pins on the test-interface module have nothing to do with the 25-pin TTL AUXILIARY connector on the rear of the unit.)

10.4 Screen Display of Lead Status

Five RS-232/V.24 control leads can be selected for a data-plus-leads display, in which the control leads are represented by two-state timing lines drawn beneath TX and RX data. See Section 5.3(B).

10.5 Program Control of Lead Activity

The status of seven RS-232/V.24 leads can be tested by triggers. The leads are RTS, CTS, CD, DTR, DSR, RI, and a lead of the user's choosing patched to the UA-input jack (see 10.3(C), above). The status of the lead may be made a trigger-menu condition (Figure 10-6) or a Spreadsheet condition (Figure 10-7).

```
                    ** Trigger Setup **
                     Trigger Number: 2
C Receiver:  NO
O
N EIA:       YES  RTS:1  CTS:X  CD:X  DTR:X  DSR:X  RI:X  UA:X
```

Figure 10-6 The status of seven RS-232 leads may be tested by triggers.

```
                 ** Protocol Spreadsheet **

     STATE: flow_ctrl
       CONDITIONS: EIA DTR OFF
       ACTIONS: ALARM
         PROMPT "Device not ready"
```

Figure 10-7 EIA status also may be made a spreadsheet condition.

On trigger menus, lead states are described as 1 or 0. For the receiver logic, 1 as an EIA trigger condition means +3 V (nominal) or more positive. 0 means less positive than +3 V. 0 on a trigger menu does not mean -3 V or more negative, even in the case of the UA lead.

Five RS-232 leads (RTS, CTS, DTR, DSR, and CD) can be driven on or off as a trigger action. This action is available on the spreadsheet for Layer 1 (see Figure 10-8) but not on trigger menus. Four auxiliary pins on the breakout panel likewise are under spreadsheet control.

An ON action by the spreadsheet program will drive an EIA lead into a plus range (+5 V to +15 V) defined by the standard. An OFF action by the spreadsheet program will drive a lead into a minus range (-5 V to -15 V) defined by the standard. The difference between a 0 condition and an OFF action (0 in a condition only meant a voltage less positive than +3, not a minus range) is explained by the fact that drivers are allowed three states—on, off, and *inactive*—whereas receivers must decide between on and off.

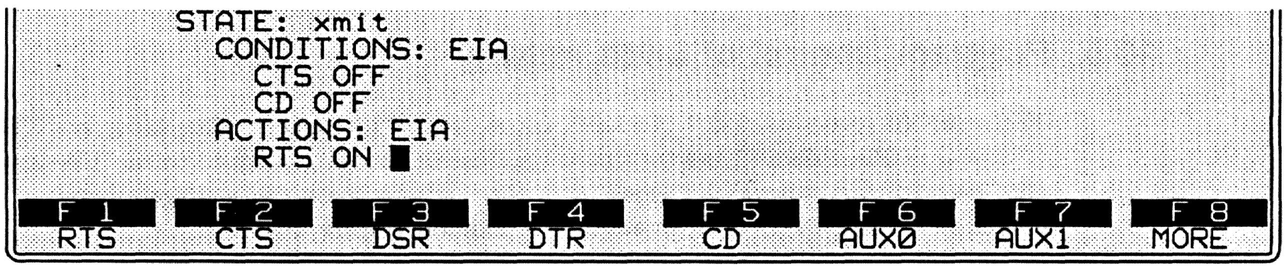


Figure 10-8 The spreadsheet program can control five RS-232 leads plus four auxiliary leads.

10.6 Interface Control Menu Screen

Figure 10-9 shows the programming selections on the Interface Control menu screen for RS-232/V.24. The menu differs slightly according to whether EMULATE DTE is the **Mode** selection on the Line Setup menu (top half of Figure 10-9) or whether EMULATE DCE is the selection (bottom half of figure). The menu simplifies the programming of EIA lead activity, especially in half-duplex environments where the RTS-CTS handshake would be cumbersome to program correctly on the spreadsheet. The screen controls the INTERVIEW's EIA drivers and is operative only in emulate modes.

On the Interface Control menu screen, ON and OFF imply that a lead is driven to *on* or *off* voltage in accordance with the RS-232/V.24 standard, which says that a signal is driven *off* within a range of -5 to -15 volts with respect to signal ground, and *on* within a range of +5 to +15 volts with respect to signal ground.

(A) Switched Leads: RTS, CTS, CD

The **RTS**, **CTS**, and **CD** fields enable the INTERVIEW to turn these three leads on and off, if it is controlling them. The **Mode** selection on the Line Setup menu determines which leads are controlled: RTS when the unit is in Emulate DTE mode and CTS and CD when it is in Emulate DCE mode.

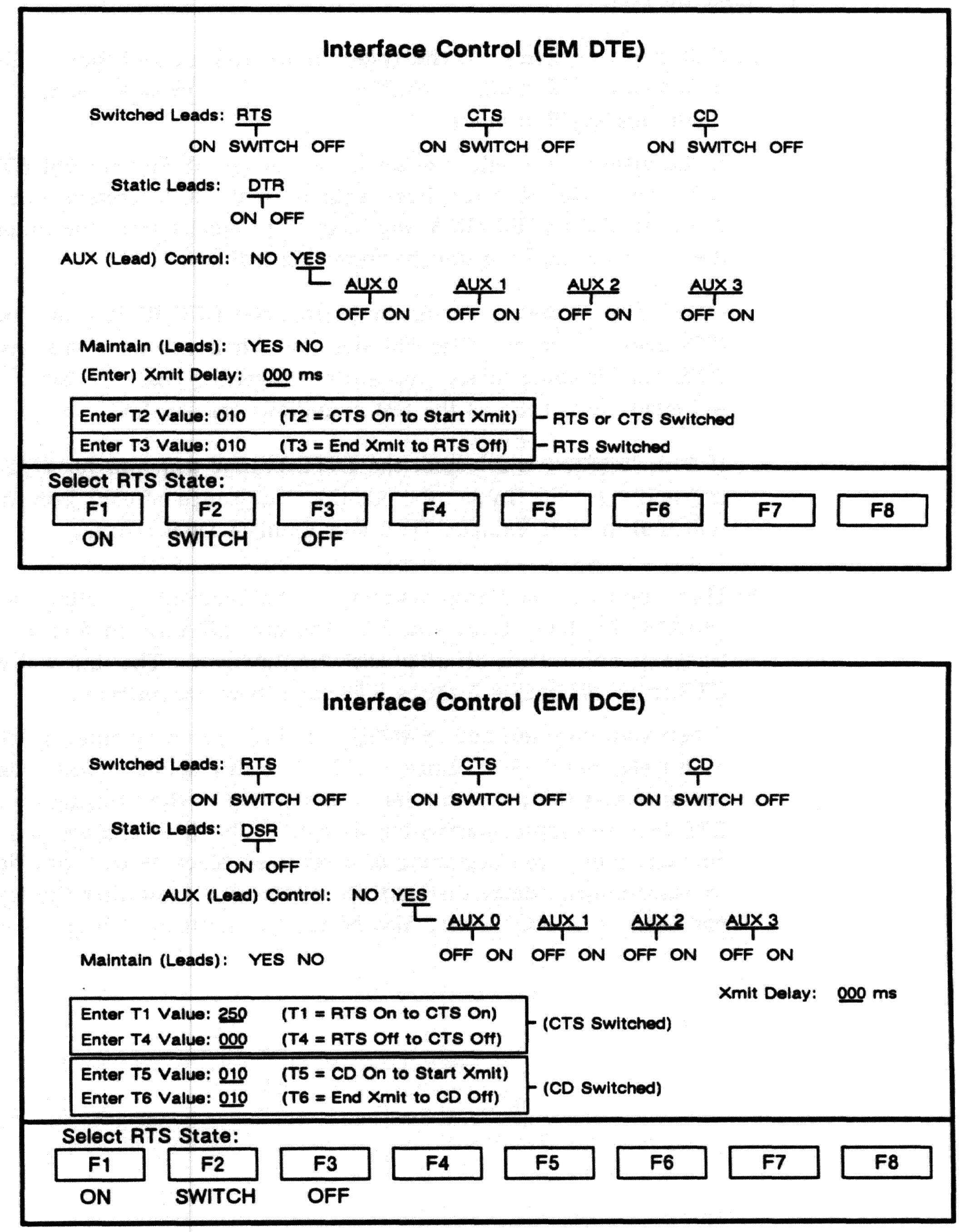


Figure 10-9 Menu fields on the Interface Control menu screen.

1. *Emulate DTE*

   a. Full-duplex systems. If the system is full duplex and the INTERVIEW is in Emulate DTE mode, turn **RTS:** ON . The unit will turn RTS on *when entering Run mode*.

      In Emulate DTE mode, the device under test should control CTS and CD. Your selections for these leads do make a difference, however. They tell the INTERVIEW what signals to expect from the other side of the interface, and the unit performs accordingly.

      CTS: ON means, for example, that the INTERVIEW will behave as if CTS always were on. Use this selection when you want to transmit as a DTE but for some reason you are not receiving Clear To Send. The unit will transmit as soon as the test conditions are satisfied.

      If **CTS:** SWITCH is selected, the INTERVIEW *will wait for CTS* before transmitting. See Table 10-1 for the significance of each control-lead selection in both Emulate DTE and Emulate DCE modes.

   b. Half-duplex or multidrop systems. In half-duplex operation, select SWITCH for RTS, CTS, and CD. The unit will turn on RTS before it transmits and turn it off after each transmission. The unit will wait for CTS to go off before it raises RTS for a new transmission.

      When you have selected SWITCH for RTS, you may enter a delay in the **Xmit Delay** field. See Figure 10-10. Use this field to enter a delay from the time that the test conditions are satisfied to the bringing up of the RTS lead to request permission to send. This field enables you to use characters near the beginning of a received block as the condition for transmission but delay the start of transmission until after the entire block has been received. It may also be used to simulate a response delay.

Table 10-1
Significance of On/Switch Selections on Interface Control Menu

Lead	On/Switch	Meaning
Mode: Emulate DTE		
RTS	ON	Turn RTS ON entering Run Mode.
	SWITCH	Turn RTS ON before each xmit. Turn RTS OFF after each xmit.
	OFF	Turn RTS OFF entering Run Mode.
CTS	ON/OFF	Xmit without respect to CTS ON.
	SWITCH	Wait for CTS ON before each xmit.
CD	ON/OFF	Raise RTS for new xmit without respect to CTS OFF.
	SWITCH	Wait for CTS OFF before raising RTS for new xmit.
Mode: Emulate DCE		
RTS	ON/OFF	Raise CD to xmit without waiting for CTS OFF.
	SWITCH	If CTS and CD switched, wait for CTS OFF before raising CD to xmit.
CTS	ON	Turn CTS ON entering Run Mode. Raise CD to xmit without waiting for CTS OFF.
	SWITCH	CTS follows RTS during Run Mode.
	OFF	Turn CTS OFF entering Run Mode.
CD	ON	Turn CD ON entering Run Mode.
	SWITCH	Turn CD ON before each xmit. Turn CD OFF after each xmit.
	OFF	Turn CD OFF entering Run Mode.

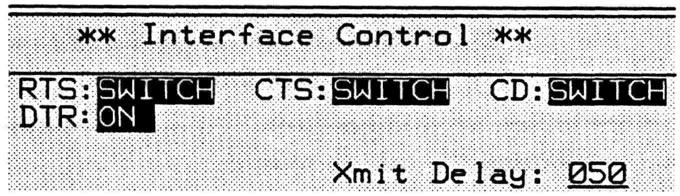


Figure 10-10 In Emulate DTE mode, *Xmit Delay* delays the raising of RTS to begin transmission, with a range of delay of zero to 999 ms.

Apart from the transmit delay, there are two other programmable delays in Emulate DTE Mode. In default, the unit will send data 10 msecs after it sees CTS come on. This delay can be set at zero to 999 msecs in the **T2** field at the bottom of the menu. See Figure 10-11. The same range of delay (and the same default setting of 010) is available for **T3**, the time the unit will wait before turning RTS off after it has transmitted the message.

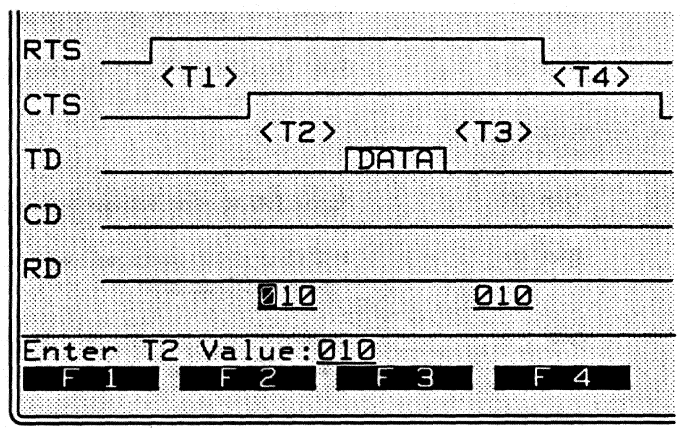


Figure 10-11 T2 and T3 delays also are selectable in Emulate DTE mode.

If **CTS:** ON is selected, the INTERVIEW will transmit after raising RTS but before it sees CTS. (Normally in half duplex, characters that arrive at the modem before CTS is granted are discarded.)

If **CD:** ON is selected, the INTERVIEW will raise RTS and start a new transmission before CTS has gone off to complete the handshake for the last transmission.

In multidrop systems, the selections depend on which side of the link you are on. If you are emulating the host (emulating DTE), select **RTS:** ON, **CTS:** ON, **CD:** SWITCH. If you are emulating DTE from the drop side of the line, select **RTS:** SWITCH, **CTS:** SWITCH, **CD:** ON.

Table 10-2 shows a group of typical switched-lead configurations in Emulate DTE (and Emulate DCE) mode.

Table 10-2

Standard Switched-Lead Configurations

Mode: EMULATE DTE

RTS: ON	CTS: ON	CD: ON	full duplex
RTS: SWITCH	CTS: SWITCH	CD: SWITCH	half duplex
RTS: ON	CTS: ON	CD: SWITCH	multidrop, emulate host at host site
RTS: SWITCH	CTS: SWITCH	CD: ON	multidrop, emulate drop at drop site

Mode: EMULATE DCE

RTS: ON	CTS: ON	CD: ON	full duplex
RTS: SWITCH	CTS: SWITCH	CD: SWITCH	half duplex
RTS: ON	CTS: ON	CD: SWITCH	multidrop, emulate drop at host site
RTS: SWITCH	CTS: SWITCH	CD: ON	multidrop, emulate host at drop site

2. *Emulate DCE*

a. Full-duplex systems. If the system is full duplex and the INTERVIEW is in Emulate DCE mode, turn **CTS** and **CD** **ON**. The unit will turn both leads on when it enters Run mode. You do not control RTS in this mode, and the **RTS** field has no significance with CTS and CD on.

If **CTS:** **SWITCH** is selected, this lead will follow RTS during Run mode.

b. Half-duplex or multidrop systems. In half-duplex operation, select **SWITCH** for **RTS**, **CTS**, and **CD**.

When you have selected **SWITCH** for **CTS**, you may enter a delay time of from 0 to 999 msec in the **T1** field at the bottom of the screen. See Figure 10-12. **T1** is a decimal field with a default value of 250 msec. When the INTERVIEW (in Emulate DCE mode) sees RTS go on, it will wait this delay before turning CTS on. After it sees RTS go off, it will wait the preset **T4** delay (zero msecs in default) to turn CTS off.

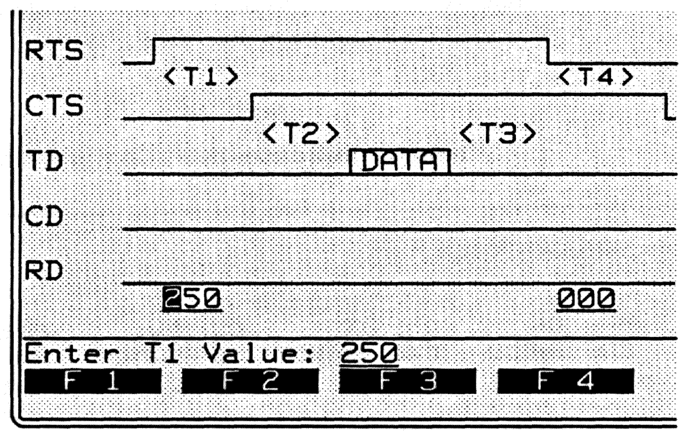


Figure 10-12 In Emulate DCE mode, T1 and T4 delay the raising and lowering of CTS.

When you have selected **CD:** SWITCH , the INTERVIEW (in Emulate DCE mode) will wait any delay time that might have been entered in the **Xmit Delay** field, and then try to raise CD. See Figure 10-13. If CTS is on (in response to RTS), the unit will not raise CD until CTS goes off. It will send data 10 msecs (or any other preset **T5** delay) after it has turned CD on, and turn CD off after the preset **T6** delay, subsequent to the block check characters or the end of transmission.

In multidrop systems, the selections depend upon which side of the link you are on. If you are emulating the modem (DCE) at the host site (that is, testing the host), select **RTS:** ON , **CTS:** ON , **CD:** SWITCH . If you are emulating a DCE at the drop site (testing a drop DTE), select **RTS:** SWITCH , **CTS:** SWITCH , **CD:** ON .

Table 10-2 shows a group of representative switched-lead configurations in Emulate DCE mode.

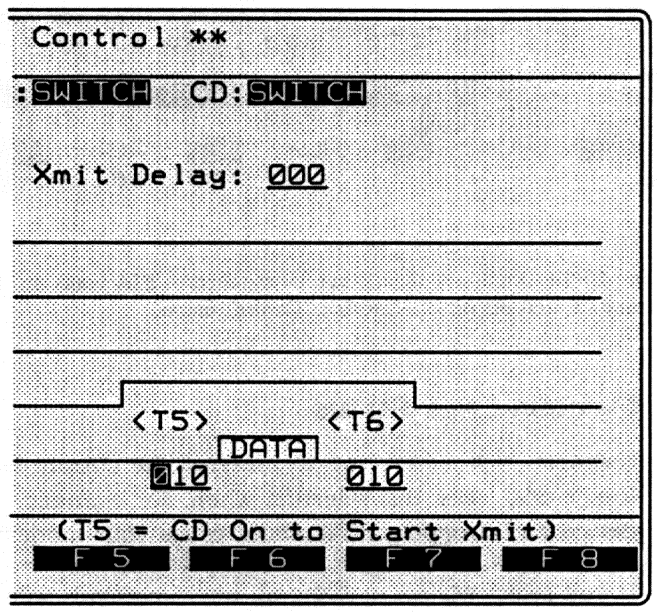


Figure 10-13 In Emulate DCE mode, Xmit Delay pertains to the raising of CD.

(B) Static Leads: DTR, DSR

Use the **Static Leads** field to instruct the INTERVIEW to drive either DTR or DSR—depending on the test mode—constantly on or off.

(C) Auxiliary Leads

These are four pins on the TIM breakout panel whose output is programmable on the Interface Control menu (and also in spreadsheet trigger actions). Four subfields appear to the right of **AUX Control:** YES on the Interface Control menu, one for each AUX driver from zero to three. See Figure 10-14. When one of these AUX fields is turned on, the output on that pin will be standard RS-232/V.24 space (+) voltage at the start of Run mode and will remain at that level until a spreadsheet trigger turns the signal to standard EIA mark (–) voltage. The output driver is a 1488, which can sink up to 10 mA.

```
                        ** Interface Control **
Switched Leads:    RTS: ON     CTS: ON     CD: ON
Static Leads:      DTR:ON
AUX Control: YES   AUX0:OFF   AUX1:OFF   AUX2:OFF   AUX3:OFF
Maintain: YES                 Xmit Delay: 000 ms
```

Figure 10-14 Auxiliary signals can be patched to EIA leads on the breakout box and then turned on and off on the Interface Control menu.

(D) Maintain Lead Status

Maintain: YES allows you to preserve the current lead status even after exiting Run mode. Use this selection when, for example, you are testing a remote device and dropping DTR would cause your modem to hang up.

If you select **Maintain:** NO, all interface leads will be reset to the *off* voltage each time the unit leaves Run mode.

11 Record Setup

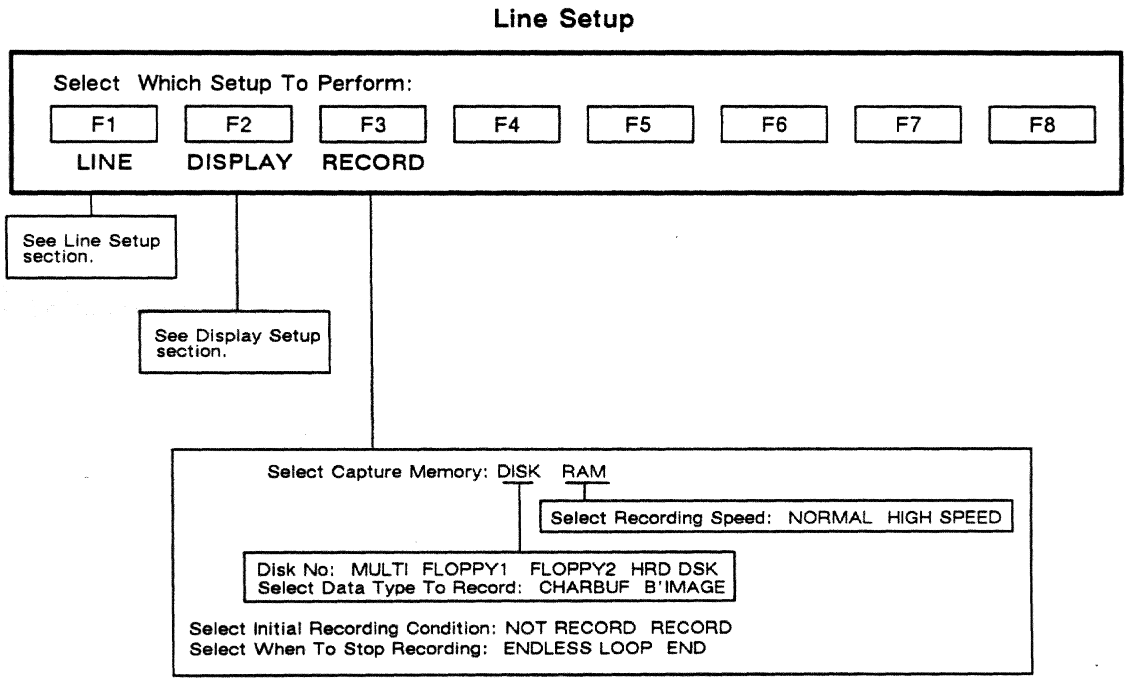


Figure 11-1 Record Setup menu.

11 Record Setup

The INTERVIEW provides storage of line data for later analysis. Recording of data can be initiated in three ways: through selections on the Record Setup menu, through manual control of the unit in Run mode, and through the RECORD action on the Protocol Spreadsheet. In addition, data is continuously saved to and can be retrieved from a temporary display buffer.

11.1 Format of Recorded Data

Data may be recorded to disk in one of two formats: as Character-oriented data, or as Bit-image data. It may be *recorded* to RAM as bit-image data only. Data is captured to character RAM (the screen buffer) automatically: this "capture" has nothing to do with the Record Setup.

(A) Character-oriented Data

Character-oriented data is data which is already formatted as specified by the user. This data is recorded as it was presented to the screen. (See Figure 2-5.) Character-oriented data is stored with programmed enhancements which may later be reviewed or replaced by the user. Superfluous data may be suppressed from character-oriented data, which allows more efficient storage. Except for code selection, line-setup parameters (described in Section 4) will not be applied to recorded character-oriented data.

(B) Bit-image Data

Bit-image data is bit-accurate data which is not preformatted. All line-setup parameters can be applied and reapplied to such data. This fact makes possible reinterpretation of data which would otherwise be unusable, because, for example, the wrong code, format, or block check calculation had been selected.

Bit-image data is stored prior to presentation to the screen. (Refer again to Figure 2-5.) This means that the data contains no enhancements and that it remains a complete record of all data as originally captured with the exception of idle, which can be discarded from the Front End Buffer. (See Section 7 for information on idle-suppression in the FEB.)

11.2 Recording Medium

Line data may be recorded directly to disk in bit-image format, recorded to bit-image RAM and then transferred to disk, or captured in the screen buffer (character RAM) and transferred to disk.

The recording medium to be used in Run mode is chosen on the Record Setup menu. By default, data is not recorded when you enter Run mode. To activate recording from Run mode, press RECORD. (Otherwise, you may reconfigure the Record Setup menu to enter Run mode recording, or add a RECORD action to a Protocol Spreadsheet program.) At that point, data is recorded in the format and to the medium specified on the Record Setup screen. By default, data is recorded in character-oriented format onto the data acquisition tracks of FD1 (since MULTI is the default **Disk No** selection). If **Capture Memory:** RAM is selected, data will be recorded in bit-image format.

Before it is played back in Run mode, data stored in bit-image RAM must be transferred to disk. Go to the Disk Maintenance menu: press PROGRAM, F7, F3 (program, utilities, disk maintenance). Then execute a data transfer *from* RAM *to* disk. To transfer all or part of the RAM buffer, select **From:** RAM and **Type:** BIT IMAGE. Once the data has been transferred to disk, monitor the data by selecting **Mode:** MONITOR and **Source:** DISK. See Section 4 for a further description of **Source** and other Line Setup selections.

> NOTE: Before data can be played back, all transmit actions must be cleared from the trigger menus, and all SEND actions and RECEIVE or RCV conditions must be deleted from the Protocol Spreadsheet.

11.3 The Screen Buffer

There is a third, alternative method of data capture always active in Run mode. A 64-Kbyte data buffer is provided for constant recording of character-oriented data as it is displayed on the screen. This means that, even though he has opted not to record data in real-time, the operator may still store the contents of the screen buffer to a file, once he places the INTERVIEW in Program mode, and review the data later. To control the capture of data to the screen buffer, use the **Capture** (ON / OFF) selection on the trigger-actions menu (see Section 22.9) or the Layer 1 CAPTURE action on the Protocol Spreadsheet (Section 28.2(F)).

Before it is played back in Run mode, screen data must be transferred from character RAM to the data acquisition tracks of a disk. Go to the Disk Maintenance menu: press PROGRAM, F7, F3 (program, utilities, disk maintenance). Then execute a data transfer *from* RAM *to* disk. To transfer all or part of the screen buffer, select **From:** RAM and **Type:** CHARBUFFER. The contents of the screen buffer can then be played back by selecting **Mode:** MONITOR and **Source:** DISK.

> NOTE: The screen buffer is erased each time RUN is pressed, so the data must be transferred to disk before the INTERVIEW returns to Run mode.

Of course, if the unit stays in Run mode, you can freeze the screen and review data without any transfer procedure. Freeze mode analysis is described in Section 3.4.

If you need to record a large amount of data for analysis, it might be preferable to employ the Record Setup features of the INTERVIEW, since the screen buffer is limited in size, and its contents are automatically overwritten once it is full.

> **NOTE:** Data in the screen buffer is stored exactly as displayed. Suppressed data is not stored in the buffer and, as a consequence, is not available for triggering. Programming techniques must take this into account.

> **NOTE:** Enhancements *are* stored with the data. The data is presented with the enhancements in playback, unless active triggers contain potential **Enhance** actions. If the INTERVIEW detects **Enhance** actions when a test is compiled, then old enhancements stored with source data are stripped to allow new enhancements.

11.4 The Record Setup Screen

The parameters for real-time data capture are selected on the Record Setup menu, which resides on the same screen as the Line Setup and Display Setup menus. All possible Record Setup selections on this menu are shown in Figure 11-1. The default menu is shown in Figure 11-2.

> **NOTE:** Bit-image data is subject to idle-suppression in the Front-End Buffer *prior* to recording. See Section 7 for details.

```
RECORD SETUP
Capture Memory: DISK
Disk No: MULTI
Data To Record: CHARACTER
Initial Cond: NOT RECORD
Stop At: ENDLESS LOOP
```

Figure 11-2 Default Record Setup screen.

(A) Capture Memory

Either DISK or RAM can be selected in this field.

1. *Disk.* DISK is the default selection. When DISK is selected, two additional fields, **Disk No** and **Data To Record**, appear immediately below. Refer again to Figure 11-2. See Section 1.6(D) on maximum line rates for recording data to disk. Also consult Section 2.8 for information on optimizing recording of data to disk.

   NOTE: Data can only be saved to formatted disks. See Section 12 for instructions on formatting.

   (a) *Disk no.* Available selections in the **Disk No** field are FD1 (Floppy Disk 1); FD2 (Floppy Disk 2); HRD (Hard Disk), when present; and MULTI (Multiple disks). The default selection is MULTI.

   MULTI causes recording to begin on the floppy disk inserted in Drive 1 and to continue on the disk in Drive 2 when the first disk is completely full. Once this second disk is full, recording reverts to Drive 1, and the process continues. You may manually replace disks in the nonactive drive to record data alternately on a new disk. If no disk is inserted in the next drive, recording continues from the beginning of the last-recorded disk.

   CAUTION: Do not remove a disk from an active drive. You can always identify the active drive by the glowing LED just to the right of the drive.

   When FD1, FD2, or HRD is the selected **Disk No**, recording proceeds continuously or stops when the disk is full in accordance with the **Stop At** selection, described later in this section.

   (b) *Data to record.* The two selections in this field are CHARACTER and BIT IMAGE data. This selection specifies the format of recorded data. The differences between these two data formats are explained at the beginning of this section. This field disappears when **Capture Memory:** RAM is selected, since the format will always be bit-image.

2. *RAM.* RAM refers to the portion of the INTERVIEW's internal memory reserved for bit-image data recording directly from the data line.

   When RAM is selected, the **Disk No** and **Data to Record** fields disappear. A new field, **Record Speed**, may appear. See Figure 11-3. If this field does not appear, RAM size is 1 Mbyte in the 7500 and the 7700 *TURBO* and 256 Kbytes in the 7000 and 7200 *TURBO*. With an additional MPM board, RAM is 1 Mbyte in the 7000 and 7200 *TURBO*. See Table 11-1.

```
RECORD SETUP
Capture Memory: RAM
Record Speed: HIGH SPEED

Initial Cond:   RECORD
Stop At:        END
```

Figure 11-3 Record Setup menu configured for high-speed recording.

(a) *Record speed.* The **Record Speed** field is present only when 1) **Capture Memory:** RAM is selected; 2) the Line Setup **Mode** is MONITOR ; 3) software revision 5.02, or higher, is installed; and 4) the unit is equipped with an FEB board capable of high-speed recording (available as OPT–951–28–1, or with current software as OPT–951–27–1). "High-speed" means a line rate faster than 256 Kbps.

NOTE: The C variable *feb_type* in the *unit_config* structure shown in Table 66-1 identifies your FEB version. Your INTERVIEW will support high-speed recording if *unit_config.feb_type* has a value of two. (Other variables in the same structure contain additional hardware and software information specific to your unit.)

There are two **Record Speed** selections, NORMAL and HIGH SPEED . The default entry is NORMAL . Normal recording can support a speed up to 256 Kbps. When line speeds approach this threshold, you may need to record according to the guidelines set forth in Section 2.8. High-speed recording is required when line rates exceed 256 Kbps.

For normal and high-speed recording, RAM size is determined by the number of MPMs and the presence of an optional XDRAM board in your unit. See Table 11-1 and Table 11-2 for RAM size based on various INTERVIEW configurations.

When HIGH SPEED is selected, record RAM is automatically increased to 2 Mbytes in the 7500 and 7700 *TURBO*. You may increase record RAM size for high-speed recording in the 7000 and the 7200 *TURBO* by adding MPM boards. An additional MPM (OPT–951–02–1) alone increases record RAM to 1 Mbyte. With two additional MPMs (OPT–951–02–2, or a second OPT–951–02–1), record RAM is 2 Mbytes. Based on MPM configuration, another optional board, XDRAM (OPT–951–23–1), can increase record RAM for high-speed recording up to 4 Mbytes in the INTERVIEW 7000 Series. Record RAM for normal recording can reach 2 Mbytes when an XDRAM board is installed. (XDRAM requires software revision 6.00, or higher.)

Table 11-1
RAM Size (bytes) for Normal and High-Speed Recording in the INTERVIEW 7000 and the 7200 *TURBO*

	MPM(s) only	MPM(s) w/XDRAM*	MPM(s) w/XDRAM w/file**
1 MPM			
Normal	256K	256K	2M
High-Speed	256K	256K	2M
2 MPMs			
Normal	1M	1M	2M
High-Speed	1M	1M	2M†
3 MPMs			
Normal	1M	1M	2M
High-Speed	2M	2M	2M††

* When the file */sys/xdram_rcrd* does not reside on the boot-up disk during power-up, XDRAM is used to increase the spreadsheet size. See Section 2.4(E).

** The file */sys/xdram_rcrd* resides on the boot-up disk during power-up.

† Increase record RAM to 3 Mbytes by adjusting the switch on the MPM in slot 8. See also Table J3-1.

†† Increase record RAM to 4 Mbytes by adjusting the switches on the MPMs in slots 7 and 8. See also Table J3-1.

Table 11-2
RAM Size (bytes) for Normal and High-Speed Recording in the INTERVIEW 7500 and the 7700 *TURBO*

	3 MPMs only	MPMs w/XDRAM*	MPMs w/XDRAM w/file**
Normal	1M	1M	2M
High-Speed	2M	2M	2M††

* When the file */sys/xdram_rcrd* does not reside on the boot-up disk during power-up, XDRAM is used to increase the spreadsheet size. See Section 2.4(E).

** The file */sys/xdram_rcrd* resides on the boot-up disk during power-up.

†† Increase record RAM to 4 Mbytes by adjusting the switches on the MPMs in slots 7 and 8. See also Table J3-1.

Choose **Record Speed:** HIGH SPEED when the line rate is between 256 Kbps and 2.048 Mbps full duplex. Two interfaces which may require high-speed record capability are T1 and G.703. To record the aggregate T1 data stream, for example, you must select HIGH SPEED. Refer to Sections 49.1(E) and 50 for more information on T1 and G.703 aggregate record. (There is no aggregate record for ISDN.)

At high speeds, data cannot be processed quickly enough to be displayed or monitored accurately. The HIGH SPEED selection, therefore, automatically turns off the monitoring function by disabling the line receivers. The following message is displayed on the status line of the Run-mode screen: *"Monitoring is disabled for high speed ram recording."* The display process continues, even though the line receivers are not supplying data for display. Stop the display process by selecting **Display Mode:** NO DISPLAY on the Display Setup menu, or by pressing NO DISP during Run mode.

Without active line receivers, data cannot be displayed and program conditions (or triggers) based on incoming data or leads can never come true. Data analysis must be performed during slower playback of recorded data. With this consequence of high-speed record in mind, you may still opt to use it at speeds less than 256 Kbps.

NOTE: For data to be available for playback, it must reside on a disk. Transfer data captured in RAM to a disk via the Data Transfer command on the Disk Maintenance screen. See Section 12.4(C).

High-speed recording formats data differently than normal recording. When recording ends (or you exit Run mode via the PROGRAM key), the data is converted from high-speed format to normal-data format. The following message is displayed: *"Reformatting ram record buffers – Please wait ..."*

(B) Initial Condition

The two selections available in this field are RECORD and NOT RECORD. When RECORD is selected, data recording begins the "instant" you place the INTERVIEW in Run mode. When NOT RECORD is selected, no recording takes place until one of three events occurs: a new program with **Initial Condition:** RECORD is loaded, a spreadsheet trigger activates recording, or the operator initiates recording manually. Trigger and manual control of recording are described later in this section.

A record/playback field (on the top line in the status area) on Run-mode screens will indicate whether recording is in progress or has been suspended. If recording is ongoing, an "R" appears next to the block-number field. If your initial condition is NOT RECORD or you suspend recording, "S" will be displayed.

The field will be blank when the end of RAM or the data-acquisition tracks is reached. The record/playback field also will be blank if the **Capture Memory** field indicates that you will record to disk, but no disk is present in the selected drive or data-acquisition tracks are not available on the disk.

> NOTE: A "P" in the record/playback field indicates that data playback is in progress. See Section 4.2.

(C) Stop At

This field defines the action which the INTERVIEW takes when bit-image RAM or disk is full. ENDLESS LOOP causes recording to continue from the beginning of disk or RAM, whichever is designated as **Capture Memory.** ENDLESS LOOP causes old data to be overwritten. As a result, only the most current data is accessible for playback.

Stop At: END indicates that no further data will be recorded once bit-image RAM or disk is full.

> NOTE: This selection does not influence recording when MULTI is selected as **Disk No.** MULTI causes data to be recorded continuously, without stopping.

11.5 Trigger Control of Capture

Capture to the screen's character buffer can be placed under trigger control. The trigger action **Capture:** OFF (or the Layer 1 CAPTURE OFF action on the Protocol Spreadsheet) stops the buffering of character data and freezes the screen display. **Capture:** ON (or CAPTURE ON) restarts data display and capture. Capture can be applied to one or both sides of the display (TD and/or RD).

When the character buffer has been frozen by trigger rather than by the FREEZE key, you will not be able to scroll through data on the screen. See Section 22.9 or 28.2(F) for a further discussion of capture.

11.6 Spreadsheet Control of Recording

Recording to RAM or disk also can be placed under trigger control. The layer-independent action RECORD OFF on the Protocol Spreadsheet stops the recording of line data. RECORD ON restarts recording. See Section 27 for a discussion of RECORD.

You can ascertain whether data is being recorded by looking at the status lines at the top of the display. Incrementing block numbers and an "R" in the record/playback field (next to the block number) indicate that data is being recorded.

11.7 Manual Control of Recording

The operator can manually initiate recording in Run mode using the RECORD key. RECORD is a toggle key which will alternately start or stop recording to RAM or disk. The selections on the Record Setup screen and trigger actions influence the function of RECORD.

During recording, the top status line of Run–mode screens will show incrementing block numbers and an "R" displayed in the record/playback field.

12 Disk Maintenance

Disk Maintenance

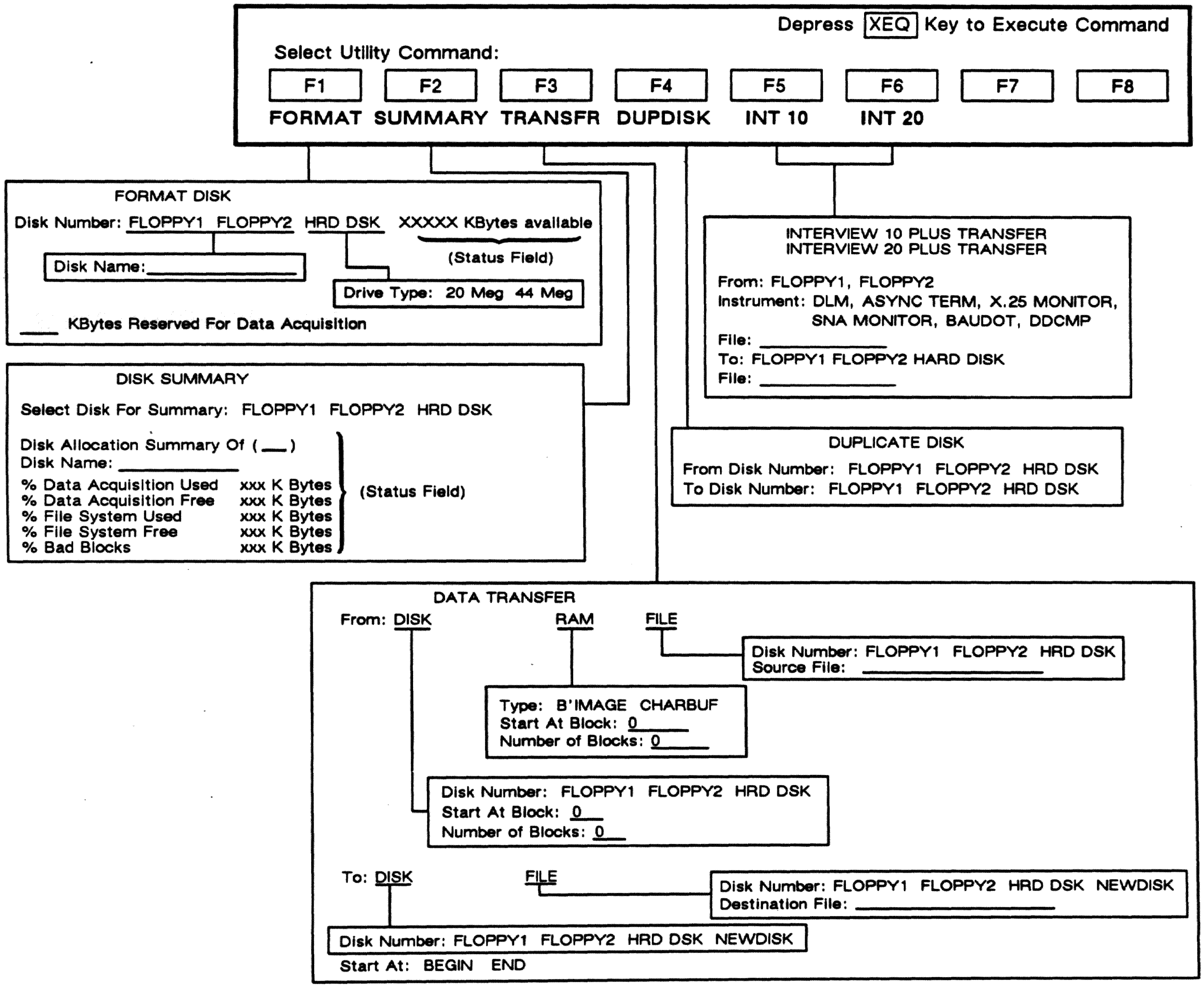


Figure 12-1 Disk Maintenance menu.

12 Disk Maintenance

12.1 The Disks

The INTERVIEW has two disk drives designed for 3.5 inch double-sided, high-density microfloppy disks. Maximum storage capacity of each microfloppy is 1.4 Mbytes.

A hard disk is installed in the 7200 *TURBO*, 7500, and the 7700 *TURBO* and is available as an option for the 7000. Depending on which hard disk is installed, maximum storage capacity of the hard disk is either 20 or 44 Mbytes.

The drives are referenced by number. Floppy Disk 1 (FD1) is the disk installed in the left-hand drive. Floppy Disk 2 (FD2) resides in the right-hand drive. The Winchester Disk is referred to as Hard Disk (HRD). The default drive at power-up is the disk from which the system loads initialization software. The INTERVIEW first checks FD1, then FD2, and finally, HRD. As soon as it detects system software, it stops the search and boots up.

12.2 Allocating Disk Space

Each disk must be formatted before it is available for data capture. Memory on each INTERVIEW disk can be partitioned for two types of storage: data acquisition tracks and a filing system. This partitioning must be performed before information is stored on disk. The Format command on the Disk Maintenance screen is used for this purpose. This command is explained later in this section.

12.3 Data Acquisition Tracks vs. the Filing System

Data acquisition tracks are sequential access data tracks which store Bit-Image or Character-oriented data in block format. Block size is 2 Kbytes, and each recorded block is numbered and date/time stamped. When data is recorded on disk in real-time, it is always captured on data acquisition tracks.

Recorded blocks can be accessed by block number and played back. However, any subsequent disk recording session overwrites the contents of the data acquisition tracks, so it is advisable to save this recorded data to a file using the Data Transfer command on the Disk Maintenance screen (see Section 12.4).

The filing system is a user-created hierarchy of files and directories for storing and organizing captured line data, setups (menu contents), protocol package data, C code, or entire test programs. Files are identified and accessed by name (full or relative pathname). Existing files and directories, descriptive information, and file management commands all appear on the File Maintenance screen. The File Maintenance screen, file naming conventions, and file access are discussed in Section 13.

12.4 The Disk Maintenance Screen

The Disk Maintenance screen is part of the Utilities menu group. All selections available on the menu are shown in Figure 12-1. The default Disk Maintenance screen is shown in Figure 12-2. Several disk management functions are grouped on this menu (as evidenced by the function keys in Figure 12-2). Disk formatting, data transfers, and disk duplication are all performed from this menu. In addition, the menu provides a summary of disk space for each of the disks associated with the INTERVIEW.

```
                       ** Disk Maintenance **

                  Command: DATA TRANSFER

From: DISK    Disk Number: FD1

Start At Block: 0
Number Of Blocks: 0

To: DISK      Disk Number: FD1

Start at: BEGIN
                          Depress XEQ Key To Execute Command

Select Utility Command
  F 1     F 2     F 3     F 4     F 5     F 6     F 7     F 8
FORMAT  SUMMARY TRANSFR DUPDISK  INT 10  INT 20
```

Figure 12-2 The default screen.

The selected command is always posted at the top of the screen. The screen repaints for each command. Once you have filled in appropriate menu fields, press XEQ to execute the command. In cases where data could be destroyed, you will have the option to continue the process by pressing GOAHEAD, or to stop the process by pressing ABORT. Status messages will inform you of any errors that are encountered. Error messages are listed and defined in Appendix A.

(A) Format Disk

This command (see menu selections, Figure 12-3) is used primarily to prepare floppy disks for data acquisition and file creation. A new disk must always be formatted before use.

The hard disk is formatted prior to delivery. *It is not recommended that you format the hard disk.* If you do want to format it to reallocate storage space, however, be sure that you know the size of your hard disk before you begin. Use the Disk Maintenance Summary command to check the size. See Section 12.4(B). The total in the right-hand column should approximate either 20 or 44 Mbytes.

> *CAUTION: Formatting a disk causes loss of its entire contents. It is recommended that you write-protect or duplicate any disk you wish to preserve. Periodic back-up of the hard disk is strongly recommended. Backup is* required *prior to formatting the hard disk. See Section 2.4 for instructions on backing up the hard disk.*

Before this command is executed, a number of subfields must be filled in. Subfields appear when you press the **FORMAT** function key.

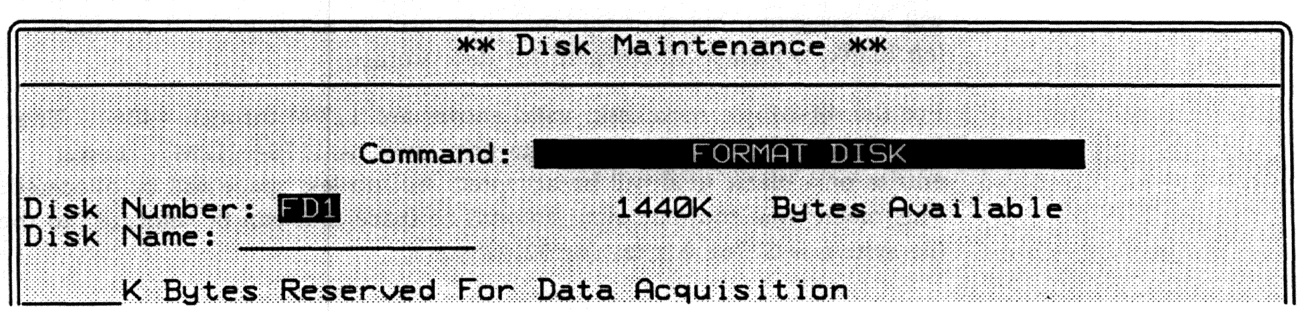


Figure 12-3 New disks must be formatted for data acquisition and file creation.

1. *Disk number*. Floppy 1, Floppy 2, or Hard Disk must be designated for formatting in the **Disk Number** field. Once the disk is selected, a status field appears to the right, indicating the total number of Kbytes of storage available on the disk.

   NOTE: Floppy 1 (FD1) refers to the INTERVIEW's left-hand micro-floppy drive; Floppy 2 (FD2) to the right-hand drive. The abbreviation HRD represents the hard disk drive.

2. *Disk name*. When one of the floppy drives is selected, the **Disk Name** field appears. A disk name is optional; however, it provides a useful identification for each disk.

```
                    ** Disk Maintenance **

              Command:           FORMAT DISK
Disk Number: HRD                 44472K Bytes Available
Drive Type:  44 Megabytes
_____K Bytes Reserved For Data Acquisition
```

Figure 12-4 **Indicate the size of the hard disk installed in your unit.**

3. *Drive type*. When you select **Disk Number: HRD**, the **Drive Type** field appears. See Figure 12-4. Select either **20 Meg** or **44 Meg** to indicate the size of your hard disk. If you try to format a 20-Mbyte disk as a 44-Mbyte disk, you will get an error message. If you inadvertently format the 44-Mbyte disk as a 20-Mbyte disk, reformat it back to 44 Mbytes.

4. *Allocate space for data acquisition*. The next menu field requests an entry for the amount of space on the disk which is to be dedicated to the data acquisition tracks. Legal entries in this field are 0 to 1322 for micro-floppies and 0 to 20536 for a 20-Mbyte hard disk. (Higher entries will be accepted, but no additional space will be allocated.) If the field is left blank, no space is allocated for data storage.

   For the 44-Mbyte hard disk, valid entries are 11704 through 44064. The minimum amount of space for data acquisition is 11704 (12M). Lower entries or a blank field will be accepted, but no less space will be allocated. This means that the maximum amount of space that can be allocated to the file system is 32768 Kbytes (or 32 Mbytes).

   NOTE: The 20-Megabyte hard disk is factory formatted to allocate approximately 5M to data acquisition and 15M to file storage. The 44-Megabyte is already formatted to allocate 12M to data acquisition and 32M to the file system.

   The amount of space allocated to data acquisition tracks is subtracted from the total Kbytes available (as listed in the status field on this menu). When disk space is allocated to data acquisition tracks, the amount of space is always rounded upwards to an integral number of cylinders. Remaining Kbytes are automatically allocated to the filing system. At least two cylinders of disk space (36 Kbytes) is always reserved for the file system on floppy disks. On the hard disk, a minimum of eight cylinders (272 Kbytes on the 20-Mbyte disk and 408 Kbytes on the 44-Mbyte hard disk) is required for the file system.

Press [XEQ] to start formatting. If the disk selected contains data, the warning message "Formatting disk will destroy data" appears at the top of the screen. Press GOAHEAD ([F1]) to continue the formatting process. Press ABORT if you decide not to format. After you press [XEQ], you may not abort formatting since the disk has already been altered.

(B) Disk Summary

Press SUMMARY, select the disk you want summarized, and press [XEQ] for a synopsis of disk contents. The status field (see Figure 12-5) is updated when you press [XEQ], so that the number of the disk drive being summarized appears between the parentheses, and the name of the disk appears on the line below.

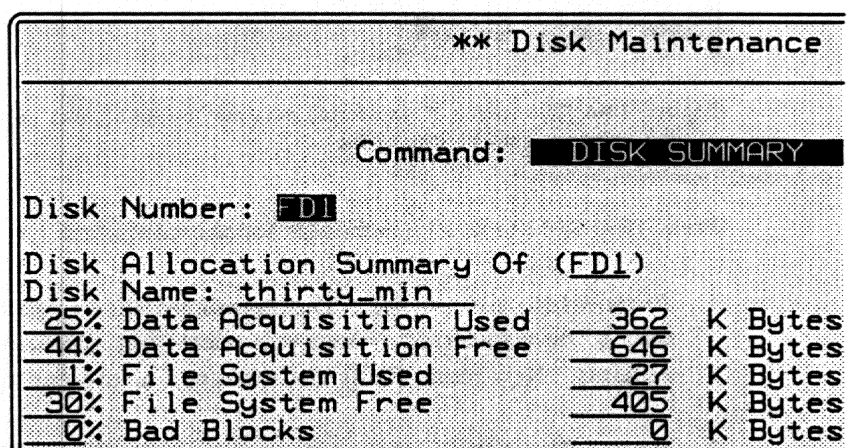


Figure 12-5 Results of a *DISK SUMMARY* command.

Several lines of disk information follow. The amount of disk space dedicated to data acquisition tracks, the amount of file system space used, and the amount of file space remaining are all reported. Each amount is given as a percentage of total disk space and in Kbytes. Note that the total in the left column always equals 100%, while the total in the right column always is 1440 Kbytes for a floppy diskette. For the hard disk, the total is either 20 Mbytes or 44 Mbytes.

(C) Data Transfer

Use this command (see Figure 12-6) to move data from one storage medium to another. Available media are the following: data-acquisition memory (whether character or bit-image) on a disk; files on a disk; bit-image RAM ("RAM" on the Record Setup menu); or character RAM (the screen buffer). Data transfer is necessary in some cases. For example, data in bit-image RAM, data in the screen buffer, and data saved to a file must be transferred to disk before it may be played back.

> **NOTE:** Transferring data to disk blocks which contain data or to an existing file will overwrite the previous contents of the disk or file.

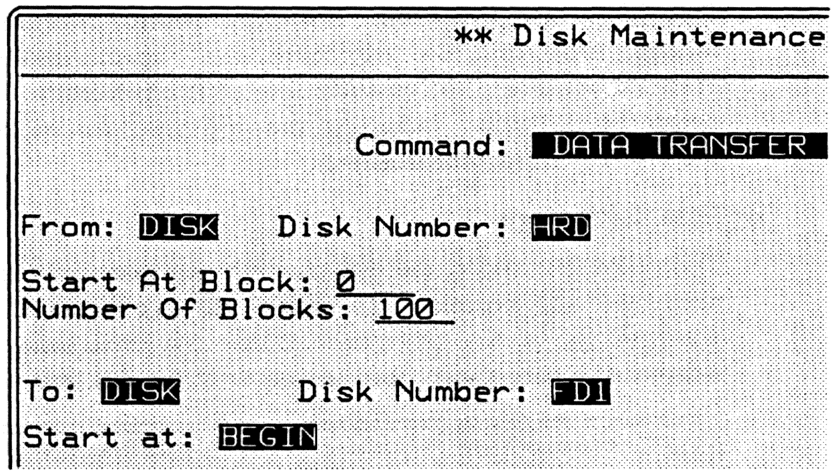


Figure 12-6 The source of transferred data may be RAM, disk, or file; the destination may be disk or file.

Press TRANSFER to display subfields for the command.

1. *From RAM, disk, or file*. The **From** field allows you to specify the source of data to be transferred. When you select RAM, DISK, or FILE, the screen repaints. New menu fields are explained at the end of this section.

2. *RAM*. When RAM is selected, you must specify type of RAM and the number and location of blocks you want to transfer. See below, subsection 6.

3. *Disk*. This selection refers to the data acquisition tracks on disk. When DISK is selected, you must specify the disk number and the number and location of blocks you want to transfer.

4. *File*. This selection allows you to transfer data out of the filing system. When FILE is selected, you must specify the name of the file and the disk number on which it resides. Data in a file is not available for later playback—it must be transferred onto data acquisition tracks to be played back.

5. *Disk number*. Designate the source disk by selecting FD1 (left-hand drive), FD2 (right-hand drive), or HRD.

6. *Type*. The first subfield which appears when RAM is selected is **Type**. You must specify BIT IMAGE or CHARBUFFER in the **Type** field when transferring data from RAM.

Bit-image RAM is the RAM that is selected in the **Capture Memory** field on the Record Setup menu. This RAM is 1 Mbyte in the 7500 and the 7700 *TURBO*, and 256 Kbytes in the 7000 and 7200 *TURBO*. (Optional MPM and XDRAM boards can increase the size of bit-image RAM. See Section 11.)

Character RAM is the 64 Kbyte screen buffer (or "character buffer").

7. *Start at block*. Enter the number of the first block to be transferred from the data source (whether disk or RAM) in the **Start At Block** field. (You can observe the current block number at the top of the display when you are recording data in Run mode.) Valid entries in the **Start At Block** field are 0 to 99999. If you do not enter a value, the value will default to zero. Block 0 means that data transfer will start from the beginning of the data source, regardless of the actual block number. All other entries represent actual block numbers.

   NOTE: It is not necessary to enter leading zeroes in this field. For example, you may enter 10 instead of 00010.

8. *Number of blocks*. In this field, enter the total number of blocks you wish to transfer. Valid entries are 1 to 99999. Again, it is not necessary to enter leading zero's.

9. *To disk or file*. When you transfer data to DISK, the data is transferred onto the data acquisition tracks for later playback. Specify the disk by selecting FD1 (left-hand drive), FD2 (right-hand drive), or NEW (for use when you have only one floppy disk drive available and are transferring data from one disk to another.)

   When you transfer data to a FILE, you must indicate the number of the destination disk as well as the file name. (Either relative or full pathname may be given.) Specify the disk by selecting FD1 (left-hand drive), optional FD2 (right-hand drive), or NEW (for use when you have only one floppy disk drive available and are transferring data from one disk to another.) If the name of an existing file is entered, the contents of the file will be overwritten with new data during the transfer. Data in a file is not available for later direct playback.

10. *Start at*. Specify in this field whether data will be stored on the destination disk starting at the beginning of the disk or file (overwriting any existing data), or whether the transferred data will be appended to the end of existing data.

Once you press [XEQ], you may stop the transfer at any point by pressing [F8] (ABORT).

(D) Duplicate Disk

If both floppy disk drives are operable, this command allows you to make a copy of full disk contents.

> NOTE: Duplicating the contents of one disk onto another destroys the previous contents of the destination disk.

Press **DUPDISK** to see subfields for this command. In the **From Disk Number** field (see Figure 12-7), select the drive number for the disk to be copied. Select the disk which will receive the copy in the **To Disk Number** field.

> NOTE: If the disk receiving data is write-protected, the Duplicate command will fail. Otherwise, any data on a receiving floppy disk will be overwritten. Only those files on a receiving hard disk drive *with the same names* as those on the sending disk will be overwritten, but files with new names will be added to those existing on the hard drive.

From time to time, you may need to use the Duplicate Disk command to install new system software on the hard disk of the INTERVIEW 7200 *TURBO*, 7500, or 7700 *TURBO*. (See Section 2.3.)

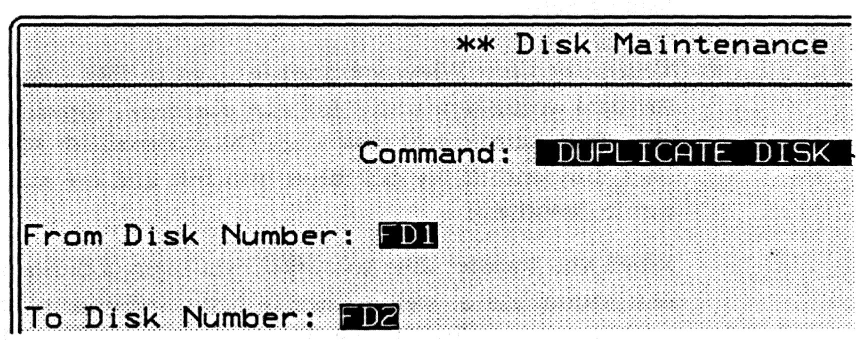


Figure 12-7 Entire disks may be duplicated on the Disk Maintenance menu.

(E) Transferring INTERVIEW 5 Plus, 10 Plus, 15 Plus, or 20 Plus Data to the 7000 Series

The INTERVIEW Transfer command (explained in Section 12.4(F)) allows you to copy files from a disk recorded with an INTERVIEW 5, 10, 15, or 20 Plus onto the hard disk of an INTERVIEW 7500 or 7700 *TURBO* or onto a microfloppy for any of the 7000 Series. The INTERVIEW 5/10/15 Plus and 20 Plus Series uses a 3.5 inch double-sided, double-density disk which can be distinguished from the INTERVIEW 7000 Series disk because it has a write-protect/enable window (with a plastic cover) but no second window on the opposite corner.

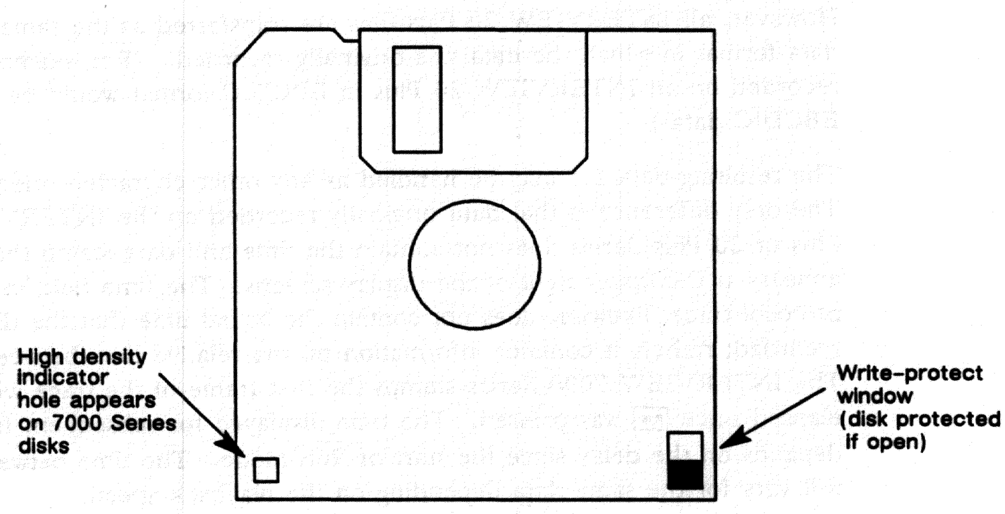


Figure 12-8 The INTERVIEW 7000 Series uses 3.5 inch quad- or high-density, double-sided microfloppy diskettes. The INTERVIEW 5/10/15 Plus and 20 Plus uses 3.5 inch double-sided, double-density diskettes which lack the high density window.

These disks are compatible (that is, they may be *read* by any 7000 Series unit) if the INTERVIEW 5/10/15 Plus or 20 Plus on which they were recorded has been reconfigured so that it records to disk in the correct format.

> NOTE: We recommend that you record disks reconfigured for the 512 bytes/sector format (Software Version 1.10A or higher). If you are communicating with INTERVIEW 5, 10, or 15 Plus field units which have not yet been reconfigured for this format (still have Software Version 1.00C with old 1024 bytes/sector format), we recommend you contact the AR Division for instructions on reconfiguring the unit so that data is recorded to disk in the proper format.

Programs for the INTERVIEW 5/10/15 Plus and 20 Plus Series may not be transferred to disk for the INTERVIEW 7000 Series. Furthermore, neither data nor programs recorded on a INTERVIEW 7000 Series unit can be copied or read by the INTERVIEW 5/10/15 Plus or 20 Plus Series. This precludes the storage of data on the 7000 Series for later analysis on the INTERVIEW 5/10/15 Plus or 20 Plus. However, a more sophisticated analysis of this data is possible when it is played back on the INTERVIEW 7000 Series.

All INTERVIEW 5/10/15 Plus files are transferred as ASCII character data, regardless of the format in which the data was originally recorded. Because of the conversion in data format, the size of the file once it is transferred may increase by as much as 5%.

However, all INTERVIEW 20 Plus files are transferred as the same character data format in which the data was originally recorded. (For example, data recorded on an INTERVIEW 20 Plus in EBCDIC format would be transferred as EBCDIC data.)

The resulting data file may be handled as any other character-oriented data. The only difference is that data originally recorded on the INTERVIEW 5/10/15 Plus or 20 Plus Series does not contain the time and date stamp that normally appears at the upper right of the display screens. The time field in a layered protocol trace, likewise, does not contain the actual time that the data was recorded; rather, it contains information on the relative time between frames. The INTERVIEW 7000 Series stamps the first frame in the trace with the time elapsed since [RUN] was pressed. The time displayed for subsequent frames depends on the delay since the start of Run mode. The time between frames will vary for the same data depending on the playback speed.

> **NOTE:** Microfloppies configured for 512 bytes/sector have a maximum storage capacity of 691,200 bytes as opposed to the 766,976 bytes of maximum storage available on the older 1024 bytes/sector disk. Maximum recording speed of the 512 bytes/sector disks is 64 Kbps.

Data samples captured on the INTERVIEW 5/10/15 Plus and 20 Plus Series and saved to disk files may be transferred to the INTERVIEW 7000 Series. You must first, however, know the filenames for the recorded data. If no printout accompanies the INTERVIEW 5/10/15 Plus or 20 Plus disk, you may obtain a listing of disk files using the procedure which follows.

1. Install the INTERVIEW 5/10/15 Plus or 20 Plus disk into the INTERVIEW 5, 10, 15, or 20 Plus.

2. Press the Menu key until you see the start-up screen. This screen displays the name of the device in a banner and gives the copyright date and the software version. The prompt above the function keys instructs you to select an instrument. Press the function key indicated for more instruments.

3. A new set of function key labels appears on the screen. Press the function key indicated for Disk Utilities.

4. *For INTERVIEW 5/10/15 Plus:* The screen repaints to reveal file listings for all files stored on the disk. As shown in Figure 12-9, for the INTERVIEW 5/10/15 Plus there are four columns, labeled at the top of the screen. The first column tells the instrument type for the file named on the same line. The second column tells whether it is a data file (D) or a program file (P). The name of the file appears in the third column. The size of the file is listed in the final column.

Figure 12-9 INTERVIEW 5/10/15 Plus disk file directory.

NOTE: Data samples which have been saved as a memory buffer rather than a file are not recorded on the microfloppy, will not appear in the file listings, and cannot be transferred to the INTERVIEW 7000 Series.

If the "-CURRENT" file is to be transferred, we recommend renaming it. In the event that another file is saved before the transfer, that new file will overwrite the present "-CURRENT" file. Select the file to be renamed and press the Rename function key; enter a new name for the file as the display directs.

5. *For INTERVIEW 20 Plus:* The screen repaints to reveal file listings for all files stored on the disk. For the INTERVIEW 20 Plus, as shown in Figure 12-10, there are three columns. The first column lists the instrument type for the file named on the same line and the size of the file is listed in the final column. The second column contains three pieces of information:

A 02 -CURRENT

"A" - the "device" in which the file is stored (A - RAM, B - Floppy, C and D - ROM disks),

"02" - the type of file (00 and 01 - program names, 02 - DLM capture buffers, 03 - VT100 capture buffers, 04 - DVOM capture buffers, PR - printer files), and

"-CURRENT" - the name of the file.

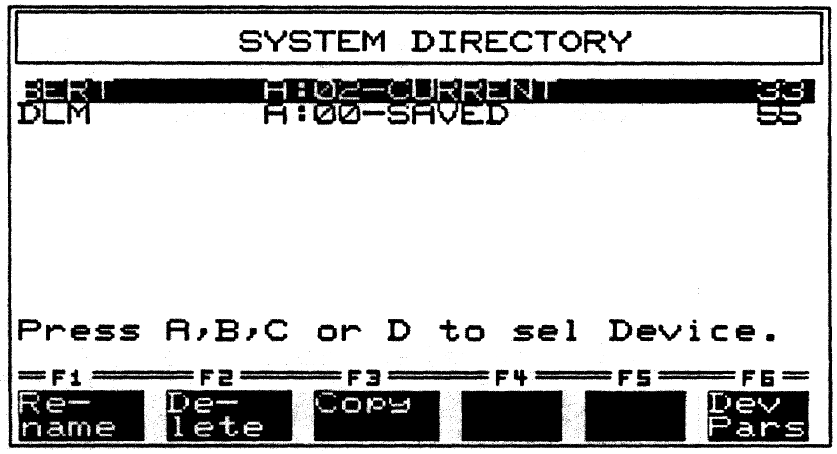


Figure 12-10 INTERVIEW 20 Plus disk System (file) Directory.

(F) INTERVIEW Transfer

To transfer data from a Series 1 INTERVIEW 5/10/15 Plus disk to the INTERVIEW 7000 Series, press the function key labeled INT 10; to transfer data from an INTERVIEW 20 Plus or a Series 2 INTERVIEW 5/10/15/20 Plus disk to the INTERVIEW 7000 Series unit, press the function key labeled INT 20. These keys appear when the cursor is at the top of the Disk Maintenance Screen. The screen then repaints to display the fields shown in Figure 12-11; the **Command** field will display INTERVIEW 10 PLUS TRANSFER or INTERVIEW 20 PLUS TRANSFER for the selection made.

Install the microfloppy from the INTERVIEW 5/10/15 Plus or 20 Plus Series into either of the floppy disk drives. If you are copying the files to another floppy, install a formatted INTERVIEW 7000 Series microfloppy into the other floppy disk drive. (The two types of disk can be distinguished before they are installed as described in Section 12.4(E).)

1. *From*. In this field, select the drive (FLOPPY1 or FLOPPY2) into which you have inserted the disk from the INTERVIEW 5/10/15 Plus or 20 Plus.

2. *Instrument*. This field indicates the type of interface used to record data on the INTERVIEW 5, 10, 15, or 20 Plus. Data from each of the instruments is recorded in a different format, and this must be taken into account in the transfer. There are six possible selections in the **Instrument** field. These are DLM (data line monitor), TERM (asynchronous terminal), X25 MON (X.25 protocol monitor), SNA MON (SNA protocol monitor), BAUDOT (Baudot protocol monitor), and DDCMP (DDCMP protocol monitor).

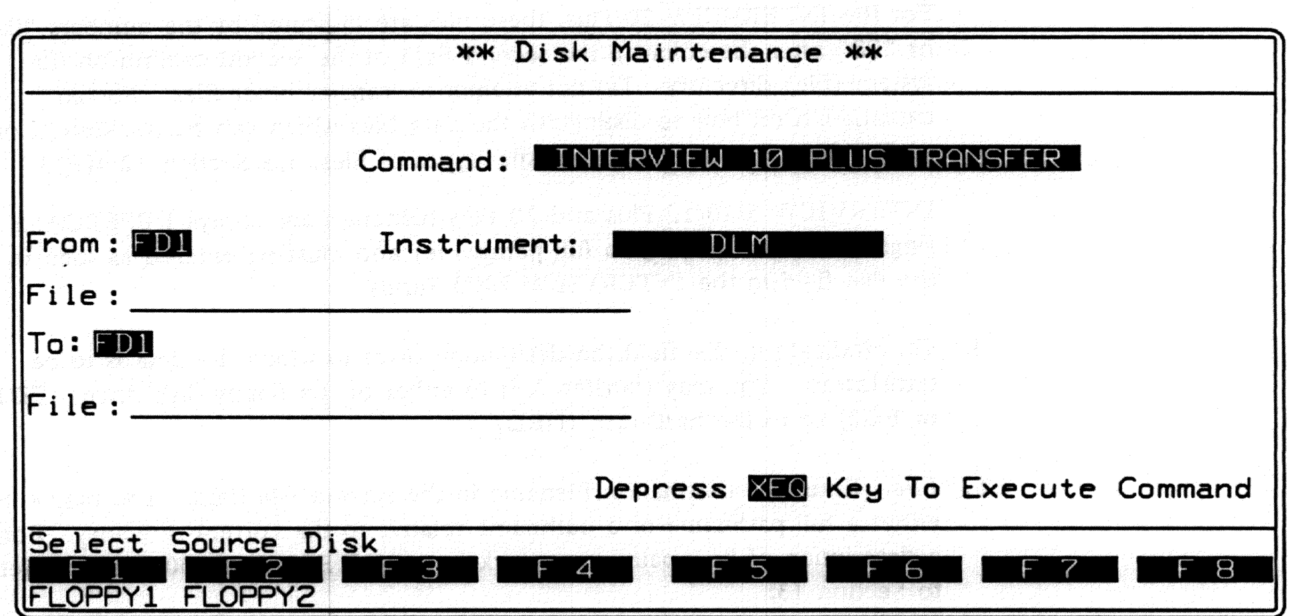


Figure 12-11 Use the Interview Transfer command to transfer data from an INTERVIEW 5/10/15 Plus disk to INTERVIEW 7000 Series disk files.

It is possible to determine from the file listings on the INTERVIEW 5, 10, 15, or 20 Plus what instrument was used to record the data. See Section 12.4(E) for instructions on accessing these file listings.

Once the data is transferred from an INTERVIEW 5/10/15 Plus Series unit, it is stored in the INTERVIEW 7000 Series as ASCII character data, regardless of the instrument on which it was recorded.

However, all INTERVIEW 20 Plus files are transferred as the same character data format in which the data was originally recorded. (For example, data recorded on an INTERVIEW 20 Plus in EBCDIC format would be transferred as EBCDIC data.)

3. *File*. Enter the name of the source file from the INTERVIEW 5, 10, 15, or 20 Plus. The filename for the last data sample collected is -CURRENT (unless the file has intentionally been renamed). Enter this filename exactly as shown. The initial hyphen is part of the name. Other filenames are listed in the disk file directory of the INTERVIEW 5, 10, 15, or 20 Plus. Obtain directory listings as described in Section 12.4(E).

   Only data files can be transferred to the units in the INTERVIEW 7000 Series. For the INTERVIEW 5/10/15 Plus, these files are indicated by the letter D in the second column in the file directory. Do not attempt to transfer program files (marked P).

For the INTERVIEW 20 Plus, these files are indicated by the numbers "02" or "03" after the colon in the second field of the second column on the system (file) directory. Do not attempt to transfer other files. For an explanation on how to distinguish the data files which can be transferred on an INTERVIEW 20 Plus from other types of files, see Section 12.4(E)5.

INTERVIEW 5/10/15 Plus and 20 Plus filenames are always UPPERCASE single words (rather than a full pathname) and must be entered as such in the **File** field in the INTERVIEW 7000 Series.

4. *To*. Indicate in this field the destination drive to which the data is to be transferred. You may transfer data to either of the floppy disk drives (FD1 or FD2) or to the hard disk (HRD).

5. *File*. Enter the destination filename in the second **File** field. You may enter either a full pathname or a pathname relative to the current directory. For a description of how pathnames work in the INTERVIEW 7000 Series refer to Section 13.

   None of the information from the INTERVIEW 5/10/15 Plus file listings is transferred with the file when it is copied into the INTERVIEW 7000 Series. It is important as a result to use descriptive filenames (or pathnames) to tag your data samples properly.

6. *XEQ*. When all entries on the screen are correct, press [XEQ]. The message "Transfer In Progress" appears on the second line of the screen to indicate that the file is being copied. To abort the transfer while it is in progress, press [F8].

   The message "Transfer Complete" is posted at the top of the screen when the process is complete. If there is a problem with the transfer, an error message appears in the same area. Refer to Appendix A for an explanation of error messages.

   Once the transfer is complete, the name of the file, the file type CHDAT (for character data), the size of the copied file (which is likely to be somewhat larger than the original file), and the date and time of the transfer are recorded in the 7000 Series directory. If the file has been placed in a directory other than the current directory, you must use the Change Directory command to find it in the listings. This command and the File Maintenance screen are described in Section 13.

   Use the regular Data Transfer command to move the data into the data acquisition tracks of the disk for playback and analysis. The Data Transfer command is discussed in Section 12.4(C). Playback is discussed in Section 4.2.

13 File Management

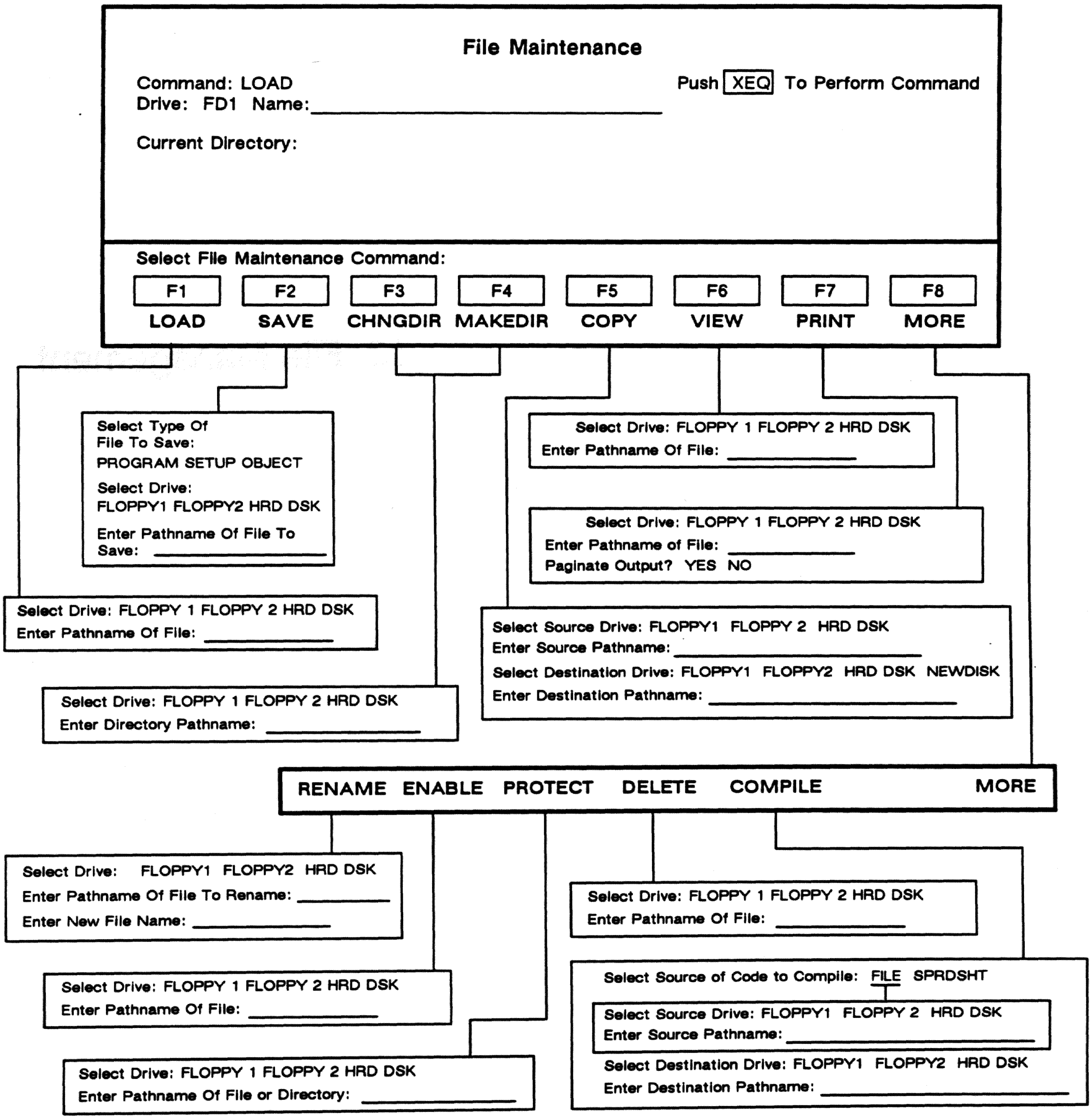


Figure 13-1 File Maintenance menu.

13 File Management

The filing system is a set of files and directories, grouped by disk, created and managed by the user. Files may contain captured line data, setups, protocol package data, entire test programs, or text. Files are identified and accessed by name. The file's location in the system is indicated by its full or relative pathname, as explained later in this section.

All file management functions are performed from the File Maintenance screen (FMAINT; see Figure 13-1 for menu options and Figure 13-2 for default screen). The menu options are described at the end of this section. These functions include copying files, loading and saving files, compiling files or the contents of the Protocol Spreadsheet, permanently deleting files, viewing the contents of certain files, write-protecting or write-enabling files, printing files, and grouping files into directories.

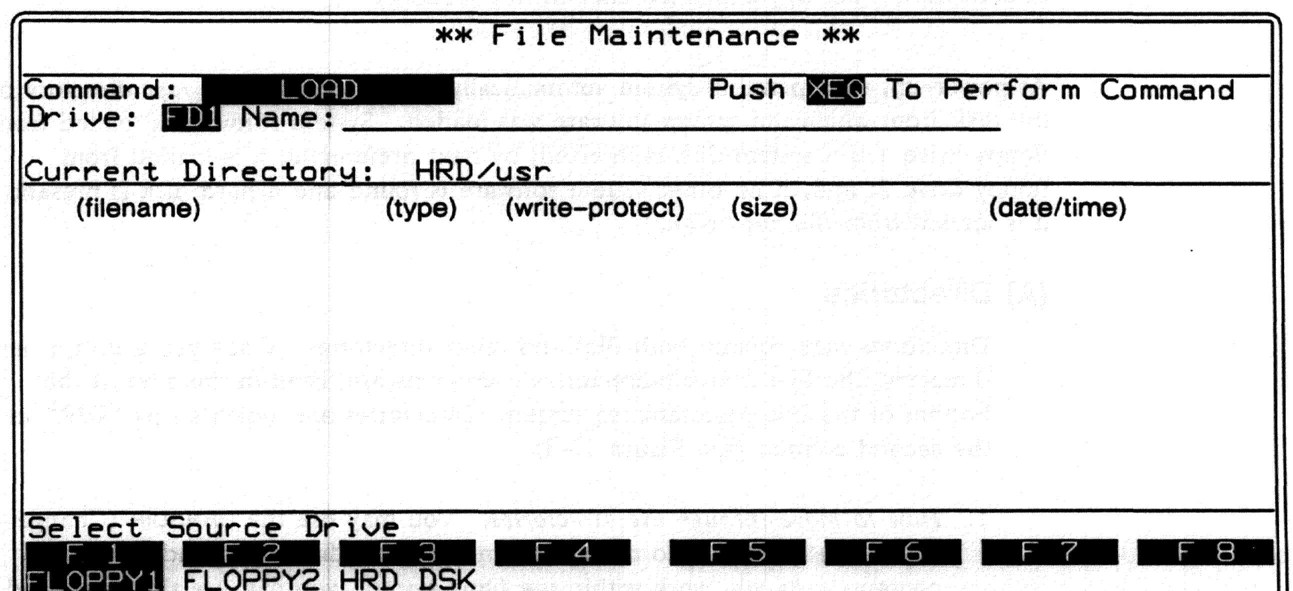


Figure 13-2 Default File Maintenance screen.

13.1 Loading and Saving Files

The File Maintenance screen is an important interface between the filing system and the INTERVIEW's data analysis functions. All INTERVIEW test programs are loaded from the File Maintenance screen. Newly created or modified tests are saved on this menu as well.

NOTES:

1. READ and WRITE commands appear as editing functions on the Protocol Spreadsheet. These commands, described in Section 26, load or save only Protocol Spreadsheet contents and do not interfere with the contents of other menus.

2. Protocol packages, although part of the filing system, are loaded from the Layer Setup screen. For a description of this menu, see Section 6.

13.2 Orienting Yourself in the Filing System

The INTERVIEW's filing system is a simple tree-structured filing system similar to the UNIX™ filing system. (UNIX is a trademark of AT&T Bell Labs.) Each disk has its own hierarchy. At the top of the tree is the "Root" directory, represented by the single slash (/). When new, the System disk contains this directory and two others, */sys* and */usr*. These are subdirectories of the Root directory; that is, they are one step below the top of the hierarchy. (The slash at the beginning of the name locates the directory with reference to the Root directory. Naming conventions for directories will be fully explained later in this section.)

At power-up, the operating system automatically moves you into the */usr* directory of the disk from which the system software was loaded. System software is loaded from floppy drive 1 if a system disk is inserted; by next preference, it is loaded from floppy drive 2; and, if no other system software is found and a hard disk is present, it is loaded from the hard disk.

(A) Directories

Directories may contain both files and other directories. Once you are in a new directory, the files and subdirectories it contains are listed in the area at the bottom of the File Maintenance screen. Directories are indicated by "DIR" in the second column (see Figure 13-3).

1. *How to move through the directories.* You may use the CHNGDIR (Change Directory) command to move into any of these directories and view their contents. As you work within the filing system, you can use this command to change levels and directories. However, you can never be in more than one working directory at a time. This working directory is referred to as the "current directory." The current directory is always posted on the fourth line of the File Maintenance screen.

   To move from the */usr* directory of the boot disk up to the Root directory, use the Change Directory command and enter the pathname /. To move into the */sys* directory, enter the pathname */sys*. There will be no other directories on a new system disk; you must create new directories yourself.

To move from disk to disk, use the Change Directory command and select the correct disk drive in the highlighted window below the command line. In the entry field provided, enter slash (/) to move to the Root directory of the new disk, or enter the absolute pathname of the directory you want. Absolute pathnames are described in the next subsection.

2. *How to create new directories.* New directories are created using the MAKEDIR (Make Directory) command on this menu. A maximum 256 files and/or directories may be created on one microfloppy diskette. The maximum for hard disk is 4,096. Directories follow the same naming conventions as files. These conventions are explained in the following paragraphs. The pathname you enter as you make a directory indicates where you wish to locate the directory in the filing hierarchy. Pathnames are explained later in this section.

```
                    ** File Maintenance **
Command:    LOAD                  Push XEQ To Perform Command
Drive: FD1 Name: ____________________________
Current Directory:  HRD/usr
BSC                 DIR            167     12/03/86  12:12
BSC_Test_Data       BITIM       114371     01/30/87  12:30
Emul_3270_Term      PRGM         12620     11/17/86  11:27
Line_Eff_3270       PRGM          4438     11/09/86  17:00
SNA_Bind            PRGM     W    3107     09/06/86  09:11
SNA_Sessions        PRGM     W   10700     09/30/86  10:22
Test_3270_Term      PRGM          9722     11/10/86  07:12
X25_Cert            DIR            213     03/14/87  10:25
X25_Cert_desc       ASCII         1020     03/16/87  19:12
X25_Frm_Lev         SETUP         2504     02/02/87  10:25
X25_Pkt_Size        PRGM          9380     02/22/87  14:32
Select File Maintenance Command
 F 1     F 2     F 3      F 4       F 5    F 6    F 7     F 8
 LOAD    SAVE   CHNGDIR  MAKEDIR   COPY   VIEW   PRINT   MORE
```

Figure 13-3 Contents of the current directory are listed on the File Maintenance Screen.

(B) Absolute Pathnames

A pathname identifies the path through the directory structure which terminates at a particular file or directory. Each file and directory has an absolute pathname and a relative pathname.

An absolute pathname always begins with a slash. This indicates the path from the "root," or starting point, of the filing system. The directories and/or file it "owns" are listed to the right, each separated from the next higher level by a slash.

The absolute pathname is useful when you aren't sure of your current location in the filing system. Using the absolute pathname always alerts the operating system of the precise location of the directory or file you specify in any command.

(C) Relative Pathnames of Files and Directories

The relative pathname of a file or directory is the route to the file or directory from the current directory. The relative pathname may be as simple as a one-word filename. (It never begins with a slash.) If, for example, your current directory (*dir_c*) contains a file (*your.file*), then the relative pathname of the file is, simply, *your.file*. Now suppose that you move to a different current directory (*dir_b*) which contains *dir_c* as a sub-directory. The same file would have a different relative pathname: *dir_c/your.file*.

Each time you move up a directory level, the relative pathname gains a new subdirectory name as a component. The new component is always separated from its subdirectory (or file) by a slash. The relative pathname of this same file when you are working in the */usr* directory might, for example, be *dir_a/dir_b/dir_c/your.file*. The absolute pathname for the same file would be */usr/dir_a/dir_b/dir_c/your.file*.

(D) Files

Files are the basic elements of the filing system. Files can be identified in the Type field of the Directory Listings. Any type other than "DIR" is a file.

The INTERVIEW files named in the directory listings on the File Maintenance screen are created in a variety of ways. The files in the */sys* directory, for example, are placed on each system disk at the factory. This directory contains data essential to the operating system. It is not advisable to store user files in the */sys* directory.

The */usr* directory, also created on each disk at the factory, is intended for the storage of files (and directories) which you create.

1. *Program files*. Program files, which contain the configuration of all INTERVIEW menus and the Protocol Spreadsheet contents, are created when you use the SAVE command on this menu.

2. *Setup files*. Use the SAVE command on the File Maintenance screen to create Setup files. Setup files contain a partial set of configured menus.

3. *Object files*. Object files, which contain the configured Setup menus, the Layer packages, and the object-code compilation of the Trigger menus and the Protocol Spreadsheet, are created when you use the SAVE command on the File Maintenance menu.

4. *Linkable-object files.* Use the Compile command on the File Maintenance menu to create linkable-object (LOBJ) files. Linkable-object files may contain the object-code compilation of standard C code. The compiled C code in linkable-object files usually contains the definitions of user-created routines.

   Linkable-object (LOBJ) files may also contain the compiled contents of the Protocol Spreadsheet, different from object (OBJ) files which additionally contain all menu configurations.

5. *Protocol Spreadsheet files.* Use the WRITE command provided by the spreadsheet editor (described in Section 26), specify a filename, and press [XEQ] or [RETURN] to save only the contents of the spreadsheet. The file which results is listed in the File Maintenance directory as type ASCII; however, when you want to use the file again, it should be read in by the spreadsheet editor (rather than loaded from the File Maintenance screen.)

6. *Data files.* Use the Data Transfer command on the Disk Maintenance screen to store data from disk into a file. See Section 12.4(C). The files which result appear in the directory listings on the File Maintenance screen. Before you replay data files, you must transfer them back onto the data acquisition tracks of a disk; a file is not a valid **Source** of data on the Line Setup menu. Do not attempt to load data files from the File Maintenance screen.

(E) Naming Conventions for Files and Directories

There are a few simple rules to keep in mind when naming files. The maximum length of any component is 12 characters. Legal characters for filenames are letters; numbers (0–9); and the symbols dash (—), underscore (_), dollar sign ($), and period (.). Filenames must start with a letter or a period. Upper and lower case letters may be used. Filenames are case-sensitive; that is, the pattern of upper and lower case letters in an existing name must be repeated exactly any time that file is referenced.

Filenames may include extensions for convenience, but the system attaches no special meaning to the extension. When you refer to a file with an extension, you must include the extension in the filename.

Filenames cannot be duplicated within the same directory. If, for example, there is already a file in your current directory called *unifile* and you save a newly created file to the name *unifile*, then the old file is destroyed.

Single periods (.) and double periods (..) have special uses when referring to files or directories. Their uses are described in the paragraphs which follow.

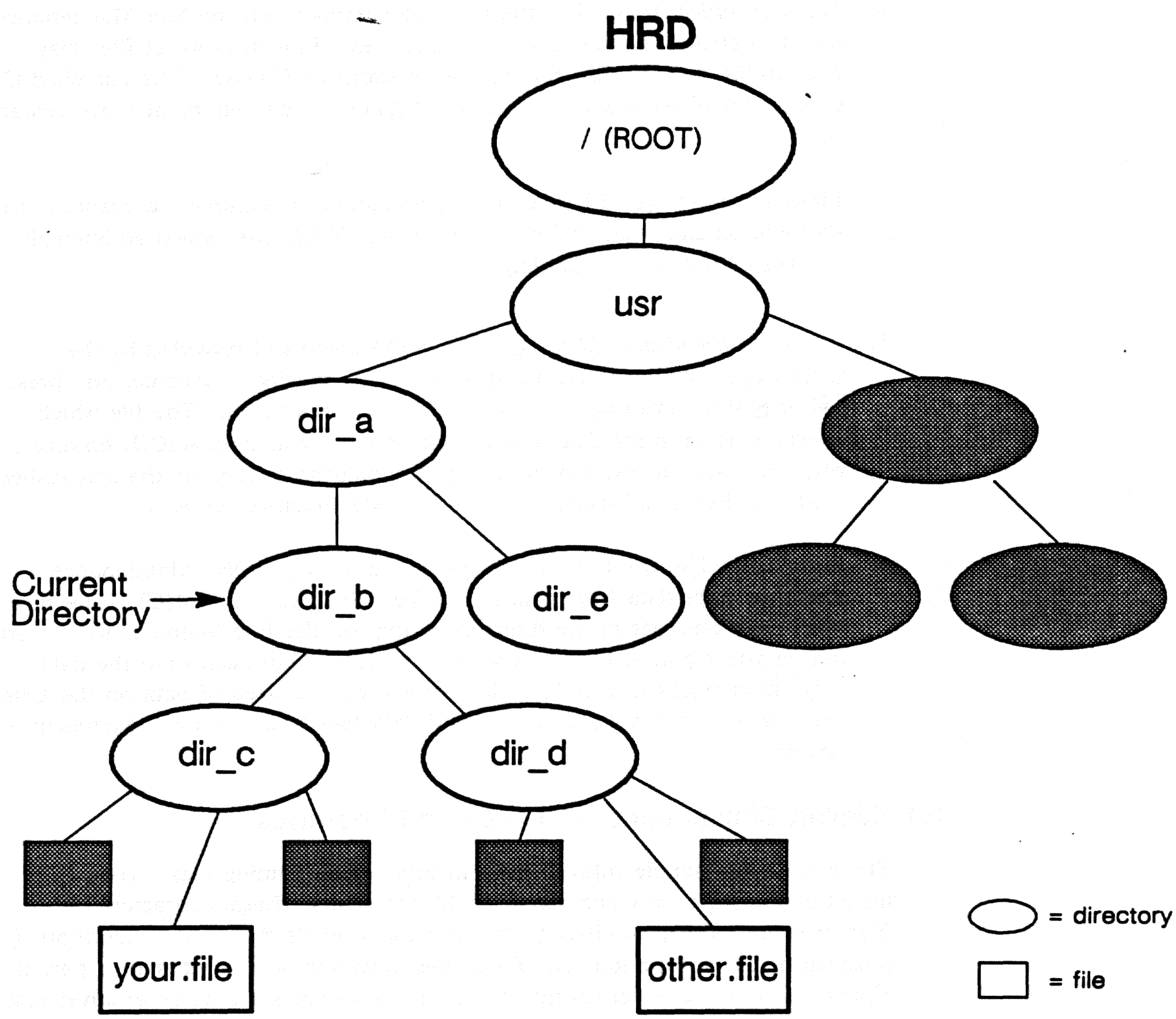


Figure 13-4 The INTERVIEW has a hierarchical filing system.

(F) Use of Periods in Pathnames

Single periods and double periods, when used alone as file components, have special meanings. A single period (.) always represents the current directory. A double period (..) always represents the parent directory; that is, the directory immediately above.

The double period (..) is a useful abbreviation for defining pathnames. A common use for the component would be to change the current directory to the parent directory. In this case, you don't need to use the name of the parent directory. Just select the Change Directory command and enter .. as the pathname to the new current directory. String a series of these together, separated by slashes (for example, Change Directory ../../..) to move up the file tree.

Study the file system in Figure 13-4 to see how the following points apply.

1. The relative pathname of *your.file* is *dir_c/your.file*. Its absolute pathname is */usr/dir_a/dir_b/dir_c/your.file*.

2. The relative pathname of *other.file* is *dir_d/other.file*. Its absolute pathname is */usr/dir_a/dir_b/dir_d/other.file*.

3. To move up to the */usr* directory from the current directory, enter the pathname ../.. when you use the Change Directory command.

4. To move from the current directory (*dir_b*) to *dir_e*, use the Change Directory command and enter this pathname to the new directory: *../dir_e*. (This is simpler than using the absolute pathname, */usr/dir_a/dir_e*.)

13.3 The File Maintenance Screen

(A) The Top of the Screen

Twelve commands can be executed from the File Maintenance screen (see Figure 13-1 for a full set of menu fields). There are two alternate banks of commands. Use the MORE function key to switch from bank to bank (see Figure 13-5 and Figure 13-6). When you press the function key to select a particular command, the screen repaints, and a set of unique menu fields appears. The selected command always appears on the top line of the menu.

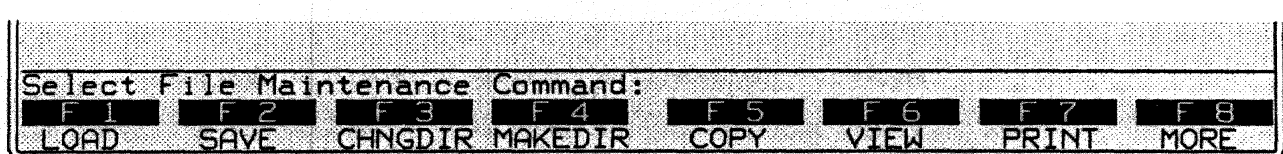


Figure 13-5 Press *MORE* to display the alternate bank of function keys.

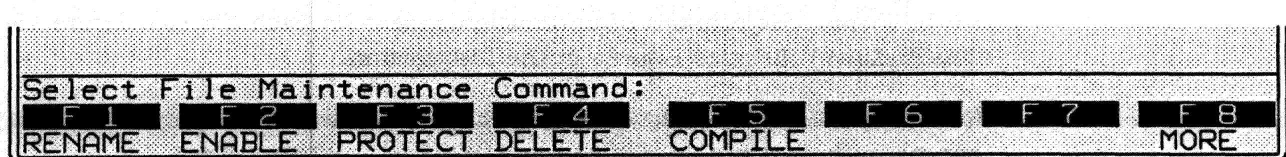


Figure 13-6 Alternate bank of function keys.

1. *Current drive.* At the top of the screen, just below the **Command** field, the name of the current disk is given (see Figure 13-7). The files displayed in the directory listings on the screen reside on the disk named in this area.

   NOTE: The current disk at power-up is the disk from which the INTERVIEW is initialized. If all three drives are present, the INTERVIEW checks FD1, then FD2, and finally HRD for system initialization software and boots from the first system disk it finds.

2. *Name field.* Every command requires at least one filename and provides a field in the menu area for filename entry (see Figure 13-7) where you MAY enter the name of the file to be acted upon. The file's absolute or relative pathname can be entered. If you enter the filename, you must type it exactly as it appears in the directory listings.

   NOTE: There are several ways to specify the file or files which are to be acted upon. Read Section 13.3(C) before executing any command.

   Study the directory listings if you are uncertain of the filename. If you require more information on a file, use the View command to see the contents of the file.

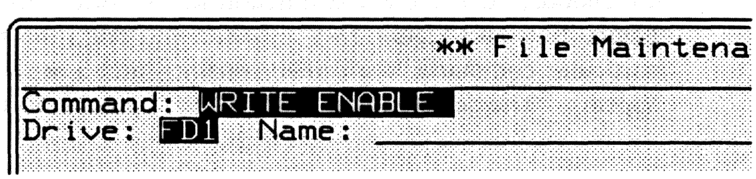


Figure 13-7 The name of the current disk is selected in the *Drive* field.

(B) Directory Listings

The name of the current directory is listed in a field at the top of the screen. The contents of the current directory are listed in a 12-line field in the center of the menu. Six columns of information appear for each file (see Figure 13-8). The (relative) filename is given in the first column.

The Type field to the right defines the contents of the file. All types that may appear in this column are defined in Table 13-1. When a file is write-protected, the letter "W" appears immediately to the right of the Type column.

The size of the file (in bytes) is given in the next column. The date and time that the file was last modified appear in the two far-right columns.

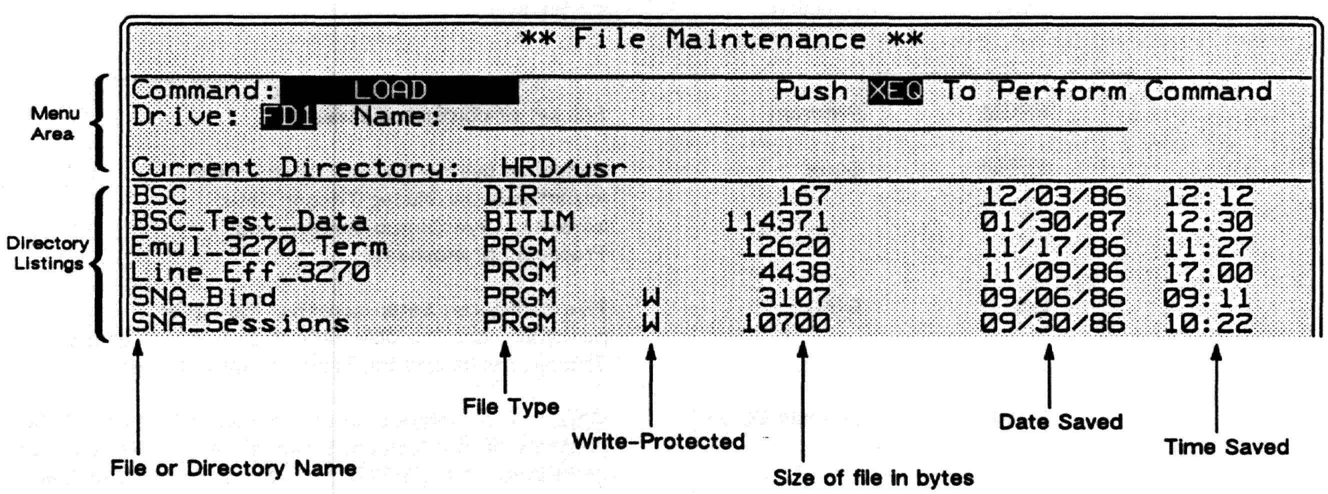


Figure 13-8 Current directory listings. Data types are listed in the column to the right of the file or directory name.

1. *Moving through directory listings*. The contents of the current directory are displayed on the File Maintenance screen.

   More than 12 lines of information may be available for the directory. To display additional lines, position the cursor on the last line of the listings and press [↓]. (This will display new lines one at a time.)

   Press [SHIFT] and [↓] at the same time to move to the end of the listings. Press [NEXT PAGE] to display the next 12 lines of information. Position the cursor on the first line and press [↑] to expose previous lines one at a time. Press [PREV PAGE] to display the previous 12 lines.

   Press [SHIFT] and [↑] to move to the top of the listings.

   To see the listings for another directory, you must use the Change Directory command.

Table 13-1
File Types

Type	Meaning	Comments
PRGM	Program	Full set of configured screens.
SETUP	Setup	Subset of five configured Setup screens, in particular, excludes Trigger Setup screens, Layer Setup screen, and Protocol Spreadsheet.
OBJ	Object	Five configured Setup screens, the Layer packages, and the object-code compilation of the Trigger menus and the Protocol Spreadsheet
LOBJ	Linkable Object	Object-code compilation of a standard C file or of the contents of the Protocol Spreadsheet. C files may be generated via the WRITE/U (editor)command on the Protocol Spreadsheet.
BITIM	Recorded data	Bit-image data saved for reanalysis. May be reformatted and rechecked for BCC error.
CHDAT	Recorded data	Character data saved for reanalysis. This data has already been formatted and checked for BCC error (if received block-checking enabled) and may not be reformatted or rechecked.
ASCII	Text	Text file generated by user on Protocol Spreadsheet screen.
DIR	Directory	A directory, potentially containing files and subdirectories, which is part of the structured file system.
SYS	System files and internal INTERVIEW files	files generated by AR Division, including Personality Packages.

(C) Selecting Files

There are several ways in which you can designate files to be acted upon by a chosen command.

1. *Name field*. The first means of selecting a file is to enter its name in the **Name** field at the top of the menu.

    NOTE: The cursor must remain in the menu area (see Figure 13-8) in order for the command to operate on the named file.

2. *Cursor location.* You may designate a single file to be acted on by moving the cursor into the directory listings and positioning it over the desired file. The file name will be highlighted.

   NOTE: When the cursor is located in the Directory Listings, the highlighted file will be acted upon by any command executed. Any file named in the **Name** field will NOT be acted upon.

   If you have selected a file with the cursor, but the file-maintenance command shown at the top of the screen is not the one you want, press [DONE]. The cursor will return automatically to the **Command** field. Choose the appropriate command and press [DONE] again. The cursor will return to its previous location, highlighting the selected file.

3. *Marking files.* For certain commands, the [MARK] key can be used to select files on which you want the command to operate. To mark a file, locate the cursor over it and press [MARK]. Once a file is marked, you need not fill in the **Name** field for the command.

   The next command executed will operate on the marked file or files. Even if there is a filename in the **Name** field, marked files (and NOT the entered file) will be acted upon.

   Marked files also take precedence over the file at the cursor location. That is, if files are marked, they will be acted upon by the command, but the file at the cursor location will not be acted upon.

   With one exception, [MARK] works only with commands which are used to operate on multiple files simultaneously. These commands are Copy, Delete, Write-Protect, Write-Enable, and Print. The exception is the Compile command. In this case, only a single file should be marked. If you mark more than one file for compiling, the following error message will be displayed: *"Too many source files selected."*

4. *Unmarking a file.* [MARK] is an alternate action key. To deselect a marked file, locate the cursor next to it and press [MARK] again.

   Once the command is executed, the file is no longer marked. Marked files are no longer marked if you leave the File Maintenance screen.

(D) Executing Commands

To execute any of the 12 commands, make sure that all entries are correct. Then press [XEQ]. Status messages will inform you of any errors. Refer to Appendix A for an explanation of error messages.

(E) Load

For fast access to this command, press [LOAD] as an alternative to accessing the File Maintenance screen with function keys. Use this command to load a working copy of a file from disk into the internal memory of the INTERVIEW. The Load command is frequently used to load complete programs into the INTERVIEW in preparation for running a test. Any program or setup file you wish to modify must first be loaded.

Only program, setup, or object (OBJ) files can be loaded with this command. Program files are a full set of configured menus, including the Layer Setup screen, Trigger Setup screens, and the Protocol Spreadsheet. Setup files are a smaller set of configured menus which includes only the five Setup screens: Line Setup, Interface Control, BCC Control, Front-End Buffer Setup, and Bit Error Rate Test Setup. Object files are the configured Setup menus, the Layer packages, and the object-code compilation of the Trigger menus and the Protocol Spreadsheet.

You must specify the disk on which the file you are loading resides and the (relative or absolute) pathname of the file before executing the load command. The simplest means of loading a file from the current directory is to place the cursor over the filename in the directory listings and press [XEQ]. Cursor selection overrides any entries that may appear at the top of the menu.

NOTES:

1. Remember that loading a program or setup overwrites the program or setup already in the INTERVIEW. Save the resident program or setup if you wish to use it later, and then load another file.
2. Loading an object file allows you to enter Run mode without recompiling, unless you make substantive changes (i.e., changes in fields not listed in Table 2-1).
3. The spreadsheet portion of a program (when saved via the Protocol Spreadsheet WRITE editor command) can be loaded via the READ command without overwriting the contents of other menus. See Section 26 for an explanation of the READ and WRITE commands.
4. Protocol layer setups are loaded from the Layer Setup screen (see Section 6). They may also be loaded along with a program or object file.
5. Data files are not "loaded" from the File Maintenance screen. Instead, see Section 12.4(C), Data Transfer.
6. Linkable-object (LOBJ) files are not loaded from the File Maintenance screen. Depending on the file's contents, use either the OBJECT block-identifier or the *#pragma object* preprocessor directive to access the compiled C code in an LOBJ file. Refer to Sections 24.4 and 56.4.

(F) Save

For fast access of this command, press [SAVE] as an alternative to accessing the File Maintenance screen with function keys. Use this command to preserve a newly created program, setup, or object file or to retain any changes you have just made to an existing file.

Before executing this command, you must select the type of file to be saved. Program, setup, and object (OBJ) are the only options on this screen. A setup is a set of five configured menus: Line Setup, Interface Control, BCC Control, FEB Setup, and BERT Setup. A program contains all menus, including the Layer Setup screens, Trigger Setup screens, and the contents of the Protocol Spreadsheet. An object contains the configured Setup menus, the Layer packages, and the object-code compilation of the Trigger menus and the Protocol Spreadsheet. If you have not compiled the program prior to saving the object, the compilation will occur as part of the SAVE process.

Before executing the command, you must also select the drive to which you wish to save the file, and you must enter the pathname to the file you are saving. If you are saving to a filename which already exists in the current directory, you may indicate the file by placing the cursor over its name in the directory listings before pressing [XEQ]. Cursor selection of a file overrides any entries which may appear at the top of the menu.

You cannot save to a directory which does not already exist. First, create the directory with the Make Directory command.

NOTES:

1. You may use the Save command to create a new set of default values for all menus. If you create a file called */usr/default* on the initialization disk, all menus will be set to your saved selections when the INTERVIEW boots from that disk. See Section 2.2(C) for a description of this procedure. See Section 12.1 for disk selection at boot-up.

2. If you only wish to save the contents of the spreadsheet, use the Protocol Spreadsheet WRITE command (see Section 26). Or use the File Maintenance Compile command to save the compiled object-code version of the contents of the spreadsheet. See Section 13.3(P).

3. Saving an *object* file requires a considerable amount of disk space and should be reserved for frequently used tests with long compilation times. (The program file for a test may occupy only 5320 bytes, while the object file for the same test occupies 109894 bytes.)

4. Preserve a copy of the source code (the program version) of a test as well as the object code. The program code is more *versatile* than the object code: in subsequent software revisions, the program version may still compile even if the object-code version no longer does. You may then generate a new object file from the source-code version.

5. Data can also be saved to a file using the Data Transfer command on the Disk Maintenance screen; see Section 12.4(C). Once data is saved in a file, the file appears in the directory listings of the File Maintenance screen.

6. Linkable-object (LOBJ) files are created via the Compile command, not the Save command. See Section 13.3(P).

(G) Change Directory

This command, labeled CHNGDIR on the function key, is the only method of moving from one current directory to another. Indicate the drive on which the new directory resides and give its absolute or relative pathname before executing the command. The name of the new current directory replaces the old one on the fourth line at the top of the File Maintenance screen, once the command is executed.

NOTES:

1. By definition, all relative pathnames of files and directories change once you change to a new current directory.

2. To move up to a higher directory, you must name the directory in the **Name** field.

3. If the name of the parent (the next higher) directory is not known, enter two periods (..) in the **Name** field. This moves you up one directory.

4. To change to a directory on another disk, select the drive in the rotating window and enter the absolute pathname of the directory in the name field.

(H) Make Directory

You must use the MAKEDIR (Make Directory) command to create a new directory. Use this command to create your own file hierarchy. You may create any number of subdirectories to the root (/) or */usr* directory on any disk, and you may subordinate directories to another directory, thereby building as many levels of subdirectories as you wish.

The relationship of one directory to another is identified by its name, as explained earlier in this section.

NOTE: When you create a directory, you may use the absolute pathname for the new directory to locate it anywhere you specify on any of the disks. If you use a relative pathname, the new directory will be created as a subdirectory of the current directory.

(I) Copy

Use this command to copy a file or group of files to a new location. (The original copy or copies will remain, unless you choose to delete them using the Delete command.) This command is useful, for example, when you wish to copy certain files from one disk onto another disk. If you are using only one floppy disk drive, the system will prompt you to insert the "source" disk or the "destination" disk at the proper times and you should select NEW as your destination disk on the File Maintenance screen.

When you select the Copy command, you will be asked to select the Source drive (where the file or files to be copied now reside), enter the source pathname of the file to be copied, select the destination drive, and enter the destination pathname (the intended directory location and filename for the new copy). The pathname you enter may be relative or absolute.

1. *Copying a group of files.* Multiple filenames may be "marked" in the directory for copying. See Marking Files, Section 13.3(C)3.

   If you designate a directory as the source you want to copy, all files and subdirectories contained in the directory are also copied.

   NOTE: Copying a group of files may require more space than is available on one disk. When the first disk is almost full, you will be prompted to insert the next disk.

2. *Copying an entire directory.* You may indicate an entire directory to be copied. The directory and all its sub-directories and files will be copied. If the name of an existing directory is given, all files and directories are placed inside that directory. But the original directory is not retained. This means that any files or directories in the destination directory are, unless write-protected, overwritten by files or directories of the same name in the copied directory. You may also copy files to a fictitious sub-directory. As long as the sub-directory has a real parent directory, such a destination pathname is valid. (For example, if you have a directory named */usr/programs* on FD1, you may copy a directory from the hard disk to */usr/programs/x25* on FD1, even though the directory */x25* did not previously exist.) The sub-directory is created as part of the Copy command, and all files and directories from the source are copied into it.

3. *Copying an entire disk.* If both floppy disk drives are operable, you would use the Duplicate Disk command on the Disk Maintenance screen. See Section 12.4(D).

   If you have only one floppy disk drive available, the Duplicate Disk command is not applicable to your hardware. However, it is possible to copy an entire disk to another disk in three steps: format the destination disk, copy the root directory to the disk, and transfer the data acquisition tracks to the disk.

After a disk is formatted, it may be copied to via the Copy command. Copy the root directory from one disk to another; the file name for both the source and destination disks will simply be "/" and the softkey selection for the destination disk is NEWDISK. The system will prompt you to insert the "source" disk or the "destination" disk at the proper times. You must then use the Data Transfer command on the Disk Maintenance screen—see Section 12.4(C)—to copy to data acquisition tracks to your destination disk. The disk is now duplicated.

> **NOTE:** Copying to a new disk in the same drive will use the same memory as the current program and the Layer Personality packages. The procedure may need fewer repetitions of disk-insertion/removal if it is done at a time when a large program and multiple layer packages are not loaded in.

(J) View

The purpose of the View command is to allow you to look at the contents of a file without actually loading the file. The program or data currently in the internal memory of the INTERVIEW is not overwritten by the View command.

Prior to executing the View command, you must select the drive on which the file resides and provide the (relative or absolute) pathname of the file.

When you press [XEQ], the screen repaints, displaying the first 12 lines of the file in the Directory Listing area. New function keys are available as labeled.

Descriptive text is presented to the user when a program or setup file is viewed. For an ASCII file, the file is presented "as is." Bit-image and character-data files cannot be viewed.

1. *Moving through a view file.* The beginning of a file appears on the screen when a file is viewed. The cursor location is highlighted. Use [↓] to move the cursor to the bottom of the screen and continue pressing [↓] to scroll down through the file a line at a time. Move the cursor to the top of the screen by repeatedly pressing [↑] and continue pressing it to scroll back up through the file.

   Press [SHIFT]-[↓] to move down to the end of the file. Use [SHIFT]-[↑] to move to the top of the file.

   Use [NEXT PAGE] to move one page (12 lines) forward in the file. Press [PREV PAGE] to move backward one page in the file.

   To leave the file being viewed and return to the File Maintenance screen, press [DONE] or the function key labeled ABORT.

(K) Print

This command prints a hard copy of the file when a printer is properly connected to the INTERVIEW's Printer Port. Indicate the disk on which the file resides, as well as the file's relative or absolute pathname. Then make a selection in the **Paginate** field.

If you select **Paginate:** YES, each printed page will contain a header. The header includes the name of the file (not its pathname) and the page number:

File : filename   Page : 1

Section 14 provides instructions on configuring a printer for use with the INTERVIEW and explains printed format.

(L) Rename

Use the Rename command to assign a new name to a file. A file can only be renamed if it resides on the active disk (named on the current directory line). In order to rename a file, you must indicate the disk on which the file resides, provide the pathname of the file (that is, give the old filename), and enter the new name you wish to give the file.

NOTE: When you rename a file, the original file disappears.

The Rename command can also be used to move a file to a new location. Both new and old locations must be on the active disk (named on the current directory line.) To relocate a file to a different disk, use the Copy command, and then delete the original file.

NOTE: Do not use the abbreviations (. and ..) for naming the new location for a renamed file since they are valid characters for a file name. They will be interpreted as part of the new name.

(M) Enable

This command is used to remove the write protection from a file or directory. Once a file or directory has been write-enabled, the save, delete, and rename commands can be executed on the file or directory.

When a directory is write-enabled, the files within the directory are also enabled, unless they have been individually write-protected. In this case, you must also enable each file before it can be modified or deleted.

Prior to executing the command, you must select the drive on which the file or directory resides and provide the (relative or absolute) pathname of the file or directory. Or you may simply cursor-select a filename for write-enabling and press [EXEC]. Multiple filenames may be "marked" in the directory for write-enabling. See Marking Files, Section 13.3(C)3.

(N) Protect

This is the Write Protect command. It is used as a security measure. When a file is write-protected, any attempt to save, delete, or rename the file will be rejected.

Prior to executing the Write Protect command, you must indicate the drive on which the file (or files) reside and you must provide the name of the file (or files) you wish to protect.

A directory may be named, cursor-selected, or marked for write protection. This write-protects the individual files within the directory. It is possible to write-protect the individual files as well; in which case, both the directory and the file must be enabled before the file can be modified or deleted.

> **NOTE:** Reformatting a floppy disk destroys all files and data, whether they are protected or not. Floppy disks can be write-protected manually against formatting, as explained in Section 1. The hard disk cannot be write-protected against a Format command entered from the Disk Maintenance menu.
>
> It is strongly recommended that you regularly back up the hard disk as well as any floppies you wish to preserve.

(O) Delete

Use this command to remove files permanently from a disk. Prior to executing the Delete command, you must select the disk drive from which you are deleting the file and give the (relative or absolute) pathname of the file you wish to delete. In order to delete an entire directory, you must first delete all files and subdirectories it contains. To delete a subdirectory you must be located in the directory above it (the parent directory).

> **NOTE:** Be aware that you can delete a file by placing the cursor over a filename in the directory listings and then executing the Delete command. Cursor selection takes precedence over any filename in the **Name** field.
>
> You may also mark one or more files for deletion with [MARK]. Any marked files take precedence and will be deleted instead of the file at the cursor location or a file named in the field at the top of the menu.

(P) Compile

Use this command to compile and save as object code the contents of the Protocol Spreadsheet or a file.

1. *File.* FILE is the default selection. A valid source file for compiling contains only standard C code, typically definitions of user-created routines. It may also contain *#pragma hook 0* preprocessor directives. (Refer to Section 56.4.) The code does not have to be a complete program. Program or setup files are not valid source files.

   NOTE: Write C code from the Protocol Spreadsheet to a file by using the WRITE/U spreadsheet-editor command. See Section 26. The file will be type ASCII in the directory listing on the File Maintenance screen.

   If you choose FILE, also select the Source drive (where the file resides) and enter the source pathname of the file to be compiled. To select a source file, you may enter the relative or absolute pathname of the file, position the cursor over the filename in the current directory, or mark the file in the current directory. See Selecting Files, Section 13.3(C).

   Depending on whether or not the file contains "hook", use either the OBJECT block-identifier (Section 24.4) or the *#pragma object* preprocessor directive (Section 56.4) on the Protocol Spreadsheet to access the C code in the file.

2. *Spreadsheet.* If you choose SPREADSHEET, the contents of the Protocol Spreadsheet will be compiled. The spreadsheet program may include C code, softkey-generated entries, or a combination of the two, but it must be a valid program in order to compile.

   The linkable-object file which results will always contain system-generated *#pragma hook* directives, at least one of which will be a type-zero hook. (See Section 56.4.) To access this spreadsheet file, therefore, you must reference it on the Protocol Spreadsheet with the OBJECT block-identifier. See Section 24.4.

Whether you are compiling a file or the spreadsheet, specify a destination drive and enter the destination pathname (the intended directory location and filename for the LOBJ file). The pathname you enter may be relative or absolute.

> **NOTE:** A */lib* subdirectory (if present in the */sys* or */usr* directory) is included in the search routine for linkable-object files. See Section 24.4. We recommend, therefore, that you make a */usr/lib* directory for storing the LOBJ files you create.

Press [XEQ]. During the Compile operation, status messages are posted at the top of the File Maintenance screen. If there are errors in the source file that prevent compilation, the following message will be displayed: *"Compilation failed — Errors detected."* For a diagnostic message about the first error, press [PROGRAM], SPDSHT, [EDIT], GO-ERR. Press GO-ERR again for a message about the next error. Continue until no more errors are detected.

You may abort the Compile procedure by pressing the ABORT softkey or [PROGRAM]. Note, however, that the destination file may have been partially overwritten if compile was to an existing file.

One of the advantages of using linkable-object (LOBJ) files instead of object (OBJ) files is that OBJ files created on one unit will not run on another unit that is configured differently. In contrast, LOBJ files are transparent to the configuration of the unit—i.e., they are just as transparent as the code would be, were it actually present in the spreadsheet buffer. The code, however, must still be compatible with the various menu parameters. For example, a call to *ll_il_transmit* or a SEND action, whether contained in an LOBJ file or written to the Protocol Spreadsheet, would not be compatible with a Line Setup selection of **Mode:** MONITOR.

Linkable-object files also assist the programmer in efficiently using the INTERVIEW's memory and spreadsheet buffer. Refer to Section 24.4(C).

14 Printer Control

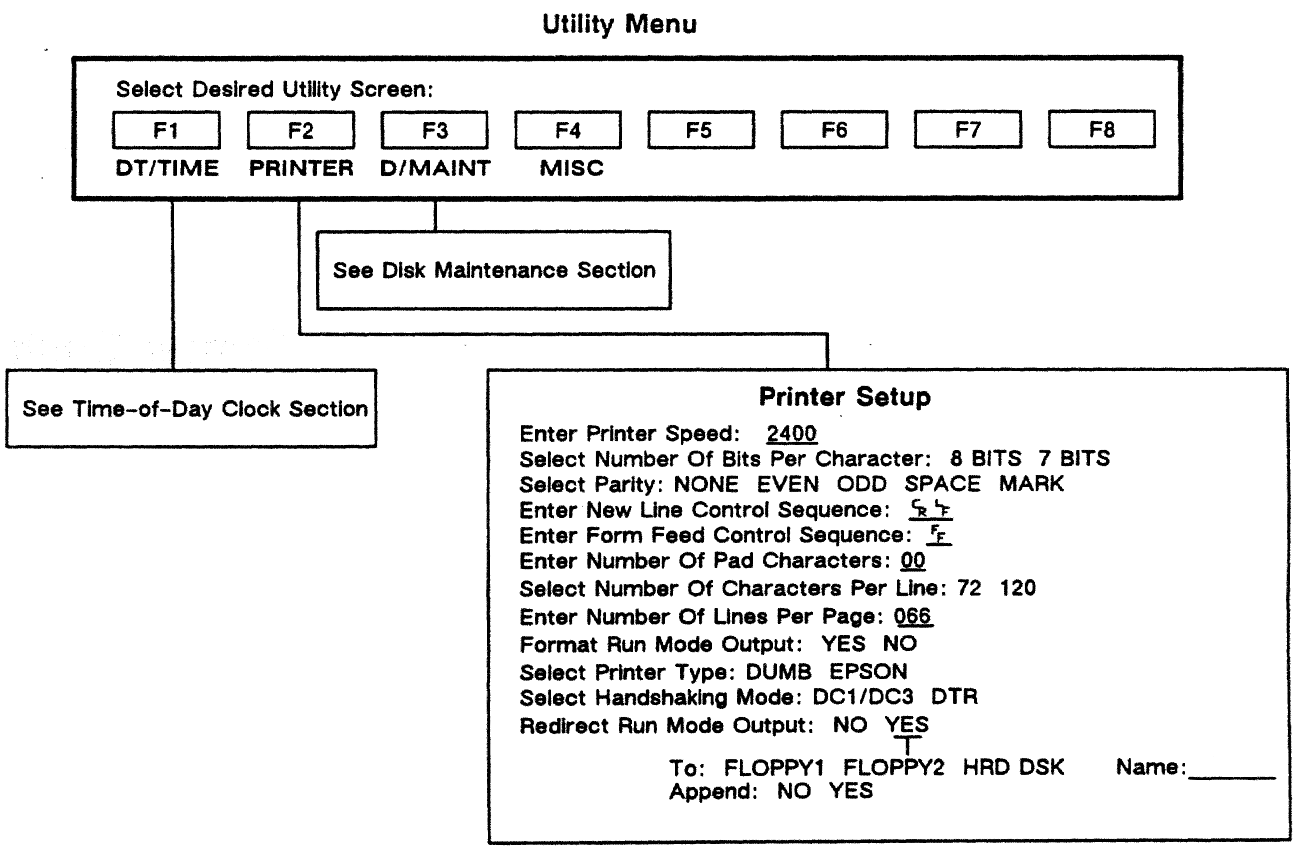


Figure 14-1 The Printer Setup menu.

14 Printer Control

The INTERVIEW will control most serial ASCII printers. In Program mode you may print program menus, triggers, the spreadsheet, and the contents of most files. In Freeze mode, you may print character data, statistics, and protocol and program traces. You may print prompts and statistics in Run mode (real-time.) Printing is controlled from the keyboard, from the Protocol Spreadsheet, and from the Printer Setup screen (see Figure 14-3), described later in this section.

14.1 The Connector

There is a separate male RS-232/V.24 Printer connector on the rear of the INTERVIEW (see Figure 14-2). The Printer connector is a DCE interface: it transmits to the printer on Pin 3 (RD) and applies ON voltage (+12 V) on Pins 5 (CTS), 6 (DSR), and 8 (CD). It monitors Pin 20 (DTR). When DTR goes OFF, the INTERVIEW stops transmitting on Pin 3. When DTR comes back ON, the INTERVIEW resumes transmitting. Information can be transmitted asynchronously in 7 or 8 bit ASCII code, with selectable parity.

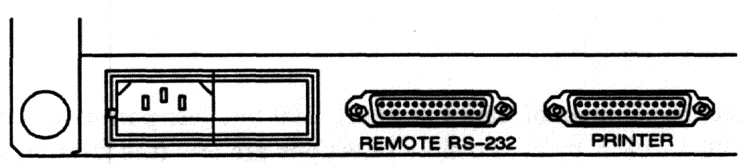


Figure 14-2 **The printer connector is a 25-pin male connector.**

14.2 Configuring the Printer Setup Screen

The Printer Setup screen is shown in Figure 14-3. The various menu fields are described in this section.

```
                    ** Printer Setup **

              Printer Speed: 2400
              Number of Bits: 8
              Parity Selection: NONE
              New Line: ␍␊
              Form Feed: ␌
              Pads: 00
              Chars Per Line: 72
              Lines Per Page: 066
              Format Run Mode Output: YES
              Printer Type: DUMB
              Printer Handshaking Mode: DC1/DC3
              Redirect Run Mode Output: YES
              To: FD1  Name: ____________________
              Append: NO
                          Press XEQ key to ABORT printing
Enter Printer Speed: 2400
  F 1   F 2   F 3   F 4   F 5   F 6   F 7   F 8
```

Figure 14-3 Printer Setup screen.

(A) Speed

Enter the speed of the printer in this field. Default entry is 2400 bps. Maximum print speed is 19200 bps.

(B) Number of bits

Select the number of data bits (i.e., total bits less parity) which the printer expects in each byte. Possible selections are 8 (the default) and 7.

(C) Parity

Select the parity of the printer. Available options are **Parity:** NONE, EVEN, ODD, SPACE, and MARK. The default selection is NONE.

(D) New Line

In this field, enter the control character or characters which the printer interprets as "Start a new line." Alphanumeric, control, and hexadecimal characters are legal entries. Default new-line characters are ␍␊ (Carriage Return/Line Feed). If the field is cleared and left blank, no new-line characters will be sent to the printer.

(E) Form Feed

Enter the printer's Form Feed control sequence (the control characters which cause the printer to advance to the top of the next page). Alphanumeric, control, and hexadecimal characters are legal in this field. You may enter up to four characters. The default entry is ꜰꜰ (press CTRL-L or HEX, 0, C; do not use HEX, F, F). If the field is cleared and left blank, no form-feed characters will be sent to the printer.

(F) Number of Pads

Some printers require pad characters following a new line command so that they have time to return to the start of the line and advance the paper without losing data. Following each new line command, the INTERVIEW adds the number of non-printing pad characters specified in this field. Only numeric entries are legal. The default entry is 0.

(G) Characters Per Line

Select the number of characters to be printed per line. Available options are 72 (default) and 120. If your printer's line length is 119 characters or less, choose 72. Lines longer than 72 characters will wrap to the next line.

If your printer's line length is 120 or greater, choose 120. Lines longer than 120 characters will wrap to the next line.

(H) Lines Per Page

Enter the length of your printer's page (in lines). The default is 66 lines. Numeric values from 1 to 999 are legal in this field.

(I) Format Run Mode Output

When YES is selected (this is the default), the Character or Screen Buffer is formatted before it is printed. (The data in the buffer is not affected.) The formatted buffer allows three positions per character and assigns symbols to special characters. If NO is selected, the character buffer is transmitted to the printer "as is" in single-line display with ASCII coding. **Format Run Mode Output:** NO might be appropriate if you were monitoring data that had already been formatted for a printer.

(J) Printer Type

Select the type of printer attached to the INTERVIEW. The options are DUMB and EPSON.

EPSON formats the menu screens so that the printouts approximate the INTERVIEW screen. The default selection, DUMB, places a carriage return after each field on the menu.

(K) Printer Handshaking Mode

The INTERVIEW responds to XON/XOFF control characters sent by the printer. The control character DC3, interpreted by the INTERVIEW as XOFF, causes transmission of data to the printer to be suspended. When the INTERVIEW receives the control character DC1, it begins transmitting data to the printer again.

Select DTR as the handshaking mode, and the INTERVIEW also responds to DTR status sent by the printer. When DTR is dropped, transmission to the printer is suspended.

(L) Redirect Run Mode Output

The default selection is NO. Select YES to write real-time prompts, counters, and timers to a disk file. To redirect Run-mode output, the **Source** field on the Line Setup menu must be LINE and the **Initial Condition** field on the Record Setup menu must show NOT RECORD. Otherwise, the Line and Record Setup menus will override a **Redirect Run Mode Output:** YES selection.

When a spreadsheet PRINT action is executed, redirected output is captured on disk together with a time stamp indicating date, hour, and minute. (You cannot use this selection to redirect buffer output generated in Freeze mode.) If you use the C print routines discussed in Section 64, the output will not be time-stamped.

> **NOTE:** Output can be redirected to a file while data is being recorded in bit-image RAM. Recording to disk, however, overrides the **Redirect Run Mode Output:** YES selection. Once you activate recording (to disk) via the RECORD key, the spreadsheet RECORD ON action, or the *start_rcrd_play* C routine, output will be sent to the printer port. Even if you suspend recording, output will continue to be directed to the printer port.

When YES is selected, additional entry fields will be displayed on the Printer Setup Screen

To: Enter the destination drive. Selections are FLOPPY1, FLOPPY2, and HRD DSK. The default is FLOPPY1.

Name: Enter the relative or absolute pathname of the ASCII file to which the output will be written. This can be an existing file or a new file name. If the designated file doesn't exist on the destination disk, an ASCII file by that name will be created.

Append: Default selection is NO. Use this selection when you wish to overwrite the data on an existing file. Select YES to append the data to the end of an existing file.

NOTE: The **Append:** NO selection will cause the permanent loss of data in the existing file. If you wish to save the data already in a file, use **Append:** YES or create a new file name.

Table 14-1
Character Representations on Menu Screen Printouts

Plasma Display	Printout
Special characters:	Character representation:
F (7E flag),	\7E
M (bit mask),	\BM
X (don't care)	\DC
((	\(
))	\)
S (sync)	\:S
\ (backslash)	\\
Not Equal (bar through character). Example: ■	\NE character. Example: \NE\7E
Control characters. Examples: SY, EX, SX	Upper-case mnemonic (displayed as a backslash followed by two upper-case characters). Examples: \SY, \EX, \SX
Hexadecimal characters. Examples: 54, B2, FF	Displayed as a # followed by two printed characters. Examples: #54, #B2, #FF

14.3 How to Print Static Displays

While displayed, most menus can be printed individually via the PRINT key. (See Figure 14-4.) Some menus, however, are summary screens for a group of submenus. Pressing CTRL-PRINT when these menus are displayed produces a printout of the group of submenus. Symbols for menu screens and the special characters they represent are listed in Table 14-1.

(A) Printing The Set of Program Menus

Display the Program Menu screen and press [CTRL]-[PRINT] to print all the Program menus listed, including the Protocol Spreadsheet. (Trigger menus will not print if they have not received programming entries.)

(B) Printing the Setup Menus

Press [CTRL]-[PRINT] with the initial Setup screen displayed to obtain a set of print-outs for all Setup screens (Line, Display, BCC, Front End Buffer, and Interface Control).

(C) Printing Triggers

Display the Trigger Summary screen. Press [PRINT] to print the summary and [CTRL]-[PRINT] for as many of the trigger menus as have received programming entries. To print an individual trigger, display it and press [PRINT].

(D) Printing The Protocol Spreadsheet

Display the Protocol Spreadsheet and press [CTRL]-[PRINT] to print the entire contents of the Spreadsheet. Press [PRINT] alone to print only that portion of the Spreadsheet which is visible on the screen. The header of every printed page will include software and firmware revision levels as well as page number as follows:

S/W v7.00 ROM v5.00 INTERVIEW 7500 9/20/89 15:02 Page: 1

You may insert a form-feed command to the printer anywhere on the Protocol Spreadsheet by employing the following string:

/*FF*/

If you have a reverse-video block on the spreadsheet (editor mode), press [PRINT] to print only that block, no matter how long or short.

This string uses the FF character formed by the keys [CTRL]-[L], not [HEX], [F], [F]. The string will send a form-feed instruction to the printer even if the spreadsheet parser rejects it and places a strike-through line over it. If you want to enter a permanent form-feed instruction in the program that the parser will accept and that will allow the program to compile, enclose the string in curly braces { and }.

(E) Printing the Layer Setup Screen

Display the main Layer Setup screen and press [CTRL]-[PRINT] to obtain printouts of the main screen and all layer-specific setup screens for layer packages that are loaded in.

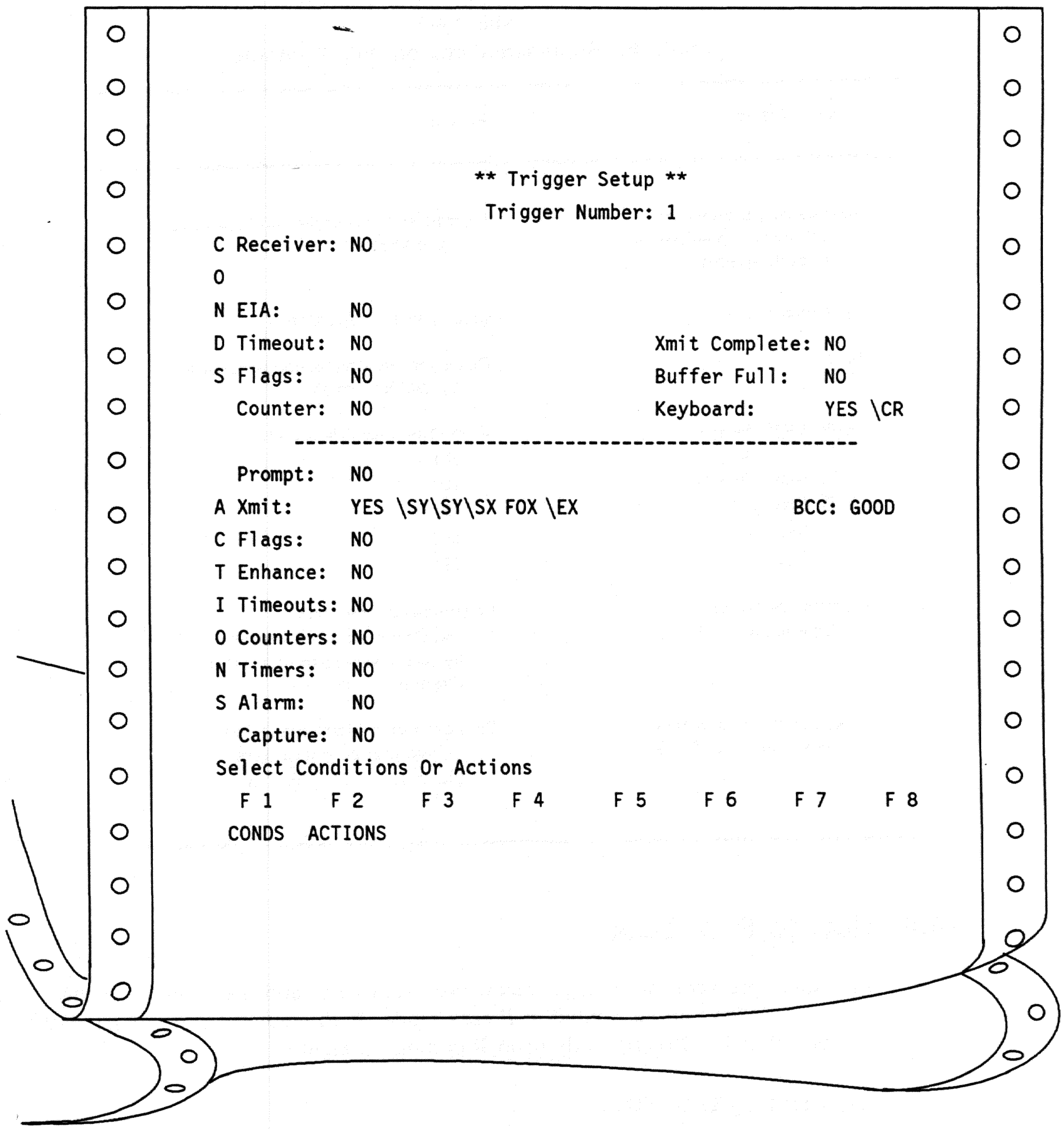


Figure 14-4 Printout of the Trigger Setup screen (*Printer Type: EPSON*).

Table 14-2
Character Representations on Data Printouts

Plasma Display	Printout
Alphanumeric characters (all ASCII non-control except space)	Character is preceded and followed by a space
Fill symbol (⠿)	Displayed as three dots (...)
Space	Displayed as a blank space followed by two letters sp
Special characters F (TE flag), G (good BCC), B (bad BCC) A (abort) S (sync)	Character representation: [F] [G] [B] [A] [S]
Control characters Examples: SY, EX, SX	Lower-case mnemonic (displayed as a blank space followed by two lower-case characters). Examples: sy, ex, sx
Hexadecimal characters Examples: 54, B2, FF	Displayed as a blank space followed by two printed characters. Examples: 54, b2, ff

14.4 How to Print Data

Line data, protocol traces, user traces, program traces, and the contents of the Display Window can be printed in Freeze mode. Both graphical and tabular statistics can be printed in Freeze mode or in Run mode (real-time.)

(A) Printing Line Data

Line data can be set up to print in single-line or dual-line formats. Setup information, date, time, offset, perc, and page number are printed at the top of each page. The date and time are the current system date/time when printing data from an actual line; for recorded data, the date/time of recording is displayed. The symbols for data printout and the characters they represent are listed in Table 14-2.

Press [PRINT] to print data which is frozen on the screen. Data is formatted according to the selection made on the Printer Setup screen—see Section 14.2(I). Figure 14-5 shows the frozen data screen; Figure 14-6 shows the data printouts at 72 and 120 characters per line.

Press [CTRL]–[PRINT] to print the entire data buffer from the frozen screen. The data buffer will continue to print until the end of the data or until you exit and re–enter Run mode (press [PROGRAM], [RUN].)

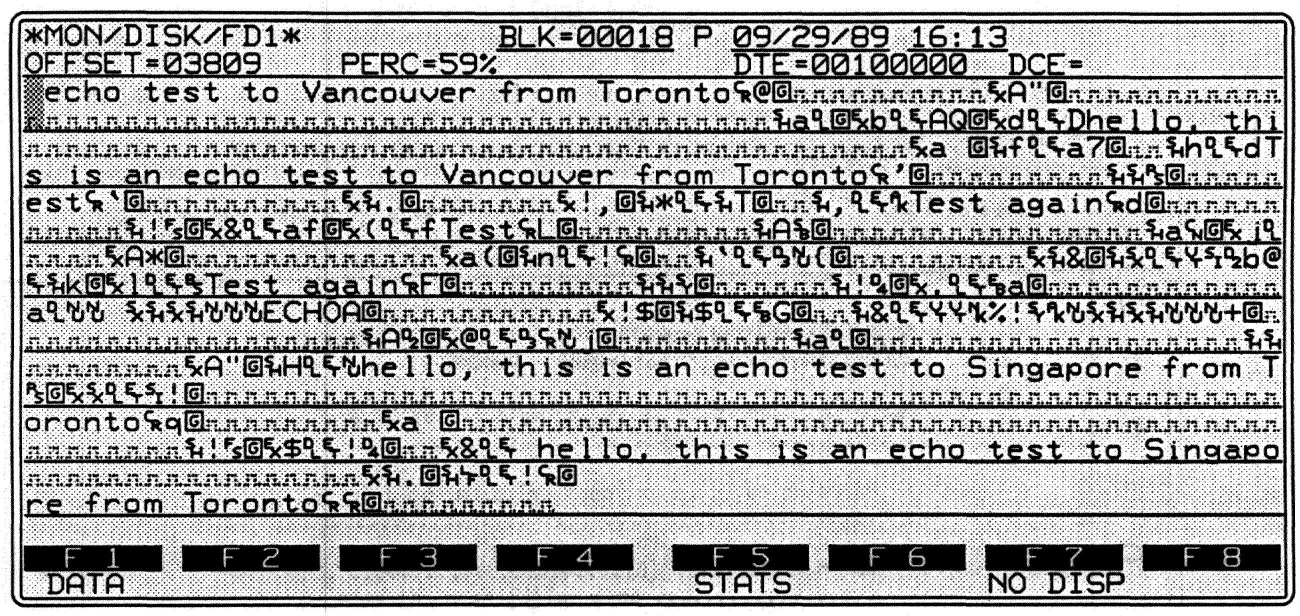


Figure 14-5 Data screen in Freeze mode.

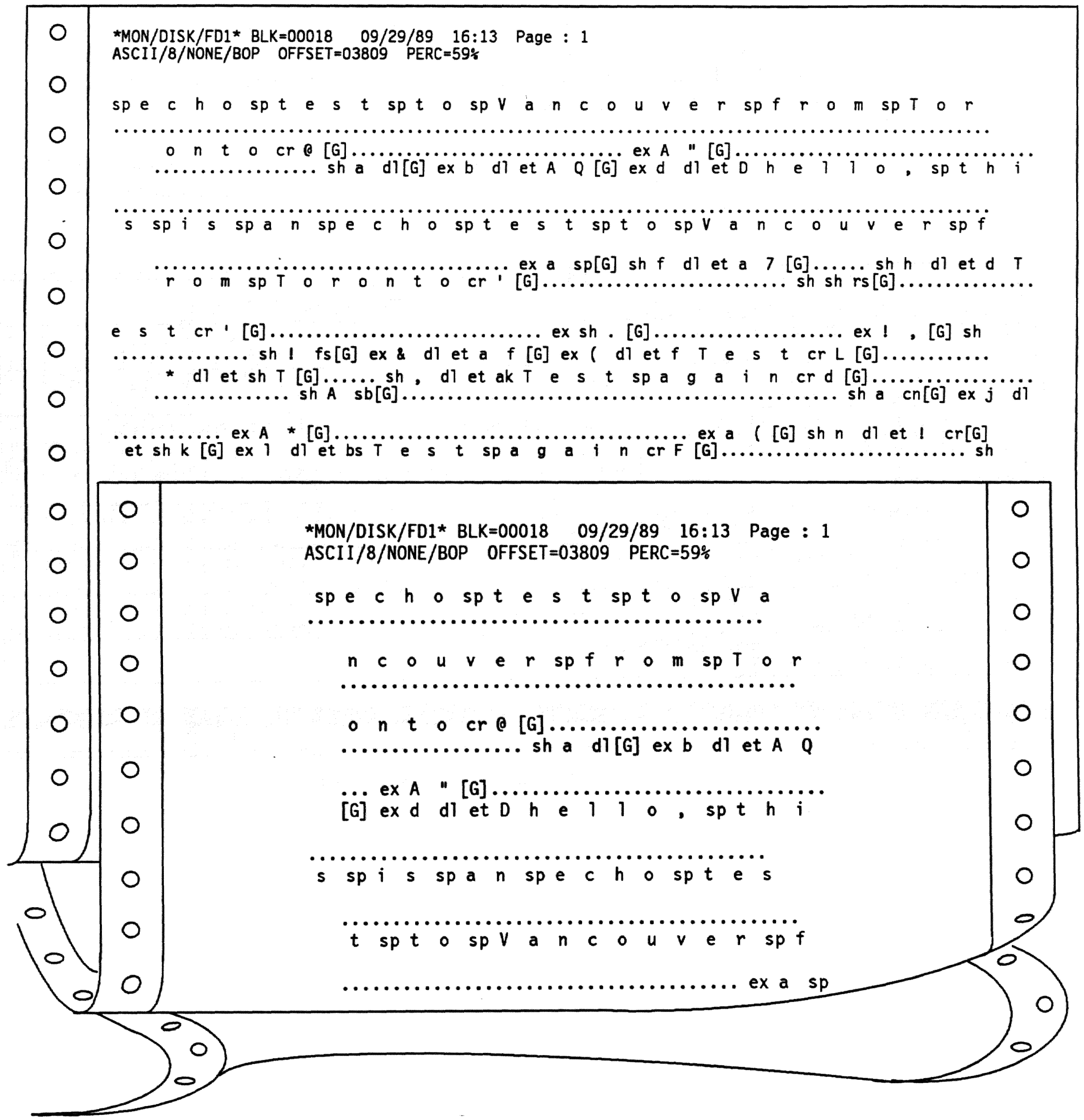


Figure 14-6 Printout of the data display in Figure 14-5 at 120 (top) and 72 (bottom) characters per line.

MON/DISK/FD1 BLK=00017 09/29/89 16:13 Page : 1

ASCII/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	03	DISC			0	0002	1613:30.687	[G]
DTE	03	UA			0	0002	1613:30.714	[G]
DTE	01	SABM			1	0002	1613:30.835	[G]
DCE	01	UA			1	0002	1613:30.897	[G]
DCE	03	INFO	0	0	0	0007	1613:30.934	[G]
DTE	01	INFO	0	0	0	0006	1613:30.938	[G]
DTE	03	RR	1		0	0002	1613:30.962	[G]
DCE	01	RR	1		0	0002	1613:31.001	[G]
DTE	01	INFO	1	1	0	0025	1613:31.199	[G]
DCE	01	RR	2		0	0002	1613:31.264	[G]
DCE	03	INFO	2	1	0	0007	1613:31.398	[G]
DTE	03	RR	2		0	0002	1613:31.422	[G]
DTE	01	INFO	2	2	0	0005	1613:31.452	[G]
DCE	01	RR	3		0	0002	1613:31.518	[G]
DTE	01	INFO	2	3	0	0023	1613:31.709	[G]

Figure 14-7 Layer 2 protocol trace printout in Freeze mode.

(B) Printing Protocol Traces

Protocol traces can be printed in Freeze mode via the [PRINT] key. Press [PRINT] to generate a printout of the current screen (see Figure 14-7). Press [CTRL]-[PRINT] to print the entire buffer from the frozen screen. Printing will be aborted if you leave Freeze mode.

(C) Printing Program Trace

The Program Trace can be printed in Freeze mode via the [PRINT] key. Press [PRINT] to generate a printout of the current screen (see Figure 14-8.) Press [CTRL]-[PRINT] to print the entire buffer from the frozen screen. An explanation of Program Trace can be found in Section 5.

```
*EMDCE/LINE* BLK=00000 12/02/89  13:01  Page : 1
ASCII/8/NONE/BOP
Program Trace
Layer 3    Test fips_module_a20    state begin_init
                                     restart_req sent
                                     restart_con recvd
Layer 3    Test fips_module_a20    state call
                                     incoming call sent
Layer 3    Test fips_module_a20    state p3
                                     call_accept recvd
Layer 3    Test fips_module_a20    state bad_PR
                                     invalid P(R) sent
Layer 3    Test fips_module_a20    state complete_init
                                     reset_req recvd
Layer 3    Test fips_module_a20    state test_06
                                     reset_c too long sent
Layer 3    Test fips_module_a20    state pass_fail
                                     timeout:  no reset_req
                                     ** test failed  **
```

Figure 14-8 Program Trace printout in Freeze mode.

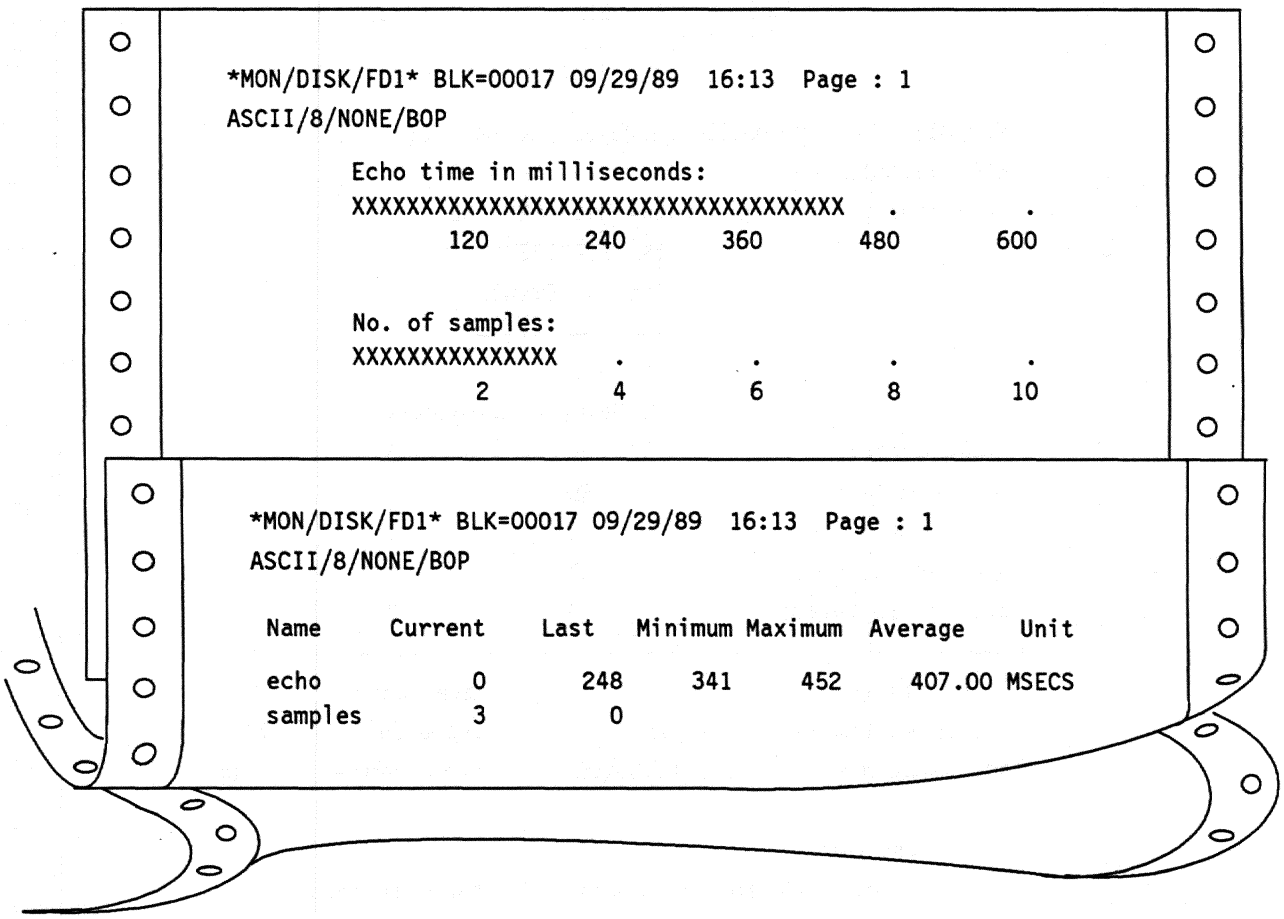


Figure 14-9 Printout of graphical (top) and tabular (bottom) statistics in Freeze mode.

(D) Printing Statistics

Tabular and graphical statistics can be accessed via softkey in Program mode and Run mode (frozen and real-time). Either of the statistics screens also may be accessed via the [RUN] key if STATISTICS is the **Display Mode** selected on the Display Setup menu.

Once a statistics screen is displayed, press [PRINT] to send the current statistics to an attached printer. Figure 14-9 is an example of graphical and tabular statistical printouts.

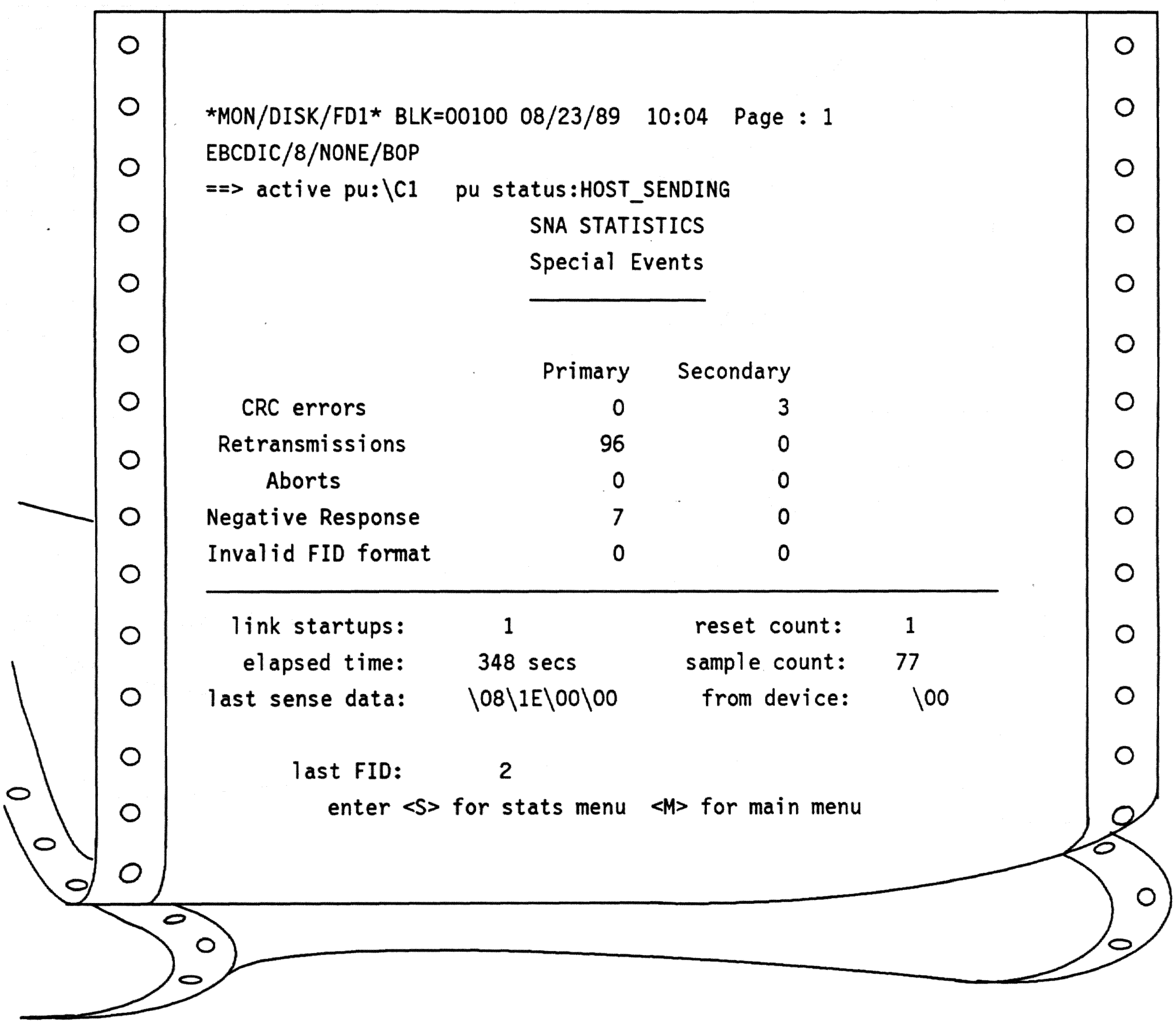


Figure 14-10 Printout of a screen from the *SNA Statistics* applications program (OPT-951-19-1) from the Display Window.

(E) Printing from Display Window

Customized screens, such as those in applications programs, can be printed in Freeze mode from the Display Window. Press [PRINT] to generate printouts like that in Figure 14-10.

(F) Printing User Traces

User traces can be printed in Freeze mode. Video enhancements are not indicated on the output. Press [PRINT] to generate a printout of the current screen. Press [CTRL]–[PRINT] to print the entire buffer from the frozen screen. User traces are explained in Section 5.

14.5 Spreadsheet Control of Printing

The Protocol Spreadsheet allows PRINT as a spreadsheet action. This causes the INTERVIEW to respond to a predetermined condition and print a line of tabular statistics for an accumulator, counter, or timer; or print a user–prompt that is sent to the printer after it has been written to the second line of the screen. (See Section 27 for an explanation of spreadsheet–controlled printing.)

The library of C routines includes several print functions. See Section 64.

14.6 Printing Disk Files

Files stored on disk can be printed from the File Maintenance menu. See Section 13.3.

15 The Time-of-Day Clock

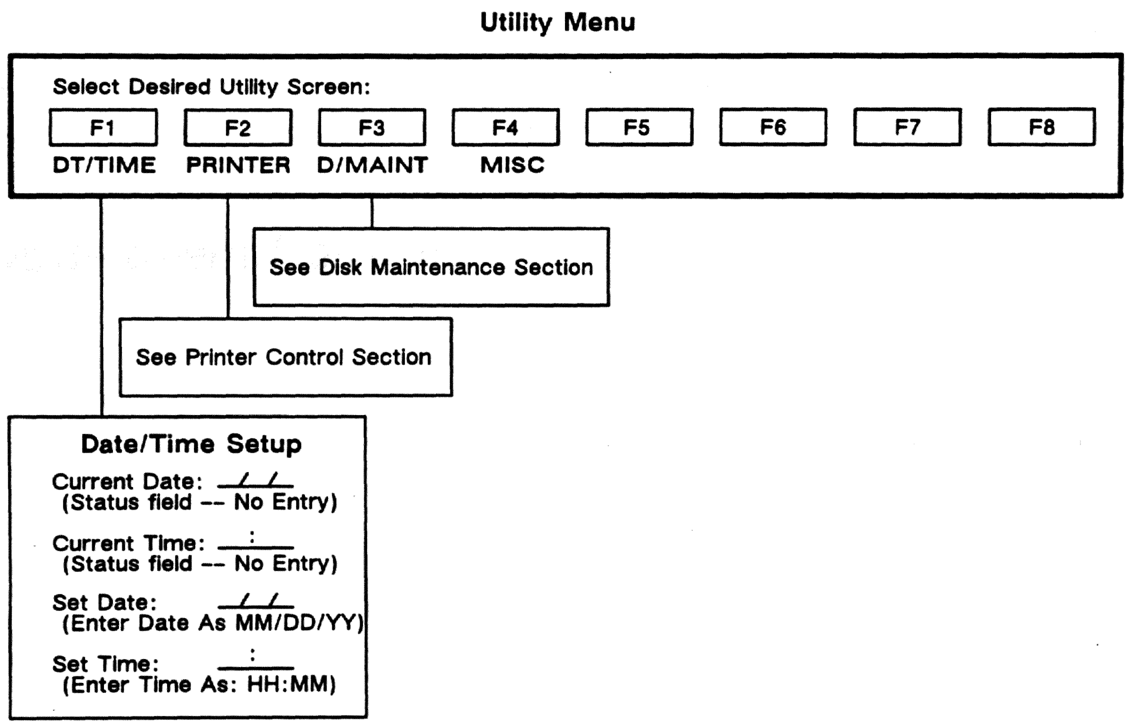


Figure 15-1 The Date/Time Setup menu.

15 The Time-of-Day Clock

The INTERVIEW has a battery-operated real-time clock. The day, month, and year as well as the current time, posted to the second, are automatically accessible as soon as you power on the INTERVIEW. Used to time/date stamp recorded data, it is also available as a Trigger Condition on the Protocol Spreadsheet. The time and date can be reset on the Date/Time Setup screen, which is a submenu of the Utilities menu.

A sample menu is shown in Figure 15-2. The current date and time appear at the top of the screen. The time is updated on the screen every second. The clock retains time and date even when powered off and adjusts itself to accommodate the length of each month. It also takes leap years into account automatically. The clock menu does, however, permit you to reset the time or date, if required.

To reset the date, select the **Set Date** field and enter month, day, and year in that order in the two-digit space provided (mm/dd/yy). Use [→] or [DONE] to move into each field. The month and day entries may be either one or two digits; it is not necessary to enter a leading zero. If only one digit appears in any of the two-digit fields, a leading zero is assumed. You may fill in the month, day, or year fields individually, if you prefer. (For example, if your only entry is 1_/ in the month field, only the month will be altered—it will be set to 01/—when you press [XEQ].)

In the **Set Time** field, hour and minute entries are made as hh:mm in a 24 hour format. (The seconds setting cannot be altered.) You may set the hour and the minutes fields simultaneously or individually. As with the date field, a single-digit entry is assumed to have a leading zero. Figure 15-2 shows the menu filled out for September 1, 1989 and 1:30 p.m.

```
Current Date: 09/01/89

Current Time:  2241:02

Set Date:  09/01/89

Set Time:  13:30
```

Figure 15-2 The real-time clock in the INTERVIEW is controlled on the Date/Time Setup screen.

To set the clock, press the XEQ key when you have entered the correct date or time. Once the clock is reset, the status fields **Current Date** and **Current Time** should match your entries.

16 Color Display

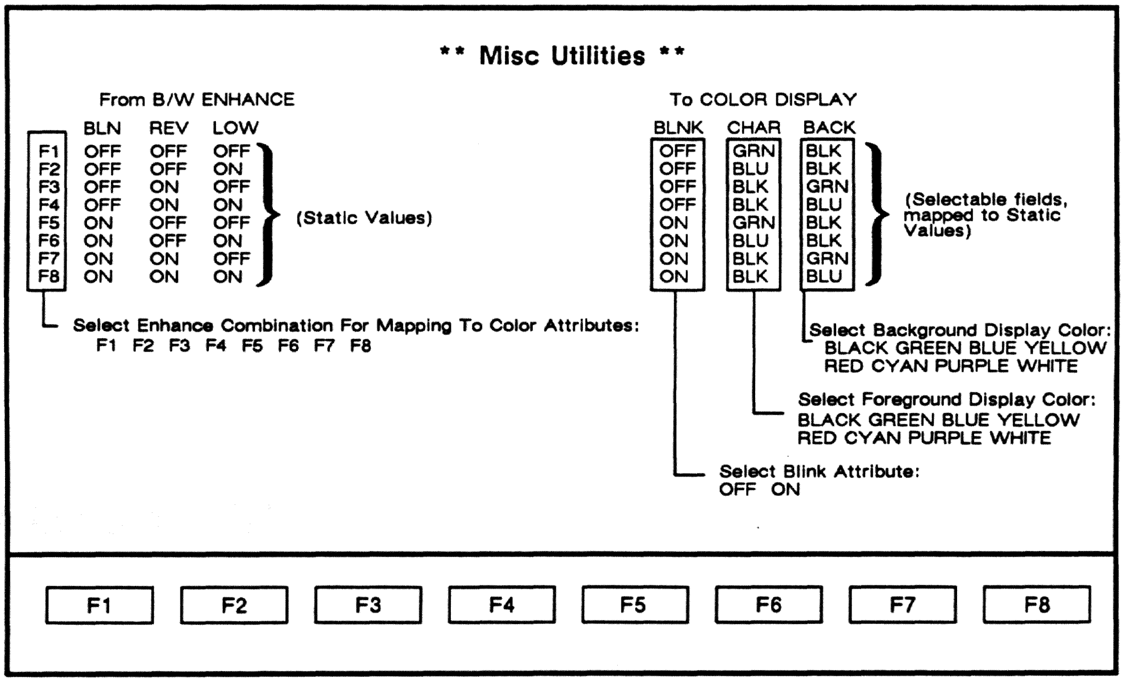


Figure 16-1 The Miscellaneous Utilities menu.

16 Color Display

Both black and white and color monitors can be used as external displays. Separate connectors are provided for each type of monitor on the rear panel of the INTERVIEW. For both monochrome and color displays, a set of video enhancements can be controlled from the INTERVIEW. For color displays, the enhancements are mapped on the Miscellaneous Utilities screen. Available options on this screen are shown in Figure 16-1.

16.1 Connectors for External Monitors

Connect a monochrome (black and white) monitor to the RS-170 connector. This is the round connector located to the far right of the rear panel (see Figure 16-2).

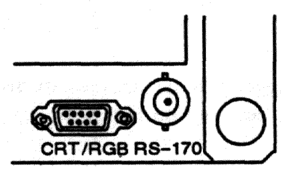


Figure 16-2 Video-out connectors for RS-170 (black and white) and RGB (color) signals are located on the rear panel of the INTERVIEW.

Connect an 8 or 16-color monitor to the 9-pin RGB connector at the right of the rear panel (see Figure 16-2). Pin configurations for the RGB connector are shown in Appendix I.

16.2 Color Control from the Miscellaneous Utilities Screen

Three of the data enhancements available as trigger actions (Blink, Reverse, and Low; see Figure 16-3) are applied differently when a color monitor is attached. There are eight possible on/off combinations for these three trigger enhancements. The user defines these eight combinations on the Miscellaneous Utilities screen.

```
C Flags:     NO
T Enhance:   BOTH Rev: 0 Blnk: 0 Low: 0 Hex: X
I Timeouts:  NO
```

Figure 16-3 The settings in the Trigger Enhance field (0 = off; 1 = on) are mapped to color and blink definitions selected on the Miscellaneous Utilities screen. The Hex setting does not pertain to screen colors.

The color setup portion of the Miscellaneous Utilities screen is shown in Figure 16-4. The screen is divided into two areas: the enhance combinations on the left-hand side of the screen; and the selectable display options on the right. User entries are made only on the right-hand portion of the screen.

** Misc Utilities **

	From B/W ENHANCE			To COLOR DISPLAY		
	BLN	REV	LOW	BLNK	CHAR	BACK
F1	OFF	OFF	OFF	OFF	GRN	BLK
F2	OFF	OFF	ON	OFF	BLU	BLK
F3	OFF	ON	OFF	OFF	BLK	GRN
F4	OFF	ON	ON	OFF	BLK	BLU
F5	ON	OFF	OFF	ON	GRN	BLK
F6	ON	OFF	ON	ON	BLU	BLK
F7	ON	ON	OFF	ON	BLK	GRN
F8	ON	ON	ON	ON	BLK	BLU

Figure 16-4 Trigger settings on the left are mapped to user-defined blink and color characteristics, selected on the right.

(A) Black and White Enhancement List

The eight enhancement combinations are labeled "From B/W ENHANCE." Each row of three settings (ON/OFF for Blink, Reverse, and Low) represents one configuration of a trigger **Enhance** field.

Press the function key indicated to the left of the list to access the selectable options to the right, in that row.

(B) Selectable Color Display Options

The user selects blink, foreground color, and background color options on the right half of the screen, labeled "To COLOR DISPLAY." The options which the user defines are matched to the static combinations to the left in the same row. Thus, when the user creates a trigger action **Enhance:** DTE **Rev:** 0 **Blnk:** 0 **Low:** 0, he is specifying that displayed DTE data take on the color characteristics defined in the first row of the Miscellaneous Utilities screen. (The **Hex** enhancement on a trigger does not influence color options.)

1. *Blink*. The first column under COLOR DISPLAY, labeled BLNK, determines whether blink is to be turned on or off in response to the trigger entry on the left.

2. *Character*. The center column, labeled CHAR, determines what color is assigned to the screen foreground (that is, the characters themselves) in response to the trigger **Enhance** entry on the far left. Possible foreground colors are black, green, blue, yellow, red, cyan, purple, and white.

3. *Background color*. The right-hand column, BACK, defines screen background color (that is, the square background around subsequent individual characters) in response to the trigger entry on the far left. Color possibilities are the same as for foreground.

> NOTE: Never use the same foreground and background color on the display if you have an eight-color monitor. (Data will not be visible.) If you have a 16-color monitor, you may be able to choose the same color in the background and the foreground and retain a contrast between data and the surrounding screen. Check the documentation for your monitor.

(C) Trigger Control of Color

When you enter the three-bit enhancement option as an **Enhance** action on a Trigger Setup screen (see Figure 16-3) or as a Layer 1 ENHANCE action on the Protocol Spreadsheet, you are designating the color scheme which the screen will adopt whenever that trigger becomes true. More specifically, you are indicating what color the next character becomes (foreground color), whether the character blinks, and what color the small rectangular box surrounding the character will be (background color). These three characteristics apply to subsequent characters and their background until another trigger alters the color scheme.

ENHANCE actions above Layer 1 are applied to specific lines on the protocol-trace display for the given layer. REVERSE, BLINK, and LOW selections may be configured at Layer 3, for example, so that a Call Request packet receives a different color enhancement from a Clear Request.

When you program a trigger, only the **Enhance** entries for Blnk, Rev, and Low influence screen characteristics. (The Hex field always causes characters to be displayed in hexadecimal, or turns off the hexadecimal character enhancement.) An **Enhance** entry of 1 equates to "ON"; an entry of 0 equates to "OFF."

> NOTE: A "Don't Care" (X) after Blnk, Rev, or Low leaves the enhancement at its previous setting, making the color which results from the trigger dependent on the effects of previous triggers.

Each time you run the program, all enhancement settings are initially reset to zero. If no trigger entries are made, or if the enhance trigger never becomes true, the color monitor retains its own color settings. (Refer to the technical documentation for the monitor to determine how colors are set internally.)

(D) Color Graphics

Several colors are offered for bar graphing on the Graphical Statistics menu. These colors are always displayed against a dark background. Their use is not related to the color setup screen. See Section 18 for a description of color graphics.

16.3 Black and White Data Enhancements

Blink and reverse data enhancements for the INTERVIEW's plasma display are available when a monochrome monitor is installed. In addition, a low intensity enhancement can be produced on a monochrome monitor. These display highlights are controlled by triggers (see Figure 16-3), either on the Protocol Spreadsheet or on Trigger Setup screens. Refer to Section 22 or 28 for a description.

17 Tabular Statistics

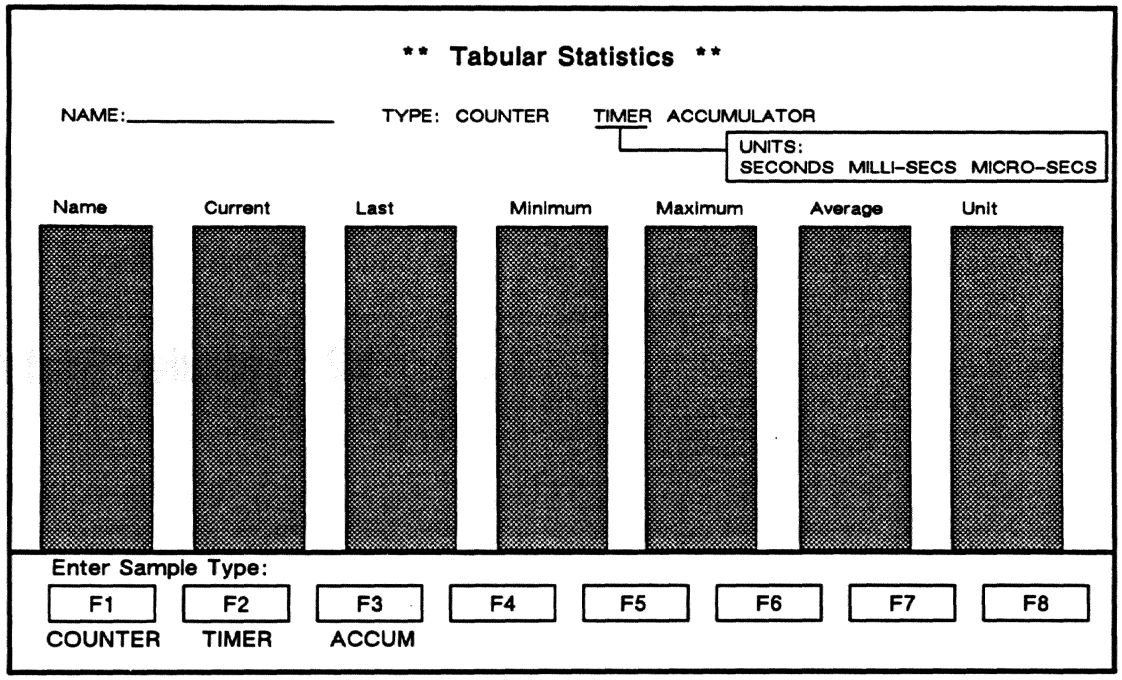


Figure 17-1 Menu fields, Tabular Statistics screen.

17 Tabular Statistics

The user of the INTERVIEW can assign tasks easily to an almost unlimited number of software counters and timers. When these incrementing counters and timers are sampled—that is, when they are read and cleared—their current totals are factored into a statistical breakout on the Tabular Statistics screen. This breakout is a real-time reading of current, last, minimum, maximum, and average values for the counter or timer.

At any one moment, the Tabular Statistics screen displays a maximum seventy-five values for fifteen counters, timers, and accumulators. (Accumulators are defined below in Section 17.4). The Graphic Statistics screen, treated in the next section, displays less information (sixteen values total) at any one time, but in a graphic format. Both statistics screens can be scrolled up or down to display additional rows of values.

The role of triggers in creating, operating, sampling, and accumulating various counters and timers is common to both screens and will be discussed here under Tabular Statistics.

17.1 Counters and Timers

Counters and timers are operated as *actions* on trigger menus and in Protocol Spreadsheet tests. In the example below, two different counters are made to increment as spreadsheet actions.

In this Bisync example, polling address A represents a drop on a multipoint circuit. The string "${}^{S}_{X}$A" on the DCE side is the beginning of a text block originating at remote drop A. When the spreadsheet program sees this string, it moves to a state called **drop_a**, where the end of every text block (**DCE STRING "${}^{F}_{F}$"**) increments one counter (**allblk_a**) and only blocks that end with a bad BCC increment another counter (**badbcc_a**).

LAYER: 1
    STATE: stx
      CONDITIONS: DCE STRING "${}^{S}_{X}$A"
      NEXT_ST: drop_a
    STATE: drop_a
      CONDITIONS: DCE BAD_BCC
      ACTIONS: COUNTER badbcc_a INC
      CONDITIONS: DCE STRING "${}^{F}_{F}$"
      ACTIONS: COUNTER allblk_a INC
      NEXT_ST: stx

The current value of a counter also can be used as a *condition* either on a trigger menu or in a Spreadsheet test. Here is an example of a counter performing this "countdown" function:

CONDITIONS: COUNTER allblk_a EQ 1000
ACTIONS: COUNTER badbcc_a SAMPLE

(The SAMPLE action is explained in Section 17.3, below.)

Timers are not used as trigger conditions, since timeouts serve this function.

17.2 Preparing the Tabular Statistics Screen

Current values of counters and timers are read on the Tabular Statistics and Graphic Statistics screen. Both statistics screens are always accessible by softkey during Run mode. A counter or timer that is named in a trigger must be identified by name on the statistics screen. This naming is done in Program mode prior to the run.

Press [PROGRAM] and then [F4] for the Statistics Menu screen. Press [F1] to enter the Tabular Statistics screen. In Program mode, the screen shows fifteen tabular rows beneath a single line of menu fields. There are two cursors, one on the menu line and one in the table. See Figure 17-2. The fields on the menu line (second line at the top of the screen) always refer to the row in the results table that has the lower cursor.

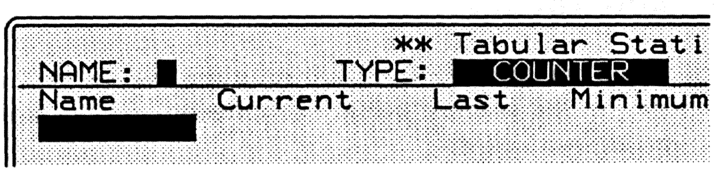


Figure 17-2 **In Program mode, this screen has two cursors.**

When you enter the Tabular Statistics screen, the upper cursor is in the **Name** field on the menu line, while the lower cursor is in Row One of the table.

Press [DONE] or [RETURN] (or [→] and [←]) to move the upper cursor from field to field in the menu area of the screen. Press [ROLL FWD] and [ROLL BACK] to change the selections in rotating-window fields.

Press [↓] and [↑] to move the lower cursor from display line to display line. The menu selections at the top of the screen will change as you cursor down the screen, since they are always keyed to the display line that has the cursor.

Each time the cursor advances one row down the table, the information that the user has entered on the menu line is written to the previous row in the table. In the top half of the sequence in Figure 17-3, the user has entered a name on the menu line above a blank table. The cursor is now in the **Type** field, where COUNTER was the default selection. The bottom of the figure shows the resulting table after the user presses [↓] .

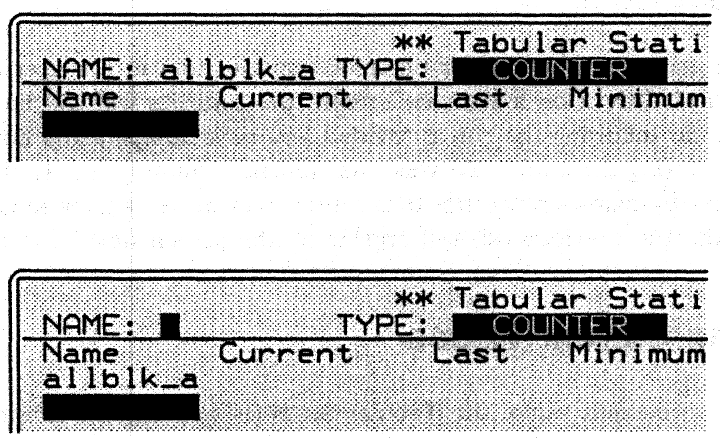


Figure 17-3 When lower cursor moves, user data is written to the vacated display line.

[↑] reverses the direction of the lower cursor. The user may name or revise counters, timers, and accumulators by moving up the table as well as down.

The tabular area of the screen is a scrolling display of variable length that sets a very high limit (100) on the number of counters, timers, and accumulators that can be named by the user. To scroll down the directory, position the cursor on the last line of the listings and press [↓]. This keystroke will display new lines one at a time. Or press [NEXT PAGE] to display fifteen new lines of counters, timers, and accumulators. [SHIFT] and [↓] together move the cursor to the end of the listings.

Position the cursor at the top of the listings and press [↑] to expose lines that have scrolled off the screen at the top. Or press [PREV PAGE] to retrieve an entire previous page of listings. [SHIFT]-[↑] will always move you to the top of the listings.

[INSERT LINE] and [DELETE LINE] are operative keys on the scrolling statistics tables.

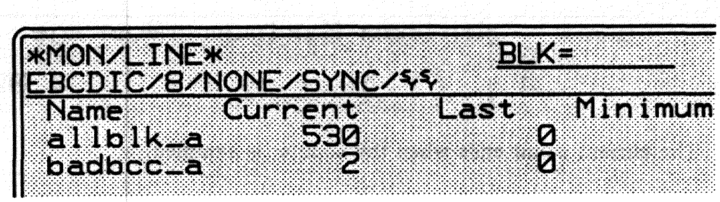


Figure 17-4 All counting and timing is performed in the Current column.

When [RUN] is pressed, a counter or timer that has been named in a trigger action will show its current value next to its name on the statistics screen. Figure 17-4 is a Run-mode display of two counters, one that is incrementing with each text block sent by a particular remote drop, and a second that is incrementing with each bad BCC from the same source.

If you have named a counter (or timer or accumulator) in a trigger action but forgotten to identify it on a statistics screen, the statistics will still be available in Program mode following the run (provided you have *sampled* the counter or timer at some point during the run). To view the statistics, simply identify the counter (timer, accumulator) by name on the statistics screen and move the lower cursor. The statistics from the previous run will appear on the screen next to the name.

17.3 Sampling Current Values

In addition to current value, the Tabular Statistics screen has columns for last, minimum, maximum, and average values. See Figure 17-5. Unit is not a value column. It applies to timers only, and reflects the unit of time—second, millisecond, or microsecond—selected by the user for that timer on the menu line during Program mode.

Last, **Minimum**, **Maximum**, and **Average** are statistical columns, based on previous samplings of the Current column. Sampling is a trigger action that reads the current value of the counter or timer and then resets it to zero. The **Last** column receives the sampled value. The other columns—**Minimum**, **Maximum**, and **Average**—compare the sampled value with previous samples.

```
*MON/LINE*                    BLK=          06/16/89 13:17
EBCDIC/8/NONE/SYNC/
 Name      Current     Last   Minimum Maximum  Average     Unit
 allblk_a      999        0
 badbcc_a        4        0
```

```
*MON/LINE*                    BLK=          06/16/89 13:18
EBCDIC/8/NONE/SYNC/
 Name      Current     Last   Minimum Maximum  Average     Unit
 allblk_a        0     1000
 badbcc_a        0        4       4       4       4.00
```

Figure 17-5 The current count ends when the counter is sampled.

We have already seen a counter that incremented with every bad BCC. A Spreadsheet trigger that *sampled* this incrementing counter every 1000 blocks would maintain a statistical record of errored blocks per thousand:

```
LAYER: 1
   STATE: stx
      CONDITIONS: DCE STRING "SxA"
      NEXT_ST: drop_a
      CONDITIONS: COUNTER allblk_a EQ 1000
      ACTIONS: COUNTER badbcc_a SAMPLE
         COUNTER allblk_a SET 0
   STATE: drop_a
      CONDITIONS: DCE BAD_BCC
      ACTIONS: COUNTER badbcc_a INC
      CONDITIONS: DCE STRING "FF"
      ACTIONS: COUNTER allblk_a INC
      NEXT_ST: stx
```

In Run mode, zero appears in the **Last** column prior to the first sampling of a counter or timer, and nothing appears in **Minimum**, **Maximum**, and **Average** columns. See the top of Figure 17-5. The bottom of the same figure illustrates the effect of the first sampling. The counter named **badbcc_a** is cleared automatically but its sampled value is retained in the Last column. Since this is a first sampling, the sampled value is carried over unchanged to the Minimum, Maximum, and Average columns also. Note that the counter named **allblk_a** was not sampled, so it had to be reset manually (COUNTER **allblk_a set** 0).

The next example uses a *timer* in an X.25 environment. A pair of triggers start and sample a timer called t2. Each sample is a measurement of the timeout observed by an X.25 PAD before it responds with an RR to a DCE Info frame. (This timeout is called T2 in X.25.) INFO and RR are spreadsheet conditions in the protocol package for X.25 Layer 2 (see Section 33.)

```
CONDITIONS: DCE INFO GDBCC
ACTIONS: TIMER t2 RESTART
CONDITIONS: DTE RR
ACTIONS: TIMER t2 SAMPLE
```

Figure 17-6 shows a set of results that might be generated by these two triggers.

```
*MON/LINE*                    BLK=         06/16/89 13:19
ASCII/8/NONE/BOP
 Name     Current    Last   Minimum  Maximum   Average     Unit
 t2             6     110        15      120    111.83  MSECS
```

Figure 17-6 This timer has been sampled several times.

17.4 Accumulators

Accumulators look like counters and timers on the statistics screens but they do not increment or reset counters, nor do they start or stop timers. Rather, they *accumulate selected samplings* of these counters and timers without interfering with the counting and timing functions. Thus they enhance the performance of counters and timers by empowering them to work for several accumulators at the same time.

For example, we have already designed a pair of counters that counted bad BCCs per thousand blocks with respect to one drop on a multipoint circuit. We will enlarge the program with a pair of counters for each of two additional drops, drop B and drop C. Then we will add an accumulator to generate error-per-thousand statistics for *the three drops taken together.*

Accumulating is a trigger action found on spreadsheet softkeys but not on trigger menus. The ACCUMULATE actions in our spreadsheet program might look like this:

```
LAYER: 1
    STATE: stx
       CONDITIONS: DCE STRING "SX A"
       NEXT_ST: drop_a
       CONDITIONS: COUNTER allblk_a EQ 1000
       ACTIONS: COUNTER badbcc_a SAMPLE
          COUNTER allblk_a SET 0
       CONDITIONS: DCE STRING "SX B"
       NEXT_ST: drop_b
       CONDITIONS: COUNTER allblk_b EQ 1000
       ACTIONS: COUNTER badbcc_b SAMPLE
          COUNTER allblk_b SET 0
       CONDITIONS: DCE STRING "SX C"
       NEXT_ST: drop_c
       CONDITIONS: COUNTER allblk_c EQ 1000
       ACTIONS: COUNTER badbcc_c SAMPLE
          COUNTER allblk_c SET 0
    STATE: drop_a
       CONDITIONS: DCE BAD_BCC
       ACTIONS: COUNTER badbcc_a INC
          ACCUMULATE alldrop COUNTER badbcc_a CURRENT
       CONDITIONS: DCE STRING "FF"
       ACTIONS: COUNTER allblk_a INC
       NEXT_ST: stx
    STATE: drop_b
       CONDITIONS: DCE BAD_BCC
       ACTIONS: COUNTER badbcc_b INC
          ACCUMULATE alldrop COUNTER badbcc_b CURRENT
       CONDITIONS: DCE STRING "FF"
       ACTIONS: COUNTER allblk_b INC
       NEXT_ST: stx
    STATE: drop_c
       CONDITIONS: DCE BAD_BCC
       ACTIONS: COUNTER badbcc_c INC
          ACCUMULATE alldrop COUNTER badbcc_c CURRENT
       CONDITIONS: DCE STRING "FF"
       ACTIONS: COUNTER allblk_c INC
       NEXT_ST: stx
```

The statistics table now can show results for six counters and one accumulator (Figure 17-7). The accumulator gives last, minimum, maximum, and average error-per-thousand counts based on all the drops on the circuit.

MON/LINE			BLK=		06/16/89 13:19	
ASCII/8/NONE/BOP						
Name	Current	Last	Minimum	Maximum	Average	Unit
allblk_a	516	1000				
badbcc_a	0	1	0	5	2.03	
allblk_b	801	1000				
badbcc_b	2	2	0	8	4.22	
allblk_c	391	1000				
badbcc_c	11	26	16	37	24.62	
alldrop		26	0	37	10.30	

Figure 17-7 The accumulator at the bottom of the table is consolidating errors-per-thousand values from three separate drops.

Not only current values but also last, minimum, and maximum values can be accumulated and broken out statistically. Values in the Maximum column, for example, often are significant *limit* values: time limits, size limits, and so forth. An accumulator might be assigned to sample only this maximum value for several counters or timers running concurrently. The resultant tabular row would be a comparison of these maximum values.

17.5 Keeping a Statistical Log

The sampling action can be used to log statistics at regular time-intervals. In the example that follows, the program counts data packets on an X.25 link and sends a line of date- and time-stamped statistical values every hour on the hour to a serial printer attached to the INTERVIEW. DTE DATA and DCE DATA are packet-level conditions in the protocol package for X.25 Layer 3 (see Section 34). PRINT COUNTER (and PRINT TIMER) is a layer-independent action described in Section 27.4.

```
LAYER: 3
  TEST: paks_per_hr
    STATE: six_am
      CONDITIONS: TIME 0600
      ACTIONS: TIMEOUT sixtysec RESTART 60
      NEXT_ST: hourly
    STATE: hourly
      CONDITIONS: TIMEOUT sixtysec
      ACTIONS: TIMEOUT sixtysec RESTART 60
        COUNTER minutes INC
      CONDITIONS: COUNTER minutes EQ 60
      ACTIONS: COUNTER minutes SET 0
        COUNTER datapaks SAMPLE
        PRINT COUNTER datapaks
      CONDITIONS: DTE DATA
      ACTIONS: COUNTER datapaks INC
      CONDITIONS: DCE DATA
      ACTIONS: COUNTER datapaks INC
```

After several hours, the resulting printout might look like this:

Time	Name	Current	Last	Minimum	Maximum	Average	Unit
09/14 07:00	datapaks	0	0				
09/14 08:00	datapaks	0	0	0	0	00.00	MSECS
09/14 09:00	datapaks	0	820	0	820	410.00	MSECS
09/14 10:00	datapaks	0	3388	0	3388	1402.67	MSECS

Figure 17-8 A counter is sampled every hour and its values are logged to a serial printer.

Accumulators might be added to the original program to gather statistics for a certain hour each day over a period of days or weeks:

```
TEST: time_of_day
   STATE: times
      CONDITIONS: TIME 1105
      ACTIONS: ACCUMULATE am10-11 COUNTER datapaks LAST
      CONDITIONS: TIME 1205
      ACTIONS: ACCUMULATE am11-12 COUNTER datapaks LAST
      CONDITIONS: TIME 1305
      ACTIONS: ACCUMULATE pm12-1 COUNTER datapaks LAST
      CONDITIONS: TIME 1405
      ACTIONS: ACCUMULATE pm1-2 COUNTER datapaks LAST
      CONDITIONS: TIME 1505
      ACTIONS: ACCUMULATE pm2-3 COUNTER datapaks LAST
```

The resulting tabular screen could tell you, for example, the average number of data packets traveling over the link between the hours of 11 A.M. and 12 noon for a given Monday through Friday:

MON/LINE BLK= P 09/14/89 16:16
ASCII/8/NONE/BOP

Name	Current	Last	Minimum	Maximum	Average	Unit
datapaks	3491	833	0	54150	5036.12	
am10-11		14107	13103	28242	16780.14	
am11-12		31541	21153	54150	26942.92	
pm12-1		15656	10445	30678	18031.33	
pm1-2		14305	14091	34916	20515.20	
pm2-3		9979	91682	25590	14456.03	

Figure 17-9 Here statistics are accumulated for specific hours of the day over a period of days or weeks.

17.6 The Sampling Action as Divisor

The sampling action can be used to divide the sum of all sampled current values on a counter by another value. To divide X by Y, count the events that add up to X and sample the counter Y times. The quotient or proportion will appear in the **Average** column of the counter.

Suppose, for example, that you want to divide the number of information frames on a link by *all* frames, as an indicator of how efficiently the link is being utilized. Count all Info frames on a counter called **Info**. Sample the **Info** counter whenever *any* frame is seen. Reference the **Info** counter on the Tabular Statistics screen. If 1000 out of 1500 frames are Info frames, your results will look like those in Figure 17-10.

MON/LINE BLK= P 01/04/89 11:26
ASCII/8/NONE/BOP

Name	Current	Last	Minimum	Maximum	Average	Unit
utiliz	0	0	0	1	0.67	

Figure 17-10 The value in the *Average* column for this counter is the sum of all sampled values divided by the number of samples.

18 Graphic Statistics

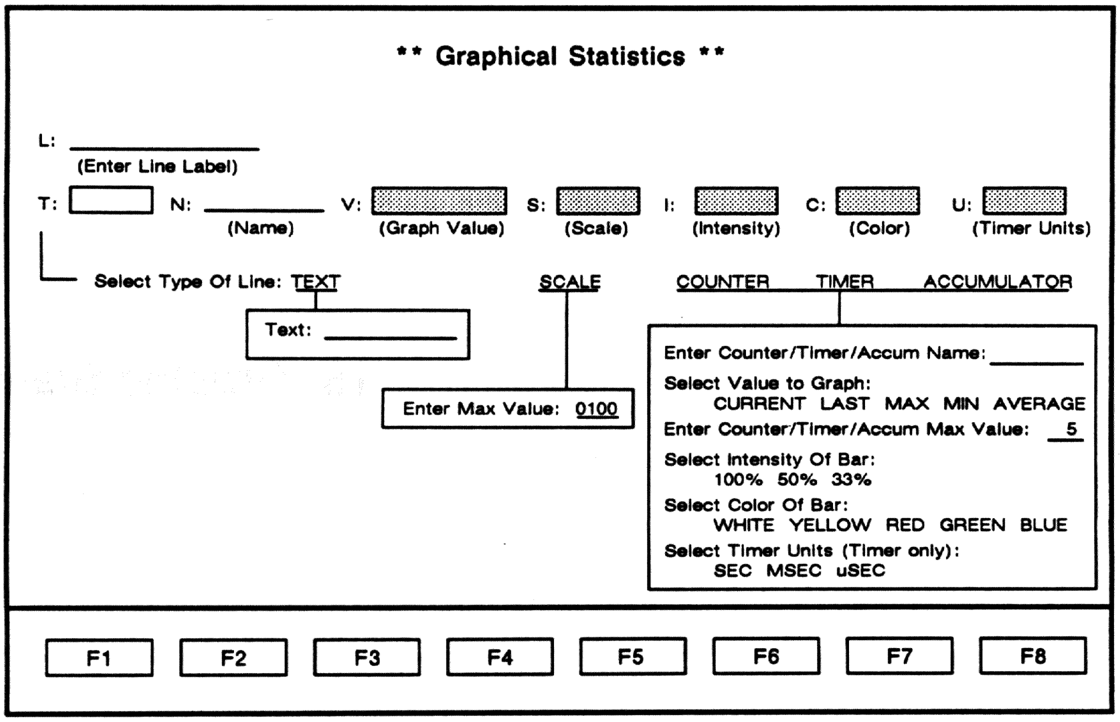


Figure 18-1 Setup selections on the Graphical Statistics screen.

18 Graphic Statistics

The operator of the INTERVIEW will find it easy to design a bar–graph display on the Graphical Statistics screen, with color parameters that can be mapped to a color monitor. Counters, timers, and accumulators that are referenced on the Graphical Statistics screen display their values on this screen as horizontal bars that are drawn in real time and retained in Freeze and Program modes. Variously shaded bars for up to sixteen counters, timers, and accumulators may be displayed.

Any of the sixteen horizontal lines in the graphics display may be reserved for explanatory text or scale numbers instead of a graphic bar. The bars themselves can represent statistics chosen from the entire pool of counter and timer values, grouped and renamed on the graphics display for clarity of overall presentation.

18.1 Enabling the Graphic Display

Both of the statistics screens, tabular and graphics, are enabled at all times during Run mode and can be entered via softkey. Both statistics displays are named on the second bank of softkeys in Run mode. See Figure 18-2. (On the first bank of Run mode softkeys, F5 is labeled **STATS** and will call up whichever screen is the current or dormant entry—TABULAR or GRAPHIC—in the **Statistics Type** field on the Display Setup menu.)

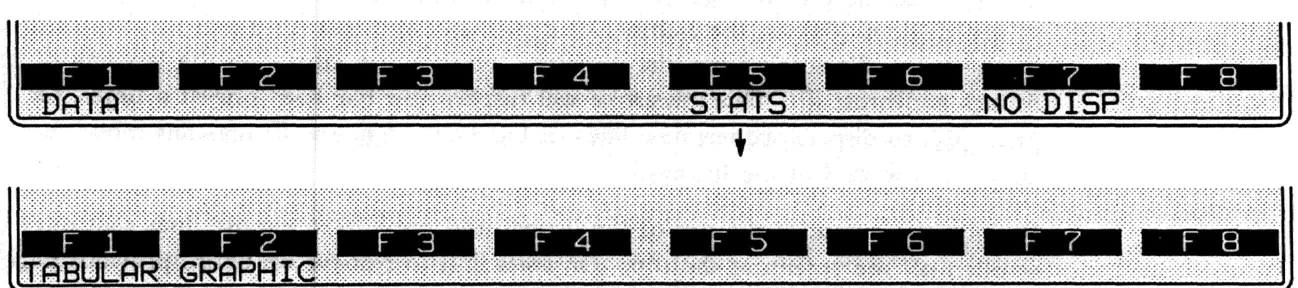


Figure 18-2 Both statistics displays can be entered via the second bank of softkeys during Run mode.

No graphic bar is drawn until a counter or timer has been named on the Graphical Statistics screen in Program mode and then put in motion by the program during Run mode. Examples of triggers that control counters and timers are given in the preceding section, Tabular Statistics. After you have created your counters and timers in the trigger–menu or spreadsheet program, enter the Graphical Statistics screen by pressing PROGRAM, F4 for Stats, and F2 for Graphical Statistics.

18.2 Cursor Movement on Graphical Statistics Menu

There are always two cursors in the Graphical Statistics menu in Program mode. When you enter the screen, one cursor is in the L(abel) field in the menu area at the top of the screen and the lower cursor is on the top line of the sixteen-line display area. See Figure 18-3. The menu-field area always applies to the horizontal display line that has the lower cursor. In Figure 18-3, the display area is blank and the L(abel) field and the other menu fields are in default condition.

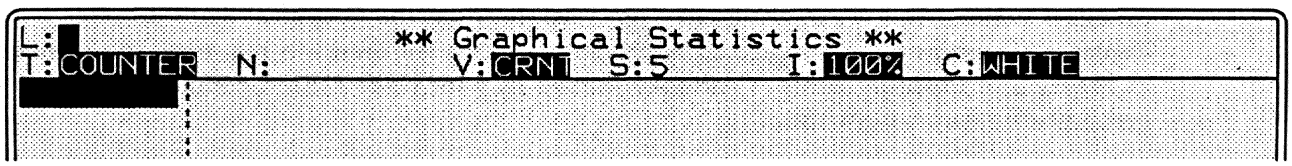


Figure 18-3 **Two cursors on default graphics setup screen: the fields in the menu area always pertain to the display line that has the lower cursor.**

Press [DONE] or [RETURN] (or [→] and [←]) to move the upper cursor from field to field in the menu area of the screen. Press [ROLL FWD] and [ROLL BACK] to change the selections in rotating-window fields.

Press [↓] and [↑] to move the lower cursor from display line to display line. The menu selections at the top of the screen will change as you cursor down the screen, since they are always keyed to the display line that has the cursor. New menu-area selections and data entries are written to the display line that has the lower cursor as soon as that cursor is moved up or down.

The graphics area of the screen is a scrolling display of variable length that sets a very high limit (48) on the number of bar, scale, and text lines that may be created by the user. To scroll down the directory, position the cursor on the last line of the listings and press [↓]. This keystroke will display new bar lines one at a time. Or press [NEXT PAGE] to display sixteen new lines of bar lines. [SHIFT] and [↓] together move the cursor to the end of the listings.

Position the cursor at the top of the listings and press [↑] to expose lines that have scrolled off the screen at the top. Or press [PREV PAGE] to retrieve an entire previous page of listings. [SHIFT]-[↑] will always move you to the top of the listings.

18.3 Menu Fields

(A) Label

L is the label field. The horizontal bar lines on the Graphical Statistics screen have labels at the far left. Referring to Section 18.3(B), below, give each bar a name that is compatible with the *text* line at the top of the chart and with the *scaling numbers* above or below the chart.

The label does not have to correspond to the *name* of the counter or timer (or accumulator) on the trigger menus or in the Protocol Spreadsheet program. For example, the label *PHILA* might be used for a counter named **badbcc_a**, if the counter is tracking errored blocks sent from multidropped device A in Philadelphia.

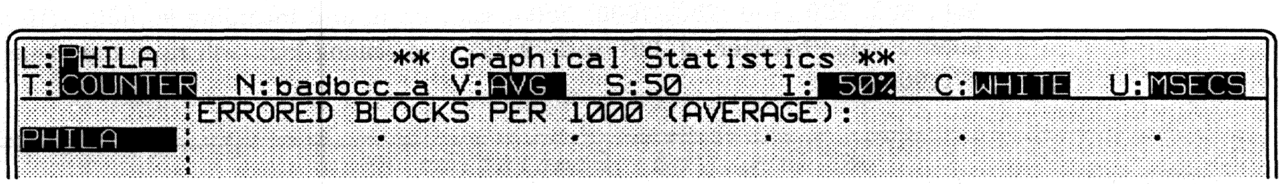


Figure 18-4 The label *PHILA* will appear alongside a horizontal bar representing the average value of the counter named "badbcc_a."

The L field is eight columns wide. Any ASCII entry may be made or the field may be left blank, as in the line of text *ERRORED BLOCKS PER 1000 (AVERAGE):* in Figure 18-4. A label in the L field is written to the display line that has the lower cursor as soon as that cursor is moved up or down.

(B) Type

T designates the type of horizontal line that will be created at the lower cursor. Line types are TEXT, SCALE, COUNTER, TIMER, and ACCUM. Counters, timers, and accumulators will be represented in Run mode by horizontal bars of various shadings that lengthen and shorten as the values for the counters, timers, and accumulators increase and decrease.

T: TEXT devotes a display line to explanatory text. The text line shown in Figure 18-4 was created by the T: TEXT entry in Figure 18-5. The text entry may be 54 characters long. This is the full width of the display area.

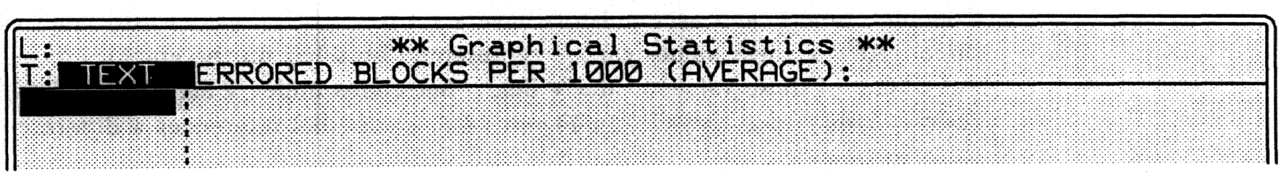


Figure 18-5 Explanatory text will be written to the display line that has the lower cursor as soon as that cursor is moved up or down.

T: SCALE creates a line with five scaling numbers. Enter a number in the S field that represents the highest number of units you will want to display on the graph. The entry may be placed anywhere in the S field. An example of an S entry and the scale line that results is given in Figure 18-6.

The logic will distribute the other four scaling numbers on the scaling line. It will scale the value you enter directly; or else it will raise your value to the next value that fits the scaling algorithm.

To be scaled directly, your **S** number should be expressible by a **single digit of precision** in scientific notation. The number 40, for example, will be applied directly to the scaling line, since in its scientific expression—4 x 10^1—4 is a single digit. 45 (4.5 x 10^1) will be raised to 50. Here is the beginning of the series of valid **S** numbers: 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 2000, etc., up to and including 90,000. (If you enter a value between 90,001 and 99,999, the scaling logic will raise the value to 100,000.)

```
L:                         ** Graphical Statistics **
T: SCALE    S:100
          :DTE T2 RESPONSE TIMEOUT IN MSECS:
CURRENT   :        .          .          .          .          .
LAST      :        .          .          .          .          .
MINIMUM   :        .          .          .          .          .
MAXIMUM   :        .          .          .          .          .
AVERAGE   :        .          .          .          .          .
          :        20         40         60         80         100
```

Figure 18-6 The scale line at the bottom of the figure was created by the menu selections at the top.

(C) Name

The **N** field appears when you have selected COUNTER, TIMER, or ACCUM in the **T**(ype) field. Enter the name of a counter, timer, or accumulator that you have created in your program. In Figure 18-6, the labels all pertain to values called out under the name **t2**.

(D) Value

Counters, timers, and accumulators have a set of statistical values associated with them. Any of these values can be represented by a bar on the graphics display. Select one of these values in the **V** field. Selections under **V** are AVG, CRNT, LAST, MIN, and MAX. In Figure 18-6, each label references a different value of timer t2.

Note that accumulators do not have a current value: see Section 17.4.

(E) Scale

Each bar line is 54 columns wide. The scale field allows you to pick a number that will display a bar that is *fifty* columns wide. When the statistical value you have selected for graphic display attains this number, its bar will *almost* fill the width of the line.

The **S**(cale) entry for a counter or timer value has no direct relation to any scale *line* (see Type, above) that may be drawn above or below it. The scale line merely writes numbers on the screen. The **S** selection for a counter, timer, or accumulator will scale the actual bar to your estimate of what the maximum value will be. If your estimate is good, the bar will have some magnitude without overflowing the width of the screen.

If your bar is drawn to too small a scale and it overflows, go back to the Graphical Statistics screen in Program mode and increase the **S** value for the counter or timer. The statistical values are kept during Program mode (until you hit [RUN] again), and the bar will be redrawn to the new scale as soon as you move the cursor up or down.

(F) Intensity

Three degrees of intensity are selectable for any horizontal bar. In the **I** field, select 100% for full intensity (white against a dark background), 50% for half intensity (medium gray), and 33% for low intensity (light gray). All three bar intensities are shown in the Run-mode graphics display in Figure 18-7. (Remember that whites and blacks are inverted in the screen illustrations in this manual.)

(G) Color

Selections in the **C**(olor) field are WHITE, RED, GREEN, BLUE and YELLOW. The selection in this field has no effect on the screen of the INTERVIEW, but it does affect the signal transmitted on the RGB interface at the rear of the unit. If a color monitor is attached at this interface, horizontal bars on the color-graphics display will be white, red, green, blue or yellow, according to the color selected for each bar (subject to the intensity selected for that bar).

(H) Unit

The **U**(nit) field appears whenever TIMER is the Type selected. Selections in this field are SECS, MSECS, and μSECS. The scale numbers on timing graphs relate directly to these units.

Do not select a timer unit that is smaller than the tick interval (**Tick Rate**) selected on the Front-End Buffer Setup menu. This rule of thumb is explained in Section 7.1(C), Time Ticks in Relation to Timer Units.

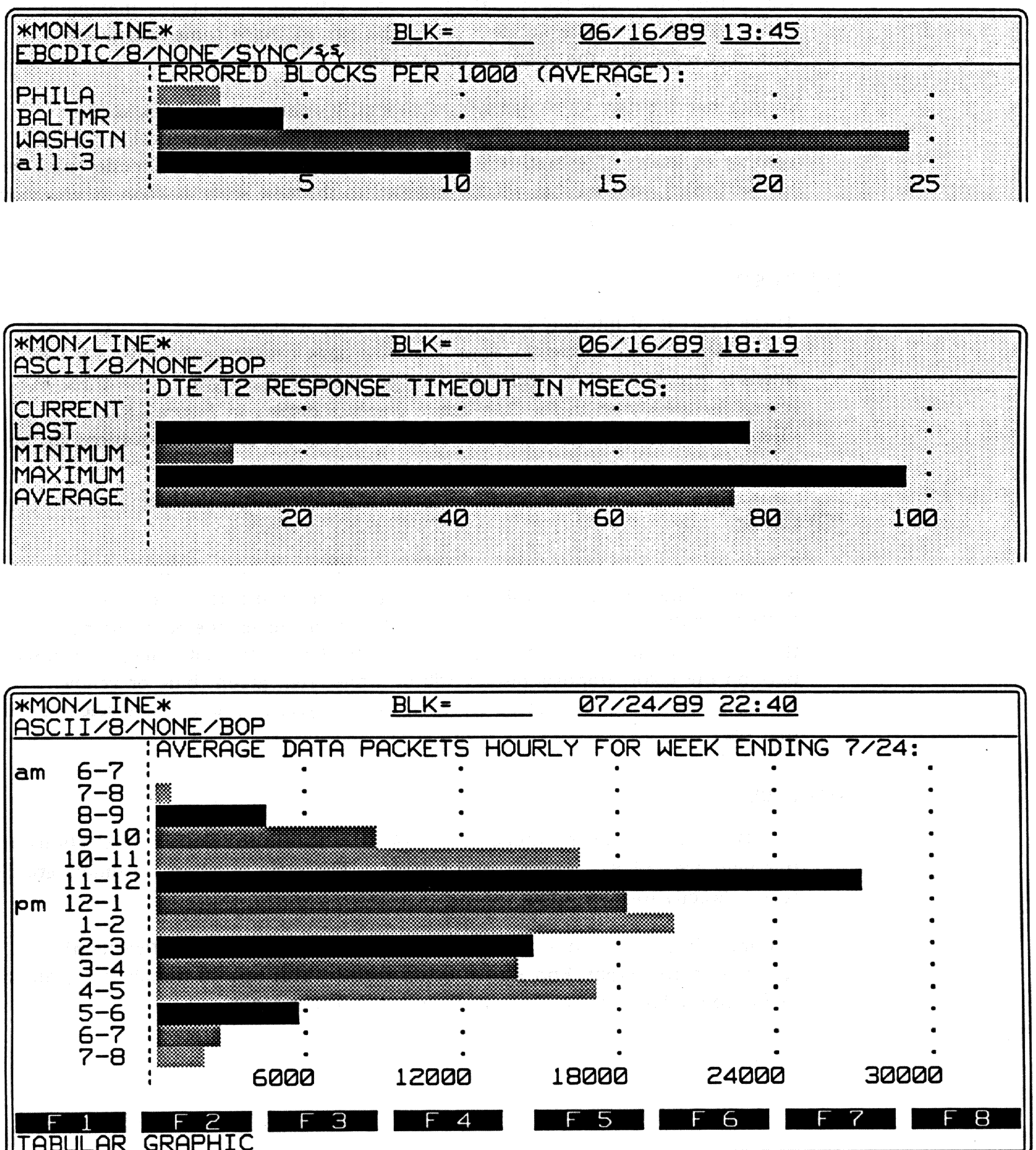


Figure 18-7 Three graphics displays.

19 Three–Tiered Programming

The INTERVIEW 7000 Series is designed to provide programming solutions for problems of varying complexity and for users with different levels of programming skill (see Figure 19-1). The simplest programming tool is the Trigger Setup screen. The setup screen guides the user through a fundamental set of programming selections.

The Protocol Spreadsheet is a more sophisticated and flexible programming method. While based on the same principles as the Trigger Setup screens, the Protocol Spreadsheet provides free–form programming options and a more advanced set of conditions and actions. The spreadsheet allows branching from program routine to program routine as well as simultaneous testing for different sets of conditions. In addition, the structure of the Protocol Spreadsheet is modeled after OSI layered architecture described in Section 20.

A third programming method is present in the INTERVIEW 7000 Series: C programming language, accessible from the spreadsheet, allows the advanced user to write code for test situations outside the scope of standard spreadsheet test selections.

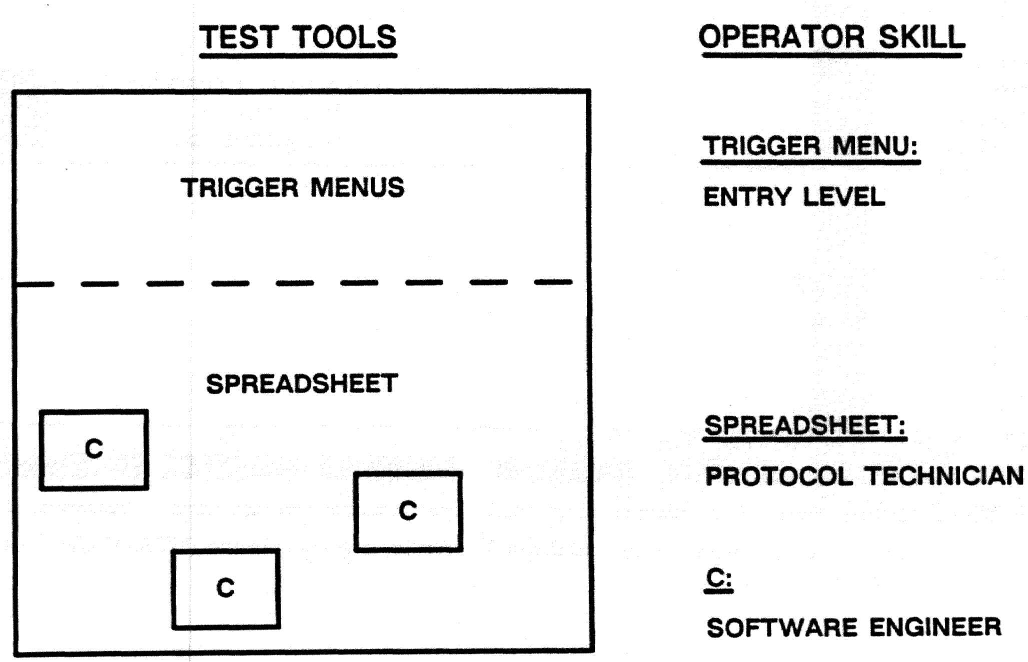


Figure 19-1 There are three separate, *integrated* user–interfaces for programmers of the INTERVIEW 7000 Series.

19.1 Trigger Setup Screens

Triggers are the basic programming tools behind all of the INTERVIEW's test activity. The operator creates each trigger in one of two ways: by using a pre-existent Trigger Setup screen or by keying in trigger conditions and actions on the INTERVIEW's Protocol Spreadsheet.

A trigger is a distinct set of conditions (input) and actions (output). That is, a trigger waits for a specified event or group of events. (These events might include, for example, receipt of a certain data string or change in an internal counter.) When all conditions are met, the trigger responds with a specified action or group of actions. (Trigger actions might include transmission of a data string, sounding of an alarm, or setting of an internal flag.)

There are 16 Trigger Setup screens available in the INTERVIEW 7000 Series. A sample Trigger Setup screen is shown in Figure 19-2. These preconfigured screens provide a simplified approach to programming. Possible conditions are grouped at the top of the menu, and actions potentially taken in response to those conditions are grouped at the bottom of the menu. Trigger conditions contained on the Trigger Setup screens are described in Section 21; Trigger Setup actions are described in Section 22.

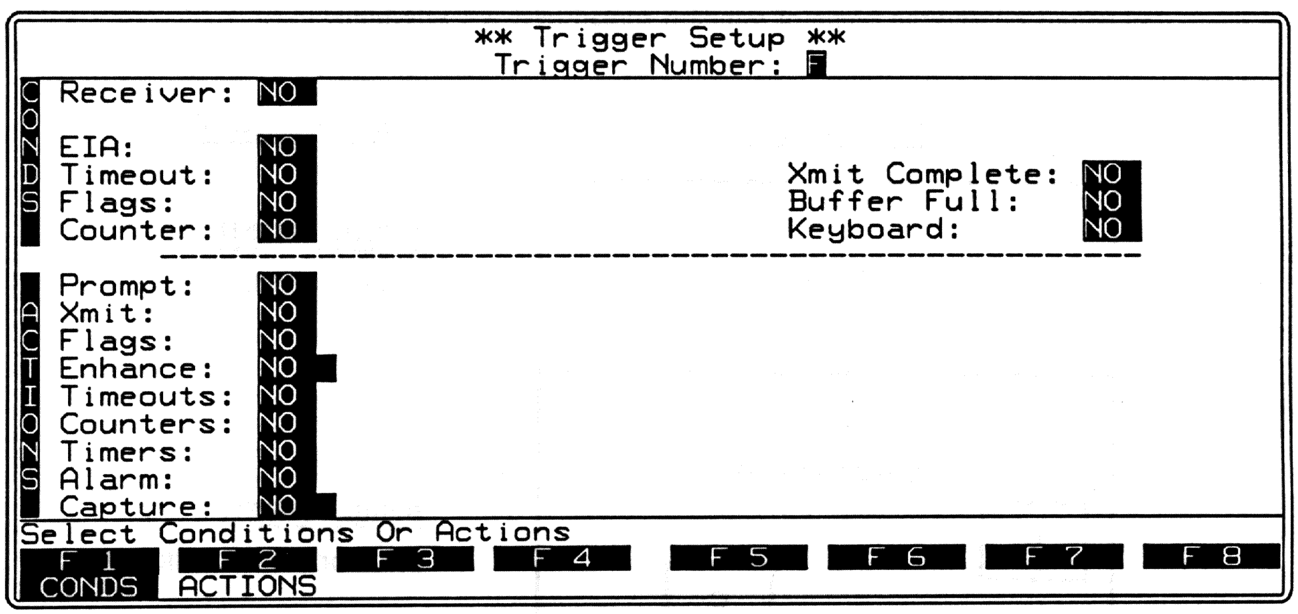


Figure 19-2 There are 16 predefined Trigger Setup screens in the INTERVIEW 7000 Series.

19.2 The Protocol Spreadsheet

The Protocol Spreadsheet, while not a prefabricated menu, contains and extends the set of programming options available on the Trigger Setup screens. As explained in Section 20, the Protocol Spreadsheet program is divided into layers, which are in turn subdivided into smaller components. At each layer, a different protocol is applicable. Depending on the protocol packages which you load, the set of trigger conditions and actions is enlarged to include automatic selections tailored to the protocol and layer you are programming. (Protocol packages are loaded from the Layer Setup screen as described in Section 6.) Figure 19-3 shows the beginning of a spreadsheet test.

Trigger conditions and actions which are always available on the Protocol Spreadsheet are described in Section 27. Conditions and actions available at Layer 1 are discussed in Section 28. Primitives used at different layers are discussed in detail in Section 30.

```
                    ** Protocol Spreadsheet **                  <Indent>
LAYER: 2
  TEST: link_err
    STATE: xmt_wndw

      CONDITIONS: FRAME_SENT
        MORE_TO_RESEND
      ACTIONS: RESEND

      CONDITIONS: FRAME_SENT
        NO_MORE_TO_RESEND
      NEXT_ST: info_xfr
~
~
~
~
~
   F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
LAYER:   TEST:    STATE:   CONDS:
```

Figure 19-3 The Protocol Spreadsheet conditions and actions shown here are part of the X.25 personality package loaded in at Layer 2.

(A) Automatic Protocol Selections: Personality Packages

Standard data units for a protocol which has been loaded from the Layer Setup screen are available by name so that it is not necessary to enter long hexadecimal strings as conditions or transmit actions. You are also spared the calculation of sequence numbers, poll bits, parity, block checking, and certain other variables that must be included in a received or transmitted string.

Timeouts, window sizes, calling sequences, transmission paths, and other protocol-specific parameters can be modified on a sub-menu which accompanies the personality package.

Protocol-specific conditions and actions are discussed at the end of this manual in a section devoted to the protocol and layer.

(B) Creating and Editing Spreadsheet Programs

Protocol Spreadsheet triggers are created by the operator through the use of indexed softkeys. The entries you make become visible on the screen only after you have made a selection. You also have the option of typing your program from the regular keyboard, as long as keyed entries match the text keywords which are displayed on the screen once you press the function keys. Syntax errors are indicated by a strike-through as you type or make function-key entries.

Press [EDIT] to invoke an alternate bank of spreadsheet keys which provide advanced editing functions. All editing functions are described in Section 26.

19.3 C Programming Language

The INTERVIEW version of C is based on the current ANSI recommendations for C programming language, with extensions to provide multitasking. C is intended as an aid to users who have advanced programming knowledge.

C statements can be incorporated in the spreadsheet as conditions or actions. Figure 19-4 shows C included as a trigger action which displays a prompt at the top of the screen and incorporates a counter value as part of the message. This gives you the ability to extend existing spreadsheet selections or to construct an entire test from scratch using C. C allows you the freedom, for example, to create a customized protocol or program trace display or to manipulate variable data strings anticipated within a user-specific protocol.

```
                    ** Protocol Spreadsheet**

    STATE: bad_fcs
      CONDITIONS: DTE BAD_BCC
      ACTIONS: COUNTER badfcs INC
      {
       pos_cursor (0,0);
       displayf ("DTE bad frames: %ld",
                               counter_badfcs.current);
      }
~
```

Figure 19-4 The *displayf* function in a C window allows you to write a variable such as a counter to the top of the data screen during Run mode.

19.4 Integrating Programming Methods

The three tiers of programming, Trigger Setup screens, Protocol Spreadsheet, and C programming language, can be integrated to match the needs of each user. The 16 preconfigured Trigger Setup screens can, for example, be employed as a simple line-monitoring test operating at Layer 1. The Protocol Spreadsheet program can later add more complex tests to this, so that several tests are operating simultaneously at a number of layers (see Section 20 for a discussion of layered architecture). Within the Protocol Spreadsheet program, unique test situations or test problems of particular complexity can be resolved by including C programming statements.

(A) Variables Shared Between Trigger Menus and the Spreadsheet

Certain internal program controls are shared between spreadsheet and Trigger Setup screens, in order to allow communication and interdependency between the two types of testing. Internal counters and program timeouts which have the same name can be monitored and controlled both from trigger screens and from the spreadsheet.

There is limited sharing of internal flag bits between Trigger Setup screens and the Protocol Spreadsheet. Trigger Setup flag bits are shared between all trigger screens. They can also be monitored or changed on the spreadsheet, where they are referenced as a flag named **trig_flag**.

(B) Saving and Loading Program Segments

The INTERVIEW's filing system provides a means for storing entire programs or portions of programs for later use by operators of any skill level. On the File Maintenance Screen, you may specify which group of menus you wish to save. For example, if you specify a "Setup," only the five setup menus (Line Setup, Interface Control, BCC Control, Front-End Buffer Setup, and BERT Setup) are saved. This allows you the freedom to create new trigger or spreadsheet tests without continually reconfiguring all menus.

If you save a "Program" on the File Maintenance screen, you are saving the configuration of all menus, including Trigger Setup screens, Layer Setup, and the Protocol Spreadsheet. A program may be a simple test ready to be enlarged, or it may be a highly complex group of tests that can be loaded and run by an operator with little or no programming knowledge.

As a complement to file maintenance options, the Protocol Spreadsheet editor allows you to save only the spreadsheet portion of a program. An advanced programmer can create a set of tests on the spreadsheet or text files containing C code, then use the editor to write his work to a file. Later, a non-programmer may load a setup or a partial program from the File Maintenance screen, call up the spreadsheet screen, and use the editor to read in the advanced programmer's file in order to complete his own program.

> **NOTE:** The File Maintenance Compile command also can be used to save the contents of the Protocol Spreadsheet. The linkable-object file which results contains the compiled object-code version of the program. See Section 24.4.

20 The Layered Program Model

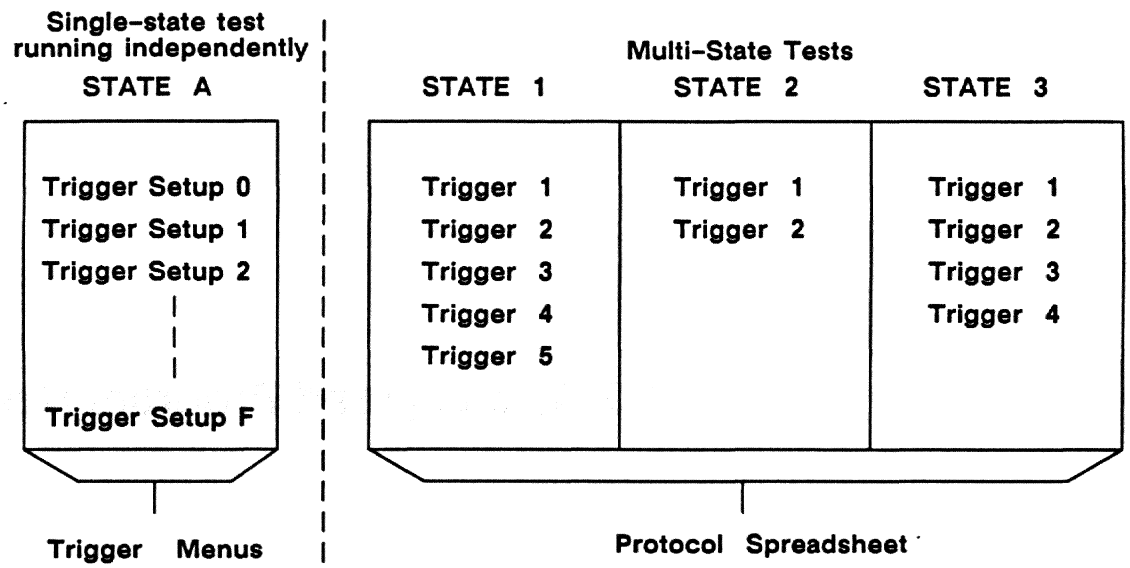


Figure 20-1 Triggers on the Protocol Spreadsheet are grouped into States which can be called in varying order.

20 The Layered Program Model

The trigger, described at the beginning of the previous section, is the fundamental component of all INTERVIEW programs. On the Protocol Spreadsheet, the trigger is grouped to form larger programming blocks, referred to as states. States are grouped to form tests. And tests are divided into layers. The largest component of the INTERVIEW program, the layer, is patterned after the Open Systems Interconnection (OSI) model.

20.1 States

It is a useful programming procedure to group triggers so that some are inactive while others are active. This is possible to a limited extent on Trigger Setup screens, using counters, timeouts, or internal flags to sequence the triggers.

On the Protocol Spreadsheet, triggers can be more easily grouped by separating them into States (Figure 20-1). A state is an independent group of simultaneously active triggers called into play as required by the test. Within a test, only one state is active at one time. That is, all the triggers in this state are awaiting input. All other triggers in the test are dormant.

(When Trigger Setup screens are compiled into the Protocol Spreadsheet, they may be thought of as a single-state test constantly running at the Layer 1 interface.)

When one of its triggers receives the right input, the active state passes control to another state and itself becomes inactive. Transitions between states are always controlled by (spreadsheet) triggers. These trigger-controlled transitions between active and inactive states make branching possible. That is, a more complex set of conditions can be set up inside of a state and certain actions can ensue. Then, at a decision point (for example, "Did the receiving party respond to my transmission?"), the test can choose the correct path from several potential paths. (A: "Yes, he answered, so transmit next message"; or B: "No, he didn't answer, so resend previous message.")

20.2 Tests

Even further flexibility is possible in INTERVIEW programs, because states can be grouped into tests. So, not only does the INTERVIEW move back and forth laterally between the groups of triggers contained in various states, but it can also use different sets of states to perform several different tests at the same time (Figure 20-2). As an example, two simultaneous tests might be used to check the different set of exchanges expected on either side of a full-duplex line.

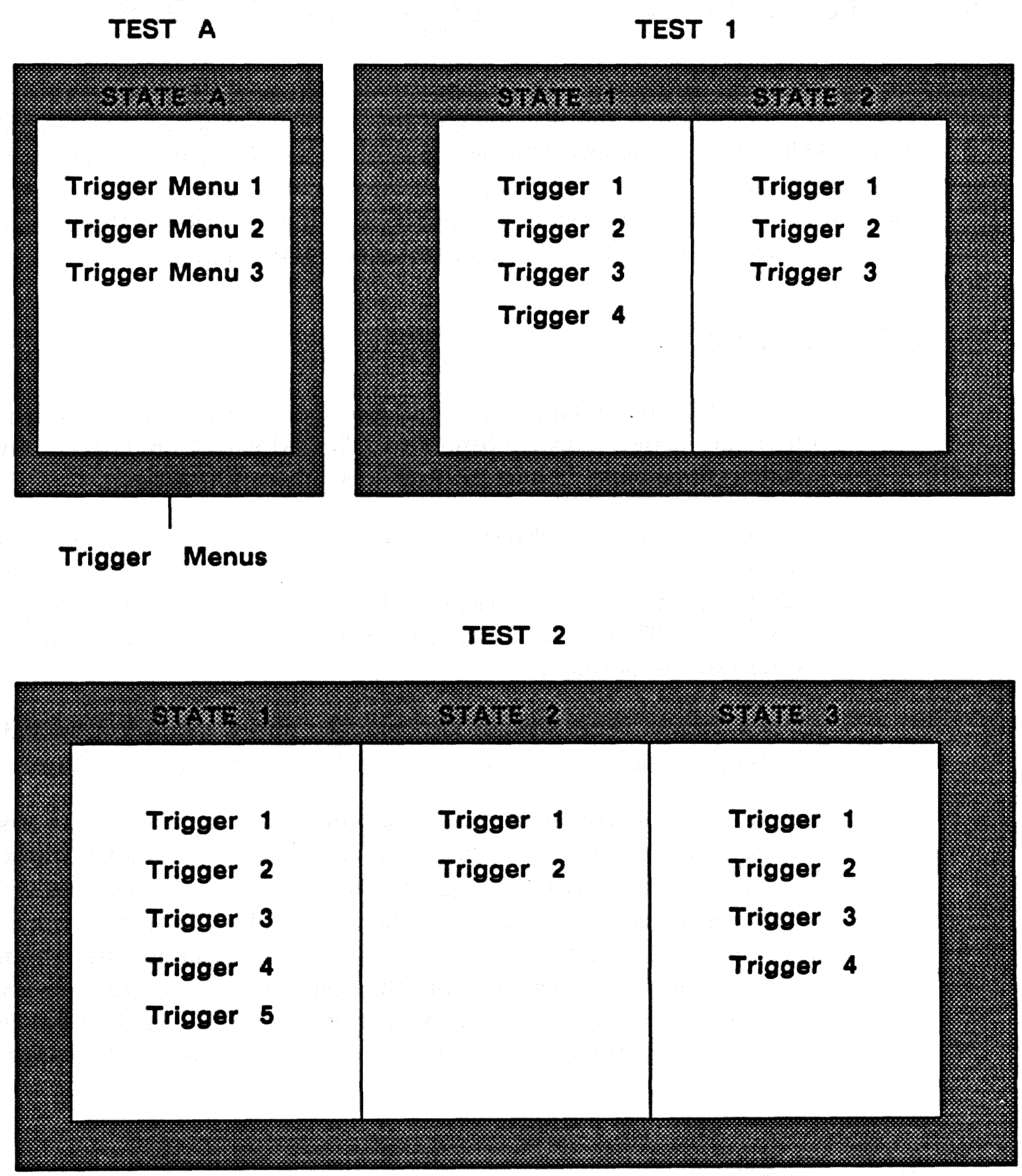


Figure 20-2 Distinct sets of states can be created so that the INTERVIEW can perform several different tests at the same time.

20.3 Layers and the OSI Model

Finally, groups of simultaneous tests can be "layered." In this way, separate tests or groups of tests can be run at a maximum of seven levels simultaneously (Figure 20-3).

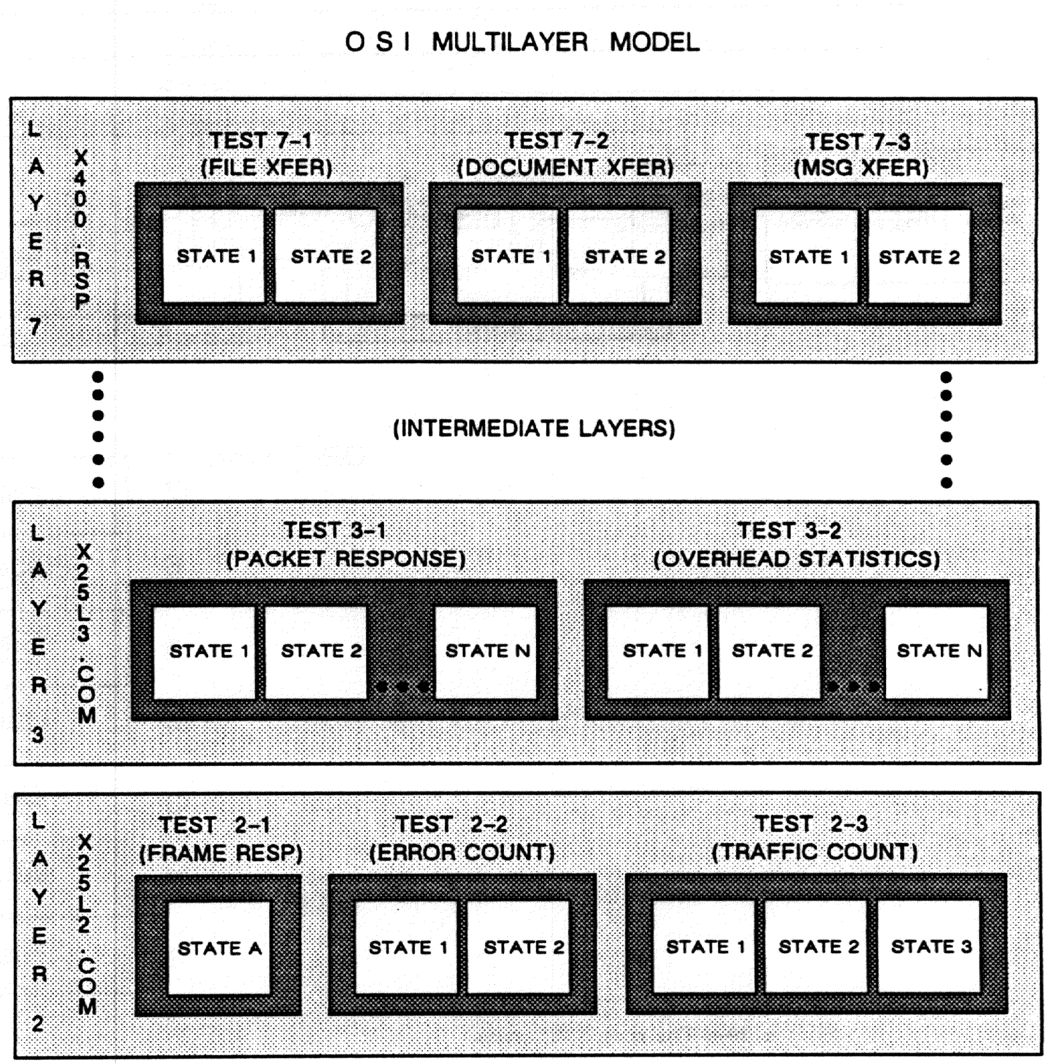


Figure 20-3 Separate tests or groups of tests can be run at a maximum of seven layers simultaneously. This capability parallels the OSI seven-layer model.

This layered structure is specifically designed to handle protocols which conform to the CCITT Open Systems Interconnection (OSI) model. The OSI model is fully described in CCITT Recommendation X.200.

This is a seven-layer model (see Figure 20-4) in which each layer performs a different data communication function. Conceptually, each layer is independent. One layer can be modified without other layers being affected, as long as the modified layer respects prescribed communication with the layer immediately above and the layer immediately below it.

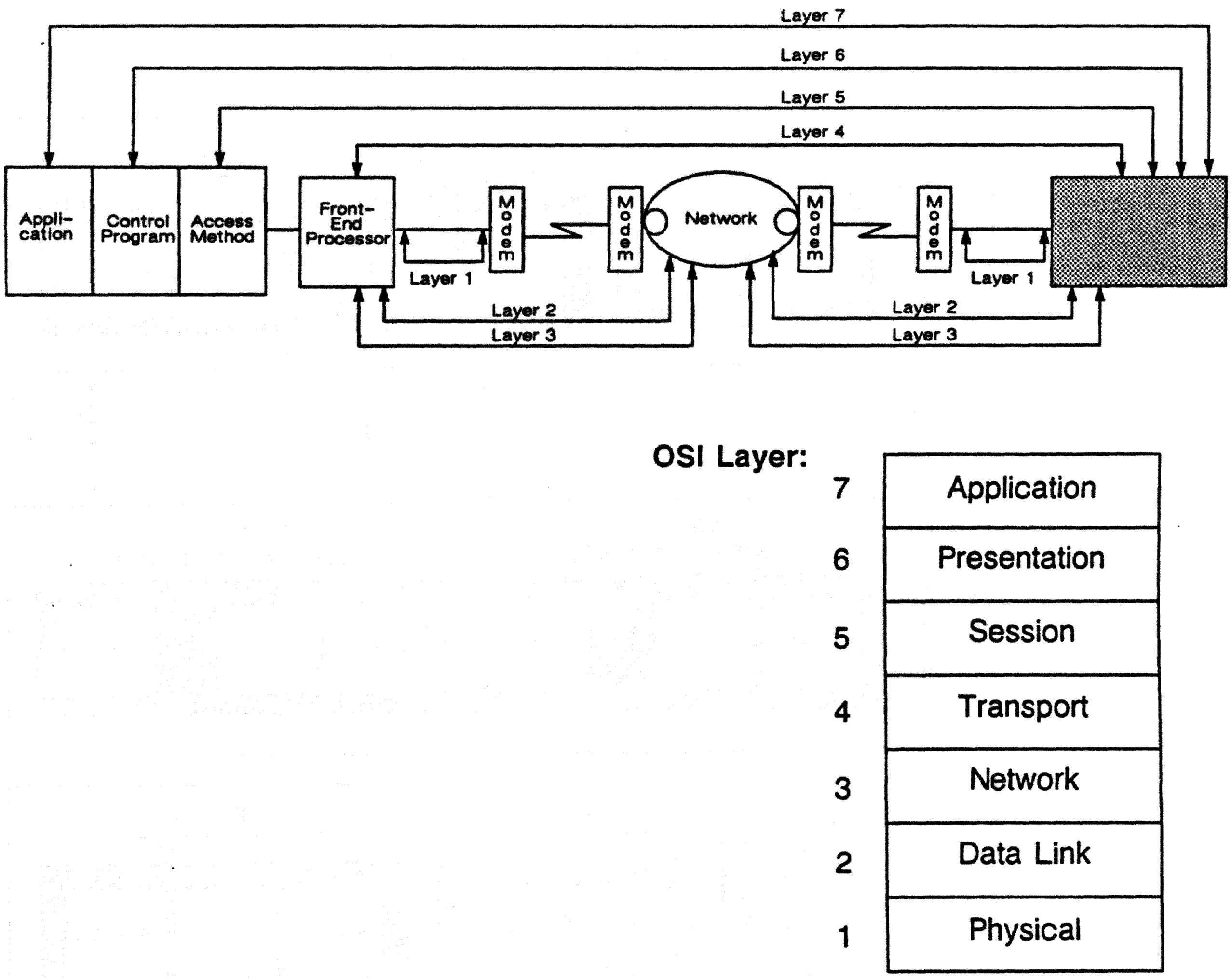


Figure 20-4 The seven OSI layers.

Suppose that the physical link between two nodes in a network were changed from copper wire to optic fiber. In an OSI configuration, only the physical layer (and possibly certain aspects of the data link layer) would be modified. The remainder of the communication process would stay the same.

The separation of programs into discrete layers generally reduces the complexity of test conditions and actions. This simplifies programming for the user. The structure allows you to verify your system—and to debug your own tests—layer-by-layer. For example, it is not necessary at Layer 3 of a protocol to anticipate variations in line-level or frame-level events. Searches for strings and protocol elements focus only on the portion of a frame which pertains to Layer 3. The validity of the frame which contains the string has already been checked.

20.4 Personality Packages

The layered structure of the OSI model allows you to use different protocols at different layers—again, provided that the rules of OSI interlayer communication are observed.

The INTERVIEW provides layer-specific protocol packages, called personality packages, which you can load from the Layer Setup screen. While certain layer protocols are more commonly used together (SDLC at Layer 2 and SNA at upper layers, for instance), it is possible to mix and match them. You could, with the correct Personality Package, load and run X.25 protocol at Layer 2 and SNA protocol at higher layers.

Personality packages are not in themselves protocol emulations; rather, they are high-level interfaces to routines in the given protocol. A package at Layer 2 X.25, for example, allows the user to *design his own application* by simple softkey-entry of a routine such as

```
CONDITIONS: RCV DISC
ACTIONS: SEND SABM
```

or

```
CONDITIONS: T1_EXPIRED
ACTIONS: RESEND
```

Personality packages are selected and loaded from the Layer Setup screen (shown in Figure 20-5; see Section 6 for a description of this screen). The contents of each personality package are described in a section dedicated to the package (refer to the Table of Contents, Sections 32 and following).

```
                                  ** Layer Setup **
                                          Selections      Packages Loaded
DRIVE: HRD        Layer 1 Package: NO PACKAGE      NO PACKAGE
DRIVE: HRD        Layer 2 Package: X.25            X.25            HRD
DRIVE: HRD        Layer 3 Package: X.25            NO PACKAGE
DRIVE: HRD        Layer 4 Package: NO PACKAGE      NO PACKAGE
DRIVE: HRD        Layer 5 Package: NO PACKAGE      NO PACKAGE
DRIVE: HRD        Layer 6 Package: NO PACKAGE      NO PACKAGE
DRIVE: HRD        Layer 7 Package: NO PACKAGE      NO PACKAGE


Depress XEQ Key To Load The Selected Packages
Select Layer
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4  LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 20-5 Personality packages, which provide the protocol elements in INTERVIEW programming, are loaded from the Layer Setup screen.

20.5 Primitives

The OSI Layers use limited-range messages called *primitives* to communicate with each other. Primitives are defined by the OSI model and are not linked to any one protocol. No matter what personality package is loaded, these generic primitives are available at each layer. This gives you the freedom to create or modify a protocol. Primitives available on the Protocol Spreadsheet are discussed in Section 30.

20.6 Constants

To represent a frequently used test value, you may define a constant once in your program and reference the constant elsewhere in the program as needed. Replacing the test value with a new value then becomes easy, since you need only change the constant definition one time.

Constants, which may be used to represent any textual string, can be defined at several levels in the spreadsheet program. The function key labeled CONSTS: is only present when it is legal to define constants.

Depending on where they are defined, constants vary in scope. You have the option of creating constants which can be used globally, throughout a layer, or throughout a test. Refer to Section 25 for a full description of constants.

21 Trigger Conditions

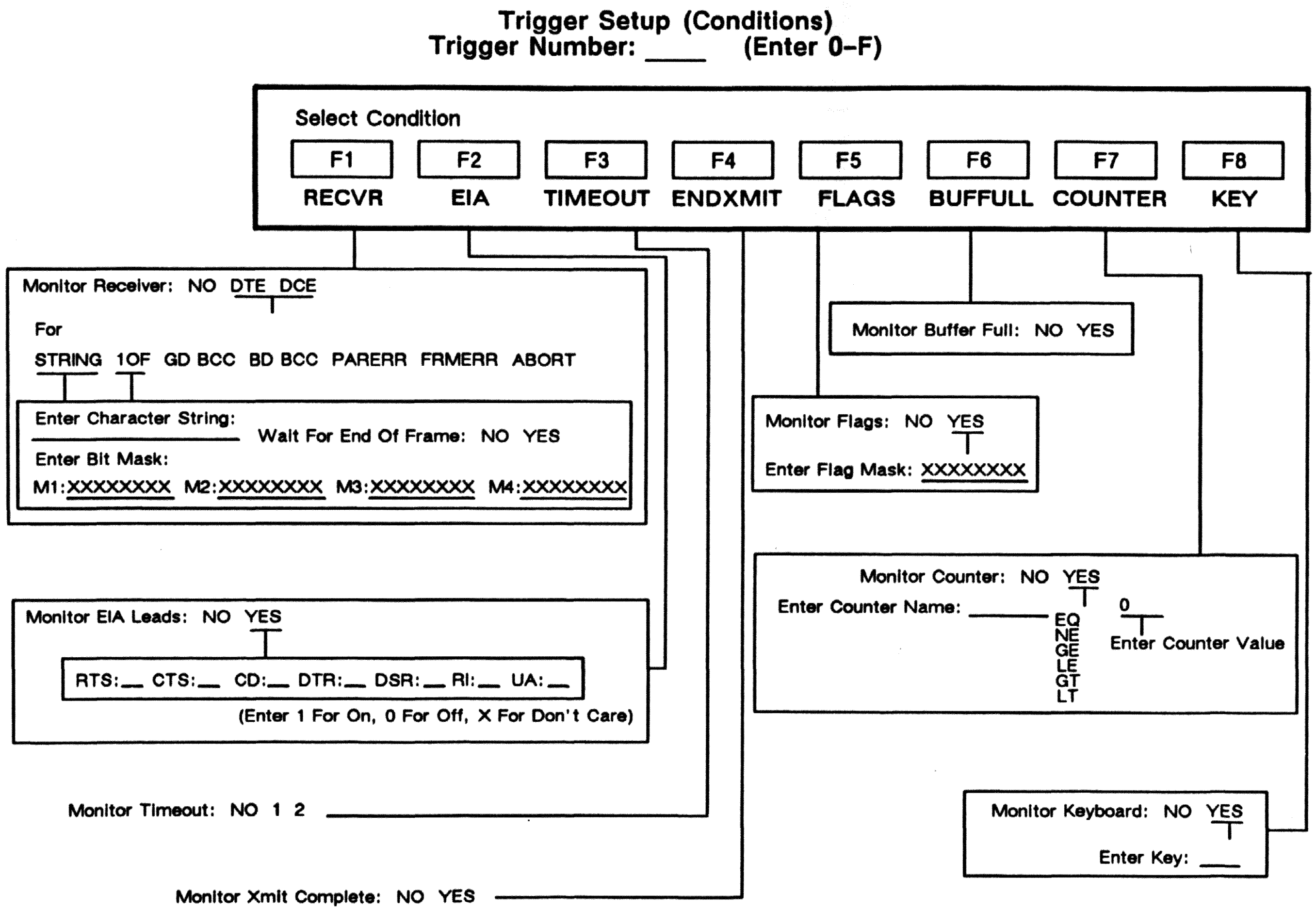


Figure 21-1 Conditions on Trigger Setup menu.

21 Trigger Conditions

Triggers can be thought of as "IF, THEN" statements, represented on the screen as "Conditions" (IF...) and "Actions" (THEN...). This section pertains to Trigger Conditions available on the preconfigured Trigger Setup screens, of which there are 16 in the INTERVIEW 7000 Series. All possible conditions available on the Trigger Setup screen are shown in Figure 21-1.

Triggers are numbered 0 through F. To access a particular trigger screen, press the TRIGS function key on the Main Program Menu. This calls up the Trigger Summary screen. Enter the Trigger Number desired (it will appear highlighted at the top of the screen) to see that trigger screen.

Each trigger screen is divided in half, with Conditions at the top of the screen and Actions at the bottom of the screen. A default Trigger Setup screen is shown in Figure 21-2.

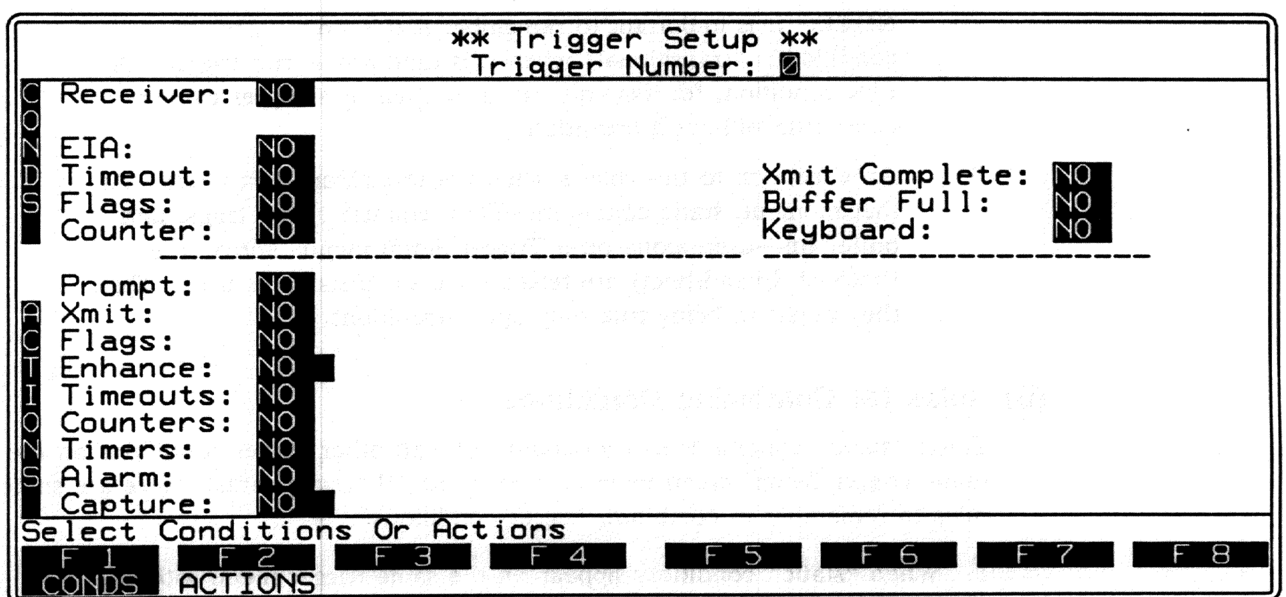


Figure 21-2 Default trigger menu.

21.1 Active Triggers

Only active triggers are tested. Trigger Setup screens are always active. (This is not true of triggers on the Protocol Spreadsheet, where triggers are configured in alternately active states as a matter of program design.)

21.2 Combining Conditions on the Same Trigger Setup Screen

A trigger is true and can take action only at the instant that *all* trigger conditions are met.

(A) Static vs. Instantaneous Conditions

Internal flag, Counter, EIA lead, and Buffer Full conditions differ from other conditions on the Trigger Setup screen. When it is used in a trigger *by itself*, each of these conditions, like other independent conditions, initiates its trigger actions only at the instant that it transitions to true. In addition, these four conditions can retain a *status* of true for a long period of time.

The *static* value of these four conditions is tested for true or false when they are combined in the same trigger with another condition.

All other trigger conditions are true only at the instant that they happen. We will refer to them as "instantaneous" or "transitional" conditions.

> NOTE: It is important to remember that even a "static" condition is "transitional" when it is used *alone* in a trigger. An EIA condition, for example, used by itself in a trigger cannot come true without a transition.
>
> An exception to this rule is when the test enters Run mode. At that moment, static conditions—flags, counters, EIA leads, and buffer full—used alone on a Trigger Setup menu (*not* on the Protocol Spreadsheet) are tested once for a status of true. Then they revert to being true only upon transitions.

(B) Rules for Combining Conditions

These "static" conditions can be combined with other trigger conditions on the same Trigger Setup screen to form compound "IF" statements. Here are some rules to remember in combining trigger conditions:

1. When "static" conditions appear on the same trigger menu with an "instantaneous" condition, the trigger is keyed to the instantaneous condition. All static conditions must be true when the instantaneous condition transitions to true. On that transition, trigger actions are taken.

   Suppose, for example, that a trigger is looking for a Bad BCC and a counter value = 20. The counter value must first increment to 20, then the Bad

BCC must be detected. As soon as the Bad BCC is detected, the trigger becomes true and takes action.

2. When static conditions are combined, both (or all) are transitional. When one of them transitions true, the other(s) becomes a static condition and is checked for a status of true. The user does not have to try to anticipate which of two (or more) conditions will transition first.

   NOTE: On the Protocol Spreadsheet, static conditions are prioritized in the order that the user lists them: only the first is transitional. The Protocol Spreadsheet therefore requires you to define which static condition will be the controlling, transitional condition. See Section 27.2.

21.3 Receiver

This condition monitors the data lead specified (DCE or DTE) for designated data. When **Receiver:** DCE or DTE is selected, several options become available: String, 1of, Good BCC, Bad BCC, Parity Error, Frame Error, and Abort.

(A) DTE or DCE

In using the Receive condition, you must specify which side of the line you wish to monitor. Select DTE to denote the TD lead. Select DCE to denote the RD lead.

(B) String

This selection allows you to enter a string of up to 16 characters in the field provided. The entire, exact sequence of characters entered must be received for the condition to be true.

(C) "One of"

When 1 OF is selected, the trigger looks for any one of the characters entered in the next field. Up to 16 individual characters can be entered.

(D) Good or Bad BCC

GD BCC (Good Block Check Calculation) and BD BCC (Bad Block Check Calculation) cannot be used as conditions unless **Rcv Blk Chk** is on in the unit (selectable on the Line Setup screen; see Section 4). Select GD BCC or BD BCC when you want the trigger to take action on receipt of the Block Check Calculation (referred to as FCS, or Frame Check Sequence in Bit-Oriented Protocols).

(E) Parity Error

PARERR looks for a parity error in relation to the **Parity** selection made on the Line Setup screen.

(F) Framing Error

FRMERR applies to start–stop formats (ASYNC and ISOC) and locates framing errors, based on the stop bits anticipated. Both **Format** and **Stop Bits** are selected on the Line Setup screen.

(G) Abort

This selection applies to all Bit–Oriented Protocols. When ABORT is selected, the INTERVIEW triggers off of the seven consecutive 1 bits which constitute an Abort. BOP should be used as **Format** on the Line Setup Menu when ABORT is selected.

> **NOTE:** The trigger condition will not respond to idle–time aborts, unless **Display Abort:** YES has been selected on the Line Setup screen.

(H) Character Entry Field

This field appears only if STRING or 1 OF is selected. It is the data–entry line for a sequential character string, if STRING has been selected; or a non–sequential character list, if 1 OF has been selected. Up to 16 characters may be entered, in either case.

1. *String entry.* The 16 characters allowed in the string may include any of the following in any order or number:

   All upper and lower–case ASCII characters available on the keyboard.

   All control character mnemonics on the keyboard.

   Two–digit hexadecimal entries. These are entered by first turning the HEX key on, then using alphanumeric keys 0 through 9 and A through F. Two alphanumeric key strokes are required for each hex character. A hex character is represented on the screen as a pair of small characters, the first ascending and the second descending. Compare hex characters to regular alphanumeric characters in Figure 21-3.

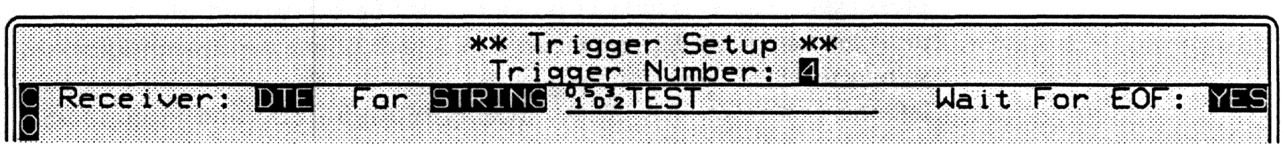


Figure 21-3 Both alphanumeric and hexadecimal characters can be entered as part of a condition search string.

Characters entered in hexadecimal are not translated, and parity is not calculated for them; therefore, you must include the parity bit, whether good or bad, in your entry.

2. *Flags*. You must press [FLAG] to enter the 7E Flag byte used in Bit-Oriented Protocols. The INTERVIEW's logic will not read a hexadecimal entry made with [HEX] as a flag.

3. *Sync*. Press [SHIFT]–[FLAG] to enter the sync symbol. The character [S] is displayed on the Trigger screen.

4. *Not equal (≠) entry*. When a character key is preceded by [NOT EQUAL], all characters not equal to that character will satisfy that position in the string. These characters are represented in the data entry field with a horizontal bar through them.

5. *Don't care*. [DON'T CARE] permits *any* character received in that position to satisfy the condition.

6. *Bit masks*. Four bit masks can be positioned anywhere in the data-entry string. To enter a bit mask, use [BIT MASK] at the desired location in the string. Each time you press [BIT MASK], a new mask field appears below the string-entry field. To move the cursor to the next position in the string-entry field, press [DONE]. The mask fields are numbered M1 through M4, to denote the order in which they appear in the string (see Figure 21-4).

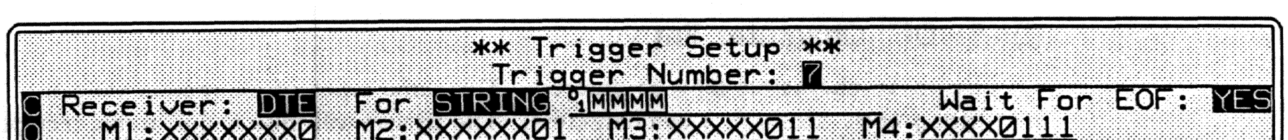


Figure 21-4 Four bit masks can be used as part of the search string.

If you have used Bit Masks 1 and 2, for example, at positions 5 and 8 of the string (as in Figure 21-5), you may decide to change the character at position 1 to a bit mask. Return the cursor to position 1 of the string and press [BIT MASK]. The character at position 1 will be overwritten with [M], the two prior bit masks will be renumbered to 2 and 3, and their menu location shifted to make room for the new Bit Mask 1. The cursor will be on the left-most bit of the new mask. (Compare Figure 21-5 and Figure 21-6.)

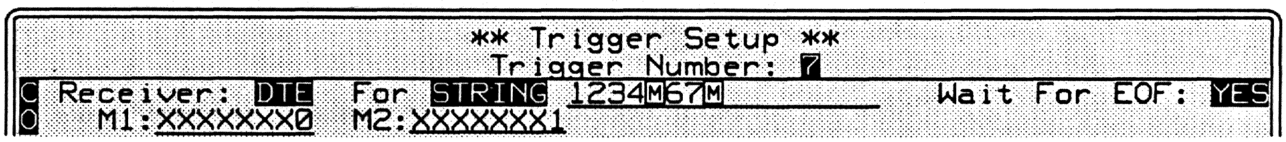


Figure 21-5 Bit masks M1 and M2 are entered at positions 5 and 8 of this string.

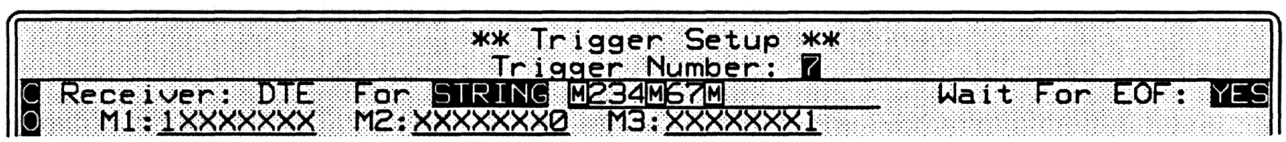


Figure 21-6 A third bit mask has been entered at position 1, and the old M1 and M2 have shifted automatically to M2 and M3.

NOTE: When a Bit-Oriented Protocol is being tested, the INTERVIEW ignores inserted zero bits. You can specify the search string on the Trigger Setup screen without considering zero bit insertion.

7. *Double parens.* A global constant declared on the Protocol Spreadsheet can be entered as part of a Receiver String. Enter the name of the constant exactly as it appears on the spreadsheet and enclose it in double parentheses, as follows: ((drop)). The double parentheses are special characters created by pressing [CTRL]-[9] for ((, and [CTRL]-[0] for)). When constants are used, the receive string cannot be longer than 32 characters *after all constants are expanded.*

(l) "1 OF" Character Entry

Up to 16 characters may be entered. The same types of characters valid in **String** entry are valid **1 OF** characters. The trigger will take action upon receipt of the first character that matches any one of the characters anywhere in the list. If [DON'T CARE] is used, only this character should appear in the **1 OF** entry field (since any character is a match for Don't Care). If *one or more* characters in the field are entered as [NOT EQUAL], only those characters not in the field will satisfy the condition. Thus, ~~pq~~z in the **1 OF** field means the same thing as ~~pqz~~: all characters other than p, q, and z will satisfy the condition.

(J) Wait For End of Frame

This is a subfield which appears when STRING or 1 OF is selected. The default selection is NO. When **Wait For EOF:** YES is selected, the trigger first tests for the data specified on the trigger. Then it evaluates the block check at the end of the frame. The trigger will not take action when a Bad Block Check or an Abort is detected on a received frame.

21.4 EIA

Select YES in the **EIA** field if you want a trigger to monitor status of up to seven RS-232/V.24 leads (see Figure 21-7).

> **NOTE:** For line data, EIA lead-status is not detected if control leads are not buffered in the Front-End Buffer. See Section 7. For recorded data, EIA lead-status is not detected if control leads were not buffered in the FEB at the time of recording.

```
N  EIA:      YES   RTS:1  CTS:X  CD:X    DTR:X  DSR:X  RI:X  UA:X
D  Timeout:  NO                          Xmit Complete:  NO
S  Flags:    NO                          Buffer Full:    NO
   Counter:  NO                          Keyboard:       NO
```

Figure 21-7 Each trigger can monitor the status of seven EIA leads.

Enter a 1 in the box under a lead to indicate ON; a 0 for OFF. No entry (X) is read as Don't Care. Entry fields are provided for six leads: RTS (Pin 4), CTS (Pin 5), DSR (Pin 6), DTR (Pin 20), CD (Pin 8), and RI (Pin 22). You may monitor a seventh RS-232/V.24 lead by strapping the desired lead to UA on the Test Interface Module (see Section 10 for instructions).

In using the **EIA** condition, you should keep the following points in mind.

- If only **EIA** conditions are selected, the trigger will wait for all **EIA** conditions to be satisfied. It will become true on the last transition necessary to satisfy these conditions.

- The **EIA** condition is a static condition. The rules for combining static conditions with other conditions are explained in Section 21.2.

21.5 Timeout

Two timeout timers can be monitored from the Trigger Setup screen.

The decrementing timeout timer is set for a specific time as part of a trigger action. The trigger which sets a monitored timeout may be any of the Trigger Setup screens or any trigger on the Protocol Spreadsheet.

The default **Timeout** selection is NO. Select 1 to monitor Timeout timer 1; 2 to monitor Timeout timer 2. The condition is satisfied at the instant of the timeout.

21.6 Transmission Complete

When **Xmit Complete:** YES is selected, the INTERVIEW tests for the end of its own transmissions.

> NOTE: The INTERVIEW transmits only when operating in Emulate DTE or DCE mode (selectable on the Line Setup screen; see Section 4).

The **Xmit Complete** condition is frequently used with an internal flag or counter condition to control when or how many times it will be tested.

21.7 Internal Flag Bits

There are eight internal flag bits reserved for the INTERVIEW's Trigger Setup screens. The purpose of the flag bits is to provide a simple way to interconnect several triggers in order to make one trigger dependent on another or to set up triggers in sequence. Each bit is a simple switch that one trigger may set as an action and all triggers can test later.

Internal flags may all be monitored and set by any individual trigger. (The same flag bit can be set and sensed by a single trigger.) Since each flag bit can be set and monitored separately, it can also be shared among the Trigger Setup screens.

The internal flag condition is a static condition and can be used in combination with other trigger conditions as explained in Section 21.2.

To test internal flags, select **Flags:** YES. In the flag mask which then appears, enter a 1 to test for a flag bit turned ON, a 0 to test for a flag bit turned OFF. Enter X in the appropriate position of the mask (or press DON'T CARE) if you do not wish to test a particular bit. See the example in Figure 21-8.

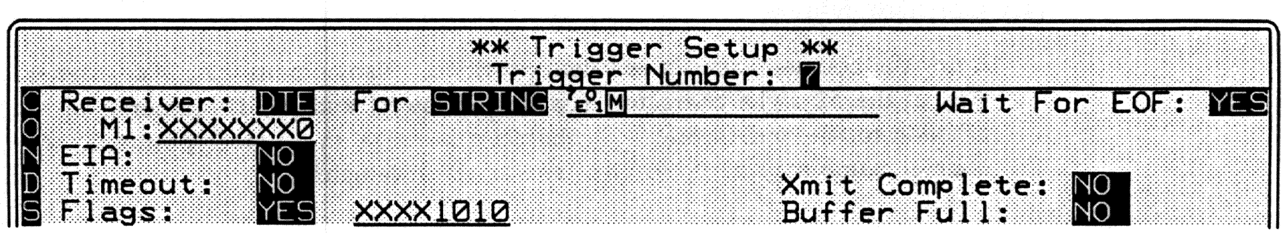


Figure 21-8 The internal flag condition is frequently used in combination with other trigger conditions.

NOTES:

All flags are set to 0 as the INTERVIEW enters Run mode.

The eight flag bits on the Trigger Setup screens are the low-order bits of a flag mask that can be accessed on the Protocol Spreadsheet by the name **trig_flag**. See Section 27.3(G).

21.8 Buffer Full

This condition checks the screen's 64 Kbyte character buffer and becomes true as soon as the buffer is full. The condition then remains true throughout the program. Buffer Full is a static condition which may be used in conjunction with other conditions. The rules for combining trigger conditions are outlined in Section 21.2.

21.9 Counter

Each Trigger Setup screen can monitor a counter with a range of 0 to 999,999. The counter which is monitored may be named and controlled either on a Trigger Setup screen or on the Protocol Spreadsheet.

The default selection is NO. When **Counter:** YES is selected, new menu fields appear (see Figure 21-9).

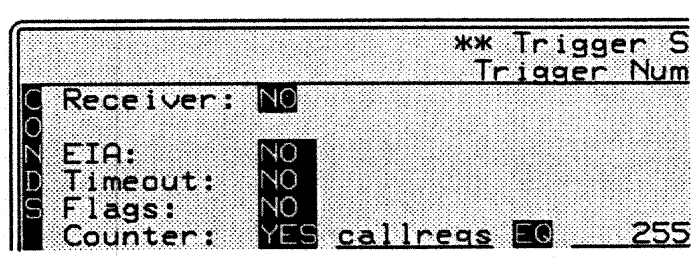


Figure 21-9 Any counter named on a trigger can be monitored as a Trigger Setup screen condition.

(A) Counter Name

Enter the counter name in the field provided. Names must start with a letter. Any of the 52 alpha characters (upper and lower) and the 10 numerals in addition to the underscore (_) character are legal in all other positions. A counter name may be up to eight characters in length.

(B) Relational Operator

Make the appropriate selection to specify when the **Counter** condition will be true. The counter may be tested for a value equal to (EQ), not equal to (NE), greater than or equal to (GE), less than or equal to (LE), strictly greater than (GT), or strictly less than (LT) the entered value on the trigger screen.

(C) Counter Value

Enter the counter value as a whole decimal number in the field provided.

21.10 Keyboard

Select **Keyboard:** YES to display a one character entry field. Then press the key which you wish to use as the condition. In Run mode when that key is pressed, the condition will be true and (if this is the only condition) will initiate a trigger action, such as a transmission. Any key *or key-combination* that produces a character listed in the ASCII chart in Appendix D1 is valid input in this field.

22 Trigger Actions

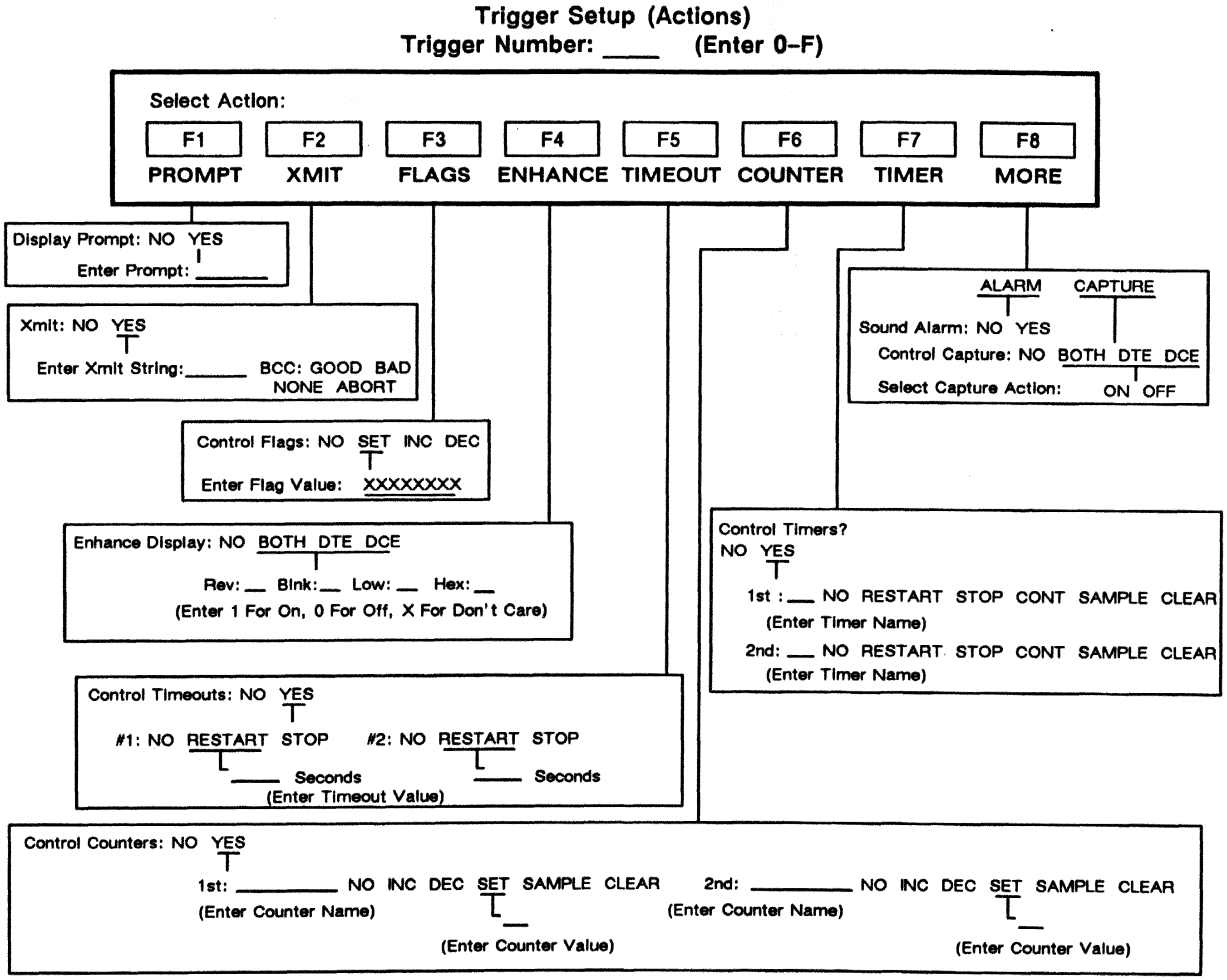


Figure 22-1 Actions on Trigger Setup menu.

22 Trigger Actions

Figure 22-1 shows all actions available on the Trigger Setup screen. Figure 22-2 shows a default trigger menu. The top half of the menu contains available trigger conditions, discussed in Section 21. A more complete set of trigger conditions and actions is available on the Protocol Spreadsheet (see Sections 27 and 28, as well as individual sections on the Protocol Packages).

All conditions selected on the top half of the Trigger Setup menu must be satisfied for the trigger to be true. Only then will the actions on the lower half of the menu be taken.

```
                        ** Trigger Setup **
                         Trigger Number: 2
C  Receiver:   NO
O
N  EIA:        NO
D  Timeout:    NO                         Xmit Complete:  NO
S  Flags:      NO                         Buffer Full:    NO
   Counter:    NO                         Keyboard:       NO
     ---------------------------------------------------------
   Prompt:     NO
A  Xmit:       NO
C  Flags:      NO
T  Enhance:    NO
I  Timeouts:   NO
O  Counters:   NO
N  Timers:     NO
S  Alarm:      NO
   Capture:    NO
Select Conditions Or Actions
  F 1      F 2      F 3    F 4     F 5    F 6    F 7    F 8
 CONDS   ACTIONS
```

Figure 22-2 Default trigger menu.

22.1 Displaying a Prompt

Select **Prompt:** YES to display a data entry field (see Figure 22-3). You may enter a message of up to 47 characters here. Any ASCII characters are legal entries. When the trigger is true, the Prompt will be displayed on line 2 of the screen. (The prompt is NOT transmitted.) It will stay on the screen until it is replaced by another prompt, or until you clear it by changing the display mode or by pressing the RUN key.

NOTE: A new prompt does not reinitialize the prompt line on the screen. Instead it overwrites the old prompt to the extent of the new one. If the prompt "LINK-UP" is overwritten by the prompt "CALL," the result will be "CALL-UP."

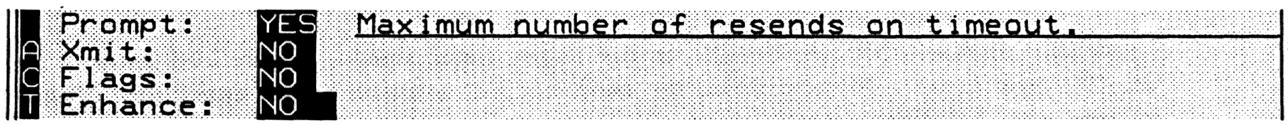


Figure 22-3 Messages entered in the *Prompt* field will appear on the second line of the screen in Run mode.

Prompts can be used to call your attention to certain occurrences, or to help you follow the course of a test. Prompts are also useful in program development because you can use a prompt to tell you when a trigger is true. Any alphanumeric or control character from the keyboard, including spaces, may be part of a prompt.

22.2 Transmitting

INTERVIEW transmissions—with the exception of BERT transmissions, described in Section 9—are always under trigger control, either from the Trigger Setup screen or from the Protocol Spreadsheet. (You may, however, control trigger operation manually by selecting **Keyboard** trigger conditions; see Section 21.)

Select **YES** to display a data entry field and a rotating window for **BCC** (see Figure 22-4). When the trigger is true, the INTERVIEW will transmit any message you enter here (up to 37 characters), ending with the block-check selection you make in the **BCC** field. ASCII characters, hexadecimal entries, and control characters are valid in this field.

Any global constant declared on the Protocol Spreadsheet may be referenced as part of the **Xmit** string on a Trigger Setup screen. Enter the name exactly as it was declared on the Protocol Spreadsheet, and enclose it in double parentheses—for example, **((drop))**. The double parentheses are special characters created by pressing [CTRL]-[9] for ((, and [CTRL]-[0] for)).

Since the standard fox message, containing the set of upper-case alpha characters and the ten numerals, is pre-defined, you may reference it as a constant on a Trigger Setup screen. It need not be declared on the Protocol Spreadsheet. Enter it as follows: **((FOX))**.

```
A Xmit:       YES ____________________________ BCC: GOOD
C Flags:      NO
T Enhance:    NO
I Timeouts:   NO
```

Figure 22-4 Transmitted messages may be terminated with good or bad BCC's or an Abort.

(A) BCC

You have the option of following each text block transmitted from the Trigger Setup screen with a block-check calculation. Block checks are calculated according to your selections on the BCC Setup screen (see Section 8).

On the INTERVIEW screen, the final byte of the calculation appears as a highlighted overlay (G, B, or A), as long as you have selected **Rcv Blk Chk:** ON on the Line Setup screen (see Section 4). This selection is only available for synchronous and asynchronous formats. When **Rcv Blk Chk** is OFF for these two formats, block-check characters appear as they are actually transmitted.

The block-check symbol will always be displayed for Bit-Oriented Protocols.

In the rotating **BCC** window, you may select GOOD, BAD, NONE, or ABORT. The default selection is GOOD.

1. *Good Block Check.* Select GOOD to terminate your text blocks with a correct block check. (Remember that not all transmissions are text blocks: a bisync poll will not receive a block check even if GOOD or BAD is selected.)

2. *Bad Block Check.* Select BAD to end your transmission with an erroneous block check. For Bit-Oriented Protocols, the bad BCC is CRC-16 instead of CCITT; for other formats, the bad BCC is an inverted good BCC.

3. *None.* When NONE is selected, no block check is sent at the end of the transmission. (For BOP transmissions, NONE has the same effect as ABORT.)

   You may cause messages to be sent in succession by different triggers, with no intervening block checks if you wish; however, at least one full character of idle (or $^{F}_{E}$ flag, in the case of Bit-Oriented Protocols) will be transmitted between blocks. When leads are switched (as indicated on the Interface Setup screen; see Section 10), the interface leads will be controlled between blocks.

4. *Abort*. This selection causes the message to which it is appended to abort before completion. When selected with Bit-Oriented Protocols, this action causes the INTERVIEW to transmit seven consecutive 1's at the end of the message. (For non-BOP transmissions, selecting ABORT has the same effect as selecting NONE.)

22.3 Internal Flags

Internal flags are bits that can be set on or off and sensed by triggers. Eight internal flag bits are shared among the Trigger Setup screens. Any combination of flag bits can be controlled by any trigger or combination of triggers.

> NOTE: The flag bits on the Trigger Setup can be controlled and monitored on the Protocol Spreadsheet, where they are referred to as **trig_flag** (see Section 27).

By default the **Flags** option is NO. Three other selections are available in the rotating window: SET, INC, and DEC.

(A) Set

When you select SET, a flag mask appears (see Figure 22-5). Use the arrow keys (→ and ←) to move the cursor to the bits you wish to set.

Enter a 1 or a 0 in any position you wish to set. Enter an X for "Don't Care." The trigger will not change the existing value of this bit.

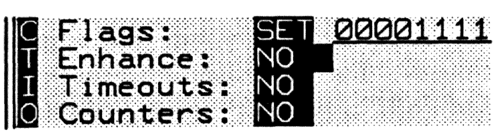


Figure 22-5 A set of eight flag bits may be set on any of the trigger menus.

(B) Increment

The internal flags, consisting of Flags 0 through 7, can be thought of as a binary number. This action increases the value of the flags by one each time the trigger is true. (Other trigger actions may change the value of the flag bits in the intervening period.) Incrementing flags is one technique for controlling recursive routines.

As the flag bits increment past 255, they roll over to zero.

(C) Decrement

This action decreases the value of the flag byte by one each time that the trigger is true. In the event that the flag decrements below zero, the value of the byte wraps to 255.

> NOTE: The value of the flag bits is always reset to zero when you enter Run mode.

22.4 Enhancing the Display

Triggers can be used to enhance display data selectively. Data on either or both sides of the line can be enhanced. Enhanced data is also stored in the character buffer with the enhancements for later review.

(A) BOTH, DTE, or DCE

Select **Enhance:** BOTH, DTE, or DCE to enable enhancement options (see Figure 22-6). BOTH indicates that enhancements will be turned on or off on both TD and RD data at the same time.

DTE pinpoints TD data for enhancement; DCE specifies RD data for enhancement.

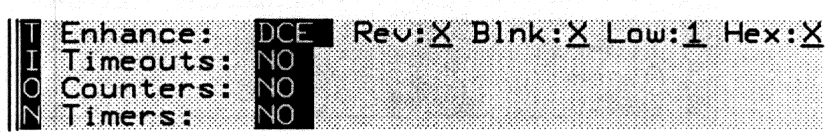


Figure 22-6 Data may be enhanced with respect to DTE, DCE, or both.

Four options, **Rev, Blnk, Low,** and **Hex,** appear to the right. To turn on an enhancement, enter a 1 on the line immediately following it. To turn off an enhancement, enter a 0 on the same line. When an X follows the enhancement, the trigger takes no action.

1. *Reverse image.* Reverse-imaged (**Rev**) characters are presented as dark letters on a lighter background.

2. *Blink.* **Blnk** causes data to blink on and off rapidly. This is the most conspicuous highlight for small portions of data.

3. *Low intensity.* **Low** has no effect on the plasma display. However, if you have installed a black and white monitor, it provides a low-intensity highlight for selected data.

4. *Hexadecimal.* When **Hex** is turned on, all data affected by the trigger is displayed in hexadecimal. Once data is stored in the buffer as hexadecimal, it remains in hexadecimal form.

(B) Color Enhancement

Color enhancement is controlled by the settings of three trigger enhancements: Reverse, Blink and Low. The three combined settings are mapped to color enhancements on the Miscellaneous Utilities screen as described in Section 16.

22.5 Controlling Timeouts

Each Trigger Setup screen can restart or stop either or both of the two timeout timers. These timers decrement from a value set on any of the triggers and, like flags and counters, serve as useful trigger conditions for internal program control.

When **Timeout:** **YES** is selected, identical new fields appear for Timeout #1 and Timeout #2. Both fields may be filled in on the same trigger.

(A) RESTART

Select **RESTART** to start or reset the timeout timer. The amount of time remaining on the timeout timer is entered in the data entry field provided (see Figure 22-7).

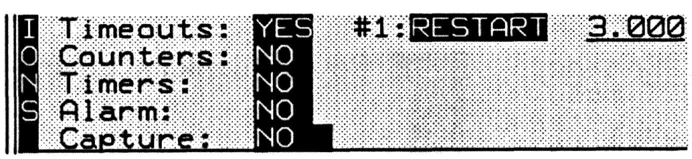


Figure 22-7 Timeout #1 activated to expire in three seconds.

1. *Entering timeout values.* The duration of the timeout is entered in seconds in the 5-character data-entry field provided. To enter a timeout value that is less than one second, use a leading zero before the decimal point, as follows: 0.25. The smallest valid timeout is 1 millisecond (0.001). The largest valid timeout is 65.535 seconds.

   Create a ten-minute timeout as follows: Start a timeout with a value of 60 seconds. When it expires, restart a similar timeout and increment a counter. When the counter equals ten, ten minutes will have elapsed.

(B) STOP

Select **STOP** to halt and clear the timeout timer, without causing the timeout to occur. If **Timeout** is selected as a trigger condition, the condition will not become true in this instance.

NOTE: Timeouts created on a Trigger Setup screen can be monitored and controlled from the Protocol Spreadsheet. These timeouts are entered as **trig_timeout_1** and **trig_timeout_2** when referred to on the Protocol Spreadsheet.

22.6 Counters

Each Trigger Setup screen can control two counters. These counters can be unique to the trigger (controlled only by it), or they may be shared with other triggers, which can monitor them and change their values. As long as the same counter name is used, the same counter is invoked.

NOTE: Counter names used on the Protocol Spreadsheet also refer to these counters, if the names match any counter name on the Trigger Setup screens. This means that program control can be shared between these screens and the spreadsheet.

NOTE: Trigger Setup screens monitor counter values from 0 to 999,999. However, Protocol Spreadsheet triggers can monitor counter values up to 4,294,967,295.

(A) Menu Fields

When **Counters:** YES is selected, two sets of new menu fields, labeled 1st and 2nd, appear (see Figure 22-8).

1. *Counter name*. Enter the counter name in the field provided. The name may be up to eight characters long and must start with a letter. Upper- and lower-case alpha characters, numerals, and underscore (_) are legal in the other positions.

   When the name field is empty, the trigger takes no action for that counter field.

```
O Counters:  YES 1st:Iframes_  INC         2nd:Retries_  DEC
N Timers:    NO
S Alarm:     NO
  Capture:   NO
```

Figure 22-8 One counter is incremented, another decremented in this action.

2. *No*. The default selection is NO. It allows you to disregard one or both counters.

3. *Increment*. When INC is selected, each trigger occurrence adds 1 to the counter.

4. *Decrement*. When DEC is selected, each trigger occurrence subtracts 1 from the counter. When a counter decrements below zero, it wraps not to 9,999,999, but to the decimal equivalent of $2^{32} - 1$, the actual maximum value of a 32-bit counter. The seven least-significant decimal digits that appear on the Tabular Statistics screen are 4967295. The complete number is over 4 billion.

5. *Set*. Select SET in order to specify the value which the counter will take when the trigger becomes true. Then, enter the decimal value of the counter in the field provided. The field is six positions long, making it possible to set counters to a value from 0 to 999999. Any leading positions not specified in your entry will be set to zero. This action does not cause statistical samples to be taken, nor does it reset last value, minimum value, maximum value, or average value for the counter. (Compare to Sample and Clear.)

6. *Sample*. This action causes the counter to reset to zero and causes measurements to be taken for last value, minimum value, maximum value, and average value. Refer to Section 17 for an explanation of how statistics are gathered and tabulated.

7. *Clear*. This action resets the counter to zero and also resets minimum value, maximum value, and average value for the counter.

22.7 Timers

Two timers are shared among the Trigger Setup screens. While these timers are not available as trigger conditions, they can be run and sampled as trigger actions. When timers are invoked by triggers, their values can be tracked on the statistics screens (see Sections 17 and 18).

> **NOTE:** Timer names referred to on the Protocol Spreadsheet may also be used on Trigger Setup screens. Thus, timer control of programs is shared between these screens and the spreadsheet.

(A) Menu Fields

The default timer selection is NO. When YES is selected, two identical subfields appear, for Timer 1 and Timer 2 (see Figure 22-9).

Figure 22-9 One or two timers may be controlled by the same trigger (second field not shown).

1. *No*. The default selection for each Timer is also NO. This allows trigger action to disregard both timers or to focus on one timer, if necessary.

2. *Restart*. When selected, RESTART causes the timer to reset to zero and begin incrementing. RESTART does not cause statistical measurements to be taken. (Compare to SAMPLE and CLEAR.)

3. *Stop*. The STOP action suspends the timer and allows it to retain its value. The timer may be started again at this value by a CONTINUE action on another trigger.

4. *Continue*. CONTINUE, when selected, causes the specified timer to increment, starting from the value at which it was stopped.

5. *Sample*. The SAMPLE action resets and stops the timer. Prior to resetting the timer, its value is read as a "last" value and passed along for other statistical measurements. Refer to Section 17 for an explanation of how statistics are gathered and tabulated.

6. *Clear*. The CLEAR action resets the current value, the last value, the minimum value, the maximum value, and the average value of the timer. Refer to Section 17 for an explanation of statistical measurements.

22.8 Alarm

The alarm is a short beep. The alarm is useful for calling your attention to the data being analyzed, especially when the situation of interest occurs infrequently. When you select **Alarm:** YES, it is sounded each time the trigger becomes true.

22.9 Capture of Data in the Screen Buffer

Capture of character-oriented data to the screen buffer can be stopped and restarted by triggers, using the **Capture** action (see Figure 22-10). When capture is turned off, data is neither presented to the screen nor stored in the buffer.

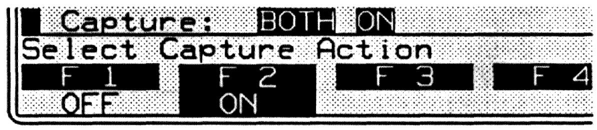


Figure 22-10 Data capture to the screen buffer can be controlled by triggers.

(A) NO, BOTH, DTE, or DCE.

The default **Capture** selection is NO. This represents no change; that is, the trigger does not influence character buffer capture. By default, data is continuously captured in the character buffer.

Select BOTH to control capture to the character buffer for TD and RD data at the same time. Select DTE to control only TD data; DCE to control only RD data.

1. *OFF, ON.* Select OFF to suppress data from the screen buffer. Select ON when another trigger has turned off capture and you wish to begin storing data in the buffer again.

23 The Trigger Summary Screen

```
                        ** Trigger Summary **
                         Trigger Number: 0
#0
#1
#2
#3
#4
#5
#6
#7
#8
#9
#A
#B
#C
#D
#E
#F
Enter Trigger Number (0-F):   0
  F 1    F 2    F 3    F 4    F 5    F 6    F 7    F 8
```

Figure 23-1 Default Trigger Summary screen.

23 The Trigger Summary Screen

The Trigger Summary screen is the access screen to all Trigger Setup screens. The default Trigger Summary screen is shown in Figure 23-1. Call up the Trigger Summary screen by pressing the function key marked TRIGS on the main Program Menu. With the summary displayed, access any trigger by typing the number of the desired screen (0 through F). To see a synopsis of configured Trigger Setups, you may return to the summary screen from any trigger menu by pressing [PREV PAGE].

Entries you make on any of the 16 Trigger Setup screens appear on the summary in abbreviated form. Each setup screen is allotted a one-line summary. A summary of conditions appears on the left-hand side of the line; a summary of actions appears on the right-hand side of the line. The summary for Trigger Setup screen 0 (Figure 23-2) is shown in Figure 23-3.

Abbreviations for possible Trigger Setup conditions are listed in Table 23-1. Abbreviations for Trigger Setup actions are given in Table 23-2.

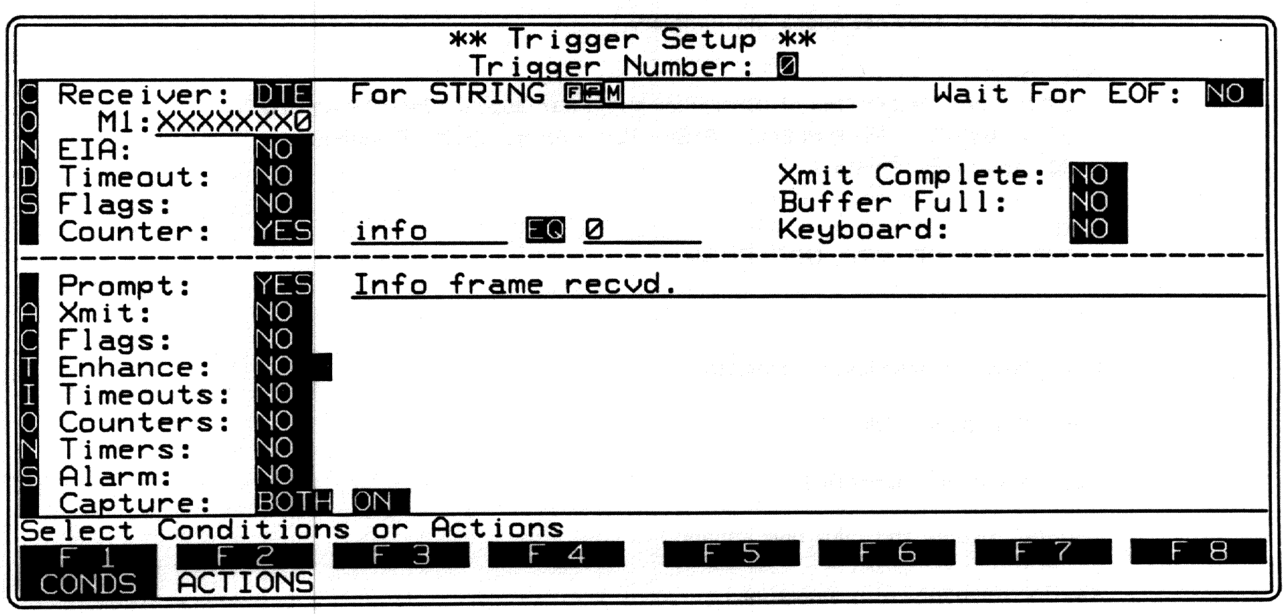


Figure 23-2 Entries on each Trigger Setup screen are indicated on the Trigger Summary.

NOTES:

Abbreviations displayed on the Trigger Summary screen are not necessarily keywords and should not be referred to when you are typing entries on the Protocol Spreadsheet.

When multiple conditions or actions are selected on a single Trigger Setup screen, the summary screen may not be able to show all selections; however, as many conditions and actions as possible will be displayed in the available space.

```
                       ** Trigger Summary **
                         Trigger Number: 0
#0 DTE STR [F][■][M]info=0                  Pmpt Info ...Capture BTH ON
#1
```

Figure 23-3 **Summary of entries made on Trigger Setup screen 0, shown in previous figure.**

Table 23-1
Abbreviations, Trigger Summary Conditions

Receiver **(Word does not appear on summary.)**

DTE, DCE
STR: String, 1OF: One of (Character string also appears for STR and 1OF.), [G]: Good BCC, [B]: Bad BCC, PrErr: Parity Error, FrErr: Frame Error, ■: Abort, [M]: Bit Mask

EIA:
RTS, CTS, CD, DTR, DSR, RI, UA

TimeOut 1, 2

Xmit_Cmpl: Transmission Complete

Buffr_Ful: Buffer full

Flag: **(Value only appears.)**

Counter: **(Name and value only appear.)**

KeyBd: Keyboard (Key indicated.)

Table 23-2
Abbreviations, Trigger Summary Actions

Pmpt: Prompt (Prompt string also appears.)

Xmit: Transmit (Xmit string also appears.)
[G]: Good BCC, [B]: Bad BCC, [A]: Abort
(Nothing appears if no BCC is selected.)

Flag: INC: Increment, DEC: Decrement (Value only appears if selection is SET.)

ENH: Enhance Display
BTH: Both DTE and DCE, DTE, DCE
REV=: Reverse, BLN=: Blink, LOW=: Low, HEX=: Hexadecimal

TO #1, TO #2: Timeout #1 or 2
RST: Restart, STP: Stop

Counter: (Only name and value appear.)
INC: Increment, DEC: Decrement, =: Set
SMP: Sample, CLR: Clear

TM: Timer (Name also appears.)
RST: Restart, STP: Stop, CNT: Continue, SMP: Sample, CLR: Clear

Alarm: Audible Alarm

Capture: Capture Memory
BTH: Both DTE and DCE, DTE, DCE
ON, OFF

24 Programming Blocks

1. These keys are at highest level:

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
LAYER:	TEST:	STATE:	CONSTS:				MORE

Press MORE to obtain:

2.

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
OBJECT:							MORE

Press MORE to return to:

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
LAYER:	TEST:	STATE:	CONSTS:				MORE

Press STATE: enter name and press [RETURN] or the spacebar to obtain:

3.

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
LAYER:	TEST:	STATE:	CONDS:				

Press CONDS: (Conditions) to obtain variable set of Conditions.* Press [F8] to access alternate racks of Conditions keys. Complete entries, then press [DONE] to obtain:

4.

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
LAYER:	TEST:	STATE:	ACTION:	NEXTST:			

Press ACTION: to obtain variable set of Actions.* Press [F8] to access alternate racks of Actions keys. Complete entries, then press [DONE] to obtain:

5.

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
LAYER:	TEST:	STATE:	CONDS:	NEXTST:			

Press NEXTST:, enter name of next state, and press [RETURN] or the spacebar *to obtain rack 3.* (Pressing CONDS: obtains variable sets of conditions.)

*Conditions and Actions available depend on what protocols are loaded and what layer number you have specified. The following selections are always available:

GENERAL CONDITIONS	
ENTER_STATE	TIME
TIMEOUT	FLAG
KEYBOARD	ON_SIGNAL
BUFFER_FULL	
COUNTER	

GENERAL ACTIONS	
FLAG	LOAD_PROGRAM
ACCUMULATE	PROMPT
SIGNAL	PRINT
COUNTER	TRACE
TIMER	ALARM
TIMEOUT	RECORD

Figure 24-1 Function key hierarchy, Protocol Spreadsheet.

24 Programming Blocks

The Protocol Spreadsheet is a highly flexible programming approach which enhances trigger conditions and actions provided on the Trigger Setup menus, furnishes new general options, and incorporates protocol-specific conditions and actions on a layer-by-layer basis.

24.1 Before You Begin a Spreadsheet Program

Be certain prior to programming that you have loaded the Personality Packages for the protocols you will be testing. Automatic protocol options are part of each layer's Personality Package. These packages are loaded from the Layer Setup screen as described in Section 6.

Check the configuration of the various Test Setup screens before you test or save your program, since the behavior of the INTERVIEW during testing is influenced by setup selections.

24.2 Creating a Spreadsheet Program

Press [F3] to access the Protocol Spreadsheet from the Program Menu. Any program which you have loaded from the File Maintenance screen appears on the spreadsheet. If no program has been loaded or created, the Protocol Spreadsheet, since it is a free-form menu, will be blank except for a header line, function key labels, and tildes (~) down the left side of the screen. Tildes always mark the end of your program file.

(A) Two Sets of Function Keys: Programming and Editing

Two full sets of softkeys are active with the spreadsheet. One set of softkeys groups available programming options, including keywords (LAYER:, TEST:, CONDITIONS: etc.). The alternate set groups sophisticated editing functions.

These editing functions, which complement the editing keypad, are accessible from the spreadsheet at any time. Press [EDIT] to activate edit softkeys. Press [EDIT] again to return to program softkeys. For a discussion of editing options, refer to Section 26.

(B) Programming Functions

Use the programming softkeys to make program entries, from the highest level of the program (OBJECT), down to individual trigger conditions and actions and their subfields. Softkeys guide you as you create your program by listing available options and providing correct syntax wherever possible. (Errors are indicated by strikeover of incorrect text as you make your program entries.) For each level of function keys, a cue near the bottom of the screen explains selectable options or prompts you for keyboard entry.

Program softkeys are immediately available when you enter the spreadsheet. The hierarchy of the program softkeys is shown in Figure 24-1. The conditions and actions listed, which are always available, are explained in Section 27. Other trigger conditions and actions are added when protocol packages are loaded. Because protocols are layer-specific, trigger options will vary from layer to layer. For each LAYER block within your program, different options are likely to appear when you enter the keyword CONDITIONS or ACTIONS. For more information on the specific trigger options enabled by a protocol, consult the section devoted to that protocol (see Table of Contents, Section 32 and following.)

You also have the freedom of typing in any program entry, if you prefer, as long as you enter the block identifiers and conditions and actions keywords as they would be posted on the screen by softkeys. Syntax errors still are automatically highlighted by a strike-through.

> **NOTE:** Softkey labels are not necessarily legal spellings on the spreadsheet. Pressing the function key usually posts an expanded keyword on the screen. Use these expanded keywords when typing entries.

1. *Successive racks of softkeys.* The rack of softkey options at the bottom of the spreadsheet screen (or the instructional prompt on the third line up from the bottom, or both the option rack and the prompt) will change automatically each time you *complete* a keyword entry. Keyword entries are complete when you make them via softkey *or* when you type the keyword followed by a space or a hard RETURN. (Pressing the softkey has the same effect as typing the keyword and then typing a space to complete the entry.)

   Programming movement is generally *down* the tree of softkey racks, as in this series of keywords:

   CONDITIONS: EIA CTS ON

   Each of the four keywords was selected from a rack of options, and each succeeding rack is a step farther down the "branch." The rack that follows ON, however—listing RTS, CTS, CD, and other EIA leads—is back up the tree, since "there is nowhere to go but up," and since a trigger with multiple EIA conditions (like the following) is valid.

   CONDITIONS: EIA CTS ON CD OFF

2. *Additional racks of valid softkeys.* There may be many more keywords that are valid to enter at a given point in the program than are showing on one rack of softkeys. Additional racks may be accessible via the [F8] softkey (MORE); and *higher* racks are generally available via the [DONE] key. In this series, [DONE] was pressed following the softkey for ON to access the softkey for COUNTER:

   ```
   CONDITIONS: EIA CTS ON
     COUNTER xmit LT 6
   ```

   In the next series of keywords, [DONE] was pressed *twice* following the softkey for ON, to access the softkey for ACTIONS:

   ```
   CONDITIONS: EIA CTS ON
   ACTIONS: SEND "((FOX))" GOOD_BCC
   ```

   Note that [DONE] is not a valid keystroke following CTS above, since the condition syntax is not "done." Whenever it is not valid to move to a rack of softkeys higher up the tree, [DONE] produces an alarm tone.

   Note also that it is never necessary to press [DONE] if you are typing in your keywords directly from the keyboard. [DONE] merely changes the *rack* that is showing, not the entire set of keywords that is valid. A keyword does not have to be showing to be typed in legally.

3. *Insert mode versus overstrike mode.* Touch–typists in particular should be aware that the Protocol Spreadsheet has an insert mode as well as an overstrike mode. The insert mode is invoked by either of two keys, [INSERT CHAR] or [INSERT LINE]. When the mode is enabled, the word <Insert> appears at the top left of the screen. In insert mode, the programmer types in a block of data while succeeding text is pushed forward with every keystroke.

   Press [INSERT CHAR] (but not [INSERT LINE]) a second time to exit *insert* mode and return to *overstrike* mode.

The remainder of this section is devoted to the fundamentals of program structure and to programming components available on the Protocol Spreadsheet which are independent of trigger options.

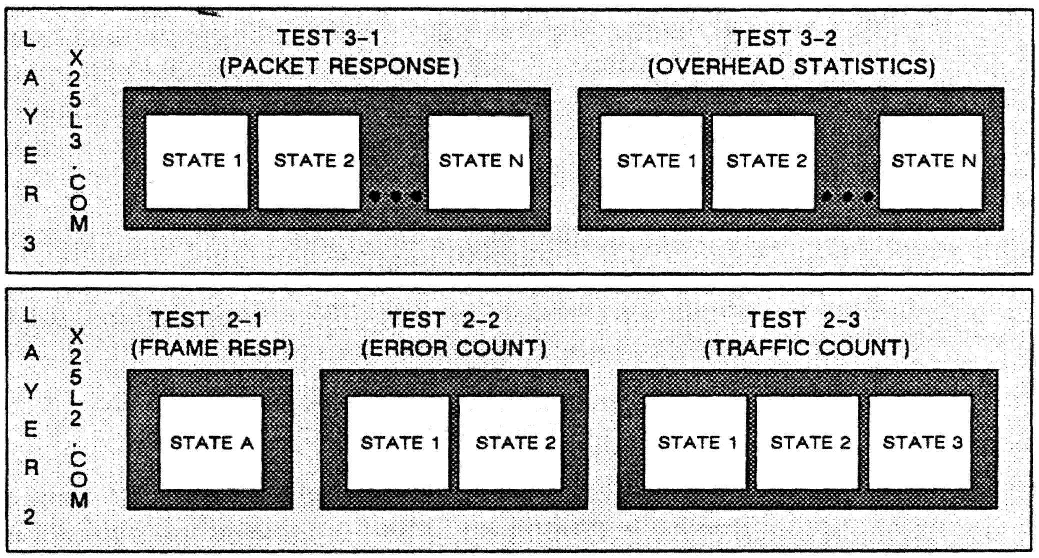


Figure 24-2 Discrete states inhabit separate tests at separate layers.

24.3 Program Structure

The components of the INTERVIEW's programming model, introduced in Section 20, are integrated into a spreadsheet program as discrete blocks according to specific structural rules. Compare the abstract program model in Figure 24-2 to the spreadsheet program outlined in Figure 24-3.

(A) Block Identifiers

The INTERVIEW's compiler must respect the distinction between one layer and the next and between one test and the next. Further, it must group triggers into designated states and track the transition from one active state to another. To indicate the boundaries of these various blocks, specific keywords are used. Each block normally begins with an identifier in upper-case letters, (optionally) followed by a colon. A block ends when a new block identifier is inserted in the program.

> **NOTE:** The identifier must not be enclosed in quotes (that is, must not be part of a text string) if it is intended as a block delimiter.

Available program blocks, from largest to smallest, are described in subsequent paragraphs. The valid block identifier for each is printed above its description.

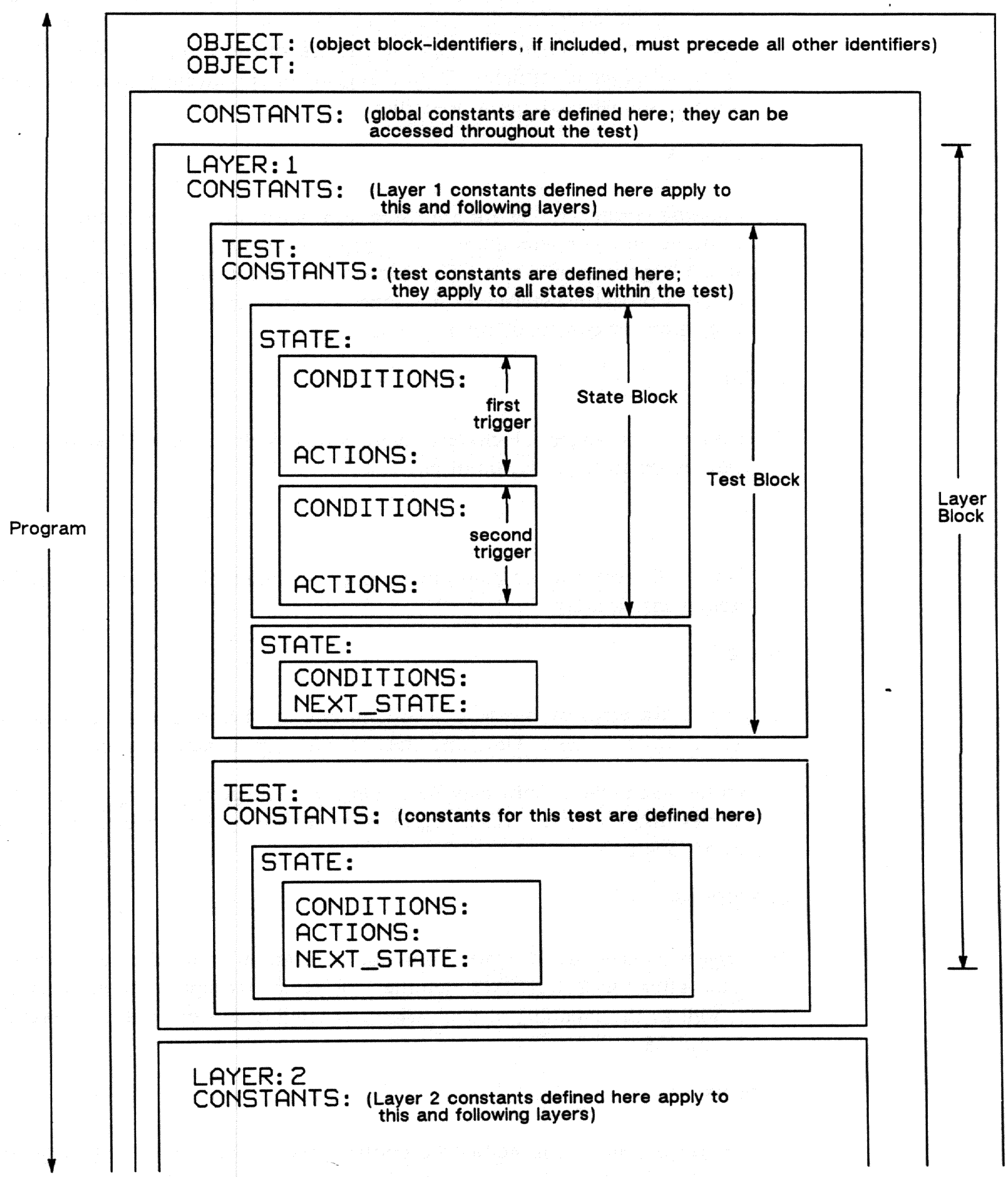


Figure 24-3 Program Structure. Component blocks begin with a keyword.

OBJECT:

1. *Referencing linkable-object files.* Use the OBJECT block-identifier to access the compiled code in a linkable-object file. See Section 24.4 below. The OBJECT identifier(s) must appear at the top of the Protocol Spreadsheet, above all other identifiers. Only C regions or spreadsheet comments may precede the OBJECT block-identifier.

CONSTANTS:

2. *Defining constants.* There are three legal locations for the definition of a constant: in the opening lines of a program, at the beginning of a layer, or at the beginning of a test. The relative placement of a constant's definition within a program determines its scope, or active range. For a complete discussion on constants, refer to Section 25.

LAYER:

3. *Layers.* The largest block, the layer, corresponds to the OSI model. There may be up to seven layers in any test.

TEST:

4. *Tests.* A layer may contain any number of simultaneous tests. Every test resides inside a layer.

STATE:

5. *States.* In turn, each test may contain any number of states. A state always resides inside a test. Only one state in each test is active at one time.

   Within each state, there may be a number of triggers. A trigger always resides inside a state. Each trigger is composed of a conditions portion and an actions portion.

CONDITIONS:

6. *Trigger conditions.* A single condition or a group of conditions is normally listed after the CONDITIONS identifier. Rules for grouping trigger conditions, as well as the meaning of each trigger condition, are explained in Sections 27 and 28.

ACTIONS:

7. *Trigger actions.* The ACTIONS identifier precedes the list of trigger actions. This list may be empty, or it may include one or several trigger actions. The various trigger actions are described in Sections 27 and 28.

NEXT_STATE:

8. *Next state*. The identifier NEXT_STATE, explained in the following paragraphs, can replace the ACTIONS: identifier in a trigger if there are no other actions; or it can follow the ACTIONS: identifier to indicate that branching to another state is one of several actions taken by the trigger.

(B) Run-time Transitions Between States

Run-time transitions between states are controlled by triggers. To indicate a run-time branch from one state to another, use the NEXT_STATE action, followed by (a) the name of the state you wish to go to, or (b) the NEXT token, indicating whatever state happens to follow sequentially in the spreadsheet program.

You may use a NEXT_STATE action once per trigger and as many times as needed in one state to allow for multiple branching possibilities.

When two triggers come true at the same time and both potentially result in branching to another state, the trigger which is checked last (the last trigger sequentially displayed on the spreadsheet) will cause branching to the state it names. (The first trigger will not cause branching.)

Look at the two triggers shown in the example which follows. The first searches for any SDLC Information frame. The second searches for an Info frame with a particular frame address. By definition, whenever the second trigger is true, the first trigger is also true. When an Info frame with the correct address is received, the second trigger causes the test to branch to the State **respfrm**. However, if these triggers are reversed as shown in the second example, the test *always* branches to the State **otherfrm**, regardless of the frame address.

correct order

```
STATE: frmadd
   CONDITIONS: DTE INFO
   NEXT_STATE: otherfrm
   CONDITIONS: DTE INFO ADR=C1
   NEXT_STATE: respfrm
```

wrong order

```
STATE: frmadd
   CONDITIONS: DTE INFO ADR=C1
   NEXT_STATE: respfrm
   CONDITIONS: DTE INFO
   NEXT_STATE: otherfrm
```

(C) Recommended Format

The format of a Protocol Spreadsheet is entirely flexible. The only rule is that block identifiers must (with rare exception) be included in the program to designate boundaries between programming blocks.

The following is a suggested program format. To create a visual distinction, the keywords which define program blocks are placed at the beginning of a line. Smaller blocks are indented to show that they reside within a larger block. An automatic indent feature, described in Section 26, is included as an editing function and is turned on by default.

```
LAYER: 1
  TEST: echo_msg
    STATE: message
      CONDITIONS: DTE STRING "hello"
      ACTIONS: PROMPT: "Spreadsheet trigger true."
      NEXT_STATE: echo

    STATE: echo
      CONDITIONS: DCE STRING "hello"
      ACTIONS: PROMPT " Echoed message received"
      NEXT_STATE: message
```

(D) Omitted Block Identifiers

It is recommended that, for ease of tracking a program, block identifiers be placed at the beginning of every block. However, in brief programs, certain block identifiers may be omitted.

It is, in fact, possible for a program to begin with a STATE identifier. The compiler then assumes that you have begun the first test inside the first layer of the program. To start another program block, you must use a STATE, TEST, or LAYER identifier.

> **NOTE:** Any constant declared in the opening lines of a test which omits the LAYER and/or the TEST keyword is still a global constant, as long as it precedes a STATE or CONDITIONS identifier.

24.4 Compiled Spreadsheet

Using the Compile command on the File Maintenance screen, you can compile and save the contents of the Protocol Spreadsheet in a linkable-object file. Later, this program can be combined with an active spreadsheet program. To do so, simply reference the file at the top of the Protocol Spreadsheet.

(A) The OBJECT Block-Identifier

Use the OBJECT block-identifier on the Protocol Spreadsheet to access the compiled spreadsheet code in a linkable-object file.

> **Note to C Programmers:** The OJBECT identifier may also be used to access definitions for user routines. Refer to Section 56.4(C).

1. *Placement*. The OBJECT block-identifier(s) must appear at the top of your spreadsheet program, ahead of any other identifier. Access the OBJECT: softkey by pressing MORE on the initial rack of softkeys. Notice that the MORE and OBJECT: softkey tokens are not available once any other programming block-identifier has been selected.

   NOTE: Use OBJECT in your active spreadsheet program only. Do not incorporate it in a spreadsheet that will be compiled and saved as an LOBJ file. Although the code will compile, the referenced LOBJ file will not be read.

2. *Format*. The format for the OBJECT block-identifier is as follows:

   ```
   OBJECT: "filename.o"
   ```

   The identifier references only one linkable-object file, but you may include as many OBJECT identifiers as you wish.

   The relative or absolute pathname of the linkable-object file is enclosed in quotation marks.

3. *Search rules for linkable-object files*. As your spreadsheet program compiles, the INTERVIEW's filing system is searched for the linkable-object files referenced in OJBECT identifiers.

   - If the referenced LOBJ filename begins with *FD1/*, *FD2/*, or *HRD/*, the INTERVIEW interprets it as the absolute pathname and makes only that one search.

   - Pathnames beginning with a / indicate that the root directory on each drive should be the beginning point of the search. The drives are searched in the following order: current drive, FD1, FD2, and HRD.

   - Otherwise, the name may be a one-word filename or a relative pathname which includes the directories leading to the file. The highest directory in a relative pathname must reside in the current directory or in one of the */lib* subdirectories. The following directories—and only the following directories—are searched, in the order given:

     1. current directory on the current drive (indicated on the File Maintenance screen)
     2. */usr/lib* on the current drive
     3. */sys/lib* on the current drive
     4. *FD1/usr/lib*
     5. *FD2/usr/lib*

6. *HRD/usr/lib*
7. *FD1/sys/lib*
8. *FD2/sys/lib*
9. *HRD/sys/lib*

If the pathname is not located in any of these directories, the program will not compile and an error message will be returned to the operator.

(B) Compiled LOBJ Code is Combined with Spreadsheet

During compilation, the compiled spreadsheet in the LBOJ file is combined with your active spreadsheet program. This means that the LOBJ code must be compatible with the current menu setups and spreadsheet program—as though the source code of the LOBJ file were actually present in the spreadsheet buffer.

(C) Counter and Flag Conditions

Special consideration is given to COUNTER and FLAG conditions during the Compile SPREADSHEET opearation. The system identifies the condition as either transitional or status. (See Section 27.2.) If it is used both ways in the same spreadsheet file, it will always be identified as transitional.

Within a single spreadsheet program, you may reference more than one LOBJ file which uses the same COUNTER or FLAG. If one of the files uses the COUNTER (or FLAG) as a transitional condition, however, all other referenced files containing the same COUNTER (or FLAG) must also use it as a transitional condition at least once. This rule ensures that each action on the specified COUNTER (or FLAG) will consistently trigger the appropriate COUNTER (or FLAG) conditions.

(D) Advantages of Compiled Spreadsheet

Linkable-object files assist the programmer in efficiently using the INTERVIEW's memory and spreadsheet buffer.

- When commonly utilized conditions and actions are saved in linkable-object files, space in the spreadsheet buffer otherwise dedicated to this purpose can be used for additional programming.

- Since the code in LOBJ files has already been compiled, the INTERVIEW can support a larger program without a corresponding increase in compilation time.

- The spreadsheet code in a linkable-object file is transparent to the configuration of the unit. LOBJ files created on one unit can be used on a unit configured differently, as long as the code is compatible with the various menu parameters.

24.5 Comments in a Spreadsheet Program

You may write comments to yourself or to others who may view your spreadsheet program. Comments begin with /* and end with */, as in the examples below. Use comments generously throughout spreadsheet programs. Since comments are ignored by the compiler, they do not affect the compilation time of the program.

(A) Characteristics

1. *Valid characters.* When an opening /* is detected by the compiler, everything that follows is disregarded until a closing */ is encountered. This means that all hexadecimal, control, and ASCII characters (or character combinations) are valid in comments. The 🄵, 🅂, ☒, and not-equal symbols are also legal entries.

   Two entries are not legal in comments. The first is the 🄼 symbol. It cannot be used because it is not a valid Protocol Spreadsheet entry. (Bit masks on the spreadsheet are delimited by ⟪ and ⟫). An alarm will sound if you try to use the bit-mask symbol. The second invalid entry is the closing delimiter (*/). An embedded */ causes the comment to be ended prematurely. Since the remainder of the comment (and the programmer's *intended* closing */) is a syntax error, the program will not compile.

2. *Length.* For practical purposes, make comments as long as you wish. They may span several lines, or they may be empty.

3. *Location on spreadsheet.* Comments may be placed within any of the programming blocks: OBJECT, CONSTANTS, LAYER, TEST, STATE, CONDITIONS, ACTIONS, or NEXT_STATE. In CONDITIONS blocks, however, they must appear with at least one valid condition. The following CONDITIONS block containing only a comment will cause compilation to be aborted:

   ```
   STATE: message
     CONDITIONS: /* KEYBOARD " "*/
     ACTIONS: SEND "⟪FOX⟫" GOOD_BCC
   ```

   Since the compiler ignores anything inside the /* */ delimiters, it can find nothing in the CONDITIONS block. When you go to the Protocol Spreadsheet and search for error messages, the following message will be displayed: *"Empty Conditions Section."*

   Comments may not be embedded within a keyword. This program also will not compile:

   ```
   STATE: message
     CONDITIONS: KEY/* This comment will cause a syntax error*/BOARD " "
     ACTIONS: SEND "⟪FOX⟫" GOOD_BCC
   ```

(B) Using Comments

Comments are particularly useful in describing the purpose of a programming block. Let's return to the two programming examples in which branching to another state occurs based on DTE Info-frame addresses. The following comment makes the programmer's intentions clear.

```
STATE: frmadd

/* If a DTE INFO frame has an address of C1, go to state "respfrm." For all other
DTE INFO frames, go to state "otherfrm." */

  CONDITIONS: DTE INFO
  NEXT_STATE: otherfrm
  CONDITIONS: DTE INFO ADR= C1
  NEXT_STATE: respfrm
```

Comments can be useful debugging tools. Suppose the same comment appeared in the programming example with the order of the two triggers reversed.

```
STATE: frmadd

/* If a DTE INFO frame has an address of C1, go to state "respfrm." For all other
DTE INFO frames, go to state "otherfrm." */

  CONDITIONS: DTE INFO ADR= C1
  NEXT_STATE: respfrm
  CONDITIONS: DTE INFO
  NEXT_STATE: otherfrm
```

With the comment present, it is easier to identify the discrepancy between the programmer's expectations and the actual program.

25 Constants

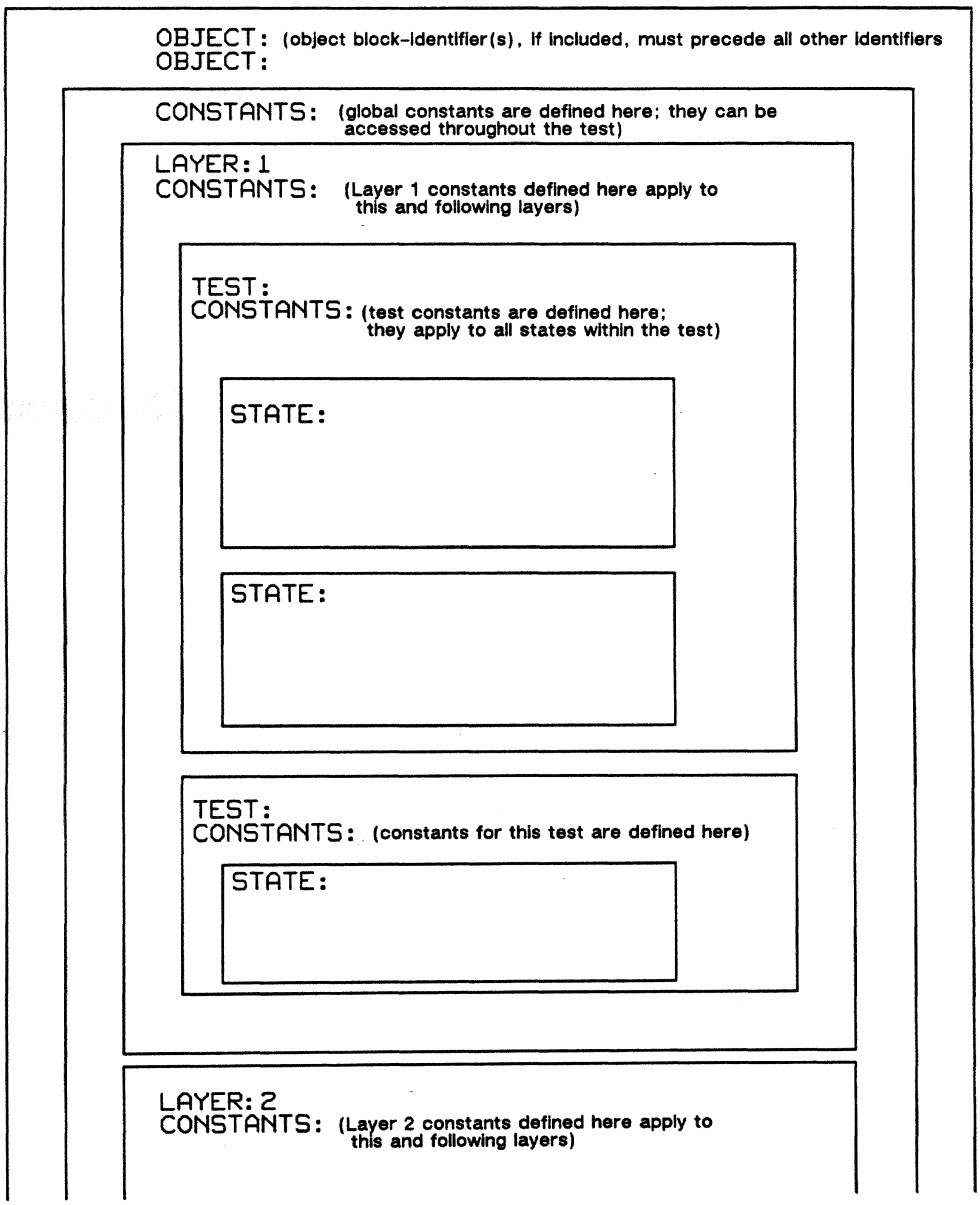


Figure 25-1 Constants may be defined in three different locations: before the first layer, after a layer identifier, or after a test identifier.

25 Constants

The Protocol Spreadsheet permits the use of constants as a means of simplifying the creation and modification of test programs. A constant is merely a symbolic reference to a predefined string of characters.

25.1 Definition of Constants

There are three legal locations for the definition of a constant: in the opening lines of a program, at the beginning of a layer, or at the beginning of a test (see Figure 25-1). Constants must always be defined at the beginning of the programming block in which they are referenced. A test-level constant may not be preceded by a lower-level block identifier (STATE, CONDITIONS, or ACTIONS). A constant definition or definition block must be followed by another keyword.

A constant definition begins with the identifier CONSTANTS. A colon (:) may follow. The constant name is then entered. Next comes the definition, a text string which the constant represents. The constant name and text string may be separated by an equal sign (=). The text string is enclosed in double quotes. Each constant definition comprises a single logical line. Logical lines wrap as needed to subsequent lines on the spreadsheet, but they do not contain hard returns. See Section 26.1(A).

More than one constant can be defined following a single CONSTANTS identifier. Following is the suggested format for a constant definition block. A constant definition block (whether it contains one or more definitions) must be followed by another block identifier.

```
CONSTANTS:

  cmd_adr    = "03"
  resp_adr   = "01"
  resend     = "1.5"
  retries    = "10"
```

To include quotation marks or backslashes in the definition string of a constant, precede each with a backslash escape-character (\). Here, for example, is the constant definition of a general poll:

```
CONSTANTS:  drop_A= "AA\"\"␅"
```

The backslash will be deleted by the parser when the constant definition is scanned:

```
AA""␅
```

If the constant is contained in a search or transmit string, it will not be scanned for the escape character or for closing quotation marks. The characters shown above represent the expanded constant. Notice that the enclosing quotation marks of the definition string are not actually part of the constant. In our example, the following string will be searched for or transmitted:

AA" " ␅

25.2 Constant Names

Constant names must begin with a letter or underscore character. They may include any of the following characters: underscore (_), upper or lowercase letters, and decimal numbers 0 through 9. Upper and lower case letters are distinguishable in constant names; for example, constants big, Big, and BIG will not be confused by the INTERVIEW's compiler.

25.3 Scope

The relative placement of a constant's definition within a program determines its scope, or active range.

(A) Global Constants

If you want to be able to reference a constant anywhere within a program, you must define it in the first lines of the program. Only an OBJECT block may precede global constants. No other block—whether a block identifier (LAYER, TEST, STATE, CONDITIONS, or ACTIONS) is entered or implied—may be placed before a global constant.

(B) Layer Constants

A layer constant must be defined before the first reference to it. The definition is placed in the lines following the LAYER identifier. (In a single-layer program, the LAYER identifier may be omitted.)

The definition of a layer constant must fall outside component blocks of the layer (outside of tests and states).

A layer constant can be referenced within any test, state, or trigger which that layer contains. It may also be referenced in any other layer which follows on the spreadsheet. The only exception to this is when the constant is superseded by a constant of the same name (see the section on precedence which follows).

(C) Test Constants

A test constant must be defined at the beginning of a test block and before the first reference to the constant. While the TEST identifier may be absent in a single-layer, single-test program, the scope of a constant can only be limited to a test if it follows a TEST identifier.

A test constant cannot be defined within a state, but it can be referenced by any trigger in any state which the test contains.

25.4 Referencing Constants

Whenever you refer to a constant in your spreadsheet program, the constant name must be enclosed in double parentheses—for example, ((Frmsize)). Use the key sequence [CTRL]-[9] and [CTRL]-[0] to create double parentheses. Shown here is the constant ADDRESS which replaces an SDLC frame address used throughout the test. When the frame address is modified, only the constant need be changed.

```
LAYER: 2
   TEST: polling
      CONSTANTS:
       ADDRESS = "C1"
      STATE: Init
         CONDITIONS: ENTER_STATE
         ACTIONS: SEND SNRM  ADR= ((ADDRESS)) P/F= 1
            TIMEOUT retransm RESTART 3.000
         CONDITIONS: RCV UA  ADR= ((ADDRESS)) P/F= 1
         ACTIONS: TIMEOUT retransm STOP
            RESET NR RESET NS
         NEXT_STATE: Info_xfr
         CONDITIONS: TIMEOUT retransm
         NEXT_STATE: Init
```

As long as syntax is observed, a constant may be used to replace a large block of text which would otherwise be repeated. Following is an example of a long, repetitive text block given as a constant definition and referenced within the program as ((LK_SETUP)). Notice that the constant definition is contained in a single logical line. The highlighted plus symbols, automatically generated by the spreadsheet editor, indicate the point at which the line wraps on the screen.

```
LAYER: 2
CONSTANTS:
LK_SETUP  = "ACTIONS: SEND  DISC  PROMPT \"Disconnect  link\"  CONDI+
TIONS:  RCV UA ACTIONS:  PROMPT \"Disconnected\"  CONDITIONS:  RCV+
DISC ACTIONS: SEND UA CONDITIONS: RCV SABM ACTIONS: SEND UA PRO+
MPT \"Link  restarted\""

   TEST: link_up
      STATE:  fr_setup
         CONDITIONS: ENTER_STATE
         ((LK_SETUP))
      NEXT_STATE: fr
      STATE: fr
         CONDITIONS: ENTER_STATE
         ACTIONS: SEND INFO NR= 01
         CONDITIONS: RCV FRMR
         ACTIONS: PROMPT "FRMR received-test OK."
```

NOTE: Global and layer constants declared on the Protocol Spreadsheet may be referenced on any of the Trigger Setup screens as part of a receive or transmit string.

25.5 Nested Constants

The definition of a constant may include a reference to another constant. This is called nesting. An example of nested constants is shown below. On the Protocol Spreadsheet, it is possible to nest constants eight levels deep.

```
CONSTANTS:
send_lcn   = "000"
rcv_lcn    = "001"
send_data  = "data ((send_lcn)) "
send_pkt   = "send ((send_data)) "
```

NOTE: It is illegal to define two constants circularly. If, for example, you define CONSTANTS: **peat = ((repeat))** and CONSTANTS: **repeat = ((peat))**, you will receive an error message when you attempt to run the program.

25.6 Precedence

Programming practice usually restricts constants to a single definition. A given name should remain the same throughout the entire program.

In some special cases a constant name may have definitions that differ in separate parts of the test. It is not legal to define the same constant name twice at the same level within the same block; however, the same constant name can be defined differently inside of distinct blocks. You might, for example, define a global constant as **maxlength = "8"** at the beginning of a program. Nothing prevents you from defining a constant as **maxlength = "128"** *within* a layer or test included in the same program.

NOTE: Use the ability to give different definitions to the same constant name sparingly and with great caution.

The rule of thumb is this: When the same constant name is defined more than once, the value of the constant is controlled by the smallest block in which it resides. When that block ends, its value is controlled by the next larger block, and so on. So, a constant might have different values within a TEST, within a LAYER, and throughout the remainder of the program.

Consult the following example. Globally, the constant maxlength has a value of 8. This value holds until the constant takes on a new value in Layer 2, where it is defined as **maxlength = "128"**. Inside the Layer 2 test named **shortfrm**, maxlength is briefly given a value of 4. In Layer 3, the constant maxlength is not redefined, and its value returns to 8 (since this is the global definition of the constant).

```
CONSTANTS:
        maxlength = "8"
LAYER: 2
CONSTANTS:
        maxlength = "128"
    TEST: shortfrm
CONSTANTS:
            maxlength = "4"
            STATE: supfrm
                CONDITIONS:

.

.


LAYER: 3
        TEST: pktlen
            STATE: datapkts
                CONDITIONS:

.

.

.
```

25.7 Expansion

The spreadsheet editor checks constant definitions and references for several types of errors as you enter your program. In the interest of time, however, it will not expand a reference to a constant embedded in a text string. This means that nested constants are not checked for errors as you write your program.

The compiler expands these constants when you run the program, and any obvious errors will result in an operator message. Be advised, however, that it is possible for embedded constants, once expanded, to produce a valid, but unintentional, program variation.

26 Editor

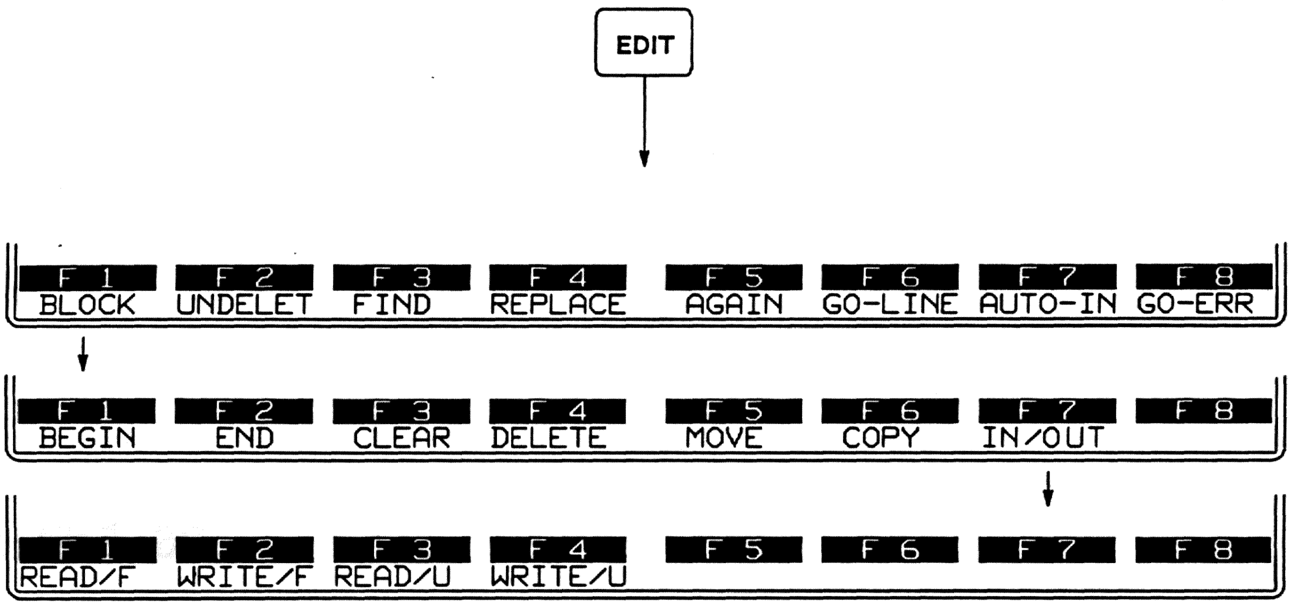


Figure 26-1 Press the *EDIT* key to access special editing functions on the Protocol Spreadsheet. Press *F1* to access additional editing functions.

26 Editor

As you create a spreadsheet program, you may use any of the keys on the editing keypad to modify your entries. Sophisticated editing options are added to these basic functions when you press [EDIT] (see Figure 26-1). [EDIT] is an alternate action key which returns you to program function keys if you press it a second time.

26.1 Basic Editing Functions

Use the editing keypad on the right of the keyboard to perform simple editing functions (see Figure 26-2).

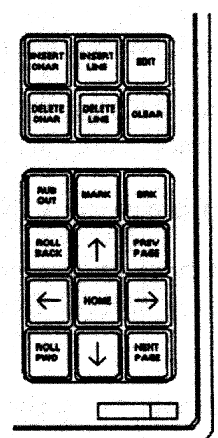


Figure 26-2 **The editing keypad.**

(A) Insert and Delete Keys

The top three rows of the keypad contain insert and delete functions. Available functions are insert a character, delete a character, rubout a character and insert, delete, or clear a line.

Insert Line and Delete Line functions apply to the logical line, not the physical line. A logical line has segments which end at the end of the screen but are not terminated with a [RETURN]. Instead, the logical line wraps to the next line or lines on the screen. You can distinguish a logical (wrapped) line by the highlighted plus symbols (+) at the end of each segment on the screen. When you insert a line, it appears above the first segment of the wrapped line. When you delete a logical line, all of its segments are deleted.

1. [INSERT CHAR] is an alternate action key. Press it once to enter Insert mode (the label <Insert> appears at the top left of the screen). Then type a character. The character is entered at the cursor position. All text moves right. Continue to insert characters as needed.

   Press [INSERT CHAR] again to leave Insert mode. Any character you type subsequently will overwrite an existing character at the cursor location.

2. [INSERT LINE] inserts a blank line above the logical line where the cursor is located. It also puts you into <Insert> character mode. Use [INSERT CHAR] as described in the previous paragraph to *exit* <Insert> mode.

3. [DELETE CHAR] deletes the character under the cursor. The next character to the right moves under the cursor, and remaining text shifts left.

4. [DELETE LINE] removes the logical line that the cursor is on.

5. [CLEAR] erases the remainder of the logical line from the cursor position and to the right, leaving the line empty. [SHIFT]-[CLEAR] erases the entire logical line which the cursor is on, but not the space the line occupies.

6. [RUB OUT] deletes the character just to the left of the cursor and moves the cursor left one space. Use [RUB OUT] to correct an error in the most recent keystrokes.

(B) Cursor and Movement Keys

1. [↑] and [↓] move up or down the screen one line at a time. [SHIFT]-[↑] moves the cursor to the first line of the file. [SHIFT]-[↓] moves the cursor to the last line of the file.

2. [←] and [→] move the cursor to the right or left one space at a time. [SHIFT]-[→] moves the cursor forward to the beginning of the next field. [SHIFT]-[←] moves the cursor back to the beginning of the previous field. [CTRL]-[→] moves the cursor forward to the end of the current line. [CTRL]-[←] moves the cursor back to the beginning of the current line.

3. [HOME] moves the cursor to the top left-hand corner of the current screen.

4. [ROLL BACK] leaves the cursor where it is and moves text down one line at a time.

5. [ROLL FWD] moves text up one line at a time, without changing the cursor location.

6. [PREV PAGE] recalls the previous screen of text and locates the cursor at the same relative position on the screen.

7. [NEXT PAGE] moves the cursor to the same relative position on the next screen of text.

(C) Other Keys on the Pad

1. [MARK] provides a means for "saving a place" in a program file. With the cursor at a desired location, press [MARK], then any number from 0 through 9. This marks the column and row in memory (no mark actually appears). At any time, you may locate one of ten possible marks in the file. Press [SHIFT]–[MARK], then the desired number to move forward or back through the file to the desired location.

2. [BRK] is not currently implemented.

26.2 Editing Function Keys

The editing keys shown in Figure 26-1 appear when you press [EDIT] with the Protocol Spreadsheet displayed. Press [EDIT] again to move back to the program function keys. When you press [F1] for BLOCK, a subset of editing options appear. Press [DONE] to move from this subset back to the top level of editing functions.

(A) Block Functions

With the regular spreadsheet programming selections displayed, press [EDIT], then BLOCK ([F1]) to display the block commands. Six editing commands (keys [F3] through [F8]) operate on blocks of text. When you are using a Clear, Delete, Move, Copy or Write command, you must mark the beginning and end of a block prior to executing the command.

1. *Begin and End*. Use BEGIN to mark the first character of a block at the cursor location. Move the cursor one position to the right of the last character you want to include in the block. Then press END. The block, once defined, is highlighted. Whenever a block is highlighted, you may clear, delete, move, or copy the block or write it to another file.

   NOTE: The block may be defined in the reverse direction. The cursor must be located one position to the right of the first character of the block and located over the last character of the block.

2. *Clear*. Press [F3] for CLEAR to "unmark" a block. The highlighting disappears to indicate that there is no longer an active editing block.

3. *Delete*. Press [F4] for DELETE to remove the marked block. Text below the block fills in the deleted area.

NOTE: You may recover a deleted block using the Undelete command on the alternate set of editing function keys. Repeated use of the Undelete command will recover up to ten deleted blocks. The text is recovered in the reverse order in which it was deleted—i.e., last deleted, first recovered.

4. *Move*. To move text, define a block and locate the cursor at the position where you want the text block to start. Then press MOVE. The text is removed from its original location and is inserted at the cursor location. The moved text remains highlighted as a block.

   To retain the original line breaks in the text, insert a blank line at the position where the new text will be located. Otherwise, inserted text will be placed at the beginning of the line marked by the cursor.

5. *Copy*. To copy text, mark a block, move the cursor to the desired location, and press COPY. A duplicate of the text block appears, highlighted. Since the block is already marked, you may copy it repeatedly without remarking it.

6. *In/Out*. To access the four Read/Write options, press the function key marked IN/OUT. A new rack of function keys appears (see Figure 26-1). These functions are explained in Section 26.2(B).

(B) Read and Write

The READ and WRITE commands are block commands but are exceptions in that they allow you to move text into and out of your program file. You can use a READ command as you would a load command to call in other Protocol Spreadsheet files. Likewise, you can save a copy of the Protocol Spreadsheet using a WRITE command.

The four command options on this rack of function keys are Read Formatted, Read Unformatted, Write Formatted, and Write Unformatted.

1. *Formatted Read and Write commands*. Read Formatted and Write Formatted are intended for use with spreadsheet files and any other files which contain non-printable (non-ASCII) characters:

   - Special characters such as bit masks, [F], [G], ■, ■, [X], «, and »
   - Any control characters outside the limited subset listed in the following paragraphs for unformatted Read and Write commands
   - "Packed" hex characters; that is, hex characters as they appear on the screen (for example 7E, 3F, and 40).

The Write Formatted command saves these non-printable characters as expanded ASCII and uses pound signs (#) and backslashes (\) as prefixes to mark their location for later decoding. Thus, when a file is written, # becomes ##, \ becomes \\, while $^{3}_{0}$ becomes #30, [F] becomes \7E, and so on.

The Read Formatted command decodes the expanded representations properly and displays them as they previously appeared on the Protocol Spreadsheet. If by mistake you use the Read Formatted command on a pure ASCII file which contains backslashes or pound signs, the INTERVIEW will attempt to decode the characters which immediately follow. For example, a preprocessor directive from an #include file such as

```
#define max 5
```

will be decoded as

$^{D}_{E}$fine max 5—which obviously cannot be interpreted by the preprocessor.

2. *Unformatted Read and Write commands.* Read Unformatted and Write Unformatted are intended for use with #include files and other pure ASCII files. Any files that contain only ASCII and a limited subset of control characters may be successfully read in or written to disk with these commands. The set of control characters which are recognized and retained by these commands follows:

   - Tab ($^{H}_{T}$)
   - Form Feed ($^{F}_{F}$)
   - Carriage Return ($^{C}_{R}$)
   - Bell ($^{B}_{L}$)
   - Line Feed ($^{L}_{F}$)

   Any other control characters are stripped from the file when one of these commands is used—as are packed hex characters ($^{3}_{F}$, $^{4}_{0}$, and so on) and special characters.

   NOTES:

   a. If you mistakenly use a Write Unformatted command on a file which contains non-printable characters, these characters will be stripped from the file without warning.

b. Since no messages inform you of whether file contents are formatted or unformatted when you perform a Read or Write, you should keep track of the file type for later reference. An easy way to do this is to append a suffix (such as *_u* for unformatted or *_f* for formatted) to the filename. *#include* files, which end with the *suffix .h*, require the Read Unformatted and Write Unformatted commands.

3. *How to execute a Read command.* To copy an existing file into the Protocol Spreadsheet, place the cursor at the location where you want the file to start. Press READ/F or READ/U, whichever is appropriate (see previous paragraphs), and type in the exact filename (full or relative pathname). Then press [XEQ] or [RETURN]. The entire file is highlighted and copied at the cursor location. Any original spreadsheet text beyond the cursor position is pushed to the end of the file which has been read in.

   NOTES:

   a. When giving the filename to be read, provide the location of the file by disk. If the destination disk is omitted, only that one named in the current directory on the File Maintenance screen will be searched. If the file is located on the current directory disk, it will be read; otherwise, an error message will appear at the top of the screen.

   b. You may read in an entire spreadsheet file without affecting the configuration of other menus in the INTERVIEW. A full program, containing the spreadsheet and the contents of all other menus, must be loaded from the File Maintenance screen. See Section 13.3(E).

4. *How to execute a Write command.* You may file a copy of all or part of your spreadsheet entries using one of the Write commands. First, mark the beginning and end of the block you wish to save to a file. Then press WRITE/F or WRITE/U, whichever is appropriate (see previous paragraphs), and give the full or relative pathname of the file when prompted. Press [XEQ] or [RETURN]. The file will appear in the directory listings on the File Maintenance screen. If you type in the name of a file which already exists, your spreadsheet text block will overwrite the entire file.

   NOTE: If you wish to save the configuration of other menus along with your spreadsheet program, use the Save command on the File Maintenance screen; see Section 13.3(F).

(C) Other Editing Commands

To return to the main set of edit keys from the bank of Block commands, press [DONE]. The remaining commands in the set are described in subsequent paragraphs.

1. *Undelete*. You can return the last deleted line or block to the screen. First, locate the cursor where you want the deleted text to appear, and press UNDELET. The deleted text will be inserted at the cursor location. Repeated use of the Undelete command will recover up to ten deleted blocks.

2. *Find*. Press FIND, and the prompt "Find:", along with the cursor, appear at the top of the screen. Type in the string you wish to locate, and press [RETURN]. The command performs a forward search to the end of the file. Press AGAIN to search for another occurrence of the same string. The message "Text not found" is posted at the top of the screen if the entered text does not occur between the last cursor location and the end of the file.

3. *Replace*. To replace a text string (with a maximum of 50 characters), press REPLACE. The prompt "Find:" appears at the top of the screen. Type in the string that you want to replace, and press [XEQ] or [RETURN]. The prompt "Replace with:" appears. Type in the new string, and press [XEQ] or [RETURN]. The command searches forward in the file from the cursor position and replaces the first occurrence of the string. To continue replacing the old string, press AGAIN, until the message "Text not found" is displayed at the top of the screen. The search for the text string stops at the end of the file.

   NOTES:

   a. If you want the entire file to be searched, make sure the cursor is positioned at the beginning by pressing [SHIFT]-[↑].

   b. Case does make a difference. If the string "echo" is replaced, "Echo" will not be replaced.

4. *Again*. You may repeat Find and Replace commands by executing the command, then pressing AGAIN.

5. *Go-line*. To move from one line to any other line in the file, press GO-LINE. When prompted, enter the sequential number of the line you want, and press [XEQ] or [RETURN].

6. *Auto-indent*. <Indent> will appear at the top right of the screen when Auto-indent is on. Auto-indent is an alternating function key. If the indent cue does not appear, press the function key once to turn on Auto-indent. Press the function key again to turn off indentation. Auto-indent is active both when editing keys and program function keys are active.

   NOTE: To move through the program one line at a time at the points of indentation, use the [RETURN] key instead of the [↑] and [↓] keys.

This feature is an aid in setting up spreadsheet programs. When you use a function key to enter a keyword, the keyword appears on a new line, and, if it is a component belonging to a larger block, it is indented. For example, if you press LAYER:, the keyword is not indented, but if you press TEST, the keyword TEST: appears on a new line, indented three spaces from the first letter of its "owner" (LAYER). When you press STATE, the keyword STATE: is indented another three spaces, to show that it is a component of the test.

NOTE: If you type in your spreadsheet entries, the last level of indentation is observed; however, other auto-indent features are not applied to manual entries.

7. *Go-error*. Most syntax errors made on the Protocol Spreadsheet are indicated by strike-through of the text where the error occurs. Press GO-ERR to move to the first editing error found moving forward (down) through the file. Press GO-ERR once more to move to the next editing error. The search for editing errors stops at the end of the file, and the message "No more errors" is displayed at the top of the screen.

   Errors which are detected by the C translator, preprocessor, or compiler are not indicated by the editor. When you press [RUN] and the test is compiled, the errors will be noted. If there are errors in the test, the INTERVIEW will revert to the Protocol Spreadsheet and display a diagnostic message about the first error rather than run the test. Press GO-ERR to search for additional errors until the "No more errors" messages is displayed.

   If you leave the Protocol Spreadsheet to go to another screen, but then want to review the list of the errors again, return to the Main Program menu. Press [F3], [EDIT], [F8] (spreadsheet screen, edit, GO-ERR). Repeat GO-ERR for the next one. When there are no more errors, a prompt to that effect will appear at the top of the screen.

   Error messages are listed in Appendix A.

27 Layer–Independent Conditions and Actions

Condition–and–action triggers are the basic programming elements on the INTERVIEW Protocol Spreadsheet. Triggers can be thought of as "If, Then" statements, organized on the spreadsheet under the headings CONDITIONS and ACTIONS. Each pairing of CONDITIONS and ACTIONS on the spreadsheet represents one trigger, similar to but also more comprehensive than one of the sixteen Trigger Setup screens (see Sections 21 and 22). Any number of triggers may be created in the spreadsheet program.

During a test, a trigger condition is active (potentially true) whenever the state it belongs to is active. An action is taken whenever the condition (or set of conditions) preceding it is true.

This section covers those conditions and actions that are *not* local to a particular protocol at a particular layer of programming. These are the conditions and actions that are made available as softkey selections in every state in the program without exception.

27.1 Naming Requirements

Flags, accumulators, signals, counters, timers, and timeouts are layer–independent trigger entities that are created by the user in any number and combination and called out by *keyword* (FLAG, ACCUMULATE, SIGNAL, COUNTER, TIMER, TIMEOUT) and by *name*. The names are assigned by the user and referenced in triggers throughout the program.

A name on the Protocol Spreadsheet must not exceed sixteen characters nor include any except the fifty–two alpha characters (upper and lower cases) and the ten numeric characters in addition to the underscore (_) character. The first character in each name must be an alpha character.

The practical size limit for the names of counters, timers, and accumulators is eight characters, since a longer name cannot be called out on the tabular and graphic statistics screens.

For the sake of program readability, we recommend that all user–assigned names be entered in lower case. In this way they will be distinguishable from keywords. The spreadsheet compiler does not insist on lower case for user–assigned names, however.

The spreadsheet compiler does treat upper- and lower-case names as distinct. A timer named **delay** will not be referenced by the name DELAY (or **Delay**), for example. Keywords are treated differently: typing timer has the same effect as typing Timer or TIMER or pressing the softkey that writes TIMER to the screen.

Names of different entities need not be kept distinct. The program will have no trouble keeping a SIGNAL named **ready** separate from a FLAG of the same name. (The user may have difficulty keeping them separate, however.)

27.2 Rules for Combining Conditions

Several layer-independent conditions are "transitional" (or "instantaneous") conditions, in that they are true only for the *instant* that they transition to true. These transitional conditions are enter-state, timeout, keyboard, time-of-day, and signal conditions. Triggers that combine two transitional conditions are illegal and will not compile, since there is no chance of two transitional events occurring simultaneously.

The other class of layer-independent conditions, comprised of buffer-full, counter, and flag conditions, may be thought of as transitional/status. When used alone in a trigger, these conditions are true only at the moment they transition to true.

For example, the condition COUNTER **retries** GE 5, used by itself preceding an Actions block, will be true once when the counter increments from 4 to 5, but not when the same counter increments to 6. For the condition ever to be true again, the counter must first transition to a value less than 5.

When used in combination with transitional conditions, these transitional/status conditions are checked for a current *status* of true at the moment the transitional condition transitions true. They may retain this status of true indefinitely.

Here is an example of a transitional/status condition (counter) used in combination with a transitional condition (timeout).

```
CONDITIONS: TIMEOUT response
   COUNTER retries GE 5
ACTIONS: ALARM
```

This set of conditions will be true every time the timeout occurs as long as the counter retains a *status* of greater than or equal to 5.

When a transitional/status condition is used in combination with one or more other transitional/status conditions, the first condition in the user-defined sequence of conditions will be transitional, while the others will be checked for truth or falsity only when the first condition transitions to true. Take, for example, a scenario where a counter increments five times and then a flag increments five times. On the fifth flag increment, the following set of conditions will be true:

```
CONDITIONS: FLAG true_last 101
   COUNTER true_first EQ 5
```

The conditions are satisfied because the flag is transitional while the counter is static: at the moment the flag transitions to binary 101 (decimal 5), the counter is checked for a status of 5. Both are true. But given the same scenario, this set of conditions is false:

```
CONDITIONS: COUNTER true_first EQ 5
   FLAG true_last 101
```

Here, the counter condition is transitional, the flag is static—simply because the counter condition is listed first. The flag condition is checked only at the moment the counter attains the count of 5. After that, the flag is not checked again.

The condition logic is streamlined in this manner in order to be economical of processor time, on the assumption that in a typical application the user knows which of two conditions will be satisfied first. If the user does not know whether the counter or the flag in the above example will increment to 5 first, nothing prevents him from entering two triggers, both having the same conditions but in a different sequence. Or he may enter the pair of conditions on a Trigger Setup menu, where combined transitional/status conditions generate enough code to cover all contingencies. See Section 21.2(B)2.

> **NOTE:** Additional rules may apply when the COUNTER or FLAG transitional/status condition is used in a spreadsheet program compiled and saved as a linkable-object file. See Section 24.4(B).

27.3 Layer–Independent Conditions

The eight softkeys that represent the full set of layer-independent conditions are shown in Figure 27-1.

(A) Enter State

This condition is true immediately as the current state is entered. Control of the action in effect reverts to the previous state. In the example below, ENTER_STATE is used as the condition for an alarm action in **second** state. The counter condition in **first** state effectively controls this alarm.

```
STATE: first
   CONDITIONS: COUNTER frm_err EQ 10
   NEXT STATE: second
STATE: second
   CONDITIONS: ENTER_STATE
   ACTIONS: ALARM
```

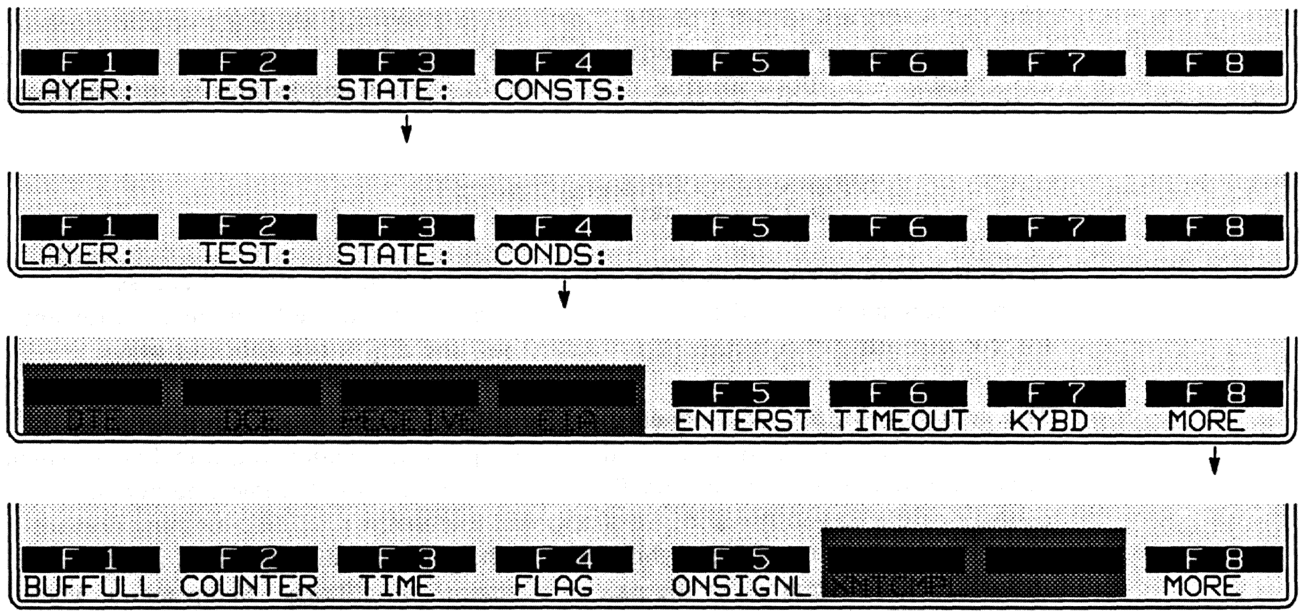


Figure 27-1 The eight layer-independent conditions are shown in the bottom two racks of softkeys.

(B) Timeout

Any number of decrementing timeout timers may be started as trigger actions and monitored by trigger conditions. The condition is true when the timeout timer expires.

Here is an example of a timeout condition:

TIMEOUT response

where **response** is the name of the timeout timer.

After pressing the TIMEOUT softkey or typing TIMEOUT followed by space, enter a name. The name can reference a timeout timer that was started either in a spreadsheet action or a trigger-menu action.

(C) Keyboard

Enter a list of characters produced by keystrokes. Any key or key-combination that produces a character on the ASCII table in Appendix D1 is valid input in this field. Lists in the spreadsheet program can extend to 128 characters.

In Run mode when any key on the list is pressed, the condition will be true and (if this is the only condition) will initiate a trigger action.

An example of a keyboard condition is the following:

CONDITIONS: KEYBOARD "1 "

Note the space following the 1 entry. Here the 1 key *or the space bar* will satisfy the trigger condition. Dual quotation marks are required for all lists and strings on the Protocol Spreadsheet.

(D) Buffer Full

This condition is true at the moment the 64-Kbyte character buffer is full. Use this condition to trigger a display-freeze (CAPTURE BOTH OFF) whenever the earliest data in the display buffer is the most important and you do not want it to be overwritten. Here is an example of a trigger that will retain the first full buffer of data:

CONDITIONS: BUFFER_FULL
ACTIONS: CAPTURE BOTH OFF

(E) Counter

Any counter named and operated as a trigger action may be monitored as a trigger condition. To create a counter condition, press the COUNTER softkey or type COUNTER followed by a space.

An example of a spreadsheet counter condition is the following:

CONDITIONS: COUNTER **byte_no** EQ **128**

where **byte_no** is the name, EQ(ual) is the relational operator, and **128** is the decimal value.

1. *Enter counter name.* Name the counter to be monitored. See Section 27.1, Naming Requirements.

2. *Relational operator.* As soon as a counter name has been typed and followed by a space, a rack of softkeys appears with names of relational operators. See Figure 27-2.

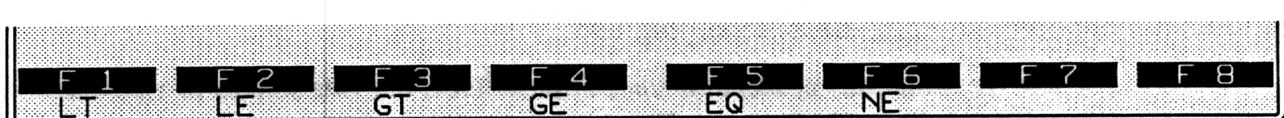


Figure 27-2 A set of relational operators compares the counter value to a user-entered value.

Make the appropriate selection to specify when the counter condition will be true. The counter may be tested for a value equal to (EQ), not equal to (NE), greater than or equal to (GE), less than or equal to (LE), strictly greater than (GT), or strictly less than (LT) the value entered on the spreadsheet.

When a COUNTER condition is used alone, it is a *transitional* condition. This means that it is true only when it transitions to true. For example, a condition that said COUNTER **drops** NE 5 would be true when COUNTER **drops** transitioned from 5 to 6—that is, on the transition from *equal 5* to *not equal 5*; but the condition would not be true when 6 changed to 7.

In combination with another condition (that is, more than one condition *per* action or set of actions), a COUNTER condition normally is a status condition, not a transitional condition. As a status condition, COUNTER **drops** NE 5 is true any time the status of the counter is not 5. Refer to Section 27.2, Rules for Combining Conditions.

> **NOTE:** Additional rules may apply when the COUNTER transitional/status condition is used in a spreadsheet program compiled and saved as a linkable-object file. See Section 24.4(B).

3. *Enter the counter value.* Enter the value as a whole decimal number. Each condition can monitor a 32-bit counter for decimal values ranging from 0 to 4,294,967,295.

> **NOTE:** The Current value for a counter on the Tabular Statistics screen is maintained to seven decimal places, for a maximum counter display of 9,999,999. The 32-bit binary counter can attain much higher values than this, however—the decimal display on the statistics screen merely rolls over to zero and continues counting. Spreadsheet counter conditions can monitor for values up to the maximum of over four billion. If a trigger looks for a counter value higher than this maximum, it will never be satisfied.

(F) Time

The time of day once a day or once a month can satisfy a trigger condition. Here, for example, is a trigger condition that comes true at 3 P.M. each day:

```
CONDITIONS: TIME 1500
```

1. *Enter day of month or time of day.* Press the TIME softkey or type TIME followed by a space. The next entry will signify day of month if it is a two-digit entry. If it is four digits, it will signify the time of day in twenty-four hour format.

2. *Enter time of day.* If the entry following **TIME** is a two-digit, day-of-month entry, it must be followed by time of day in a four-digit, twenty-four hour format.

(G) Flag

Sixteen internal flag bits are reserved for every flag mask that is named in Protocol Spreadsheet conditions and actions.

> NOTE: The eight flag bits on the Trigger Setup screens are the low-order bits of a flag mask that can be accessed on the Protocol Spreadsheet by the name **trig_flag**.

A flag condition still is valid when fewer than sixteen flag bits are specified. The flag values that are specified are right-justified when the program is compiled, and leading X's (don't cares) are assumed.

The internal flag normally is a static condition when it is used in combination with other trigger conditions—that is, more than one condition per action or set of actions. Refer to Section 27.2, Rules for Combining Conditions. Since flag bits are completely under program control and can be used in combination with other conditions, they are useful chiefly to enable or disable entire triggers.

> NOTE: Additional rules may apply when the FLAG transitional/status condition is used in a spreadsheet program compiled and saved as a linkable-object file. See Section 24.4(B).

For example, a trigger action is taken if a flag bit is 1 and a ␕ character is seen. Setting the flag to zero effectively disables this trigger.

An example of a flag condition is the following:

```
CONDITIONS: FLAG nak 1X
```

where nak is the name of the flag and XXXXXXXXXXXXXX1X is the flag bit mask.

1. *Enter the flag name.* After pressing the **FLAG** softkey or typing **FLAG** followed by space, enter a name not exceeding eight characters, beginning with an alpha character.

2. *Enter the flag condition bit mask.* A flag mask follows the flag name. The mask can include up to sixteen bits (with no spaces between them). Since the number of flag masks in your program is unlimited, you may want to restrict your masks to one or two bits. In effect you will be giving each bit or pair of bits a name.

Legal bit-entries are 1, 0, or X (for "don't care"). Press X or DON'T CARE to enter an X. The condition will not test this bit.

(H) On Signal

Signals are communicated between tests and between layers. They are the simplest way to use an event in one test to start a state or an action in another test. Here is an example of an on-signal condition:

```
ON_SIGNAL testfail
```

After pushing the ONSIGNL softkey or typing ON_SIGNAL followed by space, enter the name of a signal you have created (or intend to create) in a trigger action.

27.4 Layer-Independent Actions

When a block of conditions has been entered, press DONE to access the ACTIONS softkey. The actions that are available in all states without exception are shown in Figure 27-3 as they appear in three successive racks of softkeys.

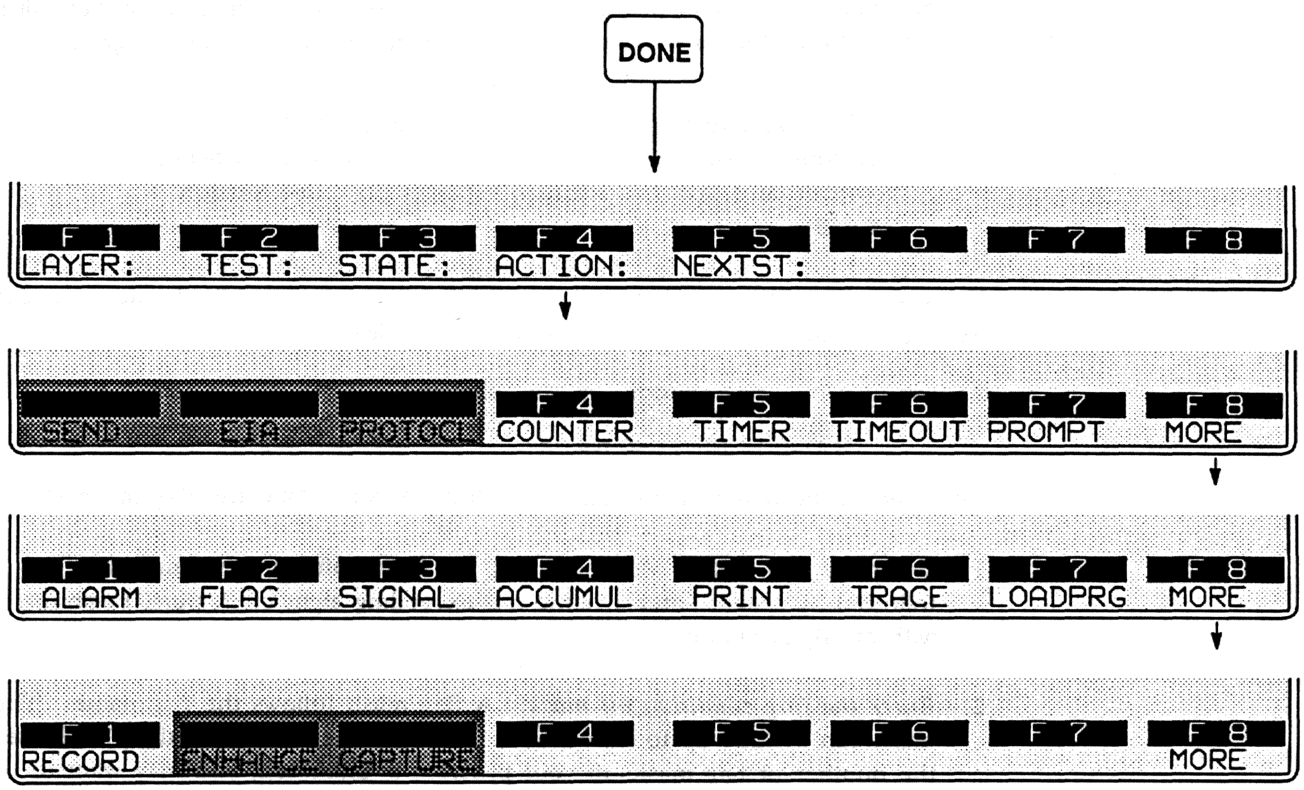


Figure 27-3 The twelve layer-independent actions are spread over the bottom three racks of softkeys in this figure.

(A) Counter

The Protocol Spreadsheet screen can control any number of counters. The Tabular Statistics screen is an expanding display that can provide statistics for 100 counters, timers, and accumulators.

Here is an example of a counter action:

ACTIONS: COUNTER datapaks INC

1. *Enter counter name*. A counter can be unique to one trigger action or it may be shared with other actions and other triggers, which can monitor it and change its values. As long as the same counter name is used, the same counter is invoked.

 NOTE: A counter named on a Trigger Menu screen also refers to a spreadsheet counter as long as the name matches. Timeouts and timers can also be shared between the Trigger Menu screens and the spreadsheet.

 After naming the counter, select among the actions shown in the rack of softkeys in Figure 27-4.

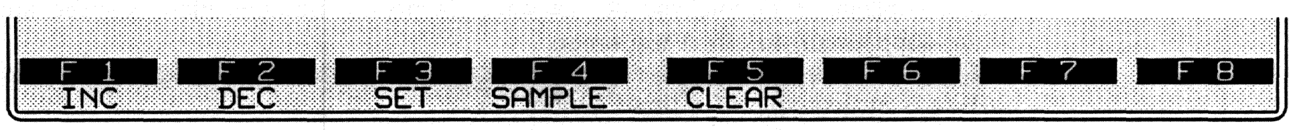


Figure 27-4 Counter actions.

2. *Increment*. Thirty-two bits are reserved for each counter. Therefore a counter will roll over after it attains a decimal value of 4,294,967,295. Spreadsheet conditions can monitor a counter for any value from zero to the maximum. (Trigger Menu conditions can monitor up to a count of 999,999.) Note, however, that the counter value will only be displayed up to seven decimal places on the Tabular Statistics screen. The maximum displayed value therefore is 9,999,999.

3. *Decrement*. When this action is selected, each trigger occurrence subtracts 1 from the counter. A counter that decrements below zero wraps to 4,294,967,295. The last seven decimal places of this maximum value will be displayed in the **Current** column on the Tabular Statistics screen.

4. *Set*. Select SET in order to specify the value that the counter will take when the trigger comes true. Enter a decimal value for the counter. To reset a counter without taking a statistical sample, use the SET action and enter a value of zero.

5. *Sample.* This action stores the current value of the counter and then resets it to zero. The stored value is posted immediately to the statistics display in the **Last** column. This value is compared with previous **Last** values in order to compute **Minimum**, **Maximum**, and **Average** values for statistical display. Refer to Section 17 for a discussion of tabular statistics.

6. *Clear.* This action resets the counter to zero and also resets last, minimum, maximum, and average values for the counter.

(B) Timer

The Protocol Spreadsheet can control any number of timers. The Tabular Statistics screen is an expanding display that can provide statistics for 100 counters, timers, and accumulators.

While timers can be run and sampled as trigger actions, they are not available as trigger conditions. Timeouts, not timers, are the mechanism that allows you to trigger off of elapsed time.

Timer values may be based on an internal "wall" clock, or, if time ticks are enabled on the Front-End Buffer menu screen, on ticks that are stored along with the data. The "tick" mode of timing is the most accurate, especially when data is played back and you do not want playback conditions such as speed and idle-suppression to affect the timers.

Here is an example of a timer action:

ACTIONS: TIMER session SAMPLE

1. *Enter timer name.* After pressing the **TIMER** softkey or typing **TIMER** followed by a space, enter a name. Like counters and timeouts, a timer can be shared between the spreadsheet program and the Trigger Menu screens. If the same name is used, the same timer is invoked.

   After naming a timer, select among the actions shown on softkeys in Figure 27-5.

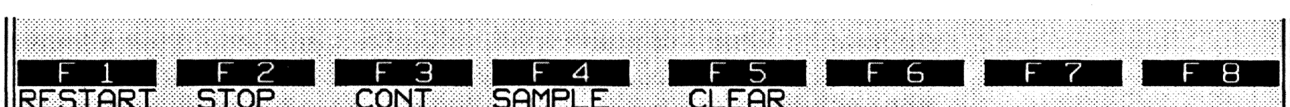


Figure 27-5 Timer actions.

2. *Restart.* Use **RESTART** to start a timer. This causes the timer to reset to zero and begin incrementing. A restart does not affect any statistical values except **Current**.

3. *Stop*. A stop action suspends the timer at its present value. The timer may be started again at this value by a Continue action on another trigger.

4. *Continue*. This action restarts the timer beginning at the value that was frozen in the **Current** column when the timer was stopped. The Continue action has no effect on a timer that is incrementing already.

5. *Sample*. Sampling a timer resets it at zero and stops it. Prior to resetting, the current value is posted as a **Last** value and passed along for other statistical tabulation.

6. *Clear*. Clearing a timer resets and stops the timer and clears the last, minimum, maximum, and average values.

(C) Timeout

Any number of timeouts can be started and stopped in the spreadsheet program. Timeouts are timers that count down instead of up. Their values are not read on any statistical display; but when they time down to zero, they satisfy trigger conditions that monitor them by name. Timeout timers that are named on the Protocol Spreadsheet also may be monitored and controlled on the Trigger Menu screens.

Here is an example of a timeout action:

```
ACTIONS: TIMEOUT t2 RESTART 3
```

where **t2** is the name of the timeout and **3** is its duration in seconds.

1. *Enter timeout name*. After pressing the TIMEOUT softkey or typing TIMEOUT followed by space, enter the name of the timeout. As soon as a name has been entered and followed by a space, a rack of softkeys appears with the names of two timeout actions, RESTART and STOP.

2. *Restart*. Select RESTART to start the timer running down.

3. *Stop*. Select STOP to halt the timer and prevent the timeout.

4. *Enter timeout value*. The duration of the timeout is entered in seconds. The timeout value is a decimal field in which entries are valid to the millisecond (0.001). For values under 1 second, you must precede the decimal with a leading zero, as follows:

   ```
   TIMEOUT delay RESTART 0.25
   ```

   The maximum timeout entry in this field is 65.535 seconds.

You may expand the maximum timeout with a program such as the following, which produces an alarm every twenty minutes.

```
STATE: twenty_min_alarm
   CONDITIONS: ENTER_STATE
   ACTIONS: TIMEOUT sixtysec RESTART 60
   CONDITIONS: TIMEOUT sixtysec
   ACTIONS: COUNTER minutes INC
            TIMEOUT sixtysec RESTART 60
   CONDITIONS: COUNTER minutes EQ 20
   ACTIONS: COUNTER minutes SET 0
            ALARM
```

(D) Prompt

Prompts are user-entered ASCII messages that appear on the second status line at the top of the screen in Run mode as a result of a trigger coming true. They are messages to the operator from the program, alerting him to important protocol or program events. Prompts are written to the second status line of any current Run-mode display screen. Switching to Freeze mode or to another display screen clears the prompt from all screens except the Display Window.

> **NOTE:** The prompt line is not zeroed out with each new prompt, and prompts are overwritten only to the extent of the new prompt. For example, the prompt "POLL" does not completely overwrite the prompt "SELECT"—the result will be "POLLCT." It is a good practice to establish a uniform prompt length and space-fill shorter prompts to that length.
>
> Special C functions that position the cursor anywhere on the prompt line (or elsewhere in the display) and write messages to the cursor position are discussed in Section 61.

A prompt that has been triggered in Run mode is illustrated in Figure 27-6. Here is the same prompt as it appears on the Protocol Spreadsheet:

```
ACTIONS: PROMPT "Echoed message received"
```

Backslashes and double-quotation marks may be included in prompt messages if they are preceded by backslashes, in accordance with the rules for entering these characters in transmit strings. See Table 29-2. Example:

```
ACTIONS: PROMPT "\"hello\" string received"
```

1. *Enter prompt message.* After pressing the PROMPT softkey or typing PROMPT followed by a space, enter a message in quotation marks. The message should not exceed 64 characters, the width of the screen.

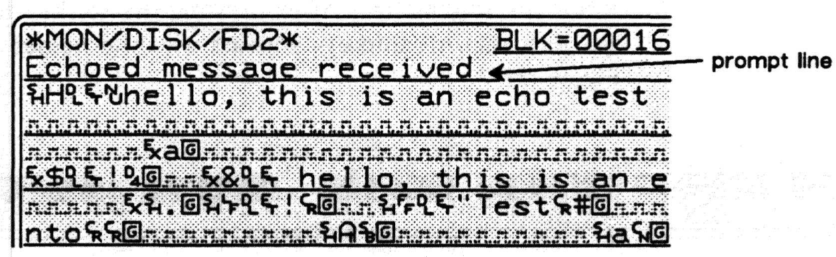


Figure 27-6 User-defined prompts are displayed at the top of the Run screen.

(E) Alarm

The alarm is a tone of less than a second duration. The alarm is sounded each time the trigger comes true. If the tone lasts longer than a second, the alarm has been triggered more than once.

The alarm action on the spreadsheet is simply the word ALARM.

(F) Flag

Internal flags are special programming bits. They can be set on or off by triggers and sensed by triggers. Flags come in masks of up to sixteen bits. Each flag mask is named and referenced by the spreadsheet program.

Any number of flag masks may be created. Flags are common to all tests and layers: if a flag name is used in tests in two different layers, it refers to the same sixteen programming bits.

A flag action still is valid when fewer than sixteen flag bits are specified. The flag values that are specified are right-justified when program is compiled, and leading X's (don't cares) are assumed.

> **NOTE:** The eight flag bits on the Trigger Setup screens are the low-order bits of a flag mask that can be accessed on the Protocol Spreadsheet by the name **trig_flag**.

Here is an example of a flag action:

```
ACTIONS: FLAG nak SET 0X
```

where nak is the name of the flag, SET is the action, and 0 is the only bit in the mask affected by the set action.

1. *Enter the flag name.* After pressing the softkey for FLAG followed by a space, a rack of softkeys appears with the names of flag actions. See Figure 27-7.

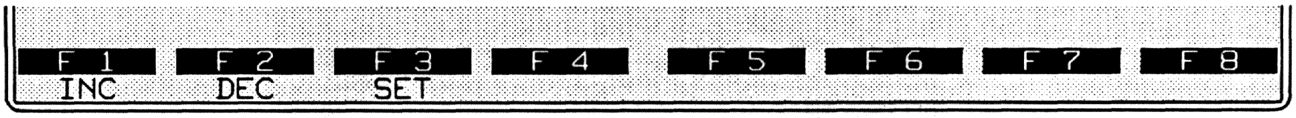


Figure 27-7 Flag actions.

2. *Increment.* The mask can be used as a sixteen-bit binary counter. The INC action increases the value of the mask by one each time the trigger is true.

   As the mask increments above 65,535, it wraps to zero.

   The INC action always toggles the least significant flag bit. If you monitor the flag for only one bit (for example, FLAG **flagname** 1), the INC action will toggle the condition true/false. This can be a useful tool when you want *every second occurrence* of an event to trigger an action.

3. *Decrement.* This action decreases the value of the flag byte by one each time the trigger is true. When the mask decrements below zero, it wraps to 65,535.

4. *Set.* This action rewrites the flag bits according to the flag-action bit mask that you enter following the SET keyword. The bit mask is comprised of up to sixteen 0's, 1's, and X's (no change).

   When you enter fewer than sixteen bits, you are leaving the leftmost bits in the mask unspecified. The action will not change the condition of unspecified bits.

(G) Signal

Use signals to convey instructions to other tests and other layers where conditions are monitoring these signals by name.

Other internal programming mechanisms, such as flags and counters, are common to all tests and layers and may perform a signaling function. Signals, however, are more efficient in that they are reusable: a signal that is sent and monitored can be sent and monitored again ten seconds later, but an action that sets a flag to 1 cannot be used again until another action has intervened to reset the flag to zero.

After pressing the SIGNAL softkey or typing SIGNAL followed by space, enter the name of the signal. Often the name will be descriptive of the event being signaled. An example of a signal action is the following:

```
ACTIONS: SIGNAL testfail
```

(H) Accumulate

The accumulate action reads a specified value for a counter or timer and presents this value to tabular and graphic statistics screens for statistical breakout. This action is distinct from the sampling action of a counter or timer in this important respect: sampling a counter or timer also resets it to zero. Accumulating a counter or timer has no effect on the ongoing counting or timing function. Examples of accumulators are given in Section 17, Tabular Statistics.

Values for more than one counter or timer may be brought into a single accumulator. For example, separate timers might measure response times for a group of multidropped DTEs. At the end of the test, a value for each timer could be brought, in separate trigger actions, into one accumulator.

Each accumulate action specifies one value only for a counter or timer. Thus the accumulator might provide meaningful statistical data based, for example, on maximum values only for a group of timers.

Here is an example of an accumulate action:

```
ACTIONS: ACCUMULATE alldrop COUNTER badbcc_a LAST
```

where **alldrop** is the name of the accumulator, **badbcc_a** is the name of a counter, and it is the last value of the counter that is being accumulated.

1. *Enter the accumulator name.* Both the accumulator and one counter or timer are referenced in the accumulate action. Counters and timers are referenced, not created, in accumulate actions.

   An accumulator is created by being named in an accumulate action. Like counters and timers, accumulators can be given display lines on either or both of the statistics screens.

2. *Clear.* This action clears the last, minimum, maximum, and average values of the accumulator. (Since accumulators neither count nor time, they never display a current value.)

3. *Counter.* This action accumulates a value for the counter named immediately following the keyword COUNTER. After the counter is named, one value for that counter is selected from the rack of softkeys in Figure 27-8.

4. *Timer.* This action accumulates a value for the timer named immediately following the keyword TIMER. After the timer is named, one value for that timer is selected from the rack of softkeys in Figure 27-8.

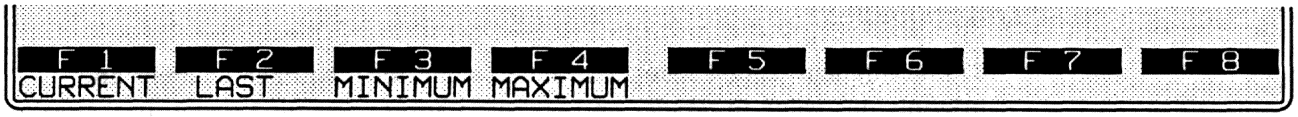


Figure 27-8 Counters and timers are accumulated with respect to one statistical value only.

(l) Print

Time-stamped printouts of single lines of data can be commanded by the spreadsheet program. The data can be a line of tabular statistics for an accumulator, counter, or timer; or a user-prompt that is sent to the printer after it has been written to the second line of the screen.

An example of a print action is the following:

ACTIONS: PRINT TIMER **echotime** MILLISECONDS

After pressing the softkey for PRINT or typing PRINT followed by a space, select an option for the type of data to be printed from the new rack of softkeys shown in Figure 27-9.

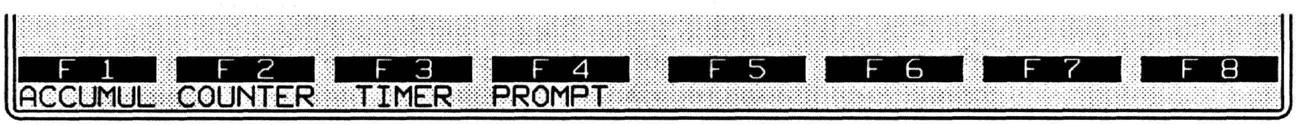


Figure 27-9 Four types of data may be printed out as a trigger action.

1. *Accumulator*. When this action is taken, the line of tabular statistics for the accumulator that you name will be printed. A line of tabular statistics includes last, minimum, maximum, and average values for an accumulator. Since accumulators neither count nor time, they never display a current value.

2. *Counter*. When this action is taken, the line of tabular statistics for the counter that you name will be printed. A line of tabular statistics includes current, last, minimum, maximum, and average values for a counter.

3. *Timer*. After the timer is named, a timer rate is selected from a new rack of softkeys as shown in Figure 27-10.

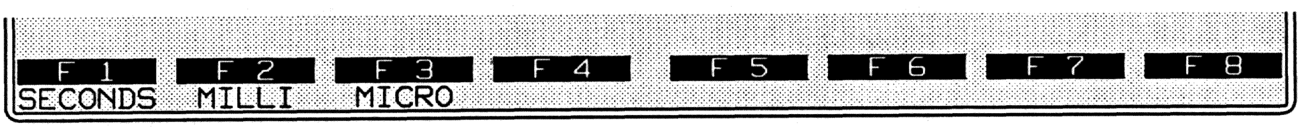


Figure 27-10 After a timer is named for printout display, a new softkey rack allows you to specify unit of time.

The selected rate will only display values to the smallest place value afforded by the tick rate selected on the FEB Setup screen. For example, if *milli*seconds is selected on the FEB screen, choosing *micro*seconds on the print-timer softkey selection will simply display three additional zeros as place holders—it will not calculate a more precise reading. Thus the most accurate selection for this example would be milliseconds, matching the FEB selection.

When a timer is controlled by a nondata event such as a keyboard condition, it will reference a "wall-time" clock whose smallest resolution is a millisecond.

When the **PRINT TIMER** action is taken, the line of tabular statistics for the timer that you name will be printed. A line of tabular statistics includes current, last, minimum, maximum, and average values for a timer. Figure 27-11 is an example of such a printout for the program given below.

```
STATE: message
   CONDITIONS: DTE STRING "hello"
   ACTIONS: PROMPT "String sent by DTE"
      TIMER echotime RESTART
   NEXT_STATE: echo
STATE: echo
   CONDITIONS: DCE STRING "hello"
   ACTIONS: PROMPT "Same string by DCE"
      TIMER echotime STOP
      TIMER echotime SAMPLE
      PRINT TIMER echotime MILLISECONDS
   NEXT_STATE: message
```

Time	Name	Current	Last	Minimum	Maximum	Average	Unit
09/29 16:13	echotime	0	452	452	452	452.00	MSECS
09/29 16:13	echotime	0	341	341	452	396.50	MSECS
09/29 16:13	echotime	0	428	341	452	407.00	MSECS

Figure 27-11 In this printout, a PRINT TIMER action has been triggered three times.

4. *Prompt.* The PRINT PROMPT action is designed to be added to an action block that already contains a prompt. The example below inserts PRINT PROMPT actions into the program described in the previous section. The user does not have to key in a long prompt message twice, once for the printout and once for the screen. The printout for this program is shown in Figure 27-12.

```
STATE: message
   CONDITIONS: DTE STRING "hello"
   ACTIONS: PROMPT "String sent by DTE"
      PRINT PROMPT
      TIMER echotime RESTART
   NEXT_STATE: echo
STATE: echo
   CONDITIONS: DCE STRING "hello"
   ACTIONS: PROMPT "Same string by DCE"
      TIMER echotime STOP
      PRINT PROMPT
      TIMER echotime SAMPLE
      PRINT TIMER echotime MILLISECONDS
   NEXT_STATE: message
```

```
Time         Name          Current    Last Minimum Maximum    Average Unit

09/29 16:13 String sent by DTE
09/29 16:13 Same string by DCE
09/29 16:13 echotime             0     452     452     452     452.00 MSECS
09/29 16:13 String sent by DTE
09/29 16:13 Same string by DCE
09/29 16:13 echotime             0     341     341     452     396.50 MSECS
09/29 16:13 String sent by DTE
09/29 16:13 Same string by DCE
09/29 16:13 echotime             0     428     341     452     407.00 MSECS
```

Figure 27-12 Printout resulting from a combination of PRINT PROMPT and PRINT TIMER actions.

(J) Trace

Traces are user-entered ASCII data strings, identical to prompts in all ways except in their mode of display: traces are posted one to a line in the multiline Program Trace display (see Section 5.6), while prompts appear on the second status line in all data-display modes (including the Program Trace).

Numerous layers and numerous tests per layer can be active concurrently in the INTERVIEW. The Program Trace can be set up to track state-to-state movement only in a particular **Layer** and **Test** identified by the operator on the Display Setup menu. State names can be included in the Program Trace via the **Display States: YES** selection on the the Display Setup menu. See Figure 27-13.

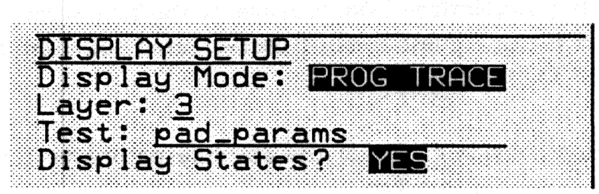


Figure 27-13 The user may select a particular layer and test for a Program Trace.

Traces are debugging tools. Inside a dead-end state they can inform you whether a particular condition that you are expecting is coming true. Prompts, by contrast, have a much fainter "trail": it is hard to be certain that a prompt was not activated and then overwritten by another prompt.

Traces also allow you to keep a record of selected protocol events—to design your own protocol analysis. Since they are written to consecutive lines rather than overwritten by other traces, they are highly useful when you are trying to track protocol events that occur in quick succession.

An example of a trace action is the following:

ACTIONS: TRACE " **Network congestion**"

1. *Enter trace message*. After pressing the TRACE softkey or typing TRACE followed by a space, enter a message in quotation marks.

(K) Load Program

A program (source code or object code) or setup that is stored in a file on hard disk or on a disk in either of the microfloppy drives can be loaded in by trigger action. This Load Program function is a means of chaining tests together.

Program files are a full set of configured menus, including the Layer Setup screen, Trigger Setup screens, and the Protocol Spreadsheet. Object files are the precompiled object-code versions of programs. Setup files are a set of configured menus which excludes trigger setups, the Layer Setup screen, and the spreadsheet. Remember that loading a program or setup file overwrites the program or setup file already in memory. Loading an object file overwrites only the object code of whatever program (if any) was compiled most recently. The new object file will not affect the data on any setup menu or programming screen.

EIA statuses can be maintained in between programs by a special menu selection on the Interface Control menu screen. (See Section 10.)

An example of a Load Program action is the following:

ACTIONS: LOAD_PROGRAM "FD1/usr/sna/sna_bind"

where *FD1* is microfloppy-diskette drive 1, the first slash (/) is the root directory, *usr* is the highest level of user-created files, *sna* is another directory, and *sna_bind* is the filename.

1. *Enter program name.* Enter the absolute pathname of your file. Put the name in quotation marks.

(L) Record

Use the RECORD action to activate or suspend line-data recording or disk-data playback. When the Line Setup menu is configured to monitor a disk, RECORD controls playback; otherwise it applies to recording. There are two selections under RECORD. Select ON to activate, or OFF to suspend, recording or playback.

During recording, the top status line of Run-mode screens will show incrementing block numbers and an "R" displayed in the record/playback field. During playback, a "P" is displayed. Whenever recording or playback has been suspended, an "S" is displayed.

For data playback, the status field will be blank if a disk is not present in the selected drive or when the end of the data-acquisition tracks are reached. This field will also be blank if you enter a starting block number on the Line Setup menu that a) precedes the block number at which data actually begins, or b) exceeds the block number at which data actually ends. Change your entry to zero.

For data recording, the status field will be blank when the end of RAM or the data-acquisition tracks is reached. It will also be blank if the **Capture Memory** field indicates that you will record to disk, but no disk is present in the selected drive or data-acquisition tracks are not available on the disk.

28 Layer 1 Conditions and Actions

There are seven protocol layers in the OSI (Open Systems Interconnect) model that is adopted in the INTERVIEW 7000 Series. Each layer reserves a distinctive set of trigger conditions and actions on the Protocol Spreadsheet.

As a rule, spreadsheet components for a given layer are loaded from disk via the Layer Setup screen. Layer 1, the Physical Layer, is an exception to this rule. Layer 1 conditions and actions are enabled on the Protocol Spreadsheet when the unit powers up.

Depending on the Test Interface Module (TIM) installed in the unit, the power-up also enables an Interface Control Menu screen, different for each module, that controls many Layer 1 parameters. For this reason, the set of Layer 1 conditions and actions is relatively small.

28.1 Layer 1 Conditions

To bring up the bank of softkey conditions for Layer 1, first press the CONDITIONS softkey. This key becomes available when the cursor enters a programming block at the state level.

The first four condition softkeys—DTE, DCE, RECEIVE and EIA—belong to Layer 1. These are followed by generic conditions discussed in the previous section. The set of Layer 1 conditions is shown in Figure 28-1. The softkey for a fifth Layer 1 condition—XMIT_COMPLETE—appears on the second rack of condition softkeys shown at the bottom of the figure.

EIA is a transitional/status condition and may be combined with other conditions. The other Layer 1 conditions are transitional only. Refer to Section 27.2 for a discussion of how conditions may be combined.

Figure 28-1 Layer 1 conditions.

(A) Data

The first three trigger conditions at Layer 1 can monitor one of the two data leads for a specific data event. This event can be any of several characters, a string of characters, a good BCC following the character or string, an error revealed by a block or parity check, and so on.

Data conditions at Layer 1 monitor the entire data stream. Conditions in other layers also check the data leads, of course, but conditions at Layer 2 and higher look for protocol events.

In searching the data stream byte by byte, Layer 1 data conditions behave similarly to **Receiver** conditions on the Trigger Setup screens. This is another way of saying that the sixteen trigger menus constitute a Layer 1 test. This test has a single state that is always current. Trigger menus with selections made on them are always active.

The three data conditions are DTE, DCE, and RECEIVE. When one of these conditions is selected, a new rack of softkeys appears. The new options are shown in Figure 28-2.

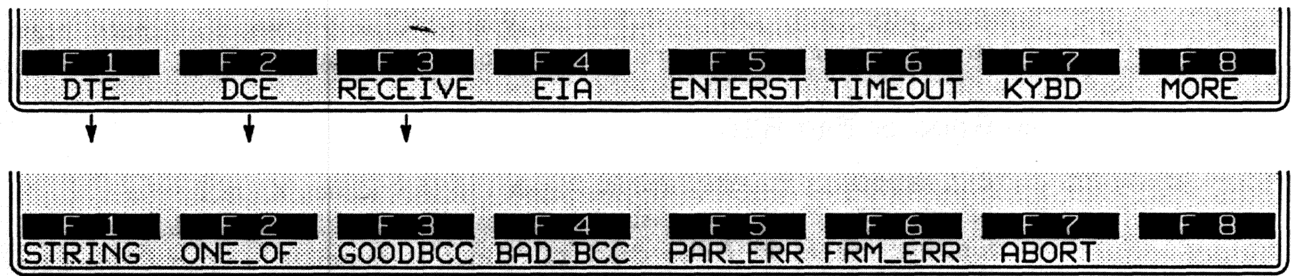


Figure 28-2 A spreadsheet trigger will monitor either data lead looking for these events.

(B) DTE

When DTE is selected, data on the TD lead will be monitored.

(C) DCE

This condition monitors the RD lead.

(D) Receive

This condition is intended for use in the emulate modes. It allows you to change the emulate mode of a program on the Line Setup screen without modifying the spreadsheet. When RECEIVE is selected, the INTERVIEW will always monitor the lead opposite its own transmit lead. With **Mode:** EMULATE DTE as the Line Setup selection, the trigger will monitor RD. In Emulate DCE mode, the trigger will monitor TD.

(E) String

When a trigger monitors a data lead for a string, it searches for the exact, entire sequence of characters entered in the condition. Strings have a size limit of 32 characters. If constants are entered in the string, the 32–character limit is applied after all constants have been expanded.

After pressing the STRING softkey or typing STRING followed by a space, begin the string. Strings are always enclosed in quotation marks on the spreadsheet.

Here is an example of a Layer 1 data condition:

CONDITIONS: RECEIVE STRING "SH%R" WAIT_EOF

where WAIT_EOF delays trigger–true until the block of data holding the string has ended with a good block check.

(F) One-Of Character

When ONE_OF is entered, the trigger looks for any one of the characters in the list that follows. A single character in the data is all that is necessary to match a list. The effect of a "not–equal" character in a one–of list is explained in Section 21.3(I).

After pressing the ONE_OF softkey or typing ONE_OF followed by a space, begin the list. Lists and strings are always enclosed in quotation marks.

(G) Good or Bad BCC

BCC is partly a Layer 1 function, in that the calculation normally is a "hardware" function that tests the physical medium. It also is a Layer 2 function, in that the frame-check calculation is transmitted as part of the Layer 2 protocol. BCC therefore appears as a set of spreadsheet functions both at Layer 1 and Layer 2.

GOOD_BCC (good block-check calculation) and BAD_BCC can only be used as conditions when **Rcv Blk Chk** is turned on. **Rcv Blk Chk** is a menu field on the Line Setup menu: see Section 4.

> **NOTE:** **Rcv Blk Chk** is *on* automatically when Format: BOP is the Line Setup selection.

Press the softkey for GOODBCC or BAD_BCC when when you want the trigger to take action on receipt of the BCC. The INTERVIEW does the block-check calculation that the user has defined on the BCC Parameters menu and compares it with the received block-check characters. See Table 8-1 and Table 8-2 for the block-check calculations done by the INTERVIEW.

(H) Parity Error

PARITY_ERROR looks for an error in relation to the **Parity** selection made on the Line Setup menu.

(I) Framing Error

FRAMING_ERROR applies to start-stop formats (ASYNC and ISOC) and detects framing errors in relation to the **Stop Bits** field on the Line Setup menu.

(J) Abort

When **Format:** BOP has been selected on the Line Setup menu, you can enter ABORT as a trigger condition. In $^{F}_{E}$-framed protocols, seven consecutive 1-bits in midframe constitute an abort.

(K) Enter Receive String

Enter strings and lists inside quotation marks. A list is a series of characters that can be matched by a single data character. (A string must be matched by a data string.) A one-of condition is an example of a list. All ASCII-keyboard, control, and hexadecimal characters are legal in a receive string or list. Of the special-character keys, [NOT EQUAL], [DON'T CARE], [FLAG], and [SHIFT]-[FLAG] are valid. [SHIFT]-[FLAG] displays the sync symbol [S] on the screen, and causes a search for the sync pattern.

[BIT MASK] is not valid. Bit masks are entered in receive strings by the keying sequence illustrated in Table 29-1.

Constants are also legal in any character position in a list or string. See Section 29, Strings, for an explanation of these string-search tools.

(L) Wait for End Of Frame

After the double-quotation mark is entered to close a string or list, the final Layer 1 condition appears under [F1] on the rack of softkeys. The condition is WAIT_EOF, or "wait for the end of the frame" before coming true and taking any actions. See Figure 28-3.

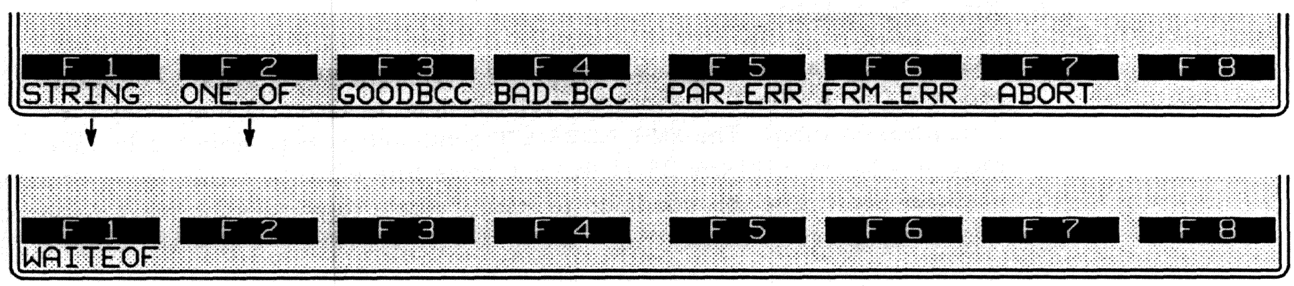


Figure 28-3 String and one-of conditions can be linked to a good BCC at the end of the frame ("EOF").

The WAIT_EOF condition does not occur above Layer 1, since data is not passed up to those layers until the frame is completed.

(M) EIA

Layer 1 conditions can monitor the status of six RS-232/V.24, V.35, or RS-449 control leads plus an additional seventh lead, the user-assigned (UA) input jack on the RS-232/V.24, V.35, or RS-449 test-interface module (TIM). Leads available for triggering are RTS, CTS, CD, DTR, DSR and RI.

The EIA condition is a transitional/status condition. This means that when it is used alone it is true only if it transitions to true; but used in a trigger in combination with other conditions, it retains its status of on or off without having to transition to either status. The rules for combining conditions are explained in Section 27.2.

After pressing the EIA softkey or typing EIA followed by a space, make your lead selection from the upper rack of softkeys in Figure 28-4. Then select a status of ON or OFF.

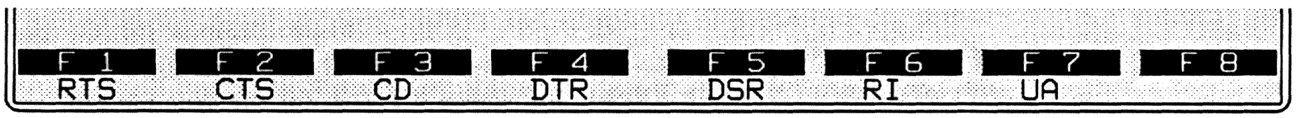


Figure 28-4 EIA leads monitored by the spreadsheet program.

For the standard RS-232/V.24 interface, ON implies that a lead is more positive than +3 volts with respect to signal ground. OFF implies only that a lead is not at or above the ON threshold, not necessarily that a minus threshold has been attained.

This is an example of an EIA condition:

CONDITIONS: EIA DTR OFF

(N) Xmit Complete

"SENDing" a transmission means queueing a transmission to send. The layer protocol (the RTS-CTS handshake, for example, at Layer 1) may delay the actual transmission. The XMIT_COMPLETE condition (selectable in the bottom rack of softkeys in Figure 28-1) will not come true until the transmission actually has been sent. Use this condition to start accurate response-time measurements.

28.2 Layer 1 Actions

When a block of Layer 1 conditions has been entered, press [DONE] to access the softkeys for ACTIONS. The set of seven Layer 1 actions is shown in the softkeys in Figure 28-5. The names of these actions are SEND, EIA, OUT_SYNC, IDLE_LINE, ENHANCE, and CAPTURE. The other, darkened softkeys in the figure are layer-independent actions present at every layer, discussed in the previous section of this manual.

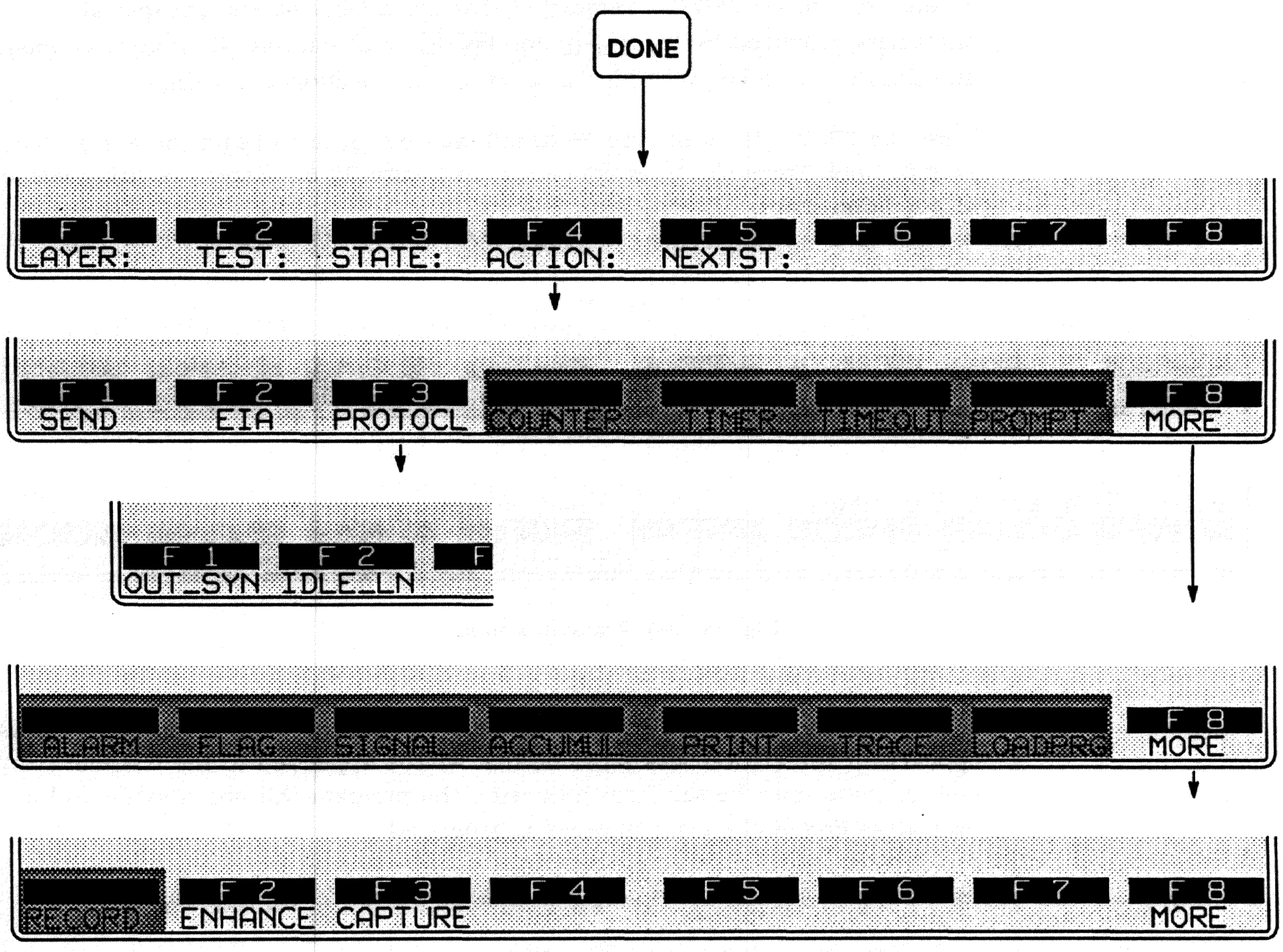


Figure 28-5 Layer 1 actions.

(A) Send

There is one SEND action—transmit a string. While transmissions occur at all layers, only Layer 1 allows the user to type in a complete transmission, character by character. At higher layers, the user types the names of protocol elements and the software converts these mnemonics to strings. The user enters character strings directly at higher layers only into specified user-data fields.

The spreadsheet compiler identifies strings by the quotation marks surrounding them. Send-strings have no size limit (for practical purposes). All ASCII-keyboard, control, and hexadecimal characters are legal in a send-string. Special keys (FLAG, DON'T CARE, BIT MASK) are not legal.

To insert a canned fox message into a transmit string, type **FOX** inside of double parens, as follows: **((FOX))**. Remember that the double parens are special characters produced by the [CTRL]–[9] and [CTRL]–[0] combinations. Constants, counters, and flags can also be embedded in a string. See Section 29, Strings.

Press the **SEND** softkey or type **SEND** followed by space to begin the entry. The prompt **Enter Transmit String** appears as in Figure 28-6. Enter the string inside of quotation marks.

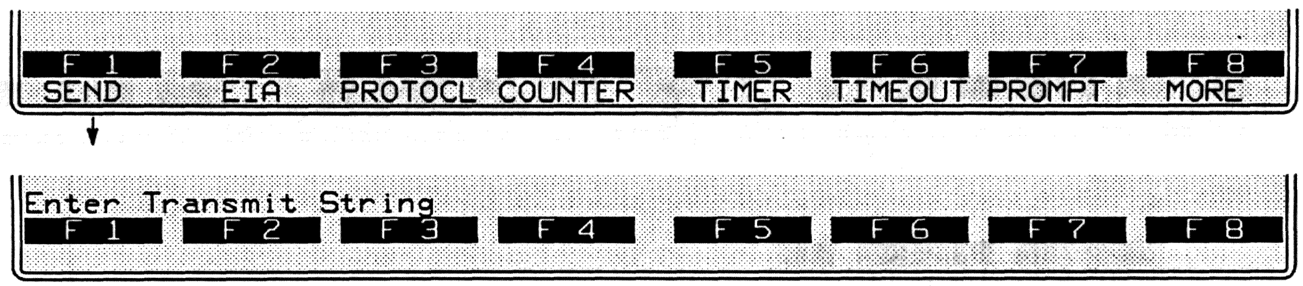


Figure 28-6 Transmit a string.

After quotation marks are typed in to close the transmit string, a set of softkeys appears for the error-checking value that will be appended to the transmit string. One of these must be selected; otherwise, the program will not compile and a **Premature End of File** error message is generated.

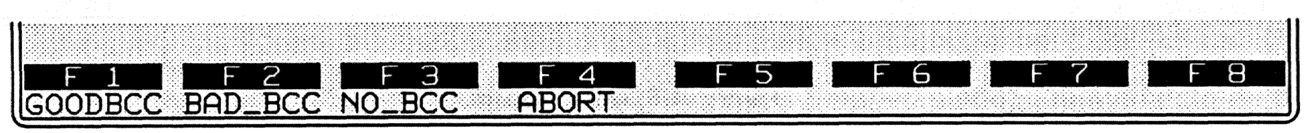


Figure 28-7 Select a block-check calculation to end the transmission.

1. *Good BCC.* This softkey entry allows you to append a good block-check sequence to your transmitted message. The INTERVIEW will make the proper calculation based on the parameters selected on the BCC Setup screen (see Section 8).

2. *Bad BCC*. Press the softkey labeled BAD_BCC to append an errorred block-check to your transmission. Assuming that Rcv Blk Chk: ON is the selection on the Line Setup menu, a BCC error will be indicated on the screen of the INTERVIEW by a ■ symbol. See Figure 28-8.

   For BOP format, the bad BCC will be CRC-16 instead of CCITT. For other formats it will be an inverted good BCC.

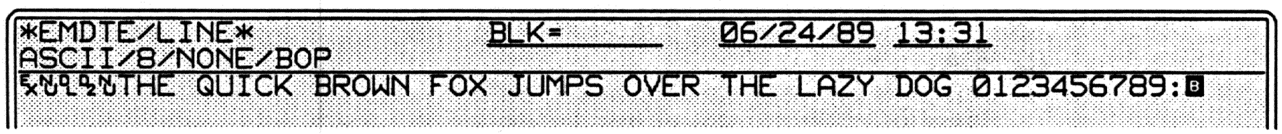


Figure 28-8 The INTERVIEW's TD monitor has detected a bad BCC transmitted by the unit's own TD driver.

3. *No BCC*. The NO_BCC softkey pertains to non-BOP formats only. Instead of appending a block-check calculation to a text message, the transmitter will revert directly to idle-line condition.

   Please note that receivers that are expecting BCC characters will treat the idle characters generated by the INTERVIEW as block-check characters. The INTERVIEW's own receivers (unless they go out of sync first) will display a bad-BCC symbol on the screen. (Refer to Figure 8-3.) The device under test probably will detect a BCC error and reject or ignore the message.

   The user may, of course, enter a good BCC "manually" as part of the text string that precedes the NO_BCC selection.

4. *Abort*. Abort is a BOP function only. Instead of appending a proper frame-check sequence (FCS), the transmitter will hold the lead at mark for eight bits (or longer if the transmitter is idling ᶠF). Inside of a frame, seven 1-bits in a row are sufficient to signal an abort.

   An aborted message is shown in Figure 28-9.

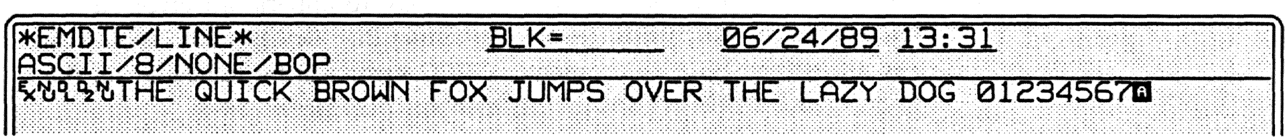


Figure 28-9 The INTERVIEW aborts a BOP frame by closing it with a byte of *FF* instead of *7E*.

(B) EIA

Press the softkey for EIA or type EIA followed by a space to bring five RS–232 leads and four auxiliary leads under spreadsheet control. The nine softkeys that represent EIA actions are illustrated in two separate racks of keys in Figure 28-10.

EIA actions are available only when the unit is in one of the emulate modes. A maximum three RS–232 leads are controllable at one time. When Mode: EMULATE DCE is the Line Setup parameter, you control CTS, CD, and DSR. You may enter RTS ON or DTR ON as a spreadsheet action; but the DTE, not the INTERVIEW, controls these leads, and the actions will not take effect. To turn RTS or DTR on, first you must emulate a DTE.

The AUX softkeys allow you to apply off/on voltage to any of the AUX output jacks (four on the RS–232 Test Interface Module, three on the V.35 and RS–449 TIMs) seated in the rear of the unit. (Refer to Figure 10-5 and Figure 44-3.) These AUX outputs are useful for turning on and off a signal that is not a softkey selection or not under the control of your emulation. Section 10.3 cites the example of an INTERVIEW in Emulate DTE mode that is using the AUX0 pin to control CTS from the "wrong" side of the interface.

> **NOTE:** The AUX actions on the spreadsheet have nothing to do with the 25–pin TTL AUXILIARY connector at the rear of the INTERVIEW.

After selecting a lead to control, select a status of OFF or ON. In the RS–232 specification for drivers, *on* is defined as +5 V to + 15 V while *off* means a range of –5 V to –15 V..

This is an example of an EIA action:

```
ACTIONS: EIA DTR ON
```

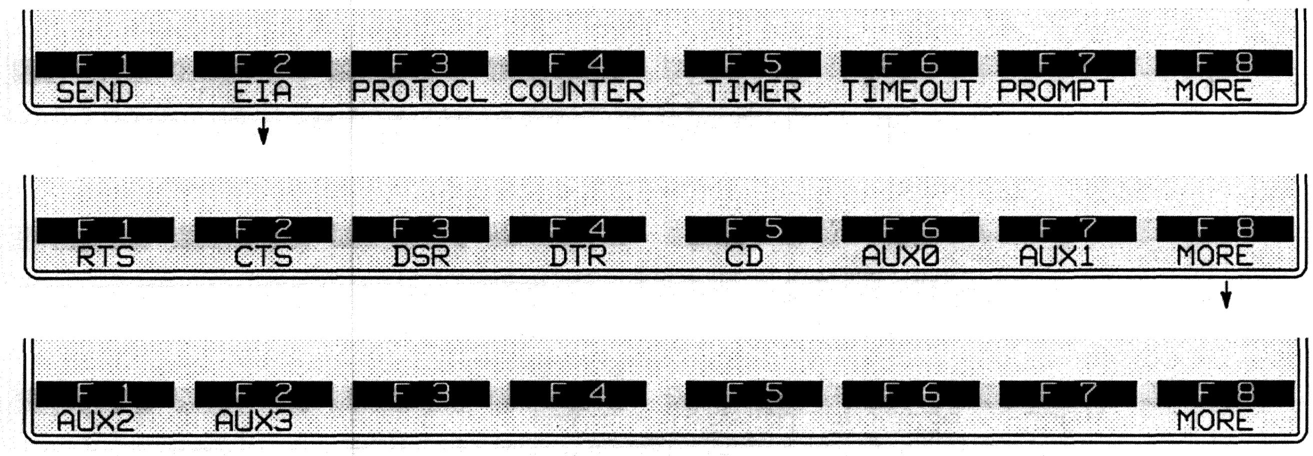


Figure 28-10 Five EIA leads and four AUX leads are under program control.

(C) Outsync

When the outsync action is taken, one or both receivers go out of synchronization from trigger true until the next synchronization pattern is received. All data that occurs in between outsync and resynchronization is considered "idle." If **Display Idle:** OFF is selected on the line setup, a receiver out of synchronization will prevent data from being presented to the screen and the character buffer as well as to the test program.

The outsync action also initiates the search for sync. Receivers that are already in sync do not look for sync. As soon as a receiver goes out of sync, the formatting logic begins to test for the one- or two-character sync pattern one bit at a time.

The outsync action may be useful when the information following a header group, for example, is of no interest. Simply go out of sync until the beginning of the next frame, when synchronization will restore the data display automatically. CAPTURE DTE (or DCE) OFF performs a similar function, except that "capture" must be turned on again by trigger when you want to resume the display.

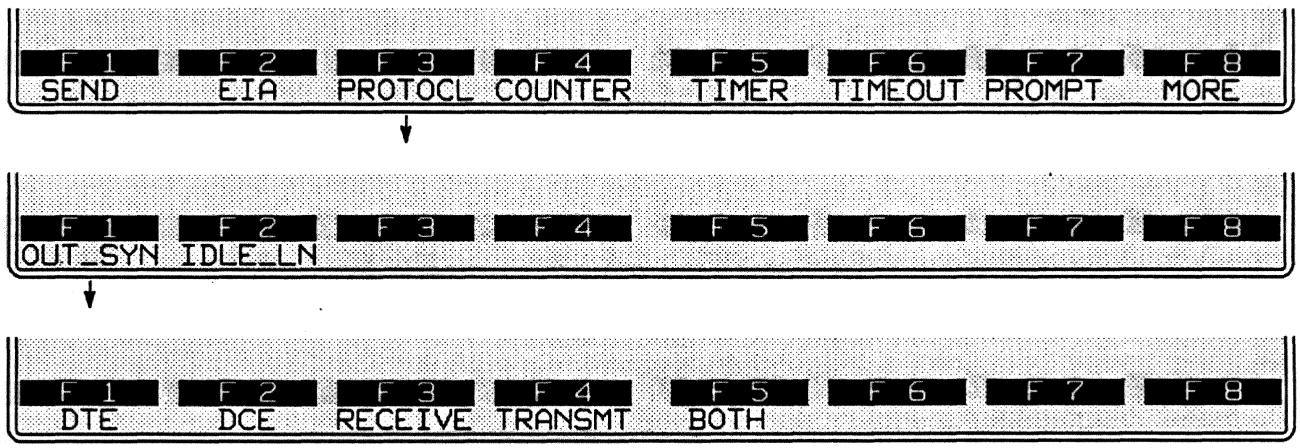


Figure 28-11 The spreadsheet program can force one or both data leads out of sync.

After you have pressed the OUT_SYN softkey or typed OUT_SYNC followed by a space, select one or both leads from the softkeys illustrated in Figure 28-11. RECEIVE and TRANSMT may refer to DTE or DCE, depending on your emulate mode at the moment. These selections allow you to change your emulation on the Line Setup menu without having to worry about changes to the spreadsheet program.

(D) Idle Line

IDLE_LINE allows you to use a trigger action to change the idle-line condition applied by the INTERVIEW. If you press the softkey for IDLE_LN (see Figure 28-11) or type IDLE_LINE followed by a space, the words **Enter Idle Character String** will appear on the prompt line in the softkey area at the bottom of the screen. Enter a single alphanumeric, control, or hexadecimal character in quotation marks. The red LED on the [HEX] key should be *on* for hexadecimal entry.

The idle-line action applies only when **Format:** SYNC has been selected on the Line Setup menu. This trigger action is useful for tests in protocols that employ different idle characters to signal changes in protocol state. An example is X.21 or X.21 BIS, which in various states will idle FF, NU, +, and so on.

Here is an example of an IDLE_LINE action:

ACTIONS: IDLE_LINE "+"

(E) Enhance

The spreadsheet program can be used to enhance display data selectively. Data on either or both sides of the line may be enhanced. Figure 28-12 shows typical reverse-image enhancements. Enhancements are stored in the character buffer for later review: see Section 11.3.

Enhancements that pertain to the plasma display are reverse-image, blink, and hex. In addition to these, a low-intensity enhancement can be applied to data that is transmitted to a black-and-white monitor connected at the RS-170 port (see Figure 1-6).

Blink, reverse and low enhancements activated by the trigger-menu or spreadsheet program can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how blink, reverse, and low enhancements relate to character and background colors in the RGB output.

Enhancements are available at every protocol level, but only Layer 1 enhancements affect the raw-data display. Higher-level enhancements are applied to the protocol trace for a given layer.

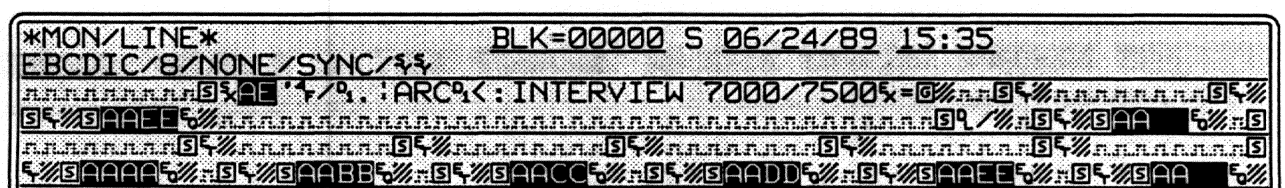


Figure 28-12 Enhancements may be used to highlight protocol fields.

After pressing the ENHANCE softkey or typing ENHANCE followed by a space, select one or both leads from the second level of softkeys in Figure 28-13.

Next, select the type of enhancement from the third tier of softkeys in Figure 28-13. Enhancements may be used in combination (such as reverse blink, or low-intensity reverse). Then at the final level, turn the enhancement ON or OFF.

1. *Reverse image.* Reverse-imaged characters are presented as dark letters on a lighter background.

2. *Low intensity.* This attribute does not affect data on the plasma display, which supports one display intensity only. Characters that are given this attribute will appear in low intensity on a CRT that is attached to the INTERVIEW through the RS-170 port.

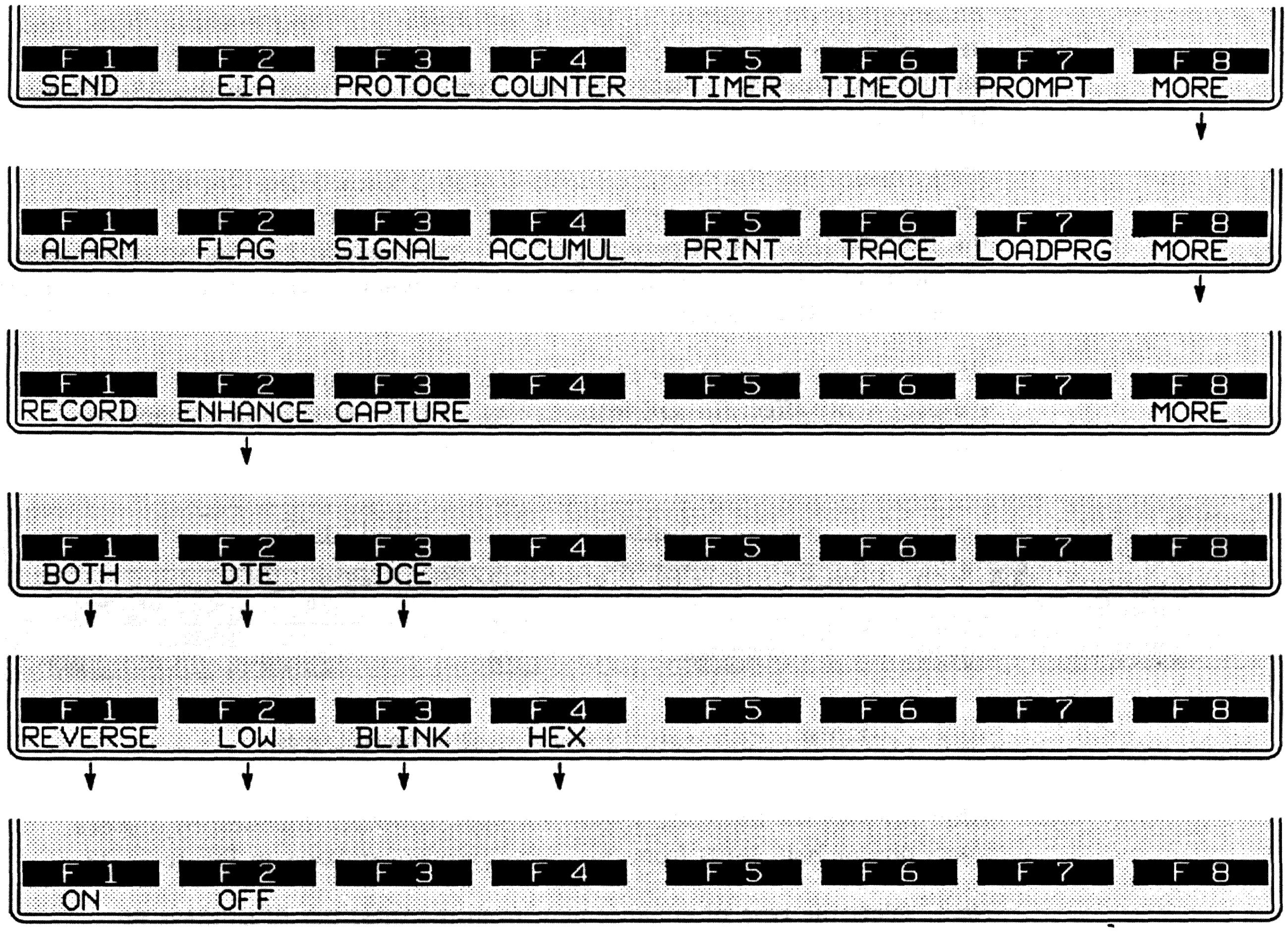


Figure 28-13 Layer 1 enhancements must be turned off as well as on by trigger.

3. *Blink.* BLINK causes data to be highlighted by a high-intensity area that blinks on and off. This is the most conspicuous highlight for small portions of data.

4. *Hexadecimal.* When the HEX enhancement is turned on, all data affected by the trigger is displayed in hexadecimal. Once data is stored in the buffer as hexadecimal, it remains in this format even if the [HEX] key is toggled.

   Refer to Figure 5-17 for data in which hex translation has been turned on for protocol characters and off for user (ASCII) data.

(F) Capture

This action turns on and off the presentation of data to the screen—that is, it stops or "freezes" the display—and capture of data to the screen buffer (character RAM). Unlike the Manual Freeze mode initiated by the [FREEZE] key, however, the "capture off" action does not allow you to scroll through the buffer while the test continues.

This action allows you to use the spreadsheet program to find important data and then preserve it in the buffer when it would otherwise be overwritten and lost.

Here is a sample capture action:

ACTIONS: CAPTURE BOTH OFF

where OFF means freeze the display and BOTH means with respect to DTE and DCE.

After pressing the CAPTURE softkey or typing CAPTURE followed by a space, select DCE, DTE, or BOTH from the rack of softkeys shown in Figure 28-14. On a subsequent set of softkeys, select ON or OFF as the capture action.

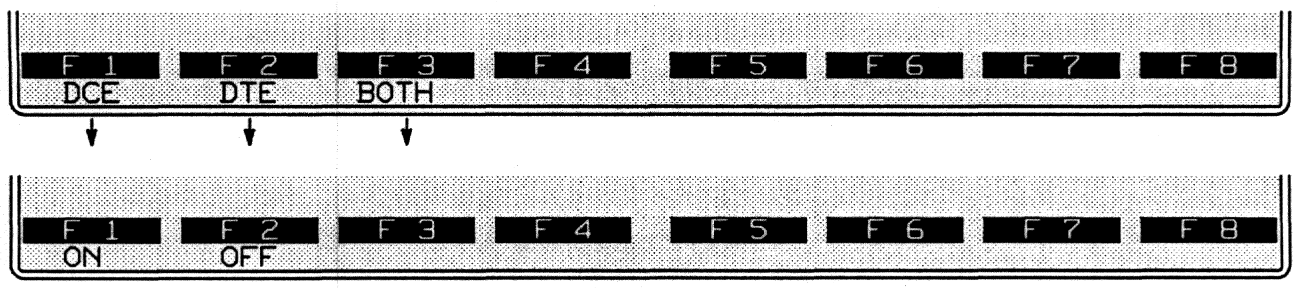


Figure 28-14 Screen display ("capture") can be turned on or off with respect to one data lead or both.

1. *DCE*. This option disables or enables the buffering and display of DCE (RD) data. Suppressing one data lead only does not serve the purpose of preserving data indefinitely in the buffer, since the other lead eventually will overwrite the buffer.

2. *DTE*. The TD lead by itself can likewise be suppressed or displayed.

3. *BOTH*. This option suppresses or displays all data.

4. *ON*. This action enables buffering and display of the selected data.

5. *OFF*. This action suspends buffering and display.

29 Strings

A string on the Protocol Spreadsheet is a sequence of text characters that the operator encloses in quotation marks and enters following certain keywords. Strings are valid in both conditions (at Layer 1) and actions (at any layer). Depending on its use in the program, the string may be searched for, transmitted, printed out, or written to the screen while the program is running.

"Lists" are a subset of strings with an important distinguishing feature: where a string is a sequence of characters, a list is a set of single characters. Examples of lists are one-of conditions at Level 1 of the spreadsheet, or keyboard conditions at any level.

Apart from Layer 1 receive conditions and transmit actions at all layers (discussed below), strings are valid also in KEYBOARD conditions, where a list of keys may be entered, any one of which will satisfy the condition; in IDLE_LINE actions, where a single-character "string" entry represents the new idle character; in LOAD_PROGRAM actions, where the string must match the absolute pathname of the file to be loaded; and in PROMPT and TRACE actions.

All ASCII-keyboard, control, and hexadecimal characters are legal both in receive and transmit strings.

Two ASCII characters are treated in a special way. If you wish to include a quotation mark within a string, you must precede it with a backslash character (\"). If you wish to include a backslash character in a string, you must precede it with a second backslash character (\\). A single backslash is never included in the string.

Control characters are entered into text strings by the action of the [CTRL] key together with the key that bears the control-character mnemonic at the top right corner. Note that CR ("carriage return") is the mnemonic at the top right corner of the [M] key. Press [CTRL]-[M] to enter CR into a text string. The [RETURN] key does not produce a character entry.

Table 29-1
Valid Entries in Receive Strings

Type entry	Example	Key sequence	Example in string or list (1of)	This data satisfies string condition	Data beginning (arbitrarily) w/ AB satisfies 1of condition
ASCII	2	[2]	"123"	123	AB2
"	\"	[\] [SHIFT]-[']	"1\"3"	1"3	AB"
\	\\	[\] [\]	"1\\3"	1\3	AB\
Control	$^{S}_{V}$	[CTRL]-[V]	"1$^{S}_{V}$3"	1$^{S}_{V}$3	AB$^{S}_{V}$
Hex	$^{0}_{B}$	[HEX] [0] [B]	"1$^{0}_{B}$3"	1$^{0}_{B}$3	AB$^{0}_{B}$
Not Equal	~~2~~	[NOT EQUAL] [2]	"1~~2~~3"	113	A
Bit Mask	((XXXX1111))	[CTRL]-[9] [X] [X] [X] [X] [1] [1] [1] [1] [CTRL]-[0]	"1((XXXX1111))3"	1$^{0}_{F}$3	AB$^{0}_{F}$
Not equal to bit mask	■XXXX1111))	[NOT EQUAL] [CTRL]-[9] [X] [X] [X] [X] [1] [1] [1] [1] [CTRL]-[0]	"1■XXXX1111))3"	123	A
Don't Care	[X]	[DON'T CARE]	"1[X]3"	153	A
Flag	[F]	[FLAG]	"1[F]3"	1[F]3	AB[F]
Sync	[S]	[SHIFT]-[FLAG]	"1[S]3"	1[S]3	AB[S]
Constant	((A)) where A is defined in a CONSTANT field as A = "abcdefg"	[CTRL]-[9] [SHIFT]-[A] [CTRL]-[0]	1((A))3	1abcdefg3	ABabcdefg

29.1 Strings To Be Matched Against Line Data

String conditions are legal in STRING and ONE_OF conditions at Layer 1 only.

Receive strings (and DTE/DCE strings) have a size limit of 32 characters. Their size cannot be expanded through the use of constants. (Any constants will be expanded *before* the size limit is enforced during compilation of the program.)

(A) Special Characters

Of the special-character keys, [NOT EQUAL], [DON'T CARE], [FLAG], and [SHIFT]–[FLAG] (for the [S] character) are valid. [BIT MASK] is not valid. Bit masks are entered in receive strings by the keying sequence illustrated in Table 29-1.

(B) Embedded Strings ("Constants")

The string represented by a constant may be embedded in a receive string or a list. A constant is a textual string that is represented by a symbolic name. This name is inserted into a string or list inside of double parens. Double parens are special non-ASCII characters produced on the keyboard by [CTRL]–[9] and [CTRL]–[0].

An example of a constant used in a spreadsheet condition is the following:

```
CONDITIONS:
  RECEIVE STRING "((ADDR_A))ED"
```

The data that satisfies this string will depend on the definition of the constant. Here is one possible definition:

```
CONSTANTS:
  ADDR_A = "AA7F7F"
```

The data that satisfies the condition will include the expanded constant along with the rest of the string: AA7F7FED.

29.2 Strings To Be Transmitted

Only Layer 1 allows the user to type in a *complete* transmit string, character by character. In the following transmit string, the entire transmission including sync characters is inside of quotation marks:

```
SEND "SYSYDL7O" NO_BCC
```

At higher layers, the user types the names of protocol units and values as "keywords" and the software converts these elements to strings. Immediately following the keyword entries, the user may add a string in quotation marks. Here is an example of a string following non-string entries in Layer 2 SDLC:

```
SEND FRMR ADR=C1 P/F=1 "116608" GDBCC
```

All ASCII-keyboard, control, and hexadecimal characters are legal in a transmit string. None of the special-character keys (NOT EQUAL, BIT MASK, DON'T CARE, FLAG) is valid.

(A) Constant

Constants may be transmitted. Simply place the name of the constant inside of double parens and insert the unit into the string. While the test is being compiled, the constant is replaced in the string by the text that is assigned to it.

The canned "fox" message is a built-in constant named FOX that is defined internally as follows: FOX = "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789." An example of the FOX constant as it appears in a transmit string is given in Table 29-2.

(B) Transmit Variables

Certain variables may be transmitted also. Any number of counters and flags may have their values transmitted at any point.

If a counter or flag is named inside of double parens in a transmit string, the current hexadecimal value of the *low-order byte* of that counter or flag is transmitted with the rest of the string. An example of a counter used in a transmit string is given in Table 29-2.

In order to be referenced in a transmit string, a counter or flag must first be created in a trigger-menu or spreadsheet condition or action. The counter or flag need not be named on a statistics screen.

Do not name a counter (or flag) in a transmit string if has the same name as another flag (or counter). It is unpredictable which one will be transmitted.

The low-order byte of a counter or flag is the default byte to be transmitted. The second byte will be transmitted instead if the name of the counter or flag is followed by **[1]** inside of the double parens. Here is an example of a Layer 2 transmission that includes both bytes of a flag named **seq** (as well as a fox message):

SEND INFO ADR=C1 NR=AUTO NS=AUTO "$^{2}_{C}$$^{0}_{0}$$^{0}_{2}$$^{0}_{1}$((seq[1]))((seq))$^{0}_{3}$$^{9}_{0}$$^{8}_{0}$5F((FOX))$^{1}_{3}$"

Flags are two bytes long, counters are four. All four bytes of a 32-bit counter may be transmitted. Here is a transmit string that sends a complete counter named **fourbyte**:

SEND " counter = ((fourbyte[3]))((fourbyte[2]))((fourbyte[1]))((fourbyte)) "

(C) Data Request

A transmit string that is created at one protocol layer may be passed down transparently to lower layers, one layer at a time. A user-entered message that is sent down at Layer 4, for example, is detected at Layer 3 as an N_DATA REQ primitive and may be handed down to Layer 2 as an "((N_DATA))" string.

The string is appended either to a SEND DATA action (or to a DL_DATA REQ primitive). See the example below. The SEND DATA action will append a packet header to the N-data automatically. The DL_DATA REQ primitive will not add a header to the N-data string; but the user may enter additional data inside of the quotation marks (*not* inside the double parens).

Layer 2, in turn, detects the data as a DL_DATA REQ primitive, and may hand it down to Layer 1 in the form of a "((DL_DATA))" string appended to a SEND INFO action (or to a PH_DATA REQ primitive).

```
LAYER: 4
     STATE: transport
        CONDITIONS: KEYBOARD " "
        ACTIONS: N_DATA REQ "((FOX))"
LAYER:3
     STATE: network
        CONDITIONS: N_DATA REQ
        ACTIONS: SEND DATA PATH= 0 "((N_DATA))"
LAYER:2
     STATE: datalink
        CONDITIONS: DL_CONNECT REQ
        ACTIONS: DL_CONNECT CONF
        CONDITIONS: DL_DATA REQ
        ACTIONS: SEND INFO "((DL_DATA))"
```

Data is sent up the layers also. The mechanism for passing data upward is the GIVE_DATA action included in the protocol personality package at each layer. Since the user will not normally wish to add protocol headers to upward-moving data, this data is not treated as a separable string inside of quotation marks. It is passed upward transparently in the GIVE_DATA action.

Table 29-2
Valid Entries in Transmit Strings

Type entry	Example	Key sequence	Example in transmit string	Data transmitted
ASCII	2	[2]	"123"	123
"	\"	[\] [SHIFT]-[']	"1\"3"	1"3
\	\\	[\] [\]	"1\\3"	1\3
Control	$^{S}_{Y}$	[CTRL]-[V]	"1$^{S}_{Y}$3"	1$^{S}_{Y}$3
Hex	$^{0}_{B}$	[HEX] [0] [B]	"1$^{0}_{B}$3"	1$^{0}_{B}$3
Constant	⟪A⟫ where A is defined in a CONSTANTS field as A = "abcdefg"	[CTRL]-[9] [SHIFT]-[A] [CTRL]-[0]	"1⟪A⟫3"	1abcdefg3
Fox	⟪FOX⟫	[CTRL]-[9] [CAPS LOCK] [F] [O] [X] [CTRL]-[0]	"1⟪FOX⟫3"	1THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 01234567893
Counter or flag, (low-order byte)	⟪addr⟫ where addr is the name of a counter with a current decimal value of 14	[CTRL]-[9] [A] [D] [D] [R] [CTRL]-[0]	"1⟪addr⟫3"	1$^{0}_{E}$3
Counter or flag, second byte	⟪seq[1]⟫ where seq is the name of a flag, the second (high-order) byte of which has a binary value of 01010100	[CTRL]-[9] [S] [E] [Q] [[] [1] []] [CTRL]-[0]	"1⟪seq[1]⟫3"	1$^{5}_{4}$3
Data in a data-request primitive	⟪DL_DATA⟫ at Layer 2, where Layer 3 string is fox message and Layer 3 header is $^{1}_{0}{}^{0}_{7}{}^{6}_{E}$	[CTRL]-[9] [D] [L] [SHIFT]-[-] [D] [A] [T] [A] [CTRL]-[0]	"1⟪DL_DATA⟫3"	1$^{1}_{0}{}^{0}_{7}{}^{6}_{E}$THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 01234567893

30 OSI Primitives on the Protocol Spreadsheet

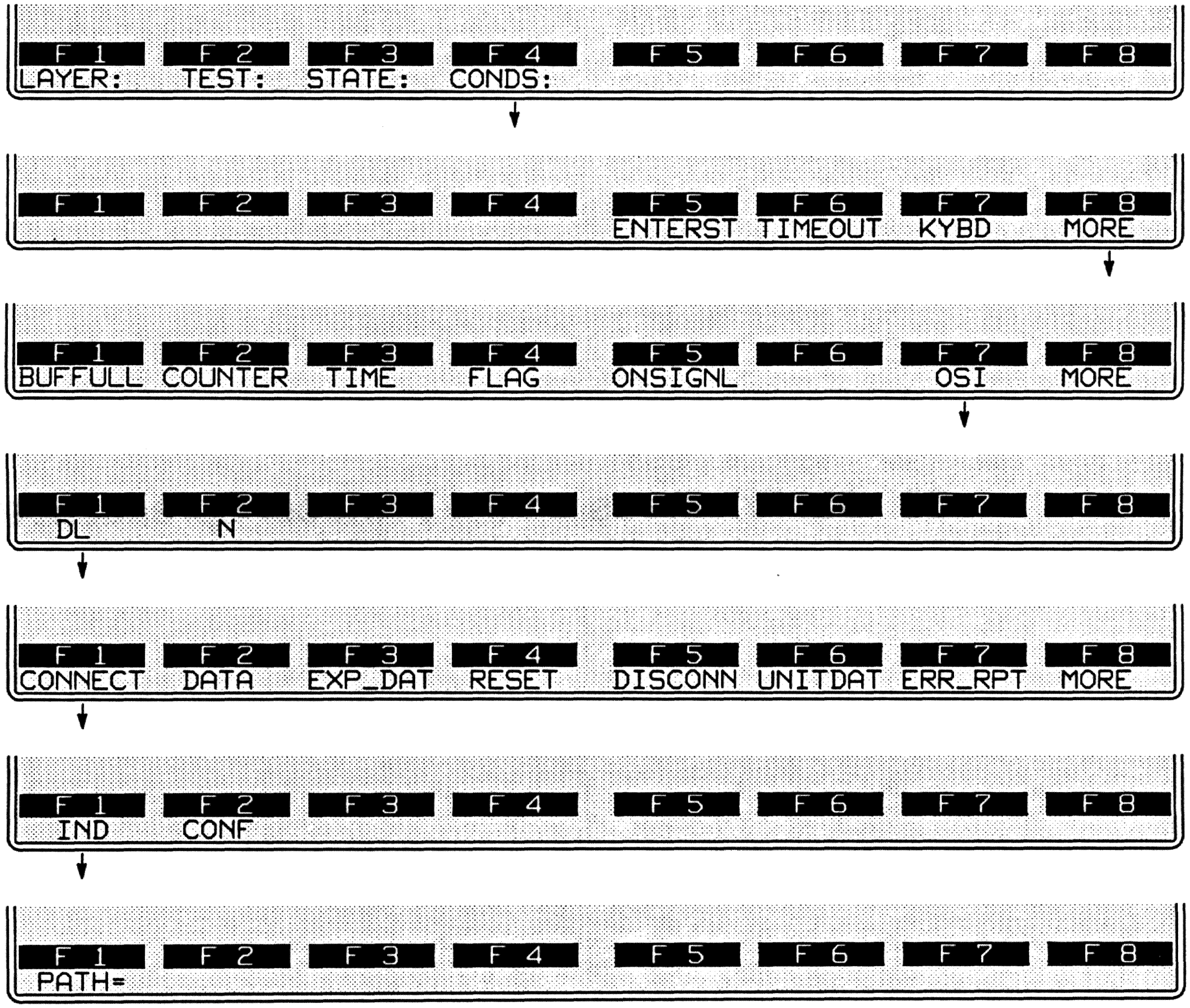


Figure 30-1 The softkey path for a *DL_CONNECT IND* condition primitive at Layer 3.

30 OSI Primitives on the Protocol Spreadsheet

Primitives are defined in the Open Systems Interconnect (OSI) Reference Model as protocol-independent interactions between adjacent layers of the model.

For example, data that comes into the INTERVIEW at Layer 1 or starts down the OSI "ladder" at a layer above Layer 1 is stored in a structure called an *IL* (interlayer) buffer. This buffer is passed between layers along with a primitive data unit (PDU), or primitive.

Since primitives are layer-specific, they are not available on the Trigger menus which offer conditions and actions at Layer 1. You must use the Protocol Spreadsheet to send, receive, or monitor primitives.

The Protocol Spreadsheet is divided into seven layers in accordance with the OSI model. By giving the operator control of the boundaries between these layers, primitives make layered programming possible.

Primitives for a given OSI layer may be entered in the Protocol Spreadsheet whether or not a protocol personality package is loaded in for that layer. Table 30-2 lists the primitives that may be entered on the current Protocol Spreadsheet. Due to the uncomplicated, "always-connected" nature of the RS-232/V.24, V.35, and RS-449 interfaces, Layer 1 primitives are automatic and do not appear on the Protocol Spreadsheet for that layer. OSI service for Layers 2 through 7 currently is available.

> **NOTE:** Unless a Layer 1 package (such as DDCMP) is loaded in, primitives are not available when **Format:** SYNC is selected on the Line Setup screen.

On the Protocol Spreadsheet, primitives take the form of conditions and actions. A condition primitive monitors the layer boundaries for action primitives that are sent down from above or up from below. An action primitive at any layer is sent either up or down to the next layer. Each primitive is shared by two layers. DL_CONNECT IND, for example, is an action primitive at Layer 2. At Layer 3, the same primitive is a condition. The prefix (DL) is an abbreviation for the name of the lowermost layer (Data Link) which shares the primitive. Table 30-1 lists all primitive prefixes and the layers which share them.

Table 30-1
Primitive Prefixes and Associated Layers

Prefix	Lowest Layer of Operation	Shares with Layer
PH	Physical (Layer 1)	2
DL	Data Link (Layer 2)	3
N	Network (Layer 3)	4
T	Transport (Layer 4)	5
S	Session (Layer 5)	6
P	Presentation (Layer 6)	7

30.1 Softkey Selections

The condition and action primitives specific to a given layer will be arrayed on softkeys that appear when you press the softkey for OSI. OSI is F7 on the second rack of condition softkeys. Figure 30-1 shows the softkey path to an OSI condition primitive at Layer 3. OSI is F1 on the third rack of action softkeys. Layer-specific softkey racks corresponding to the following general categories appear successively as selections are made:

(A) Direction

Indicate the direction from which the condition primitive will come. At Layer 3, for example, the first choice (DL) will detect primitives handed up from the layer below; the second selection (N) will detect primitives handed down from the layer above. As an action, you select the direction which you wish the primitive to go: the first choice (DL) sends the primitive to the layer below; the second selection (N) sends the primitive to the layer above.

(B) Type

Choose among the primitive types offered at each layer. Each layer has its own set of primitives, but they all can be grouped into four major phases: establishment, data transfer, release, and debug and error reporting.

In the establishment phase, a layer establishes a connection with the layer above and/or below. The activate and connect primitives provide this function. Data transfer is accomplished via the data, expedited data, and reset primitives. Deactivate and disconnect primitives break the connection between layers in the release phase. Debug and error reporting primitives include debug, error report, and unitdata.

(C) Request/Response

For some primitives, you must indicate whether you are searching for—or sending—a request (REQ or IND) or a response (RESP or CONF). INDications and CONFirms come from the layer below or go to the layer above; REQuests and RESPonses come from the layer above or go to the layer below.

(D) Path

Provide a path, if necessary. Interlayer primitives must handle channel or "path" information in order to insure that data moving down from Layer 4 is given the correct logical channel at Layer 3, or that data moving from Layer 3 to Layer 2 bears the correct frame address when it goes out on the data link.

A softkey sequence that leads to the PATH= selection for a primitive on the Protocol Spreadsheet is shown in Figure 30-2.

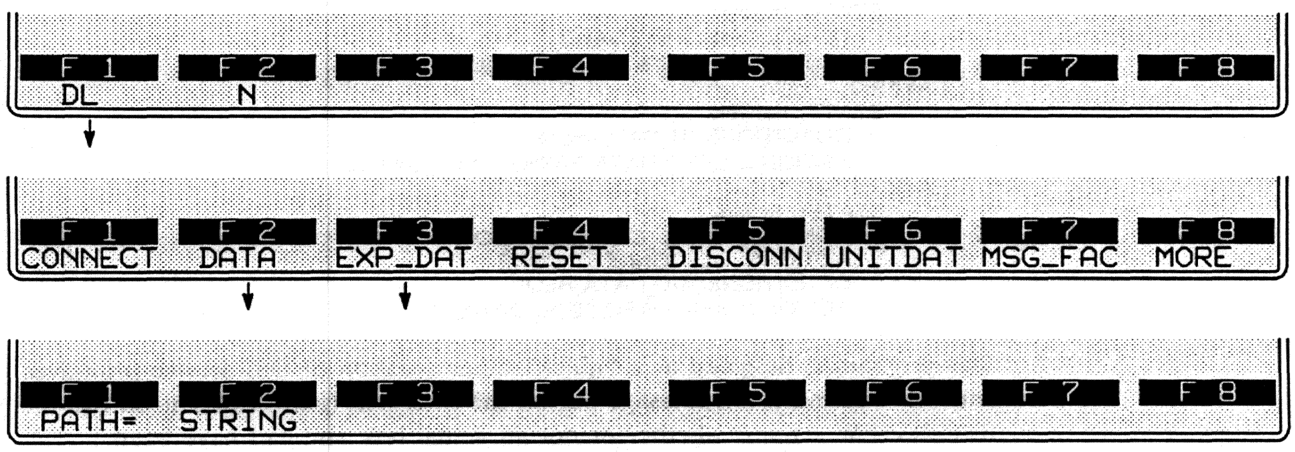


Figure 30-2 *DATA* **and** *EXPEDITE_DATA* **action-primitives may carry path information as well as a data string.**

Refer to Section 34.1(E) for a discussion of how paths are tied to call parameters (and directly or indirectly to logical channel numbers) via user entries on the Packet Level Setup screen (Figure 34-2) at X.25 Layer 3.

Primitive paths are only an important consideration when more than one layer is multiaddress or multichannel. In that situation, the vertical path numbers should match. Layer 3 might provide several logical channels, for example, while Layer 2 services more than one link address. When a set of call parameters is assigned by the user to path #1 at Layer 3, path #1 on the setup screen at Layer 2 should reference the appropriate link address for that call.

Remember that data primitives along with their path parameters usually are handled automatically (see Section 31). Automatic primitives will carry the same path information as the SEND or GIVE_DATA actions that generated them.

(E) String

Optional *strings* may be added to DATA or EXPEDITED_DATA action-primitives at any layer. A string is external data that is referenced in the list node of an interlayer buffer. (See Figure 63-1.) This buffer is passed with the selected primitive. One special use of the string field is to identify an IL buffer that has just been handed down from above. The macro N_DATA (or T_DATA or PH_DATA) enclosed in double parens in a data-primitive string field will identify the buffer that was just received from above. When the current action primitive is processed, the IL buffer will be passed to the layer below. One softkey sequence leading to a string selection is given in Figure 30-2. Always enclose a string in double quotation marks.

Here is an example of a data primitive at Layer 4 passing a string down to the next layer below:

```
LAYER: 4
     STATE: transport
        CONDITIONS: KEYBOARD " "
        ACTIONS: N_DATA REQ "((FOX))"
LAYER:3
     STATE: network
        CONDITIONS: N_DATA REQ
        ACTIONS: SEND DATA PATH= 0 "((N_DATA))"
LAYER:2
     STATE: datalink
        CONDITIONS: DL_CONNECT REQ
        ACTIONS: DL_CONNECT CONF
        CONDITIONS: DL_DATA REQ
        ACTIONS: SEND INFO "((DL_DATA))"
```

This program is designed as a "quick" demonstration of OSI service primitives and will transmit a fox message out on the interface (and display it on the INTERVIEW screen) whether or not an actual link and call have been established. (Layer packages must of course be loaded in at Layers 2 and 3.) Note the following:

- The action at Layer 4 forces the fox message down to Layer 3.
- The SEND DATA action at Layer 3 adds an appropriate Layer 3 header to whatever data is referenced in the action.
- The string that contains the macro ((N_DATA)) indicates that the Layer 3 header should be copied into the IL buffer that was passed with the N_DATA primitive from Layer 4.
- The same SEND action at Layer 3 triggers an automatic DL_CONNECT REQUEST primitive, since Layer 3 does not send *packets* to Layer 2 unless the link has been established.
- The Layer 2 program bypasses link-establishment by forcing a DL_CONNECT CONFIRM primitive up to 3.

- Now the data packet can be passed down to Layer 2, where a SEND INFO action inserts a frame header in the buffer received (in a DL_DATA REQ primitive) from Layer 3.
- Layer 1 primitives are automatic.

The fox message will also be transmitted if DATA REQUEST primitives are used instead of SEND actions at Layers 2 and 3 (or if no protocol packages are loaded); but the data in that case will not receive protocol headers.

30.2 Sample Primitives: CONNECT INDs and CONNECT REQs

Figure 30-3 and Figure 30-4 illustrate the flow of "connect" primitives between Layer 2 and Layer 3. The primitives in the figures are the labeled arrows positioned between the layers.

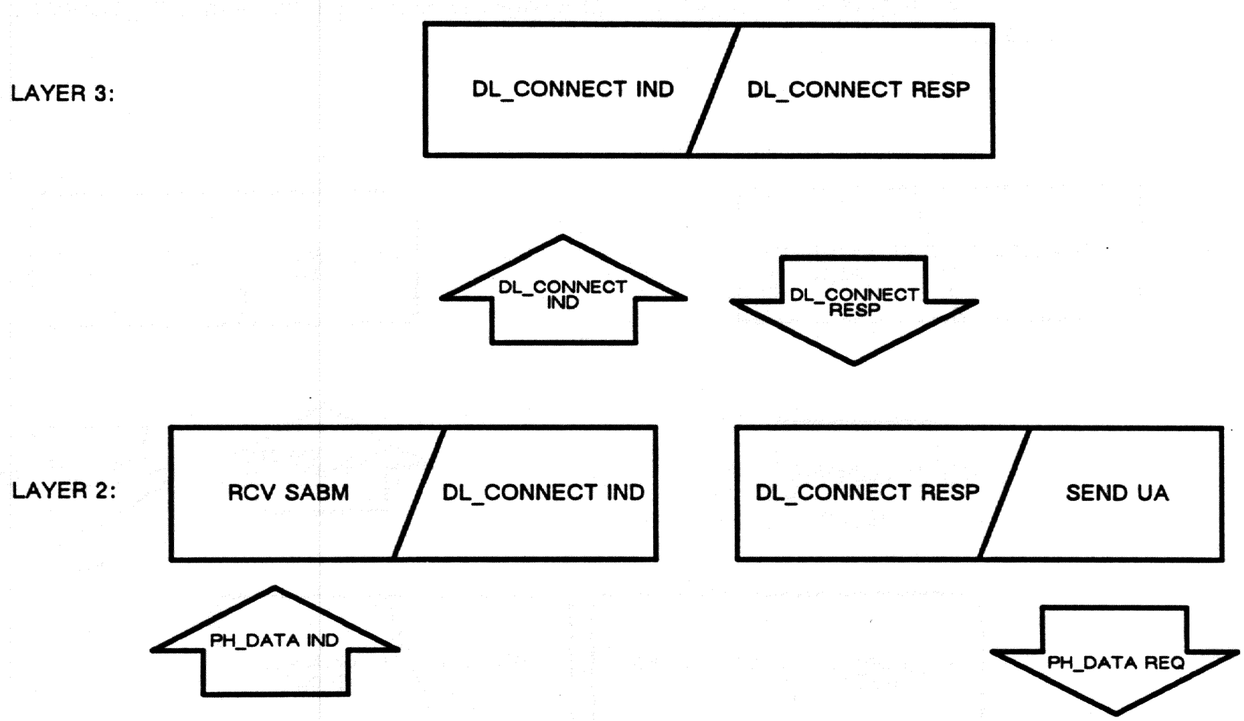


Figure 30-3 The (arrow-shaped) primitives moving between Layers 2 and 3 are intended to satisfy Layer 2 that a Layer 3 entity really is "up there." (The three rectangles contain spreadsheet conditions and actions.)

In Figure 30-3, Layer 2 receives a Set Mode command (SABM) from the data link. Before it responds positively (UA) to this command, Layer 2 passes up a DL_CONNECT IND primitive in order to verify that a Layer 3 entity really is "up there." When the active status of a Layer 3 entity is confirmed, Layer 2 sends the positive response (UA) down to Layer 1 and out onto the link to invite its Layer 2 peer to begin transferring data (Info frames).

The spreadsheet block that accomplished this exchange of primitives would be the following:

```
LAYER: 2
     STATE:establish_link
        CONDITIONS: RCV SABM
        ACTIONS: DL_CONNECT IND
        CONDITIONS: DL_CONNECT RESP
        ACTIONS: SEND UA
LAYER: 3
     STATE: dl_connect
        CONDITIONS: DL_CONNECT IND
        ACTIONS: DL_CONNECT RESP
```

In Figure 30-4, the request for confirmation of an adjacent layer is downward. Layer 3 wishes to send a Restart packet to the Layer 3 entity on the other side of the link; but it doesn't want to pass the packet down to Layer 2 if there is no mechanism at that layer to handle it. So Layer 3 precedes the Restart packet with a DL_CONNECT REQ primitive.

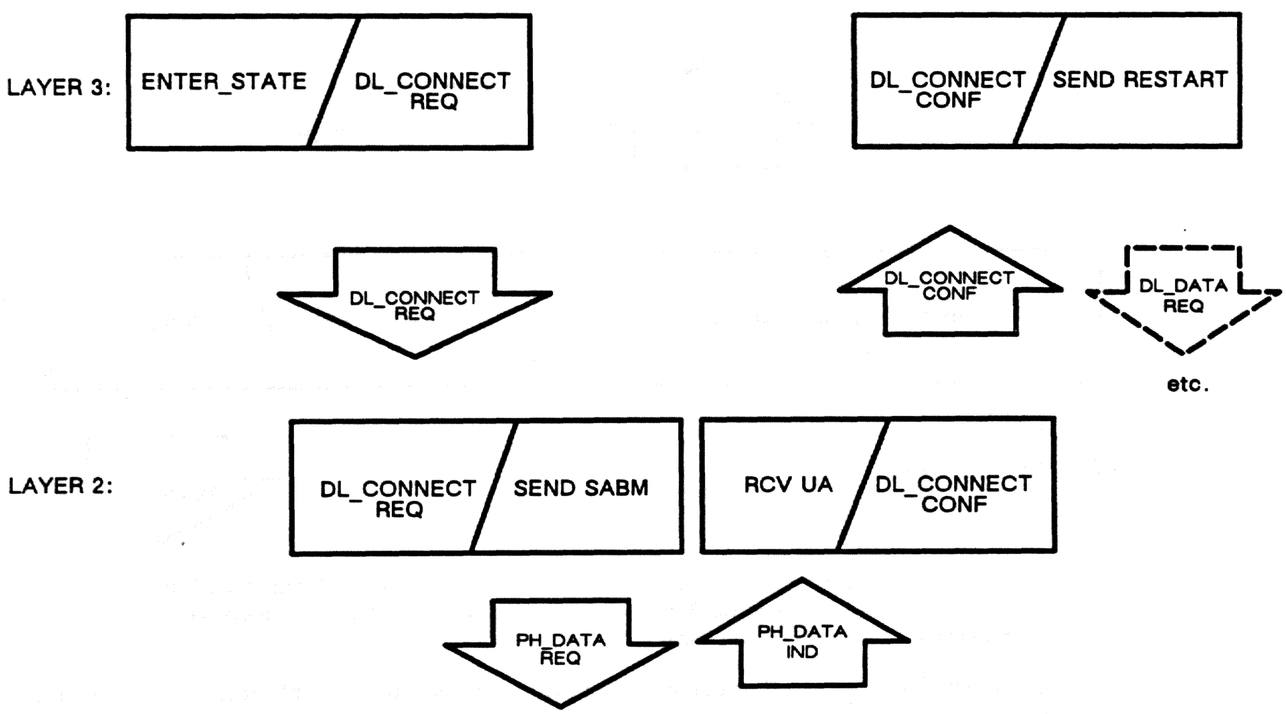


Figure 30-4 Layer 3 uses connect primitives to be sure that the Layer 2 entity below has established a link.

In the scenario illustrated in the figure, Layer 2 has not yet established the link. It responds to the connect-request primitive by sending a SABM, the X.25 command that initiates "connection" between link-level peers. When the SABM is acknowledged in a UA response, Layer 2 gives the DL_CONNECT CONF primitive up to Layer 3.

30.3 Sample Primitives: DATA INDs and DATA REQs

Figure 30-5 illustrates the primitives that are generated and monitored by the Protocol Spreadsheet when data is passed in both directions through an intermediate protocol layer (Layer 2). In this example, X.25 is the protocol package loaded in for both Layer 2 and Layer 3. Here a call-request packet is passed up through Layer 2 and received at Layer 3, and a call-confirm packet is sent down by Layer 3. The primitives in the figure are the labeled arrows positioned between the layers.

Data is in the form of physical-layer (PH) data when it moves in either direction between Layer 1 and Layer 2. PH_DATA primitives control the movement of this data. In between Layers 2 and 3, the data takes the form of data-link-layer (DL) data, with DL_DATA primitives responsible for data-delivery.

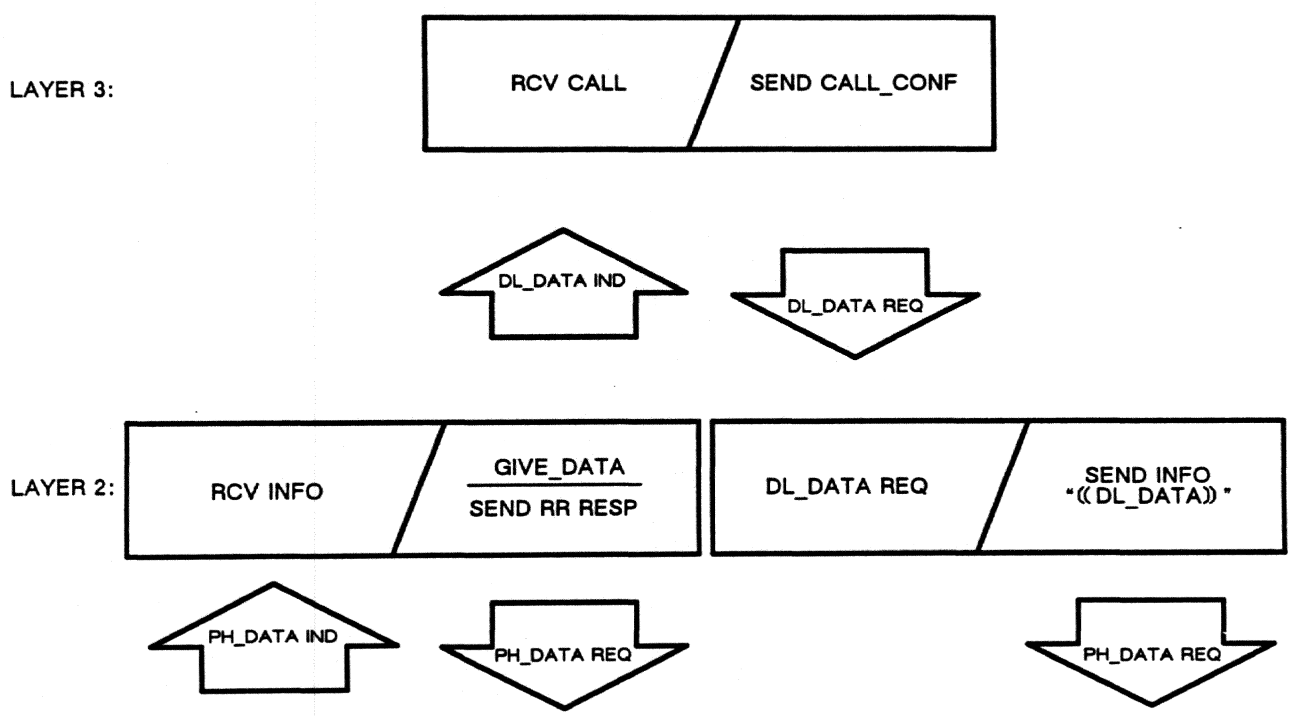


Figure 30-5 These (arrow-shaped) primitives are generated and monitored at Layer 2 when Layer 3 receives and sends data. (The three rectangles contain X.25 conditions and actions.)

The PH and DL versions of the data are not exactly the same. DL data has one less layer of protocol attached to it. In the example in Figure 30-5, the Layer 2 protocol was stripped off by the GIVE_DATA action when the call-request packet was being passed upward. On the call-confirm packet's trip down through the layers, Layer 2 protocol was added to the DL data by the SEND action—thus yielding PH data.

Note that "DL data" refers to data that moves above the DL layer (Layer 2), not below it. "DL data" can be taken literally to mean that as far as the DL layer is concerned, this is pure data, with no protocol that is recognizable at Layer 2.

When data is being passed upward, the primitives that signal the data are called indications (DATA INDS). When data is sent downward, the primitives at each layer are termed requests (DATA REQS).

Table 30-2
OSI Service Primitives

	Conditions		Actions	
Layer	From Layer Below	From Layer Above	To Layer Below	To Layer Above
7	P_CONNECT IND P_CONNECT CONF P_DATA IND P_EXPEDITED_DATA IND P_RELEASE IND P_RELEASE CONF P_UNITDATA IND P_ERROR_REPORT IND P_MGT_FACILITY IND P_DEBUG IND P_TD_DATA IND P_RD_DATA IND P_TD_EXPEDITED_DATA IND P_RD_EXPEDITED_DATA IND P_TD_UNITDATA IND P_RD_UNITDATA IND		P_CONNECT REQ P_CONNECT RESP P_DATA REQ P_EXPEDITED_DATA REQ P_RELEASE REQ P_RELEASE RESP P_UNITDATA REQ P_MGT_FACILITY REQ P_DEBUG REQ	
6	S_CONNECT IND S_CONNECT CONF S_DATA IND S_EXPEDITED_DATA IND S_RELEASE IND S_RELEASE CONF S_UNITDATA IND S_ERROR_REPORT IND S_MGT_FACILITY IND S_DEBUG IND S_TD_DATA IND S_RD_DATA IND S_TD_EXPEDITED_DATA IND S_RD_EXPEDITED_DATA IND S_TD_UNITDATA IND S_RD_UNITDATA IND	P_CONNECT REQ P_CONNECT RESP P_DATA REQ P_EXPEDITED_DATA REQ P_RELEASE REQ P_RELEASE RESP P_UNITDATA REQ P_MGT_FACILITY REQ P_DEBUG REQ	S_CONNECT REQ S_CONNECT RESP S_DATA REQ S_EXPEDITED_DATA REQ S_RELEASE REQ S_RELEASE RESP S_UNITDATA REQ S_MGT_FACILITY REQ S_DEBUG REQ	P_CONNECT IND P_CONNECT CONF P_DATA IND P_EXPEDITED_DATA IND P_RELEASE IND P_RELEASE CONF P_UNITDATA IND P_ERROR_REPORT IND P_MGT_FACILITY IND P_DEBUG IND P_TD_DATA IND P_RD_DATA IND P_TD_EXPEDITED_DATA IND P_RD_EXPEDITED_DATA IND P_TD_UNITDATA IND P_RD_UNITDATA IND

Table 30-2 (Continued)

	Conditions		Actions	
Layer	From Layer Below	From Layer Above	To Layer Below	To Layer Above
5	T_CONNECT IND	S_CONNECT REQ	T_CONNECT REQ	S_CONNECT IND
	T_CONNECT CONF	S_CONNECT RESP	T_CONNECT RESP	S_CONNECT CONF
	T_DATA IND	S_DATA REQ	T_DATA REQ	S_DATA IND
	T_EXPEDITED_DATA IND	S_EXPEDITED_DATA REQ	T_EXPEDITED_DATA REQ	S_EXPEDITED_DATA IND
	T_DISCONNECT IND		T_DISCONNECT REQ	
		S_RELEASE REQ		S_RELEASE IND
		S_RELEASE RESP		S_RELEASE CONF
	T_UNITDATA IND	S_UNITDATA REQ	T_UNITDATA REQ	S_UNITDATA IND
	T_ERROR_REPORT IND			S_ERROR_REPORT IND
	T_MGT_FACILITY IND	S_MGT_FACILITY REQ	T_MGT_FACILITY REQ	S_MGT_FACILITY IND
	T_DEBUG IND	S_DEBUG REQ	T_DEBUG REQ	S_DEBUG IND
	T_TD_DATA IND			S_TD_DATA IND
	T_RD_DATA IND			S_RD_DATA IND
	T_TD_EXPEDITED_DATA IND			S_TD_EXPEDITED_DATA IND
	T_RD_EXPEDITED_DATA IND			S_RD_EXPEDITED_DATA IND
	T_TD_UNITDATA IND			S_TD_UNITDATA IND
	T_RD_UNITDATA IND			S_RD_UNITDATA IND
4	N_CONNECT IND	T_CONNECT REQ	N_CONNECT REQ	T_CONNECT IND
	N_CONNECT CONF	T_CONNECT RESP	N_CONNECT RESP	T_CONNECT CONF
	N_DATA IND	T_DATA REQ	N_DATA REQ	T_DATA IND
	N_DATA_ACK IND		N_DATA_ACK_REQ	
	N_EXPEDITED_DATA IND	T_EXPEDITED_DATA REQ	N_EXPEDITED_DATA REQ	T_EXPEDITED_DATA IND
	N_RESET IND		N_RESET REQ	
	N_RESET CONF		N_RESET RESP	
	N_DISCONNECT IND	T_DISCONNECT REQ	N_DISCONNECT REQ	T_DISCONNECT IND
	N_UNITDATA IND	T_UNITDATA REQ	N_UNITDATA REQ	T_UNITDATA IND
	N_ERROR_REPORT IND			T_ERROR_REPORT IND
	N_MGT_FACILITY IND	T_MGT_FACILITY REQ	N_MGT_FACILITY REQ	T_MGT_FACILITY IND
	N_DEBUG IND	T_DEBUG REQ	N_DEBUG REQ	T_DEBUG IND
	N_TD_DATA IND			T_TD_DATA IND
	N_RD_DATA IND			T_RD_DATA IND
	N_TD_EXPEDITED_DATA IND			T_TD_EXPEDITED_DATA IND
	N_RD_EXPEDITED_DATA IND			T_RD_EXPEDITED_DATA IND
	N_TD_UNITDATA IND			T_TD_UNITDATA IND
	N_RD_UNITDATA IND			T_RD_UNITDATA IND

Table 30-2 (Continued)

Layer	Conditions		Actions	
	From Layer Below	From Layer Above	To Layer Below	To Layer Above
3	DL_CONNECT IND	N_CONNECT REQ	DL_CONNECT REQ	N_CONNECT IND
	DL_CONNECT CONF	N_CONNECT RESP	DL_CONNECT RESP	N_CONNECT CONF
	DL_DATA IND	N_DATA REQ	DL_DATA REQ	N_DATA IND
		N_DATA_ACK_REQ		N_DATA_ACK IND
	DL_EXPEDITED_DATA IND	N_EXPEDITED_DATA REQ	DL_EXPEDITED_DATA REQ	N_EXPEDITED_DATA IND
	DL_RESET IND	N_RESET REQ	DL_RESET REQ	N_RESET IND
	DL_RESET CONF	N_RESET RESP	DL_RESET RESP	N_RESET CONF
	DL_DISCONNECT IND	N_DISCONNECT REQ	DL_DISCONNECT REQ	N_DISCONNECT IND
	DL_UNITDATA IND	N_UNITDATA REQ	DL_UNITDATA REQ	N_UNITDATA IND
	DL_ERROR_REPORT IND			N_ERROR_REPORT IND
	DL_MGT_FACILITY IND	N_MGT_FACILITY REQ	DL_MGT_FACILITY REQ	N_MGT_FACILITY IND
	DL_DEBUG IND	N_DEBUG REQ	DL_DEBUG REQ	N_DEBUG IND
	DL_TD_DATA IND			N_TD_DATA IND
	DL_RD_DATA IND			N_RD_DATA IND
	DL_TD_EXPEDITED_DATA IND			N_TD_EXPEDITED_DATA IND
	DL_RD_EXPEDITED_DATA IND			N_RD_EXPEDITED_DATA IND
	DL_TD_UNITDATA IND			N_TD_UNITDATA IND
	DL_RD_UNITDATA IND			N_RD_UNITDATA IND
2	PH_ACTIVATE IND	DL_CONNECT REQ	PH_ACTIVATE REQ	DL_CONNECT IND
	PH_ACTIVATE CONF	DL_CONNECT RESP	PH_ACTIVATE RESP	DL_CONNECT CONF
	PH_DATA IND	DL_DATA REQ	PH_DATA REQ	DL_DATA IND
		DL_EXPEDITED_DATA REQ		DL_EXPEDITED_DATA IND
	PH_RESET IND	DL_RESET REQ	PH_RESET REQ	DL_RESET IND
	PH_RESET CONF	DL_RESET RESP	PH_RESET RESP	DL_RESET CONF
	PH_DEACTIVATE IND		PH_DEACTIVATE REQ	
		DL_DISCONNECT REQ		DL_DISCONNECT IND
		DL_UNITDATA REQ		DL_UNITDATA IND
	PH_ERROR_REPORT IND			DL_ERROR_REPORT IND
	PH_MGT_FACILITY IND	DL_MGT_FACILITY REQ	PH_MGT_FACILITY REQ	DL_MGT_FACILITY IND
	PH_DEBUG IND	DL_DEBUG REQ	PH_DEBUG REQ	DL_DEBUG IND
	PH_TD_DATA IND			DL_TD_DATA IND
	PH_RD_DATA IND			DL_RD_DATA IND
				DL_TD_EXPEDITED_DATA IND
				DL_RD_EXPEDITED_DATA IND
				DL_TD_UNITDATA IND
				DL_RD_UNITDATA IND

31 Automatic OSI Primitives

Often the Protocol Spreadsheet primitives that operate below a given layer are handled automatically by the protocol package at that layer.

Data primitives are automatic any time a SEND or GIVE_DATA softkey action is entered on the spreadsheet.

Connect Requests are automatic when the first spreadsheet data primitive is passed downward. The DL_CONNECT REQ in Figure 30-4 does not have to be entered in the user program. The connect request (but not the confirm) is handled automatically by the layer-package software, which assumes that the user never wishes to pass data *downward* to an empty layer.

The Connect Ind and Connect Resp primitives in Figure 30-3, on the other hand, are not automatic. They are completely at the discretion of the programmer of the Protocol Spreadsheet. If the programmer wishes Layer 2 to complete the link setup and begin transferring Info frames without the active participation of a higher layer, that is a viable alternative.

In the sequence in Figure 30-5 all of the primitives designated by arrows—with one exception—are generated and monitored automatically by the RCV, GIVE_DATA, and SEND spreadsheet entries. (The lone exception is the DL_DATA REQ primitive that is used as a condition in Layer 2.) This automatic handling of primitives frees the user at the top layer from programming considerations outside of his own immediate protocol.

When protocol packages are loaded, monitor primitives (such as DL_TD_DATA IND) are passed up the layers automatically. These primitives allow the Layer 2 and Layer 3 protocol-trace screens to display frame and packet information even when emulate primitives have not been passed up.

Automatic handling of primitives will vary with different protocols. Refer to the sections on the individual protocols for information on which primitives are tied to which protocol conditions and actions.

32 X.21 Layer 1

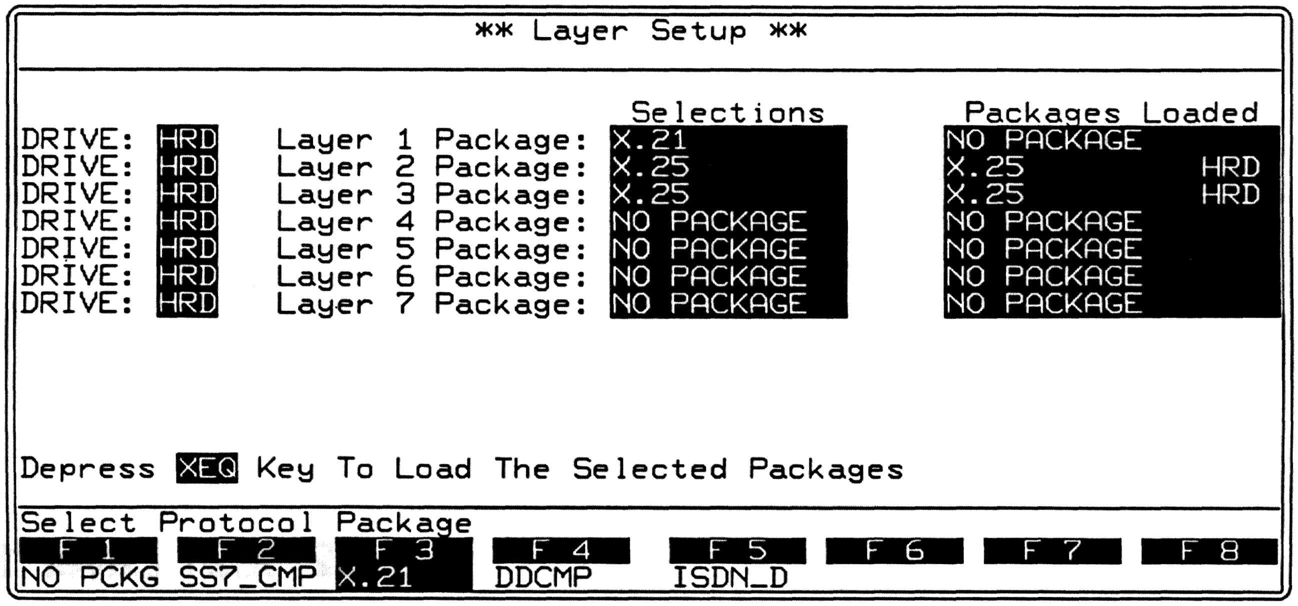


Figure 32-1 In addition to being a Test Interface Module, X.21 is a "layer-personality package" of softkey functions at Layer 1.

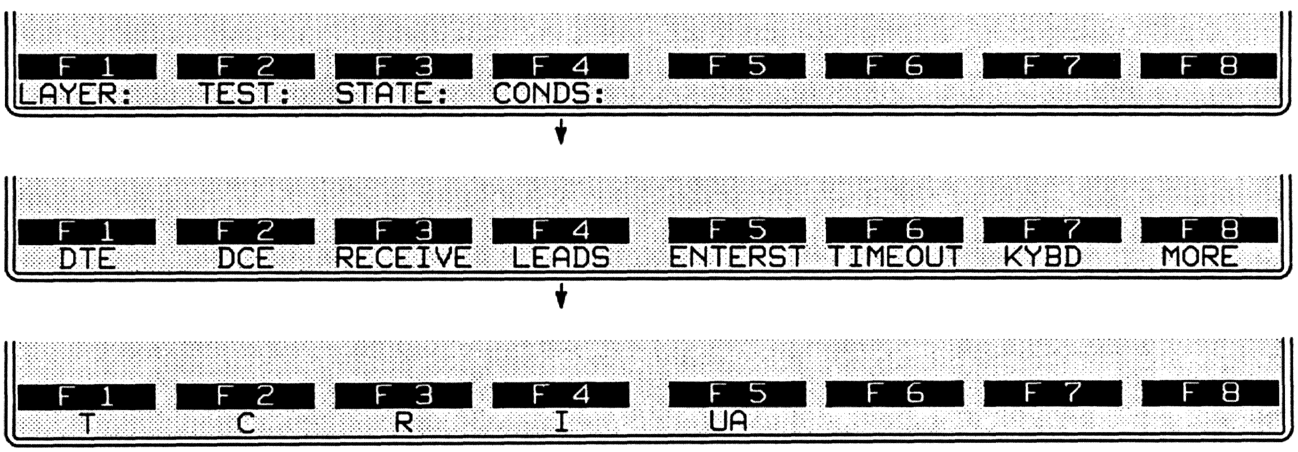


Figure 32-2 A special set of leads are available for monitoring once the X.21 package has been loaded in.

32 X.21 Layer 1

In addition to being a Test Interface Module (see Section 46), X.21 is a "layer personality package" of functions loaded into memory from disk via the Layer Setup screen. Figure 32-1 shows the Layer Setup screen configured to load in the X.21 package from the hard–disk drive. Refer to Section 6 for information on operating the Layer Setup screen.

The X.21 package consists of a group of conditions and actions at Layer 1 on the Protocol Spreadsheet that facilitate X.21 programming. Figure 32-2 shows the softkey path to a rack of condition softkeys that represent X.21 leads. These softkey conditions allow you to detect lead changes and lead status. Of the conditions on the first rack of softkeys below CONDS:, only LEADS is specific to X.21 and will be documented fully in this section.

Figure 32-3 shows the highest rack of softkeys containing actions that are specific to X.21. The SEND softkey includes a CALL_SETUP_SEND function that sends text messages always in ASCII code (consistent with X.21 call–setup protocol). The LEADS softkey gives the user control of X.21 control and data leads in emulation mode. The PROTOCL softkey includes functions that switch the line setup back and forth from ASCII 7–bit odd parity for call setups to whatever line setup the user has configured for data transfer on the Line Setup menu.

Other softkey actions in Figure 32-3 are not specific to X.21 and are discussed elsewhere in the manual.

A group of Figures at the end of this section, Figure 32-10 through Figure 32-13, shows the INTERVIEW emulating either the user or the switch in calling, called, clearing, and cleared scenarios. The "conditions" and "actions" in these drawings are softkey conditions and actions in the X.21 Layer 1 personality package. The "new states" in the drawings are standard X.21 state names which may be borrowed as state names on the Protocol Spreadsheet.

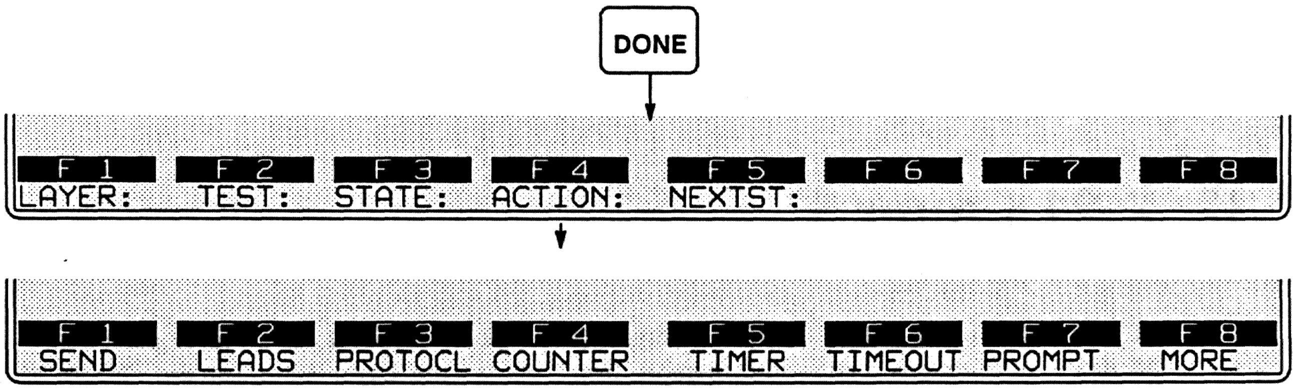


Figure 32-3 The *SEND*, *LEADS*, and *PROTOCL* softkeys branch to actions that are specific to X.21.

32.1 X.21 bis

The X.21 Layer 1 package also will work with the standard RS-232/V.24 TIM in an X.21 *bis* configuration. With the standard RS-232 TIM installed, the **LEADS** softkey shown in Figure 32-2 will be replaced by the **EIA** softkey that branches to standard EIA control-lead names: **RTS**, **CTS**, etc. The X.21 *bis* recommendation maps X.21 data and control leads to EIA leads according to the following conversions:

T	=	TD
C	=	DTR
R	=	RD
I	=	DSR

The **LEADS** softkey in Figure 32-3 changes to **EIA** in X.21 *bis*. When the RS-232 TIM is installed, data leads can be set to one of the standard X.21 idle conditions (+, BL, SY, NU, and so forth) only via the **IDLE_LN** softkey action.

32.2 Transmitter/Receiver Phases

X.21 requires that data such as selection signals (the destination phone number) be transmitted during call setup. The data is transmitted in the following synchronous format: ASCII code, SY SY sync pattern, 7 data bits, odd parity, no BCC.

Once the call is established, a different format and code may be used at the link level and above. In order to monitor and transmit X.21 data and higher-level data correctly without exiting Run mode and reconfiguring the line setup, the X.21 layer package provides two different "phases" of the transmitter and the receivers. These phases are called **CALL_SETUP** and **DATA_TRANSFER**, and they are entered into the program via softkey. See Section 32.5(C), below.

When the program is in call-setup phase, data is monitored and sent according to the synchronous format and ASCII code defined above. In data-transfer phase, the format and code are as defined by the user on the Line Setup menu.

32.3 Sending From Layer 2

When Layer 1 is in data-transfer phase, a SEND action at Layer 2 will cause a transmission to go out onto the line automatically. No SEND action at Layer 1 is required.

When Layer 1 is in call-setup phase, a SEND action at Layer 2 will be ignored. If Layer 1 wishes to communicate to Layer 2 its readiness to send data, it must do so by SIGNAL action (see Section 27.4), since primitives are not currently operative at Layer 1.

32.4 X.21 Conditions

To bring up the bank of softkey conditions for Layer 1, first press the CONDITIONS softkey. This key becomes available when the cursor enters a programming block at the state level.

The first three condition softkeys—DTE, DCE, and RECEIVE—are common to all Layer 1 configurations. The fourth condition softkey, LEADS, is specific to the X.21 test-interface module. To the right of the LEADS softkey are general (layer-independent) conditions discussed in Section 27.

LEADS is a transitional/status condition and may be combined with other conditions (including other LEADS conditions). Refer to Section 27.2 for a discussion of how conditions may be combined.

(A) Data

The first three X.21 conditions can monitor one of the two data leads for a specific data event. This event can be any of several characters, a string of characters, a good BCC following the character or string, an error revealed by a block or parity check, and so on. When DTE is selected, data on the T lead will be monitored. A DCE condition monitors the R lead. RECEIVE conditions are intended for use in the emulate modes. When RECEIVE is selected, the INTERVIEW will always monitor the lead opposite its own transmit lead.

The fourth X.21 condition, LEADS, also can monitor both data leads. Figure 32-4 shows that T and R leads can be monitored for ZERO or ONE status. A data lead will satisfy one of these conditions when it is valid zero or valid one—that is, when it has retained its zero or one status for sixteen consecutive bit times.

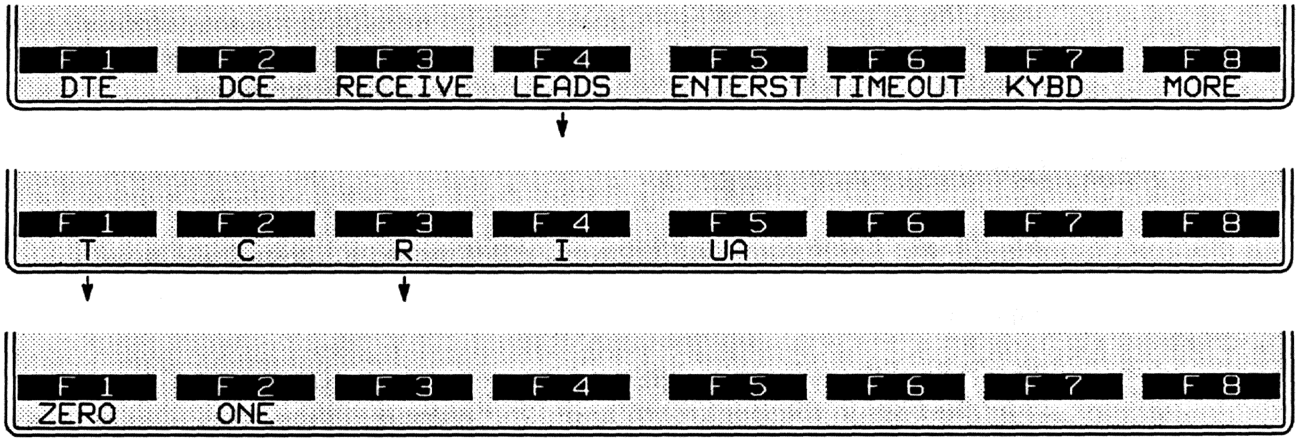


Figure 32-4 T and R leads can be monitored for *zero* or *one* status.

A mere transition from zero to one (or from one to zero) has no significance in X.21 protocol and cannot be detected by a LEADS T or LEADS R condition. (Control leads C and I, on the other hand, may be monitored either for a mere transition or for a valid status—see below.)

(B) Control Leads

X.21 conditions can monitor the status of C and I control leads. The C and I softkeys are in the conditions rack below LEADS. See Figure 32-5.

> **NOTE:** Before you may monitor the status of C and I leads, the buffering of control leads must be enabled on the Front-End Buffer Setup menu. See Section 7.1(B).

C and I may be tested for true status or for valid status. In the X.21 protocol, the state of the lead is valid if it has been true for sixteen bit times. LEADS C ON, for example, checks the true state of the C lead. If the condition is alone in a CONDITIONS block, any momentary transition of the C lead from *off* to *on* will satisfy the condition. If the condition is used in a context where it is static rather than transitional—see Section 27.2 for a definition of this context—the true *on* state at the moment the lead is checked will satisfy the condition.

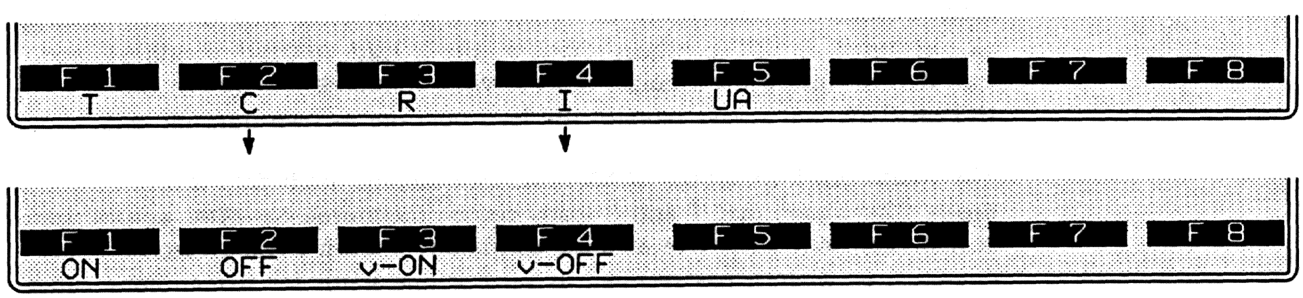


Figure 32-5 C and I leads may be tested for true status or for valid status.

The LEADS C ON_VALID condition requires not only that the state be true but also that it be valid. Valid conditions may be transitional or static, depending on how they are combined with other conditions in the same CONDITIONS block. When LEADS C ON_VALID is used alone in a CONDITIONS block, it is transitional. A transitional ON_VALID condition will be valid sixteen bit times after the transition from off to on—assuming that it retains its true status for the entire sixteen clock pulses.

(C) User Assigned

A LEADS UA condition detects an *on* or *off* state only if that state is valid. If a data lead is patched to the UA input, ON equals zero and OFF equals one.

32.5 X.21 Actions

When a block of conditions has been entered, press [DONE] to access the ACTIONS softkey. The actions that pertain to the X.21 Layer 1 personality package are SEND, LEADS, and PROTOCL, shown in Figure 32-3. SEND and LEADS actions are operative in emulate modes only.

(A) Data Leads

Data leads may be programmed to send character strings via the SEND softkey. They also may be programmed to idle constant mark, constant space, bell characters, plus characters, sync characters, and an alternating pattern of 0's and 1's via the LEADS softkey.

1. *Data-transfer send.* Figure 32-6 shows the two send options that branch under the SEND softkey. If you press SND_DTA, the keyword SEND is written to the spreadsheet screen and this prompt appears below the screen: "Enter Transmit String." This is a normal Layer 1 send action and it is appropriate whenever you are in Data Transfer state according to the X.21 protocol.

   Press the SND_DTA softkey or type SEND followed by space to begin the entry. Enter the string inside of quotation marks. After quotation marks are typed to close the transmit string, a set of softkeys appears for the error-checking value that will be appended to the transmit string—GOODBCC, BAD_BCC, NO_BCC, or ABORT.

   To execute a data-transfer send, the program must be in data-transfer phase—see below. In this phase, the transmitter and receivers are obeying the code and format options selected on the Line Setup menu.

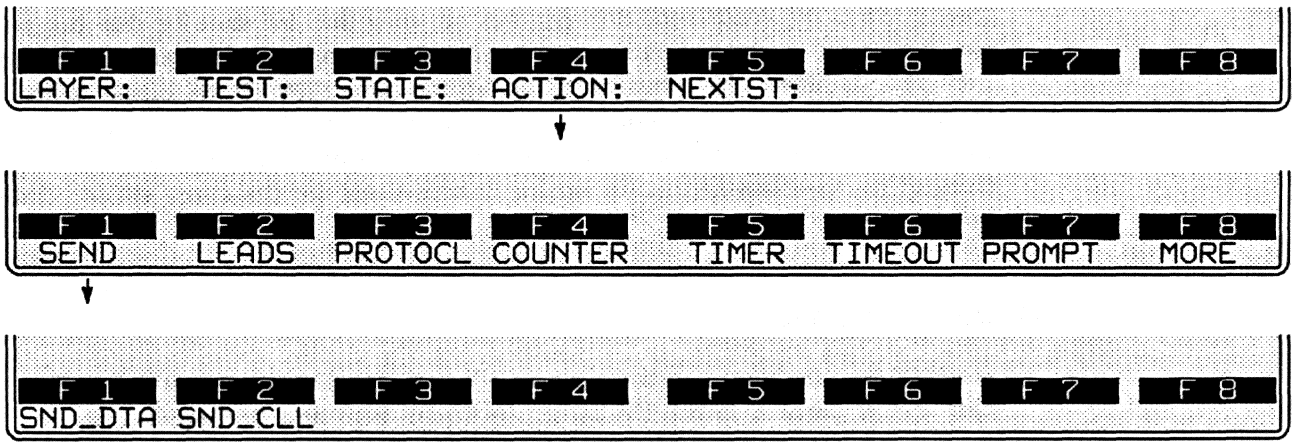


Figure 32-6 Two separate *SEND* actions are used to transmit either in data-transfer or call-setup format.

2. *Call-setup send.* The **SEND** softkey includes a **CALL_SETUP_SEND** function that sends text messages always in a code and format that is consistent with X.21 call-setup protocol. Press the **SND_CLL** softkey (Figure 32-6) or type **CALL_SETUP_SEND** followed by space to begin the entry. Enter the string inside of quotation marks.

   The code and format of a call-setup send action always is the same: ASCII code, 7 data bits, odd parity, no block check transmitted. Synchronization characters are $^S_Y$$^S_Y$ (hex $^1_6$$^1_6$). The synchronization pattern must be provided in the transmit string—it is not automatic.

   To execute a call-setup send, the program must be in call-setup phase—see 32.5(C), below. In this phase, the transmitter and receivers are disregarding the code and format options selected on the Line Setup menu.

3. *Idle.* Data leads also may be programmed to idle constant mark, constant space, bell characters, plus characters, sync characters, and alternating 0 and 1. Figure 32-7 shows the softkey path going through **LEADS** and **T** or **R** to the various idle states.

4. *One or zero.* Select **ONE** to idle constant mark, **ZERO** to idle constant space. Assuming that the program is in call-setup phase, a data lead idling mark will appear on the data display as ^F_F. Space idle will be displayed as $^0_0$.

5. *Plus, bell, or sync.* Plus (+) characters, bell (^B_L) characters, and sync (^S_Y) characters also may be transmitted as contiguous idle characters. A transmit stream of any of these characters will be preceded by two ASCII sync characters (hex $^1_6$). In other respects, the action **LEADS R BELLS** has the same effect as the action **IDLE_LINE** "^B_L".

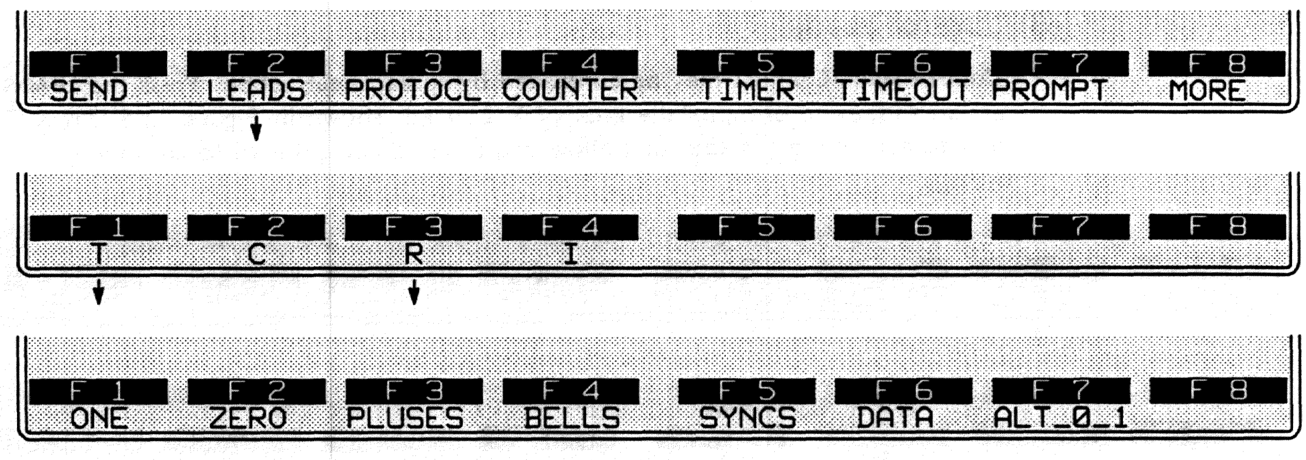


Figure 32-7 **X.21 data leads T and R sometimes perform a "control" function by idling various characters.**

Plus–, bell–, and sync–character idle actions do not take effect unless the program is in call–setup phase at the time the action is executed. The LEADS R ZERO action or the LEADS T ONE action will take effect even in data–transfer phase. The monitors may not be set up properly to detect or display the idle state, however, and we recommend that the programmer switch to call–setup phase as soon as one of the control leads first signals a clear request or indication.

6. *Data.* A ONE or ZERO leads action will clamp the line to the requisite voltage level. Once a lead is clamped, it must be unclamped before it can be used again for data. The DATA softkey shown in Figure 32-7 represents the "unclamp" action.

   To change from idling space to transmitting selection signals, for example, you would insert the unclamp action (LEADS T DATA) shown here:

```
STATE: call_request
  CONDITIONS: ENTER_STATE
  ACTIONS: LEADS T ZERO
    PROMPT "Press S to send selection signals"
  CONDITIONS: KEYBOARD "Ss"
  ACTIONS: LEADS T DATA
    CALL_SETUP_SEND "␖␖123123+"
```

   The PLUSES, BELLS, SYNCS, or ALT_0_1 action also will unclamp the line automatically.

7. *Alternating 0/1.* Press the softkey for ALT_0_1 to send an alternating series of zeroes and ones. The sequence is not preceded by sync characters. This idle action does not take effect unless the program is in call–setup phase at the time the action is executed.

(B) Control Leads

Control leads C and I may be controlled by spreadsheet action. Press the LEADS action softkey to bring up the rack of X.21 leads shown in Figure 32-8. Press C or I to access the softkeys that allow you to set a control lead to ON or OFF voltage.

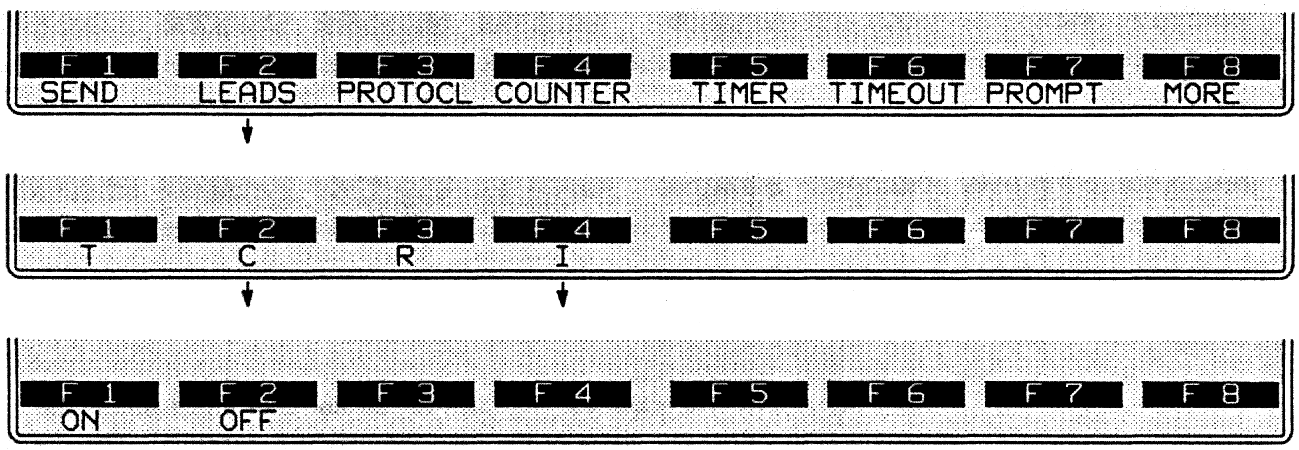


Figure 32-8 **Control leads C and I may be turned on or off via softkey.**

(C)Two Phases

The X.21 layer package provides two different "phases" of the transmitter and the receivers. These phases are called CALL_SETUP and DATA_TRANSFER, and they are entered into the program via softkey in the ACTIONS softkey rack that branches below PROTOCL. See Figure 32-9.

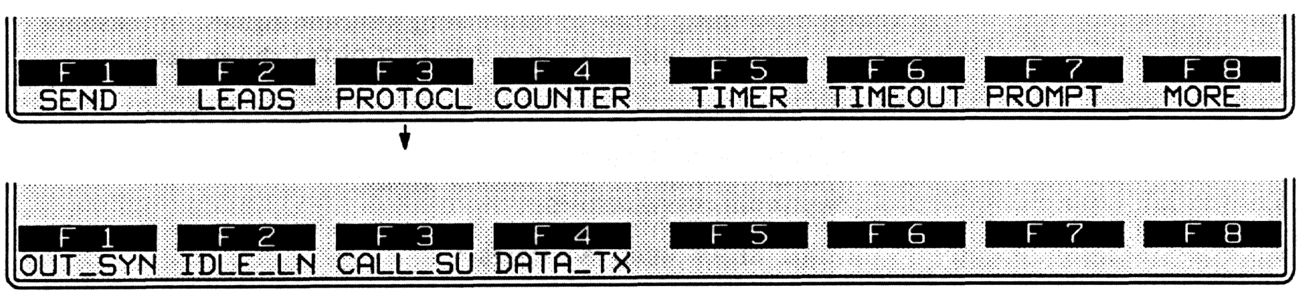


Figure 32-9 **The X.21 layer package provides two different "phases" of the transmitter and the receivers, *Call Setup* and *Data Transfer*.**

The initial configuration phase that the program adopts upon entering Run mode is selectable on the X.21 Interface Control setup menu. See Section 46.8. The default program-initiating phase is data transfer.

1. *Call setup.* When the program is in call-setup phase, data is monitored and sent according to the synchronous format and ASCII code defined above in Section 32.2. Idle display is automatically on. This means that when receivers encounter a condition that normally would send them out of sync (such as one or more FF-idle characters), the receivers begin looking for sync as they normally would but the raw data continues to be displayed, in reverse video.

   With idle display automatically on, the transition will appear on the screen as a series of NU (NULL) characters when the data lead goes to zero to signal a call request or a clear request. For this reason, we recommend that the program adopt CALL_SETUP phase as soon as possible after a clear request or clear indication is signalled. In this way, the screen display of NU characters will record the clear request. In data-transfer phase, the steady zero signal will not be preceded by a special sync pattern and, depending on the line setup, may not be displayed.

   Figure 32-10 shows the INTERVIEW on the user side of the X.21 interface. Here the INTERVIEW adopts call-setup phase prior to clamping its leads to signal **dte_clear_request**.

   Figure 32-11 shows the INTERVIEW on the network-switch side of the X.21 interface. When the user side clears a call, the INTERVIEW programs a change to call-setup phase prior to clamping its leads to signal **dce_clear_confirmation**.

   The appropriate SEND action in call-setup phase is CALL_SETUP_SEND. See Section 32.5(A)2. The simple SEND action, appropriate for data-transfer phase, will not be executed in call-setup phase.

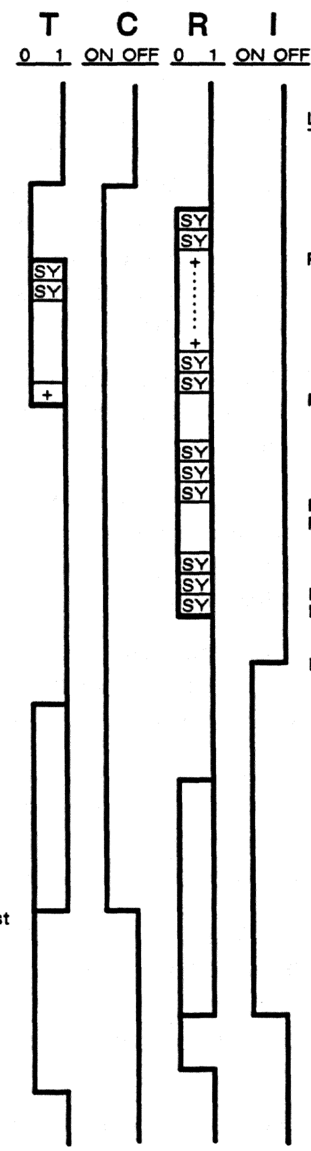
   When Layer 1 is in call-setup phase, a SEND action at Layer 2 will be ignored. If Layer 1 attains data-transfer phase and wishes to notify Layer 2 that it now is ready to send data, it must do so by SIGNAL action (see Section 27.4), since primitives are not currently operative at Layer 1.

2. *Data transfer.* When you press the softkey for DATA_TX (Figure 32-9) or type DATA_TRANSFER in an Actions block on the spreadsheet, you are sending the unit into data-transfer phase. In this phase, the unit monitors and sends according to the parameters selected by the user on the Line Setup menu. See Section 4.

   The appropriate SEND action in data-transfer phase is entered on the Protocol Spreadsheet via the SEND softkey labeled SND_DTA. This action is written to screen simply as SEND. CALL_SETUP_SEND cannot be executed in data-transfer phase.

   When Layer 1 is in data-transfer phase, a SEND action at Layer 2 will cause a transmission to go out onto the line automatically. No SEND action at Layer 1 is required.

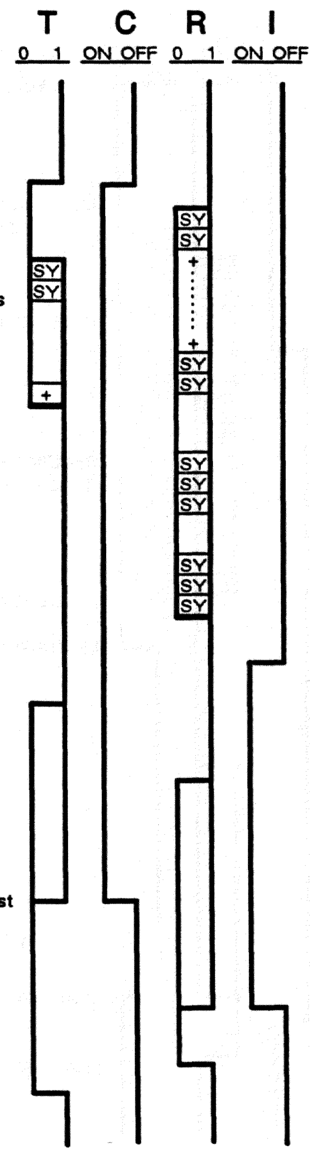
EMULATE USER, USER CALLING AND CLEARING



ACTIONS	NEW STATE	CONDITIONS	NEW STATE
CALL_SETUP LEADS T ONE C OFF		LEADS R ONE I VALID_OFF T ONE C VALID_OFF	ready
LEADS T ZERO C ON	call_request		
LEADS T DATA CALL_SETUP_SEND "[SY][SY]123123+"	selection_signals	RECEIVE STRING "[S]++"	proceed_to_select
(XMIT_COMPLETE) LEADS T ONE	dte_waiting	RECEIVE STRING "[S]"	dce_waiting
		RECEIVE STRING "[S]/" RECEIVE STRING "[S]*"	dce_provided_information (called_line_identification)
		RECEIVE STRING "[S]" LEADS R ONE I VALID_OFF	dce_waiting connection_in_progress
		LEADS I VALID_ON	ready_for_data
LEADS T DATA DATA TRANSFER SEND *"link-level data"*	data_transfer		
CALL_SETUP LEADS T ZERO C OFF	dte_clear_request		
		LEADS R ZERO I VALID_OFF	dce_clear_confirmation
		LEADS R ONE I VALID_OFF	dce_ready
LEADS T ONE	ready		

Figure 32-10 In this DTE-calling-and-clearing scenario, the INTERVIEW is on the user (DTE) side of the X.21 interface.

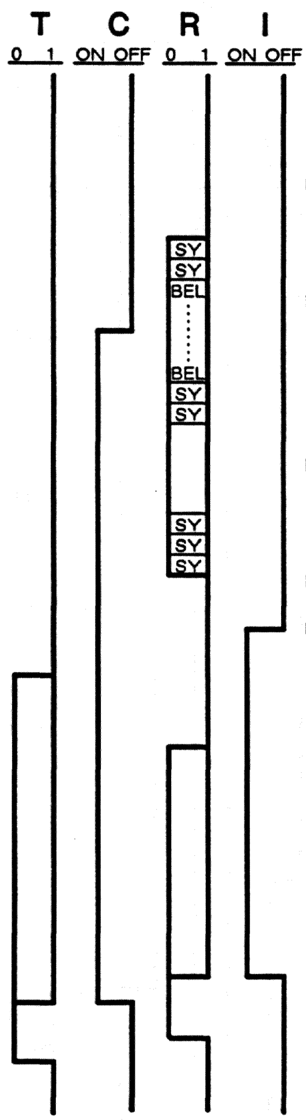
EMULATE SWITCH, USER CALLING AND CLEARING



CONDITIONS	NEW STATE	ACTIONS	NEW STATE
LEADS T ONE C VALID_OFF R ONE I VALID_OFF	ready	CALL_SETUP LEADS R ONE I OFF	
LEADS T ZERO C VALID_ON	call_request		
		LEADS R PLUSES	proceed_to_select
RECEIVE STRING "S"	selection_signals		
		LEADS R SYNCS	dce_waiting
LEADS T ONE	dte_waiting		
		CALL_SETUP_SEND "*/ etc.*"	dce_provided_information
		LEADS R ONE	connection_in_progress
		LEADS I ON	ready_for_data
		LEADS R DATA DATA TRANSFER SEND "*link-level data*"	data_transfer
LEADS T ZERO C VALID_OFF	dte_clear_request		
		CALL_SETUP LEADS R ZERO I OFF	dce_clear_confirmation
		LEADS R ONE	dce_ready
LEADS T ONE C VALID_OFF R ONE I VALID_OFF	ready		

Figure 32-11 In this DTE-calling-and-clearing scenario, the INTERVIEW is on the network/switch side of the interface.

EMULATE USER, USER CALLED AND CLEARED



ACTIONS	NEW STATE	CONDITIONS	NEW STATE
CALL_SETUP LEADS T ONE C OFF			
		LEADS R ONE I VALID_OFF T ONE C VALID_OFF	ready
		RECEIVE STRING "[S] ʅ ʅ "	incoming_call
LEADS C ON	call_accepted		
		RECEIVE STRING "[S] / " RECEIVE STRING "[S] * "	dce_provided_information (calling_line_identification)
		LEADS R ONE I VALID_OFF	connection_in_progress
		LEADS R ONE I VALID_ON	ready_for_data
LEADS T DATA DATA_TRANSFER SEND *"link-level data"*	data_transfer		
		LEADS R ZERO I VALID_OFF	dce_clear_indication
CALL_SETUP LEADS T ZERO C OFF	dte_clear_confirmation		
		LEADS R ONE I VALID_OFF	dce_ready
LEADS T ONE	ready		

Figure 32-12 In this DTE-called-and-cleared scenario, the INTERVIEW is on the user (DTE) side of the X.21 interface.

EMULATE SWITCH, USER CALLED AND CLEARED

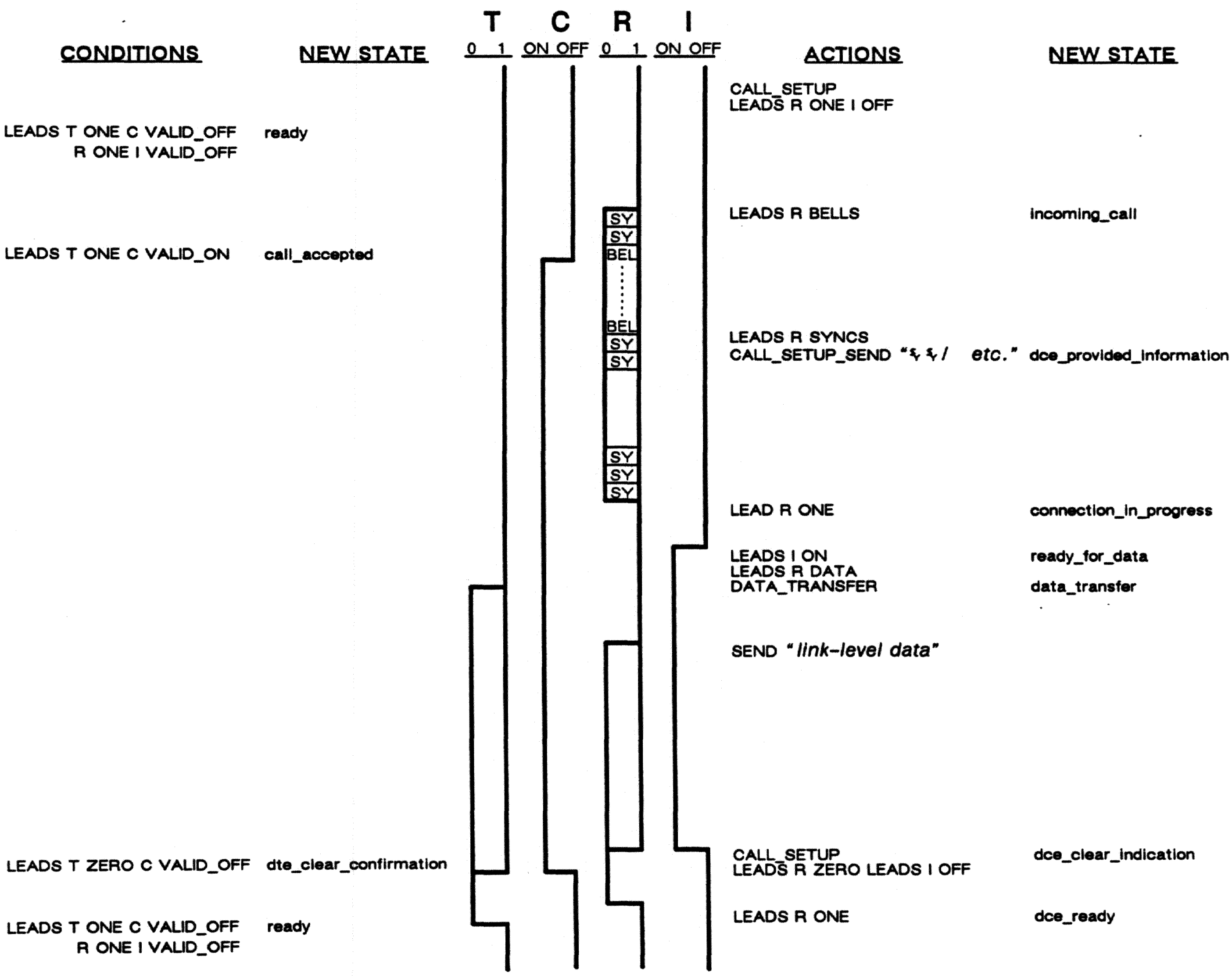


Figure 32-13 In this DTE-called-and-cleared scenario, the INTERVIEW is on the network/switch side of the interface.

33 X.25 Layer 2

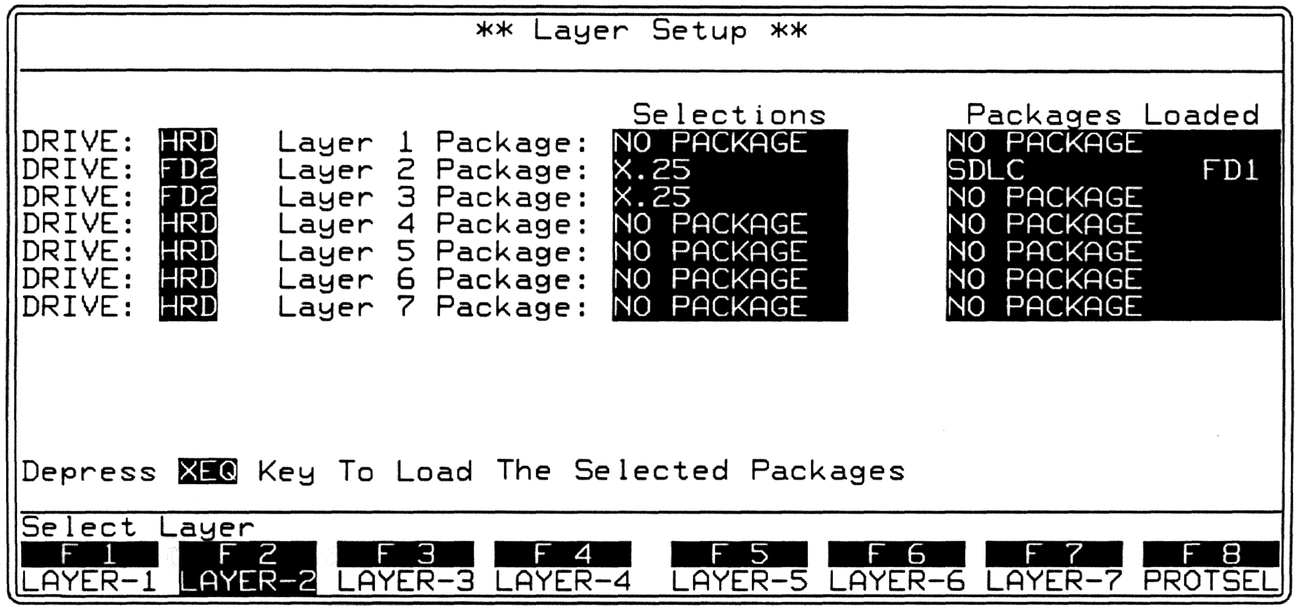


Figure 33-1 The X.25 personality package for Layer 2 is loaded from the Layer Setup screen.

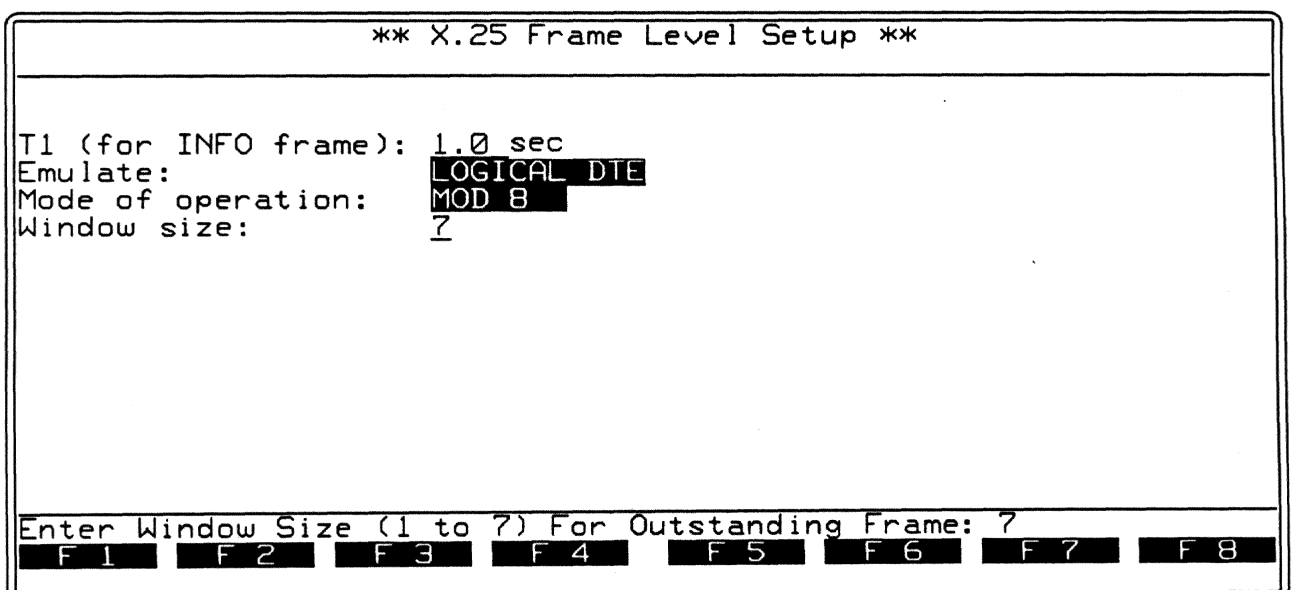


Figure 33-2 Protocol Configuration screen for X.25 Layer 2.

33 X.25 Layer 2

Layer 2 X.25 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 33-1 shows the Layer Setup screen configured to load in the Layer 2 X.25 package from floppy-disk drive #2. Refer to Section 6 for details on operating the Layer Setup screen.

The Layer 2 X.25 package consists of the following:

- A special X.25 Frame Level Setup screen that controls certain parameters when the unit is tracing or emulating X.25.
- A protocol trace (illustrated in Figure 33-3) that distills from X.25 data the Level 2 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.
- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate X.25 programming. Figure 33-8 shows the softkey path to the first rack of condition softkeys when the X.25 package is loaded in at Layer 2.

33.1 Frame-Level Setup

The parameters on the X.25 Frame Level Setup screen must be configured correctly for an accurate trace display and for proper emulation.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the X.25 selection at Layer 2: **X.25** should appear in the **Packages Loaded** column. Press F8 (labeled PROTSEL) to bring up a prompt to **Select Protocol Configuration Screen**. Then press F2 (LAYER-2) to call up the X.25 Frame Level Setup screen.

The four parameter fields on this screen are shown in Figure 33-2. **T1**, **Emulate**, and **Window Size** apply to interactive (emulate) tests only. **Mode of Operation** must be configured correctly for the protocol trace as well as for proper emulation.

(A) T1

Enter a four-digit (including decimal point) T1 timeout value in this field. The largest valid entry is 65.5 seconds. The smallest entry is .001 second, or 1 millisecond.

T1 is the name given to the retransmission timer for INFO frames. When a value is entered in the **T1** field on this menu, the layer 2 package will handle T1 timings correctly, as follows:

- Whenever the INTERVIEW sends an I-frame at Layer 2 and *there are no previous frames sent by the INTERVIEW currently outstanding (unacknowledged)*, the timer starts timing down from the value entered on the Frame Level Setup screen.

- An acknowledgment by the device under test of the most recent frame transmitted by the INTERVIEW *stops* the timer (so that it does not expire).

- An acknowledgment by the device under test of a frame that is not the most recent frame transmitted by the INTERVIEW—an "incomplete" acknowledgment—restarts the T1 timer to the value selected on the configuration screen.

Expiration of this Frame Level Setup timeout can only be detected by a T1_EXPIRED condition on the Protocol Spreadsheet at Layer 2. This particular timeout cannot be detected by a generic condition of TIMEOUT T1.

According to the protocol, a T1_EXPIRED condition should result in a RESEND action.

(B) Emulate Logical DTE/DCE

There are two selections in the **Emulate** field on the X.25 Frame Level Setup screen, LOGICAL DTE and LOGICAL DCE. The entry in this field determines the Layer 2 address bytes used by the INTERVIEW during interactive testing.

Configured as a logical DTE, the INTERVIEW uses address 01 for commands and 03 for responses. Usually a logical DTE is the PAD at the user site.

Configured as a logical DCE, the INTERVIEW sends commands to address 03 and responds using address 01. Usually a logical DCE is a network switch.

Use the **Mode** selection (EMULATE DTE or EMULATE DCE) on the Line Setup menu to regulate the *physical* interface—whether to use pin 2 or pin 3 to transmit, and so on.

(C) Mode of Operation

The **Mode of Operation** field refers to the mode of numbering INFO and supervisory frames. There are two options, MOD 8 and MOD 128 .

MOD 8 uses sequence numbers 0–7. MOD 128 adds an extra byte to the control field in INFO, RR, RNR , REJ, and SREJ frames. See Figure 33-5. This extra byte allows sequence numbers in a range of 0–127.

The correct "modulus" must be selected in this field in order to conduct interactive communications and also to generate an accurate X.25 Layer 2 trace.

(D) Window Size

Any window size may be entered up to the current modulus minus one: 7 or 127. The window size is the maximum number of unacknowledged I-frames that Layer 2 will buffer for retransmission. When the limit is reached, any further INFO frames that are named in SEND actions triggered at Layer 2 will be passed to Layer 1 for transmission but not buffered for retransmission.

The window is a queue that buffers frames for retransmission in case one or more transmissions are lost or in error. A RESEND action will resend the first (earliest) frame in the window. Successive RESENDs will send successive frames until there are no more frames to resend; or until the window is reset by an acknowledgment or by a RESEND FIRST action.

33.2 Protocol Trace

The Layer 2 X.25 package includes an automatic frame-trace display that summarizes link-level activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE to bring the protocol trace for X.25 Layer 2 to the screen. (If the X.25 package for Layer 3 is also loaded in, the L2TRACE softkey will appear after you have pressed PROTOCL, [F2] on the primary rack of display-mode softkeys.)

Figure 33-3 is an example of the Layer 2 trace display. Each horizontal row in the trace represents a frame.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

MON/DISK/FD2 BLK=01443 P 04/21/89 08:55
ASCII/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	03	DISC			0	0002	0855:03.061	G
DTE	03	UA			0	0002	0855:03.172	G
DTE	01	SABM			1	0002	0855:03.210	G
DCE	01	UA			1	0002	0855:03.440	G
DTE	01	INFO	0	0	0	0006	0855:03.482	G
DCE	03	INFO	0	0	0	0007	0855:03.723	G
DTE	03	RR	1		0	0002	0855:03.844	G
DCE	01	RR	1		0	0002	0855:03.915	G
DTE	01	INFO	1	1	0	0018	0855:03.916	G
DCE	01	RR	2		0	0002	0855:03.959	G
DCE	03	INFO	2	1	0	0005	0855:04.033	G
DTE	03	RR	2		0	0002	0855:04.384	G
DCE	03	INFO	2	2	0	0017	0855:04.505	G
DTE	03	RR	3		0	0002	0855:04.697	G
DTE	01	INFO	3	2	0	0005	0855:04.742	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 33-3 Each horizontal row on the trace display represents a frame.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys. Figure 33-4 shows part of a dual-line data screen in Freeze mode. The first frame in the display is the same one that is traced at the top of Figure 33-3.

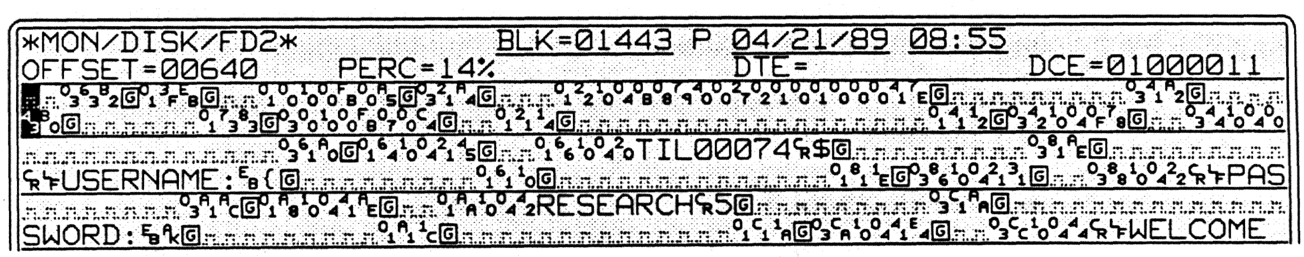


Figure 33-4 Data-display of Protocol Trace shown in Figure 33-3.

(B) Trace Columns

The columns in the protocol trace for Layer 2 X.25 are explained below.

1. *Source*. The **SRC** column identifies the lead on which the frame was monitored, TD (DTE) or RD (DCE). This column identifies the *physical* source of the frame, not the *logical* source. The physical DTE uses the TD lead to transmit. The physical DCE uses RD to transmit.

   Just as on the data display, RD data is underlined.

2. *Address*. The address octet (see Figure 33-5) is given in the **ADDR** column, with its two hexadecimal quartets presented as full-size alphanumerics. The address may be $^{0}{}_{1}$ or $^{0}{}_{3}$ in single-link operation.

   This column identifies the logical DTE and DCE. The logical DTE uses address $^{0}{}_{1}$ for *INFO frames and other command frames*, and address $^{0}{}_{3}$ for responses. The logical DCE uses address $^{0}{}_{3}$ for INFO frames and other commands, and address $^{0}{}_{1}$ for responses.

3. *Type*. The mnemonic (abbreviated) names for eleven frame types as they appear in the **TYPE** column of the protocol trace are shown in Figure 33-5 under "CONTROL." The control field, therefore, indicates the frame type. If a control octet does not fit any of the patterns in the figure, the frame is listed in the **TYPE** column as UNKWN followed by the hexadecimal value of the control byte: UNKWN=F3.

   If the number of bytes in the frame is below the required minimum, the frame is posted as INVALID.

4. *N(R) and N(S)*. One column on the frame-level trace is devoted to N(R) values, and one column to N(S). The frame types that include N(R) or N(S) fields in their control fields are indicated in Figure 33-5. N(R) and N(S) occupy three bits each in modulo 8, seven bits each in modulo 128.

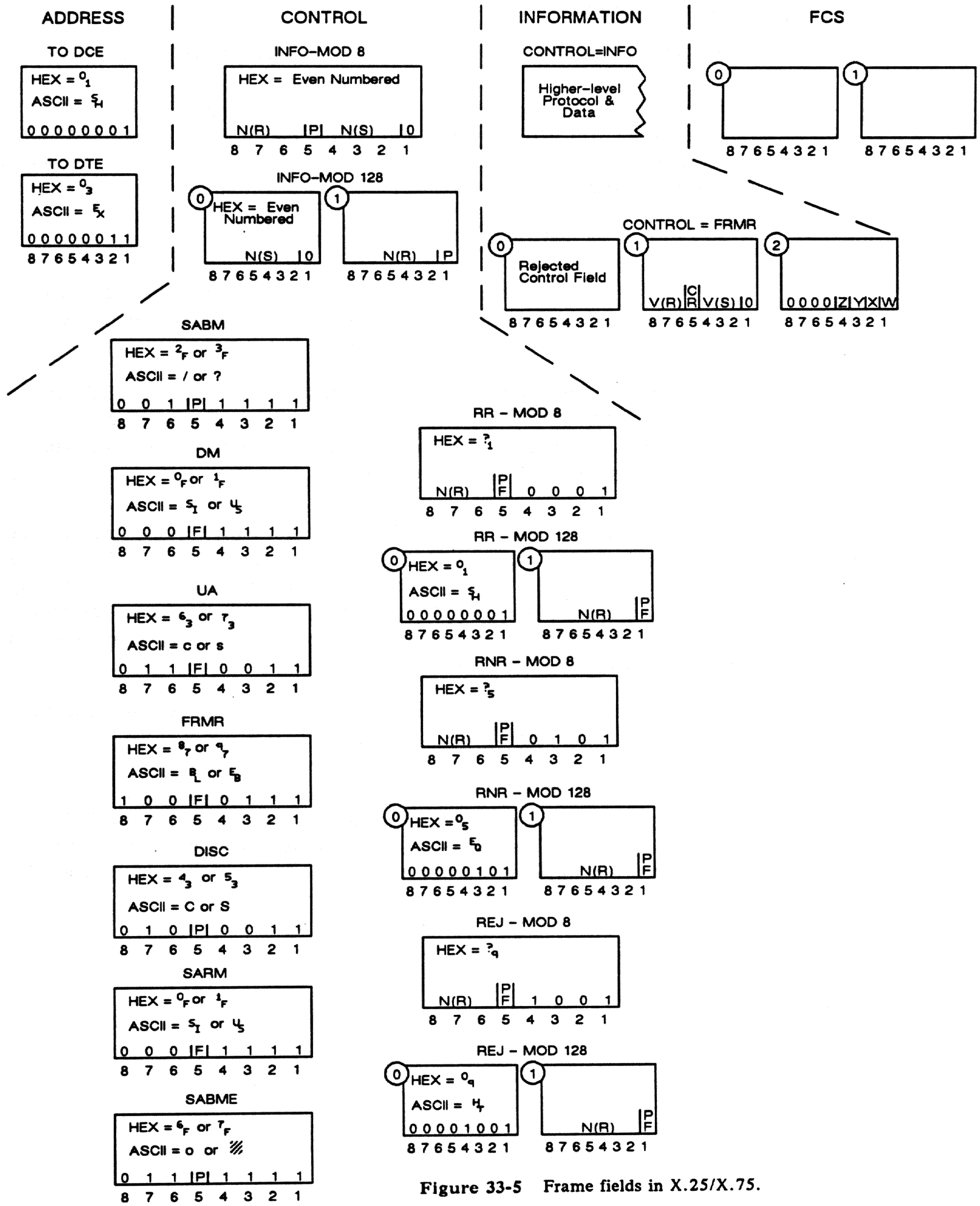


Figure 33-5 Frame fields in X.25/X.75.

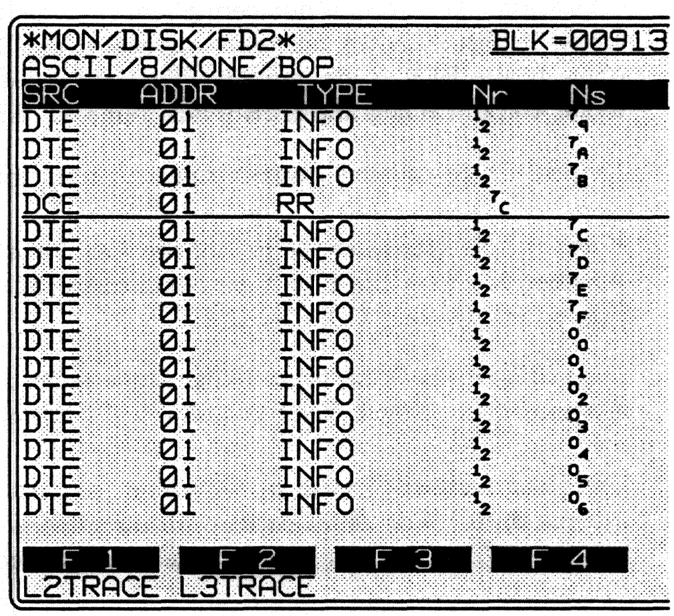


Figure 33-6 **MOD 128 sequence numbers are displayed in two-digit hexadecimal *characters*.**

N(R) and N(S) values are presented in decimal format in modulo-8 traces. Each column displays a single digit that represents a 3-bit binary value. For modulo 128, the values ${}^{0}{}_{0}$ to ${}^{7}{}_{F}$ are given in "character" format, where the columns contain a two-digit hexadecimal character (see Figure 33-6).

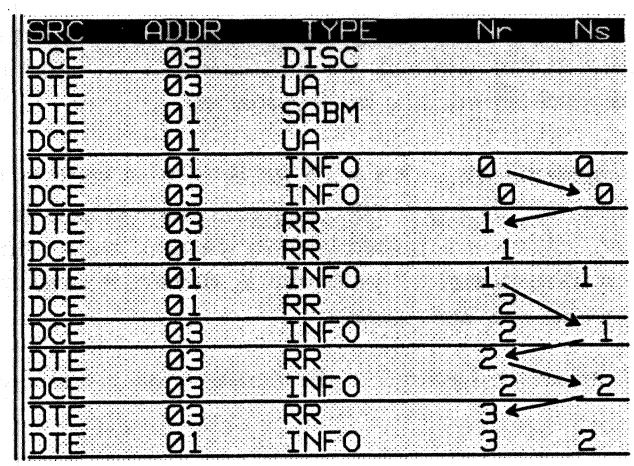


Figure 33-7 **Nr and Ns columns are staggered, with the *outside* columns representing the sequence of *DCE* numbered I-frames.**

Note that the **Nr** and **Ns** columns on the trace are staggered to suggest four columns. The two outside columns, comprised of the DTE's N(R) value and the DCE's N(S), form a numbering sequence for DCE I-frames. The arrows in Figure 33-7 indicate the sequence: the DTE expects to receive frame 0, the DCE sends frame 0. The DTE expects frame 1; it asks for frame 1 again; finally the DCE sends frame 1. And so on.

The two inside columns reveal a similar pattern for DTE I-frames.

5. *P and F*. The status of the poll or the final bit is given in the **P/F** column. Whether this bit is the P or F bit is indicated for most frame types in Figure 33-5 (under "CONTROL").

   The setting of the P bit in an INFO frame often denotes the retransmission of an unacknowledged frame following a T1 timeout.

6. *Size*. The number of bytes in each frame is given in this column in four decimal digits. The count begins with the address byte and excludes the two-byte FCS. Frames without I-fields show a count of two.

7. *Time*. The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

8. *Frame checking*. An X.25 frame ends as soon as a $^{F}{}_{E}$ flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the **BCC** column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

   A for abort is posted to the display when a frame is ended by seven 1-bits.

33.3 Monitor Conditions

When the Layer 2 X.25 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 2. See Figure 33-8.

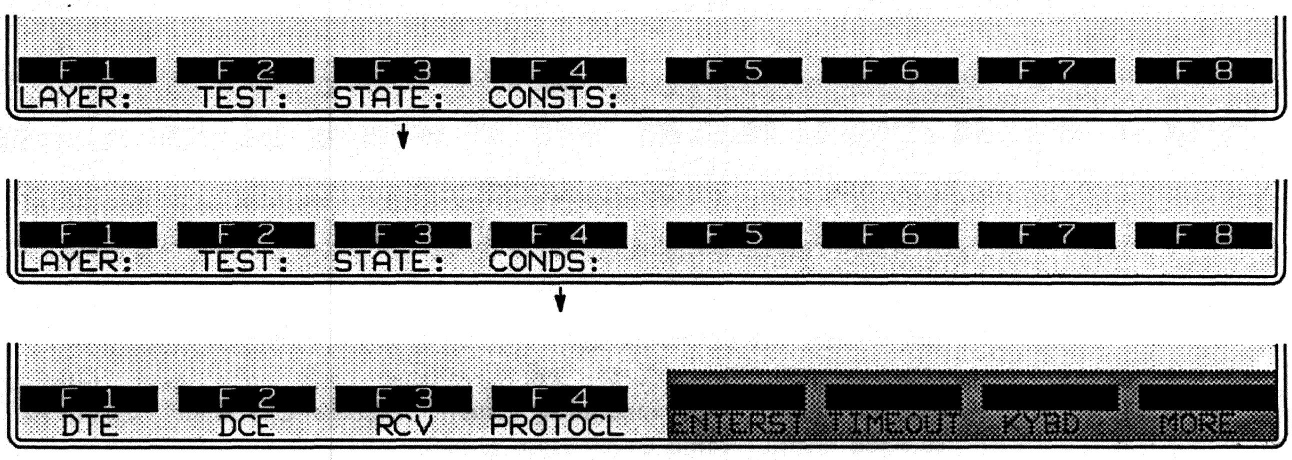


Figure 33-8 Unlike *RCV* conditions, the softkeys for *DTE* and *DCE* are valid when the INTERVIEW is monitoring the line passively.

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represent *types* of frames: INFO, SABM, UA, and so forth.

(A) Frame Types

The softkeys for INFO, supervisory, unnumbered, and "other" frames are illustrated in Figure 33-9. Press a softkey to write one of these frame types to the Layer 2 spreadsheet. DTE or DCE followed by a frame-type mnemonic—DTE INFO, for example, or DCE SABM—is a complete condition and will come true if a matching frame is monitored. Address, poll/final, and BCC conditions may be added to the simple frame mnemonic, but they are optional.

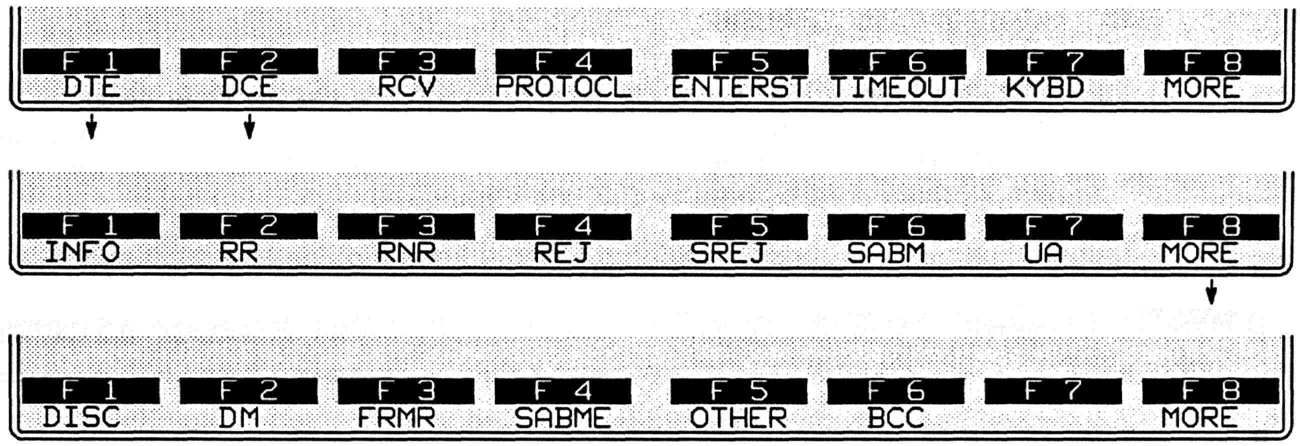


Figure 33-9 Frame types.

1. *Info frames.* INFO frames differ for MOD 8 and MOD 128 numbering schemes. (See Figure 33-5.) For spreadsheet conditions to match I-frames accurately, the correct numbering system (**"Mode of Operation"**) should be selected on the Frame Level Setup screen.

2. *Supervisory frames.* The four supervisory-frame types that can be searched for on the data leads are RR (Receive Ready), RNR (Receive Not Ready), REJect, and SREJ (Selective Reject). These frames always contain N(R) fields (see Figure 33-5) and serve mainly to acknowledge or reject INFO frames.

   Like INFO frames, supervisory frames are constructed differently according to the numbering scheme, MOD 8 or MOD 128.

3. *Unnumbered frames.* Unnumbered frames generally assist in link-setup and takedown. Different set-mode commands are used in different protocols: SABM for LAPB MOD 8 and SABME for LAPB MOD 128.

4. *Other frames.* Any frame type may be entered as a hexadecimal value instead of by name. Press the softkey for OTHER. See Figure 33-10. Then enter the hex byte in the form of two alphanumerics. Here, for example, is a SABM (with the P bit set) entered as a hexadecimal:

   CONDITIONS: DCE OTHER 3F

   Address, poll/final, and BCC conditions may be appended to OTHER conditions. In MOD 8, the P/F bit is already specified in the hex entry, and a P/F condition will be ignored.

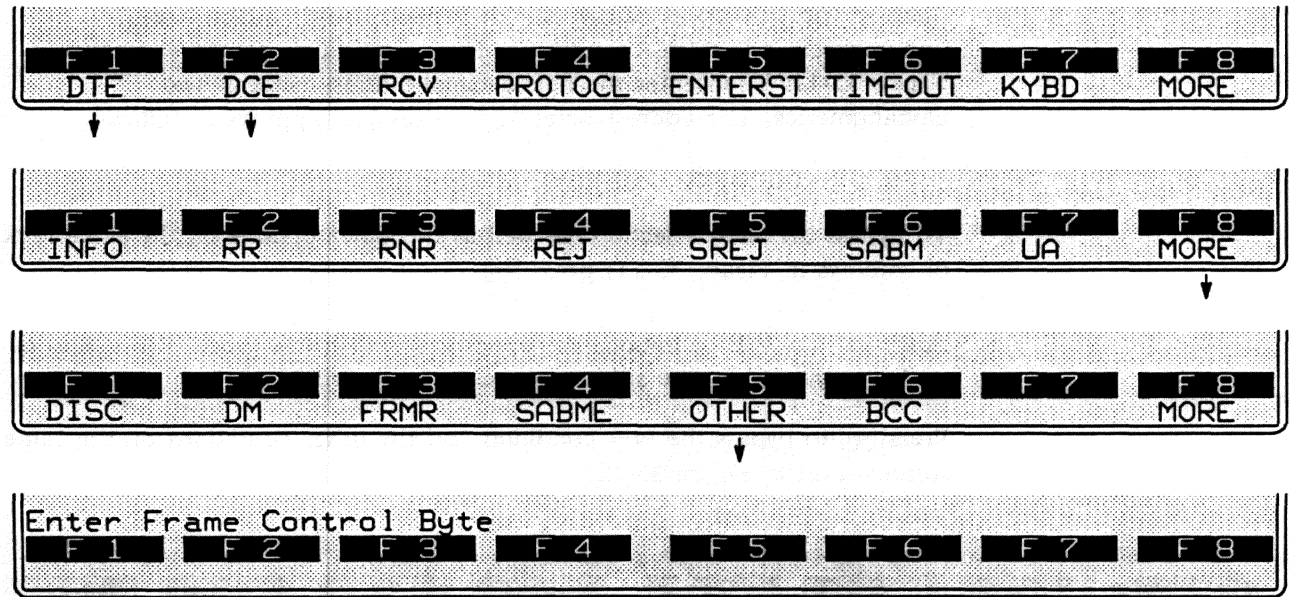


Figure 33-10 The hex value of any frame may be specified under *OTHER*.

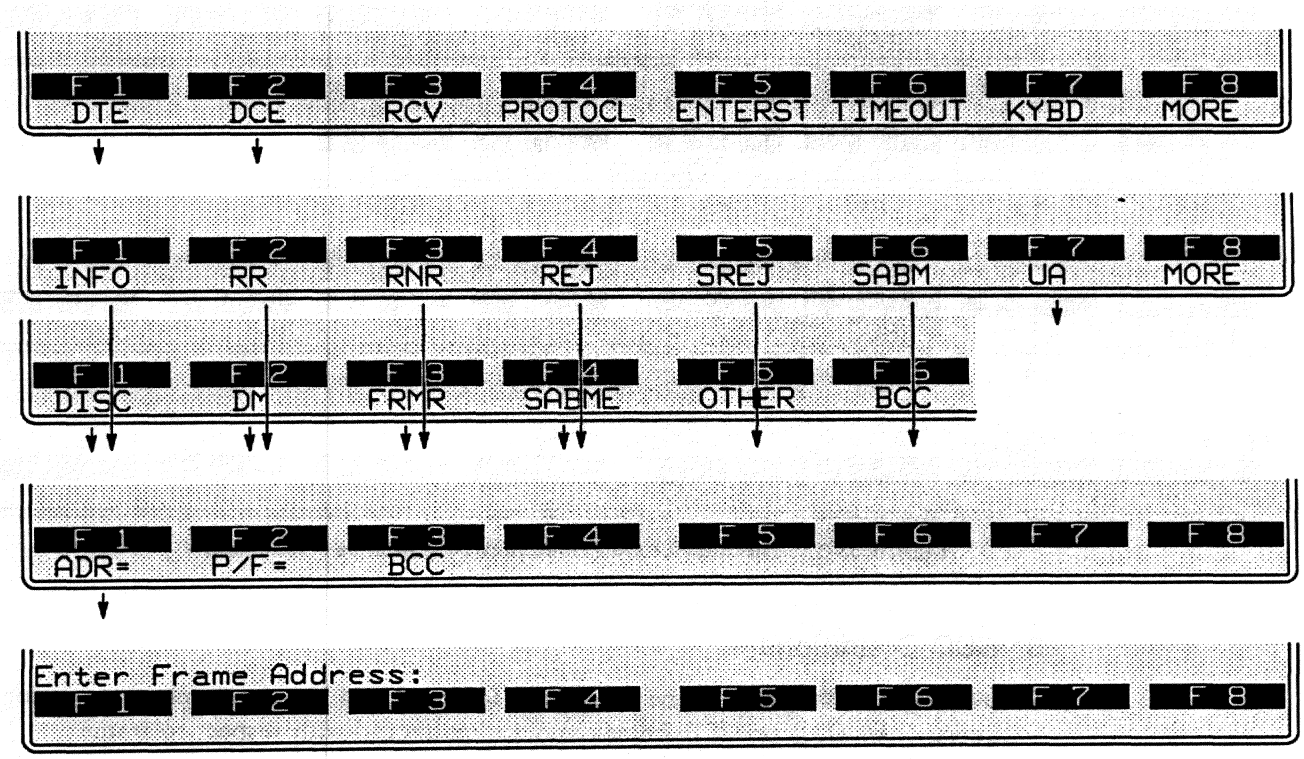


Figure 33-11 The hex value of the address byte is entered as two alphanumerics for *all* frame types.

5. *Address*. An address condition may be added to INFO, supervisory, unnumbered, and OTHER conditions. Press the softkey for ADR=, shown in Figure 33-11. Then enter the hexadecimal address octet as two alphanumerics. The address octet 01, for example, appears as follows:

   CONDITIONS: DTE INFO ADR= 01

   To bypass the ADR= selection (as well as the other options on the same rack of softkeys in Figure 33-11) press [DONE].

6. *Poll/final bit*. P/F conditions are optional for all frame types. P/F values of 0 or 1 are entered by the softkey sequence in Figure 33-12.

   Press [DONE] to bypass the P/F= condition and the other conditions on the same softkey level in Figure 33-12.

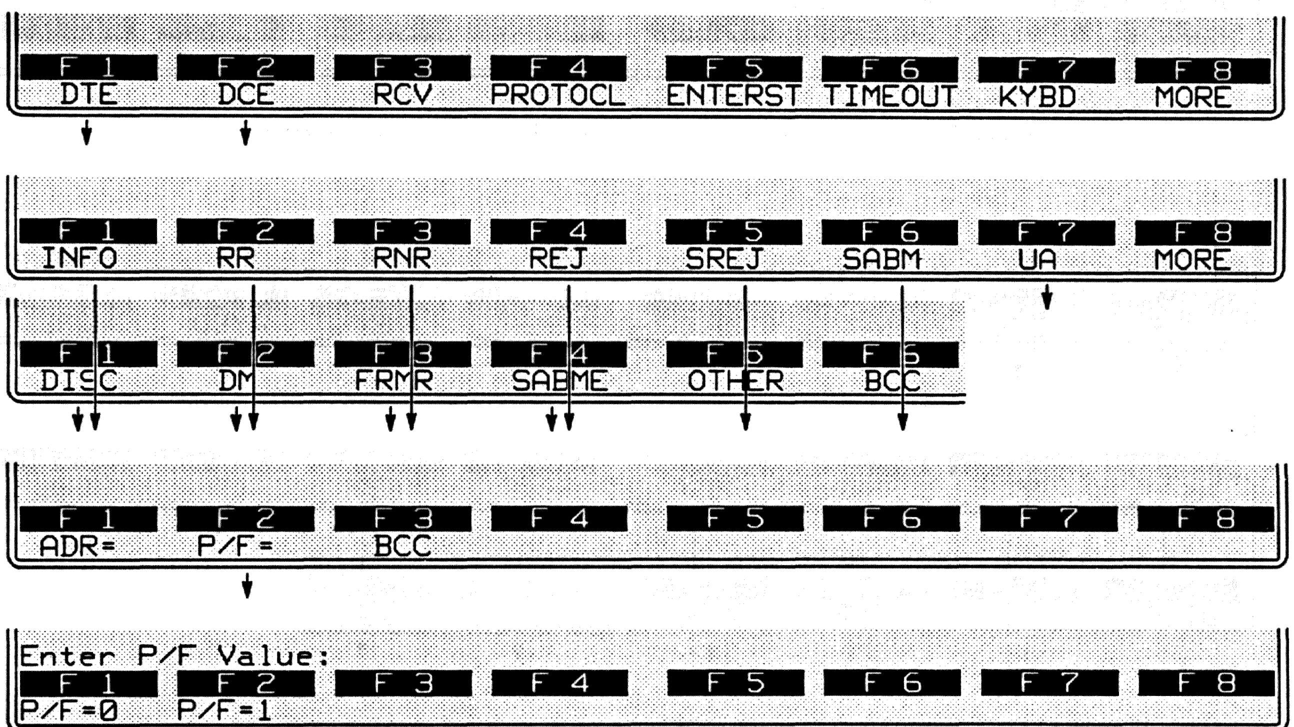


Figure 33-12 The value of the P/F bit may be chosen as a condition.

(B) BCC Conditions

DTE and DCE frames may be monitored for good and bad frame checks and for aborts. *All* DTE or DCE frames may be monitored with respect to frame checking, as in this example:

CONDITIONS: DTE BDBCC

The softkey sequence for this spreadsheet entry is given in Figure 33-13.

Or a particular *type* of frame may have a BCC or abort condition appended to it:

CONDITIONS: DCE INFO ABORT

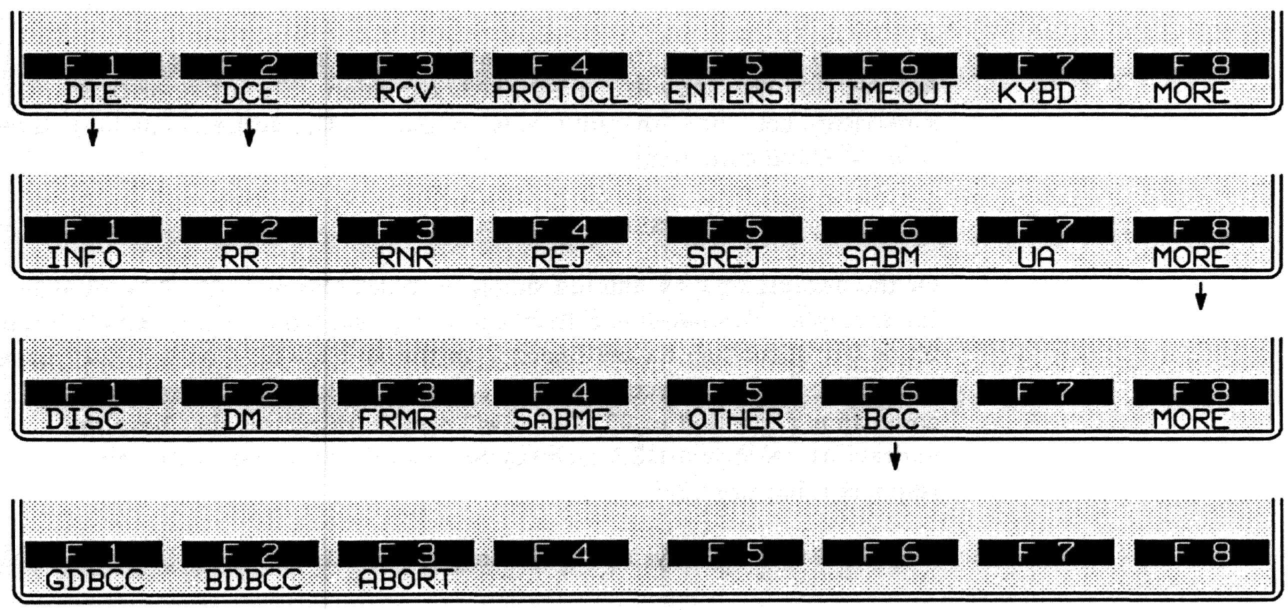


Figure 33-13 A condition may search for *all* good, bad, or aborted frames.

33.4 Emulate-Mode Conditions

The remaining conditions are functional only when the Line Setup menu is configured for **Mode:** EMULATE DTE or EMULATE DCE.

(A) Receive Conditions

Like DTE and DCE conditions, RCV conditions monitor a data lead for X.25 frame types. RCV conditions operate only in emulate modes, and they check only the data lead that the INTERVIEW is not using to transmit. While a RCV condition may look like a DTE or DCE condition—RCV INFO P/F=1 looks the same as DCE INFO P/F=1—there are important differences that are noted below.

1. *Valid frame sequencing.* To satisfy RCV conditions, numbered frames must have correct N(R) and N(S) sequencing.

2. *Good BCC.* RCV conditions cannot match frames with bad frame checks, nor can they match aborted frames. (Emulate-mode conditions are designed

for ease of programming, and the assumption is that as an X.25 emulator, you are not required to acknowledge—or negative-acknowledge—bad or aborted frames.)

If you wish to count bad BCCs or aborts, use DTE or DCE conditions instead of RCV conditions.

3. *Address in supervisory frames.* An address condition *must* be added to a RCV RR, RCV RNR, RCV REJ, or RCV SREJ condition. (In a DTE or DCE supervisory condition, the address is optional.) The address may be entered as in DTE/DCE conditions:

   CONDITIONS: RCV RR ADR= 01

   Or the address may be entered simply as COMMAND or RESP—RCV RR RESP, for example. COMMAND and RESP conditions will look for a specific address, 03 or 01, depending on the selection in the **Emulate** field on the X.25 Layer 2 Setup screen (see Section 33.1(B), above). A logical DTE will *receive* commands addressed to 03, and it will receive responses that have the address 01. A logical DCE receives commands addressed to 01 and responses that use 03.

   CMND and RESP softkeys are shown in Figure 33-14.

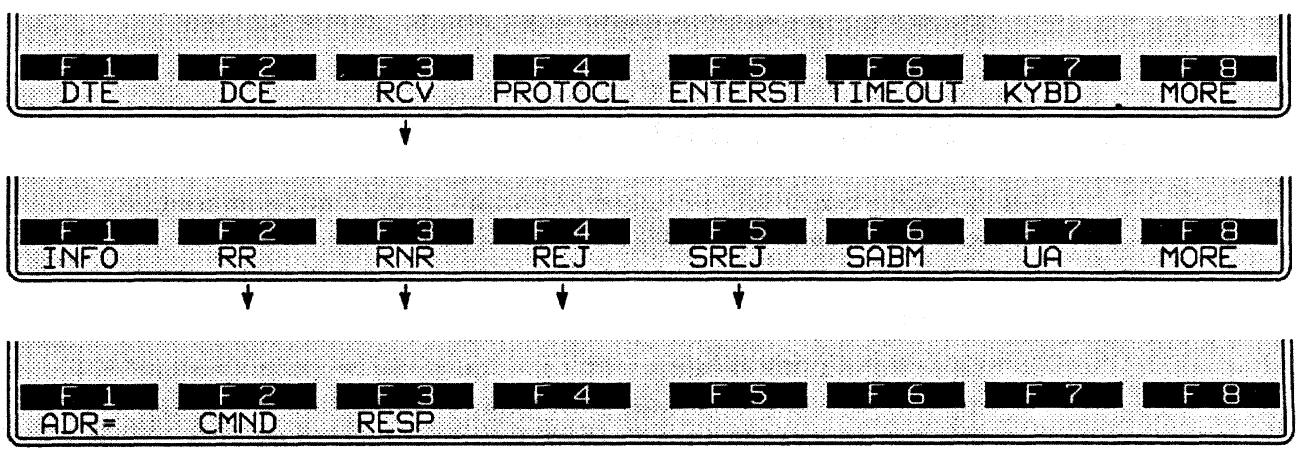


Figure 33-14 Addresses are required in *RCV RR*, *RCV RNR*, *RCV REJ*, and *RCV SREJ* conditions.

4. *Type invalid.* RCV conditions can detect frames that are invalid "types"—the control field is missing, for example, or the I-field is missing in an I-frame. The Protocol Spreadsheet entry for this condition is RCV INVALID, and the softkey sequence is illustrated in Figure 33-15.

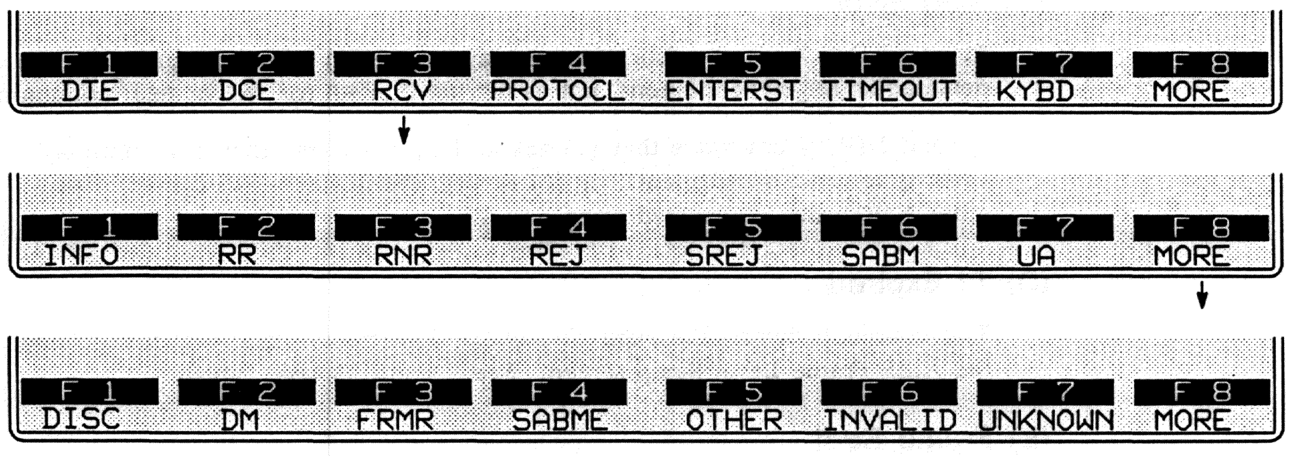


Figure 33-15 *INVALID* **and** *UNKNOWN* **are frame types for** *RCV* **conditions.**

5. *Type unknown.* A frame may be valid in all respects but have a control field that indicates a nonstandard frame type. Such a frame may be matched by a RCV UNKNOWN condition (Figure 33-15).

(B) N(S) Error

As a Layer 2 emulator, you do respond to INFO frames that have N(S) errors. These are detected as NS_ERR conditions, not as RCV INFO conditions.

NS_ERRs apply only to frames received when you are emulating. The same frame that triggers an NS_ERR condition also may satisfy a DTE INFO or DCE INFO condition—but not a RCV INFO condition.

NS_ERR will come true for any received frame whose N(S) value is not one higher than the previous N(S).

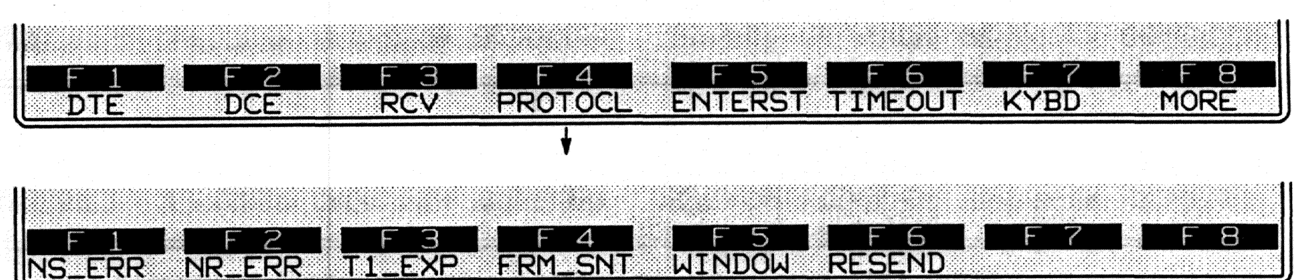


Figure 33-16 **The** *PROTOCL* **key brings up six X.25 emulate conditions.**

In the first rack of condition softkeys at Layer 2, press PROTOCL. Then press the softkey for NS_ERR. See Figure 33-16.

(C) N(R) Error

Received INFO or supervisory frames may have N(R) errors. Such errors are detected as NR_ERR conditions, not as RCV INFO or RR (or RNR or REJ) conditions.

A valid N(R) is any value that (1) acknowledges a frame that is *outstanding* (waiting for acknowledgment); or (2) repeats the last acknowledgment. Any other N(R) value is detected as an error.

(D) T1 Expired

This condition detects the expiration of the T1 timeout-timer that is regulated on the X.25 Frame Level Setup screen. See Section 33.1(A), above.

(E) Frame Sent

This condition is true when, as a result of a SEND or RESEND action, a frame has been passed down to Layer 1. Note that merely SENDing a frame *does not actually transmit the frame onto the line* if, for example, Layer 1 is the X.21 package in call-setup phase.

(F) Window Conditions

The size of the Layer 2 retransmit window is configured on the X.25 Frame Level Setup screen. See Section 33.1(D). There are four conditions that test the current status of this window. They are WINDOW FULL, WINDOW EMPTY, WINDOW NOT_FULL, and WINDOW NOT_EMPTY. The softkey sequence for the WINDOW options is shown in Figure 33-17.

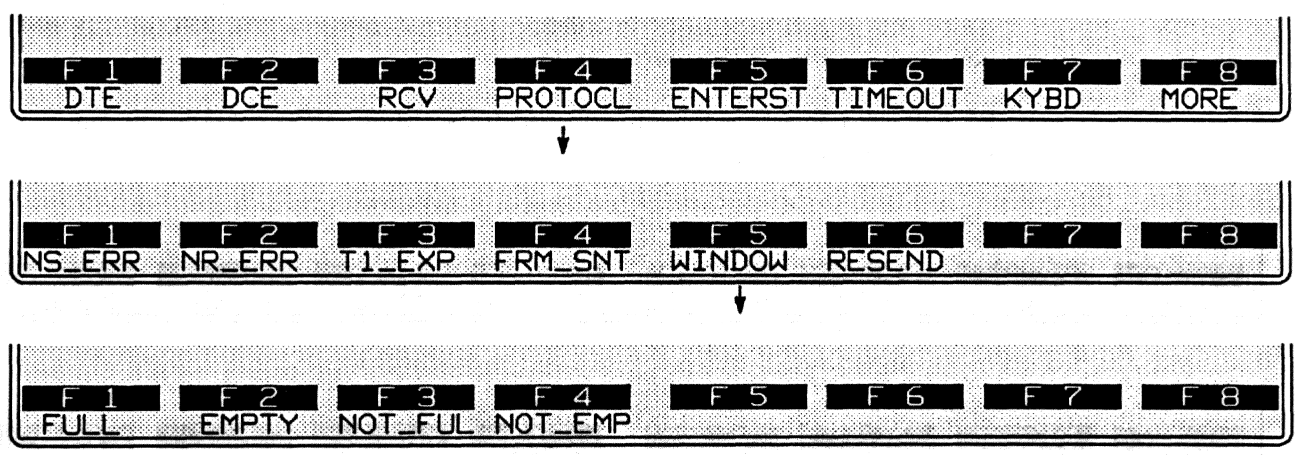


Figure 33-17 When the retransmit window fills, Layer 2 stops buffering frames for retransmission.

WINDOW FULL is true when the window is full of unacknowledged frames and the Layer 2 protocol package will not buffer additional frames until some acknowledgment is received.

Each time an acknowledgment is received, the window is flushed to the extent of the acknowledgment. WINDOW EMPTY means that the latest acknowledgment was complete and left no frames outstanding (unacknowledged). If an RR response is received and the acknowledgment is only partial, this condition will be true:

```
CONDITIONS: RCV RR RESP
   WINDOW NOT_EMPTY
```

CAUTION: Window conditions are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as a* RCV *condition.*

(G) More to Resend

Frames in the window may have to be resent, usually as the result of a T1 timeout or a Reject frame. One RESEND action retransmits one frame in the window, beginning with the earliest. Subsequent RESEND actions retransmit subsequent frames. The MORE_TO_RESEND and NO_MORE_TO_RESEND conditions allow you to retransmit the entire window, as in the "recover" state in this example:

```
   CONDITIONS: RCV REJ RESP
   ACTIONS: RESEND FIRST
   NEXT_ST: recover
STATE: recover
   CONDITIONS: FRAME_SENT
      MORE_TO_RESEND
   ACTIONS: RESEND NEXT
   CONDITIONS: FRAME_SENT
      NO_MORE_TO_RESEND
   NEXT_ST: xfer
```

MORE_TO_RESEND and NO_MORE_TO_RESEND conditions may be written to the Protocol Spreadsheet by the softkeys shown in Figure 33-18.

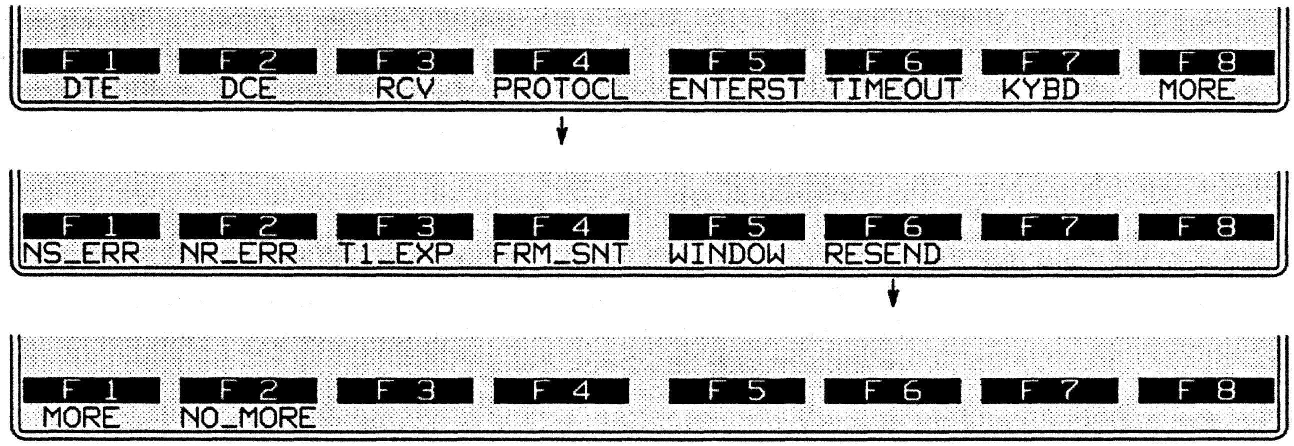


Figure 33-18 The *MORE_TO_RESEND* condition allows you to resend the entire window of frames and then stop when there are *NO_MORE_TO_RESEND*.

CAUTION: MORE_TO_RESEND and NO_MORE_TO_RESEND are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as FRAME_SENT.*

33.5 Emulate Actions

When you have completed a block of conditions in a Protocol Spreadsheet test at Layer 2, press DONE to access the set of actions that can be taken as a result of the block of conditions coming true. The set of actions that are specific to the X.25 Layer 2 personality package are shown in the racks of softkeys in Figure 33-19. Except for ENHANCE and SUPPRES, the actions shown have meaning only when the INTERVIEW is emulating DTE or DCE, and not when it is monitoring the line passively.

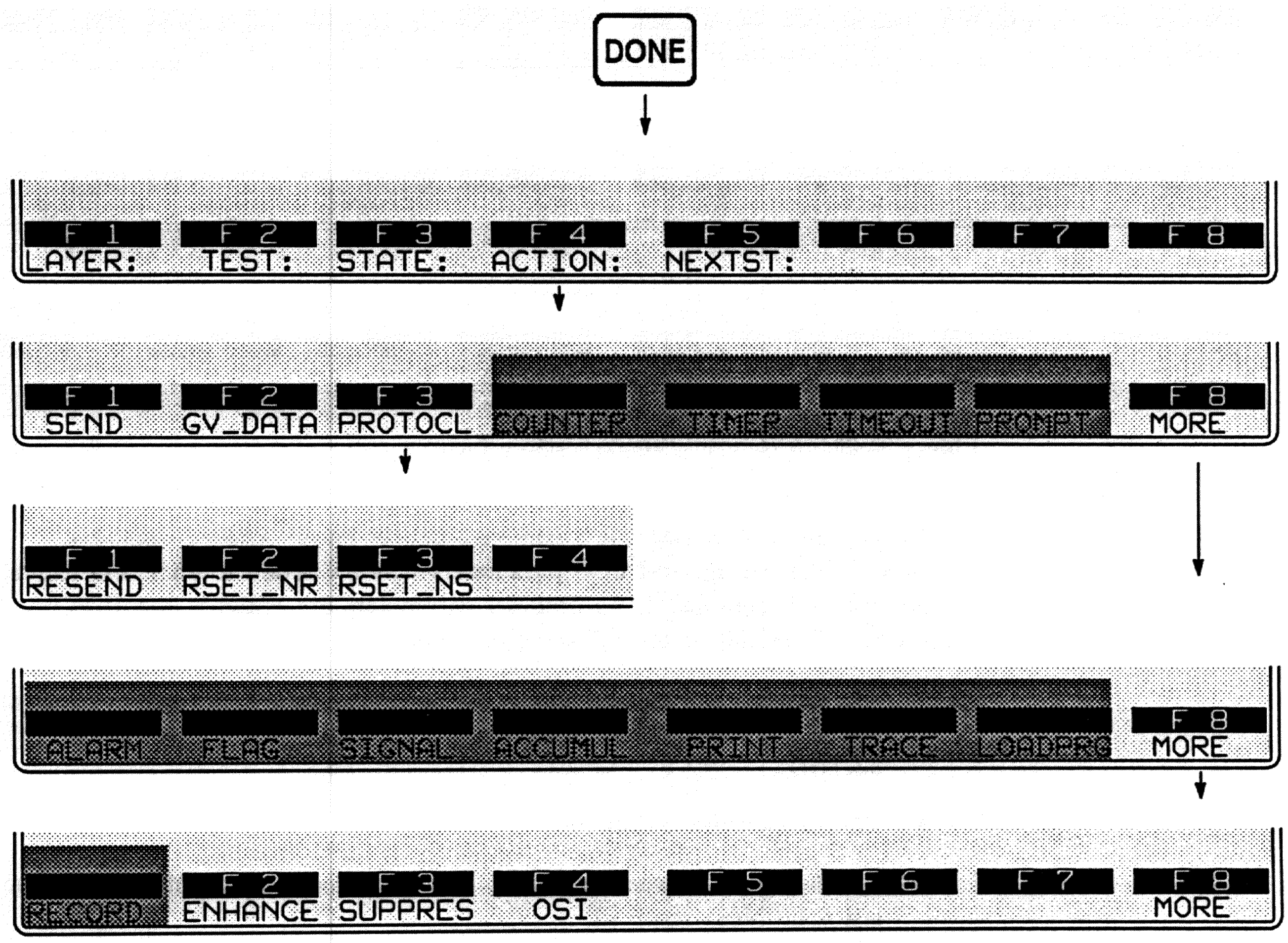


Figure 33-19 Action softkeys specific to X.25 Layer 2.

(A) Send Actions

Press the softkey for SEND to access two racks of softkeys with names of frame types that may be named in SEND actions. All data generated by the Layer 2 X.25 package must be enclosed in a frame that is identified in a SEND action by *type*. (Only at Layer 1 can data be generated as a simple character string without any protocol building blocks.) The complete set of frame types is given in Figure 33-20.

When conditions are true for a SEND action, frames are sent immediately down to Layer 1 to be transmitted there. (Note that when the X.21 Layer 1 package is loaded, the sending down of INFO frames will be conditional on data-transfer phase being active at Layer 1.)

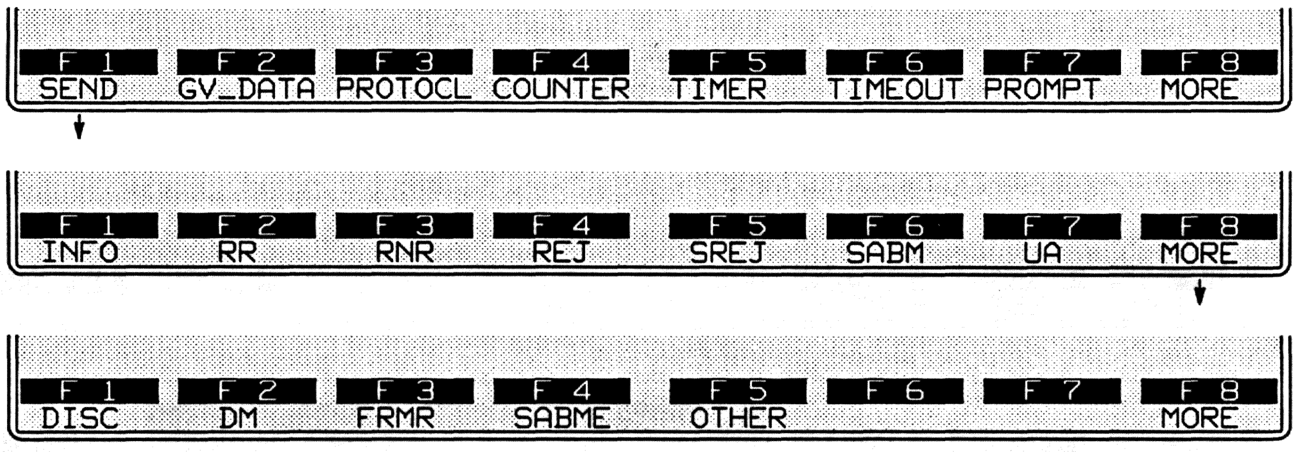


Figure 33-20 ***SEND*** **actions always specify a frame type.**

1. *INFO frames*. SEND INFO is a complete action-entry. Address, poll-bit, N(R), N(S), string, and BCC parameters may be added to an INFO frame, but they are optional. If no optional parameters are entered, the INFO frame will default to the following parameters:

   - The address will be appropriate for an INFO frame sent by the "logical emulator" selected on the Frame Level Setup screen. See Section 33.1(B).
   - The poll bit will be set to 1.
   - The N(R) will increment to the "automatic" value, one higher than the last valid N(S) received.
   - The N(S) will increment to the "automatic" value, one higher than the last valid N(S) sent.
   - Since there is no default data-string, the I-field will be empty.
   - The BCC will be good.

   The default parameters for INFO and other frames are given in Table 33-1.

If a Layer 3 package is installed and Layer 3 data is being handed down to Layer 2, the following condition-and-action trigger will accept this data and convey it properly to Layer 1:

```
CONDITIONS: DL_DATA REQ
ACTIONS: SEND INFO "((DL_DATA))"
```

SEND INFO actions pass the INFO frame immediately to the next layer down. If the retransmit window is full, the frame is still sent—but it is not buffered in the window and can not be *re*sent.

An INFO frame will be buffered for retransmission regardless of the status of the window if a specific value is entered for the NS= parameter (see "*N(S)*," below). The specific N(S) value will clear the window and the INFO frame will be buffered in the first window position.

Table 33-1
Default Parameters in *SEND* Actions

SEND	ADR= logical DTE	logical DCE	P/F	NR=	NS=	STRING	BCC
INFO	01	03	1	AUTO	AUTO	none	GDBCC
SABM	01	03	1	N/A	N/A	N/A	GDBCC
UA	03	01	L	N/A	N/A	N/A	GDBCC
DISC	01	03	1	N/A	N/A	N/A	GDBCC
DM	03	01	L	N/A	N/A	N/A	GDBCC
FRMR	03	01	L	N/A	N/A	none	GDBCC
SABME	01	03	1	N/A	N/A	N/A	GDBCC
RR CMND	01	03	1	AUTO	N/A	N/A	GDBCC
RR RESP	03	01	L	AUTO	N/A	N/A	GDBCC
RNR CMND	01	03	1	LAST_NR	N/A	N/A	GDBCC
RNR RESP	03	01	L	LAST_NR	N/A	N/A	GDBCC
REJ CMND	01	03	1	LAST_NR	N/A	N/A	GDBCC
REJ RESP	03	01	L	LAST_NR	N/A	N/A	GDBCC
SREJ CMND	01	03	1	LAST_NR	N/A	N/A	GDBCC
SREJ RESP	03	01	L	LAST_NR	N/A	N/A	GDBCC
OTHER	01	03	N/A	N/A	N/A	none	GDBCC

2. *Unnumbered frames*. SEND SABM, SEND UA, and so forth, are complete action-entries. Address, P/F-bit, string, and BCC parameters may be added to the SEND action, but they are optional. Default values are sent in the absence of specific optional entries: see Table 33-1.

3. *Supervisory frames*. An address value must be added to SEND RR, SEND RNR, SEND REJ, and SEND SREJ actions. The address may be entered as a specific value.

ACTIONS: SEND RR ADR= 03

Or the address may be entered simply as CMND or RESP—SEND RR RESP, for example. CMND and RESP frames will carry address 01 or 03, depending on the selection in the **Emulate** field on the X.25 Frame Level Setup screen . See Section 33.1(B). Refer to Table 33-1 for the address values sent by the two different logical emulators.

Figure 33-21 shows the address selections for all supervisory frames.

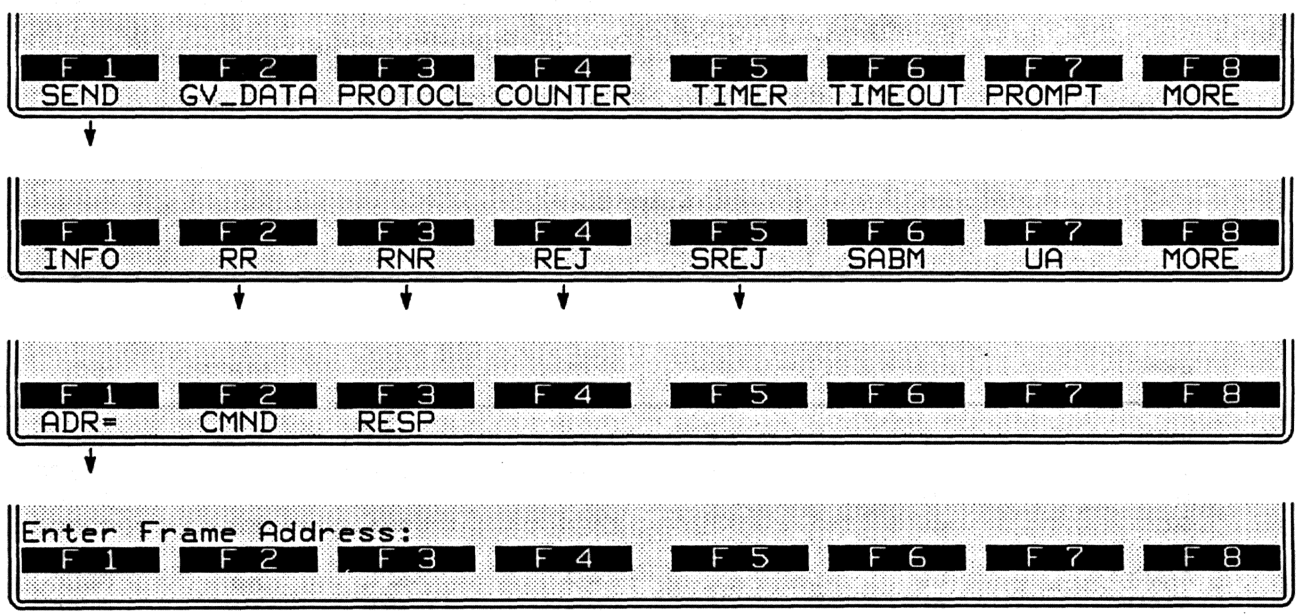


Figure 33-21 An address value must be added to *SEND RR*, *SEND RNR*, *SEND REJ*, and *SEND SREJ* actions.

4. *Other frames*. Any frame type may be entered in a SEND action as a hexadecimal value instead of by name. Press the softkey for OTHER, on the bottom rack in Figure 33-20. Enter the hex value in the form of two alphanumerics. Then press the softkey for ADR= (Figure 33-22) and enter an address value. Here is a DISConnect command entered as a SEND OTHER action:

ACTIONS: SEND OTHER 43 ADR= 03

P/F, N(R), and N(S) fields are implied in the user-entered hexadecimal control field. An address *should* be added to a SEND OTHER action, but if it is not, the default is the (CMND) address 01 when the **Emulate** field on the X.25 Frame Level Setup screen shows LOGICAL DTE. The address defaults to 03 for LOGICAL DCE. The other default parameter is a good BCC. (In MOD 128, P/F is not included in the hex entry and is a valid optional entry.)

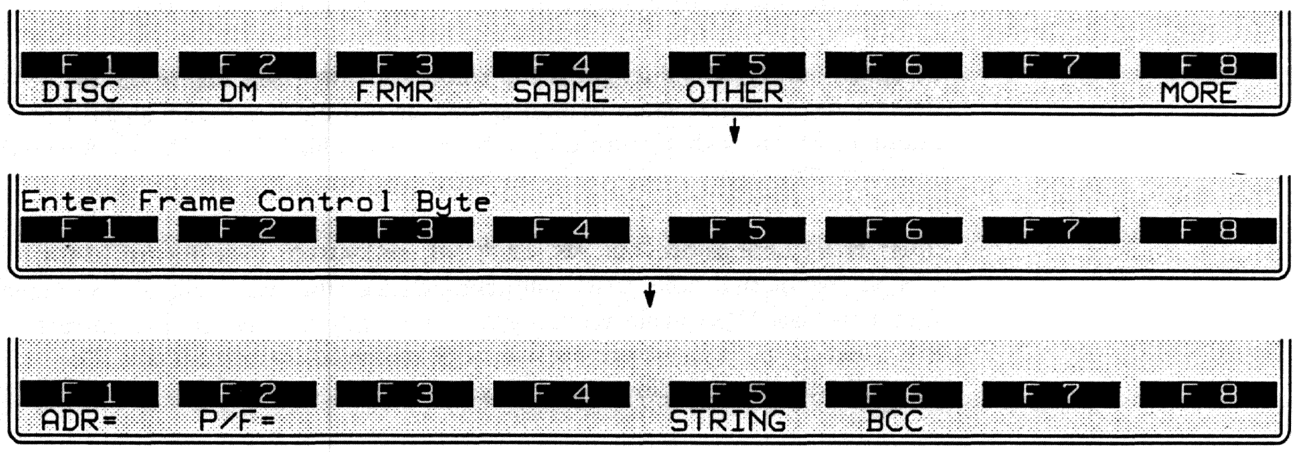


Figure 33-22 ***SEND OTHER*** **actions always specify a** ***type*** **value.**

5. *Address*. An address may be specified for INFO, unnumbered, and OTHER frames. It must be specified for supervisory frames. There are three softkeys pertaining to address in supervisory frames, ADR=, CMND, and RESP. See under "*Supervisory frames*," above.

   The ADR= entry is always followed by the hexadecimal address octet typed as two alphanumeric characters. The address field 03, for example, appears as follows:

   ACTIONS: SEND RR ADR= 03

6. *Poll/final bit*. The P/F bit is an optional entry in all SEND actions. P/F values of 0, 1, or LOOPBAK are entered by the softkeys in Figure 33-23. If P/F= LOOPBACK, the bit will echo the last P/F bit received. (Looping the P/F bit is appropriate for UAs and supervisory frames.) Default P/F values are given in Table 33-1.

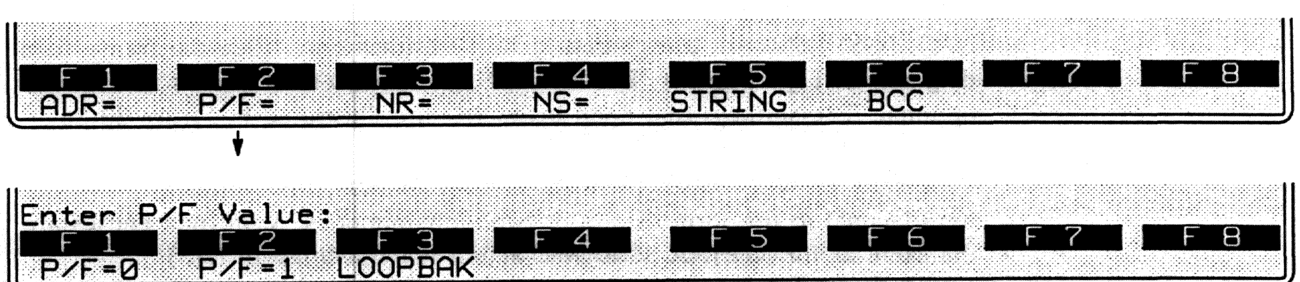


Figure 33-23 A P/F value is optional in all ***SEND*** **entries.**

7. *N(R)*. N(R) fields are transmitted in INFO and supervisory frames.

   To specify an N(R) value, press the softkey for NR= (see Figure 33-24). Enter a hexadecimal value written as one or two alphanumeric digits. For example, an entry that represented the highest valid N(R) in MOD 8 would be NR= 7. The highest valid entry in MOD 128 would be NR= 7F.

   Other N(R) options are ACK_NS, LAST_NR, and AUTO. (See Figure 33-24.) ACK_NS means that your N(R) will acknowledge (that is, it will be *one higher than*) the last N(S) value you received. Normally this will be the correct N(R), except in cases where the last N(S) received was erroneous. The NR= ACK_NS selection allows you to overlook N(S) errors.

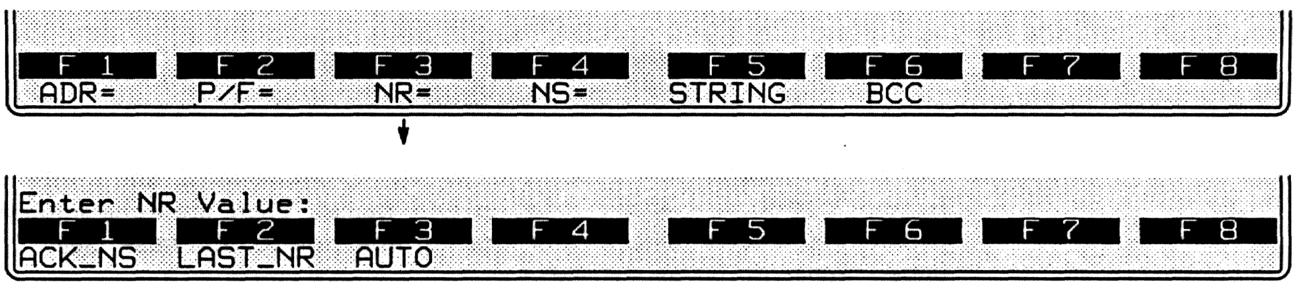


Figure 33-24 **The N(R) field may be specified in INFO and supervisory frames to be sent.**

   LAST_NR means that you simply repeat the last N(R) you sent. Normally this is the correct N(R) following a bad N(S). The NR= LAST_NR option allows you to force the other side to initiate recovery.

   AUTO means that you will behave as a normal X.25 Layer 2 station, acking valid N(S) values and repeating your last N(R) whenever an invalid N(S) is received. AUTO is the default N(R) selection in SEND INFO, SEND RR, SEND REJ, and SEND SREJ actions. See Table 33-1.

8. *N(S)*. N(S) fields are transmitted in INFO frames only. (See the frame-field diagrams in Figure 33-5.) Entries for N(S) in SEND INFO actions are optional. The softkeys that open below NS= are illustrated in Figure 33-25.

   To specify an N(S) value, press the softkey for NS=, then enter a hexadecimal in the form of one or two alphanumerics. Valid hex entries are the same as for N(R). A SEND INFO action that *specifies* an N(S) value—NS= 0, for example—will clear the window so that the INFO frame is buffered immediately.

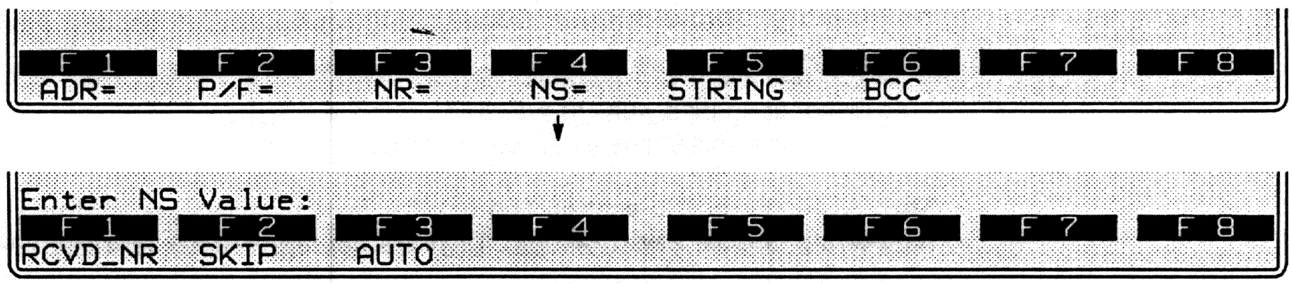


Figure 33-25 **The N(S) field may be specified in a *SEND INFO* action.**

Other N(S) options are RCVD_NR, SKIP, and AUTO. RCVD_NR means that you send the N(S) value that the other side says it is expecting. This is the valid N(S) in most cases, but not when you send two or more I–frames in a row without waiting for acknowledgment.

SKIP means that you *add one* to your correct N(S). This will look to the other side as though the line has taken a "hit" and a frame has been lost. This selection causes the window to be cleared.

NS= AUTO is the default setting for SEND INFO actions. AUTO means that every *new* INFO frame sent will have an N(S) value of one higher than the previous.

9. *String*. Strings are sent at X.25 Layer 2 only as adjuncts to frame–types when they are named in SEND actions. If you want to send a string of raw data without a protocol "envelope," you must go to Layer 1 and send the raw string from there.

   Press the SEND softkey followed by the softkey for a frame type. Add any necessary or desired SEND options for the particular frame type. Then press the STRING softkey (Figure 33-25).

   There is no spreadsheet keyword that identifies send–strings at any layer. *The spreadsheet compiler identifies strings by the quotation marks surrounding them*. Always enclose strings in quotation marks. (To send an actual " –character in your string, type \" .) See Section 29 for more information on strings.

   Here is a simple SEND action that includes no options besides a string:

   ACTIONS: SEND FRMR " $^{1}_{1}{}^{6}_{6}{}^{0}_{8}$ "

And here is a SEND action that includes a full complement of optional fields, including a string:

```
ACTIONS: SEND INFO ADR= 03 P/F= 0 NR= AUTO NS= AUTO
         " 10 02 00 CR LF This is user data." GDBCC
```

Most ASCII-keyboard, control, and hexadecimal characters are legal in a send-string. Special keys (FLAG, DON'T CARE, BIT MASK) are not legal. Refer to Table 29-2.

To insert a canned fox message into a transmit string, type FOX inside of double parens, as follows: ((FOX)). Remember that the double parens are special characters produced by the CTRL-9 and CTRL-0 combinations. Constants, counters, and flags can also be embedded in a string. See Section 29, Strings.

10. *BCC*. There are three BCC options for every SEND action at X.25 Layer 2. One of the options, GDBCC, is the default. Any frame that does not request a bad BCC or an abort will have a good frame-check sequence calculated for it and appended to it. BCC also is an option for SEND actions at Layer 1; but it does not occur at Layer 3 or higher.

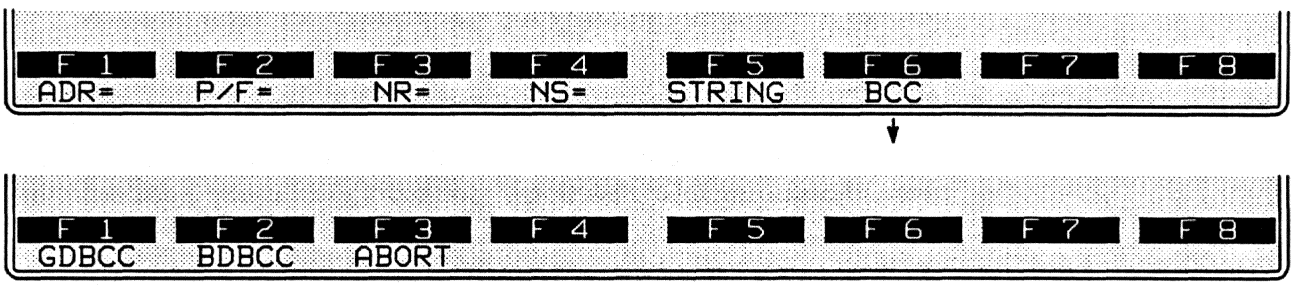


Figure 33-26 Type of BCC is a *SEND* option for frames at Layer 2.

The three softkey selections for BCC are shown in Figure 33-26. A sixteen-bit CCITT frame check is selected automatically for BOP protocols and cannot be changed or disabled. A bad BCC will be CRC-16 instead of CCITT.

When ABORT is the BCC selection, instead of appending a proper frame check the transmitter will hold the lead at mark for eight bits (or longer if the transmitter is idling F). Inside of a frame, seven 1-bits in a row are sufficient to signal an abort.

(B) Give Data

GIVE_DATA is the F2 action on the first rack of action softkeys (refer to Figure 33-19). This action takes the I-field from a received INFO frame and passes it up to Layer 3 along with a DL_DATA IND primitive. (See Figure 30-5 in the section, OSI Primitives on the Protocol Spreadsheet.) In an emulate mode, data is delivered up to Layer 3 only by one of two actions at Layer 2: GIVE_DATA, or else a DL_DATA IND primitive followed by the data string.

(C) Resend

The RESEND function is mapped to [F1] on the second layer of action softkeys at Layer 2 for X.25. See Figure 33-27. The first RESEND action will resend the first frame in the window. The window is a queue that buffers INFO frames for retransmission in case one or more transmissions are lost or in error.

The first frame in the window always is the *earliest outstanding* (unacknowledged) frame. Every time an acknowledgment is received, the window is cleared to the extent of the acknowledgment and a new "first-frame" position is established. The first RESEND after an acknowledgment always sends the first window frame.

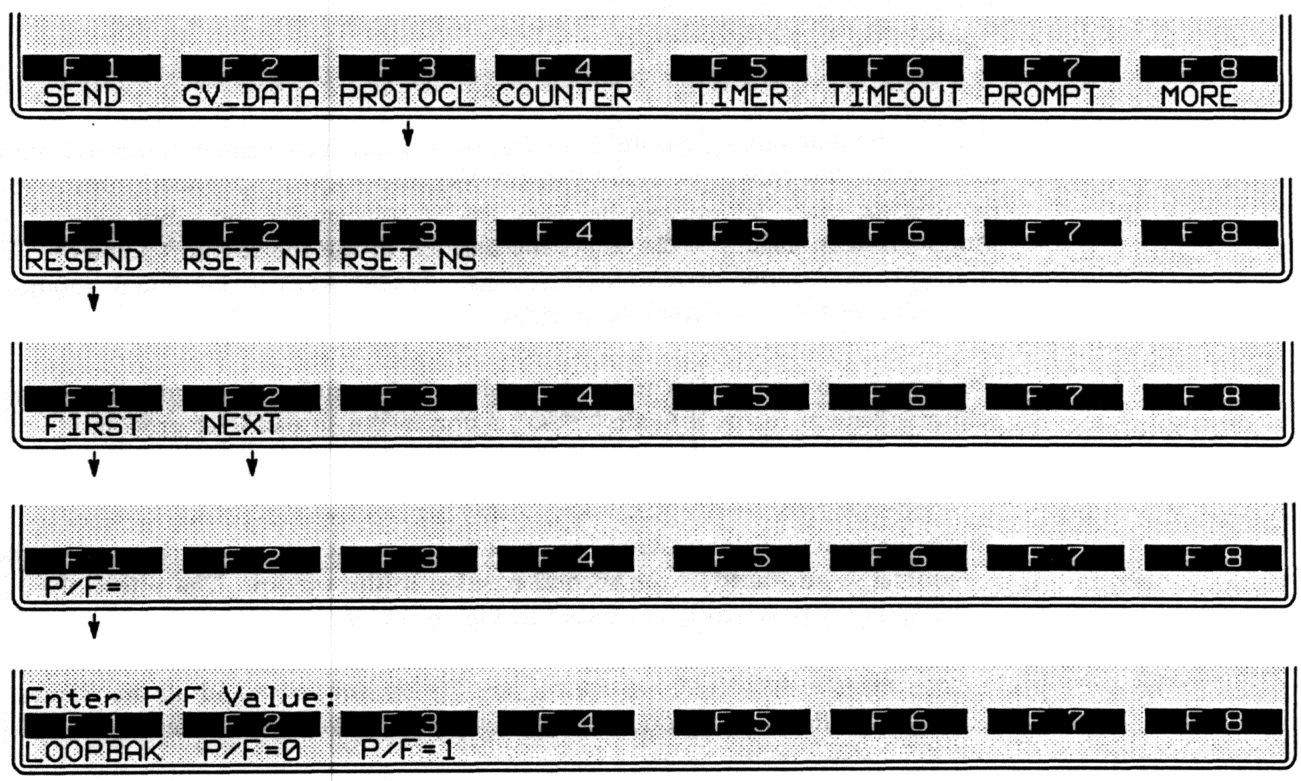


Figure 33-27 The *RESEND* action allows you to recover from sequence errors.

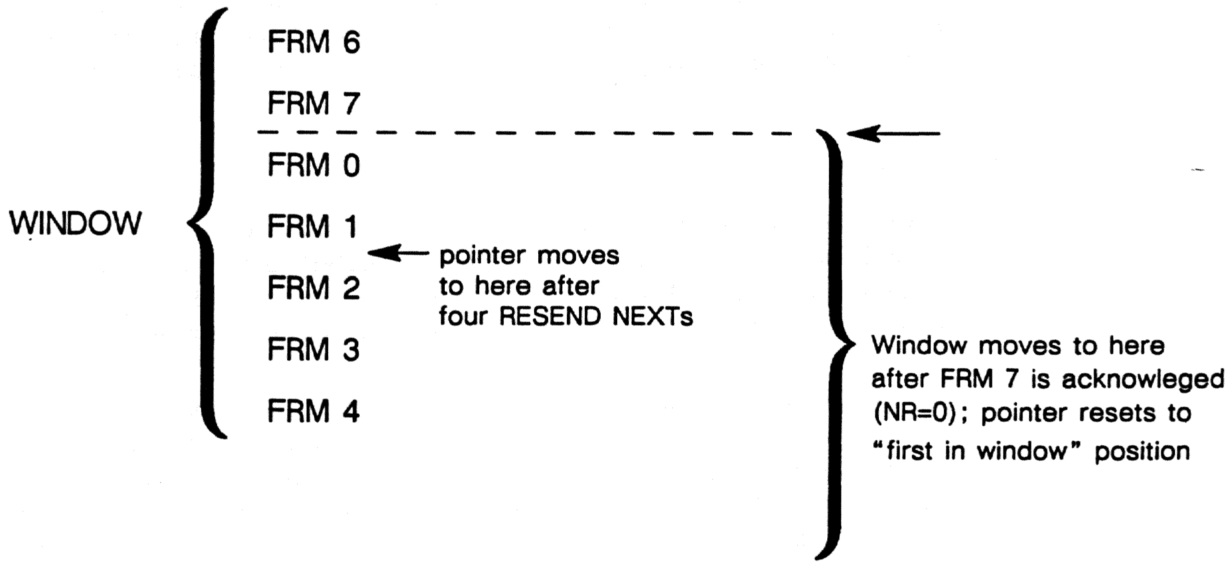


Figure 33-28 Resends cause the pointer to move, while acknowledgments move the pointer *and the entire window*.

The *second and subsequent* RESENDs following an acknowledgment also will send the first window frame, provided that the keyword FIRST is appended directly to the RESEND entry. Otherwise, they send the NEXT (second) and subsequent window frames. Figure 33-28 shows the position of the the resend "pointer" after four consecutive RESEND NEXT actions. RESEND NEXT is the default resend when neither FIRST nor NEXT is specified.

The resend-pointer is reset to the beginning of the window automatically by any acknowledgment, or by a RESEND FIRST action in the spreadsheet program.

1. *Resend first/next.* RESEND FIRST means that the resend-pointer is reset to the beginning of the window, the first frame in the window is resent, and the pointer is advanced to the second position in the window. The effect of a RESEND FIRST action is illustrated in Figure 33-29.

   The RESEND FIRST action makes it possible for you to resend all the frames in the window one by one, and then *resend them again* if necessary.

2. *P/F=loopback/0/1.* The P/F bit in the resend-frame can be set to 0 or 1 by this optional action. If PF= LOOPBACK, the bit will echo the last P/F bit received. (Default is 1 in a RESEND action.)

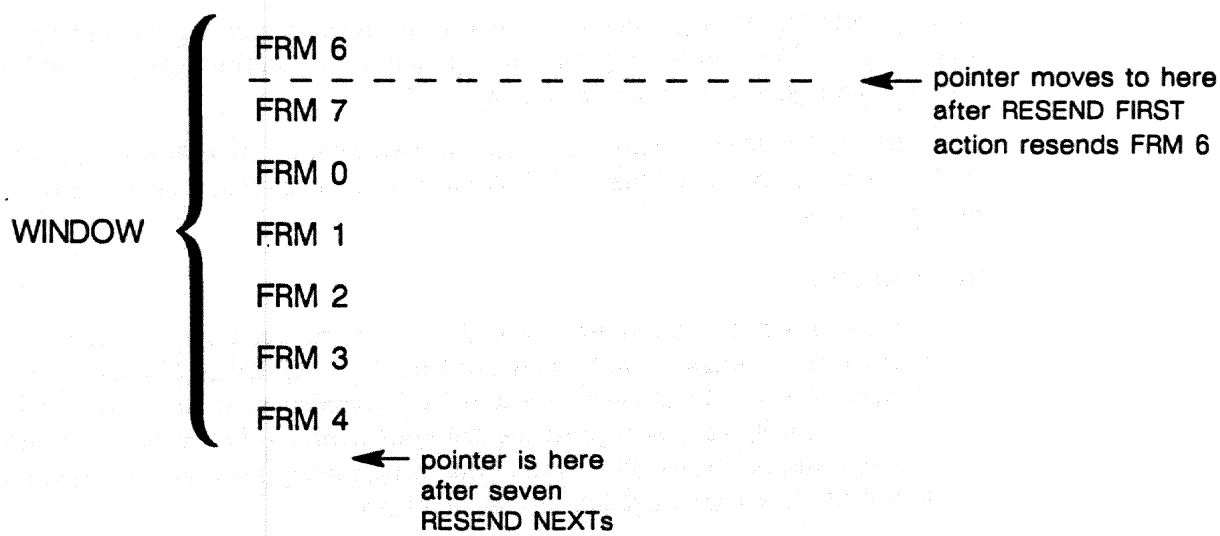


Figure 33-29 *RESEND FIRST* resets the pointer, allowing you to resend the entire window *repeatedly*.

(D) Reset N(R) and Reset N(S)

RESET_NR and RESET_NS are the [F2] and [F3] actions on the second rack of action softkeys for X.25 Layer 2. (Refer again to Figure 33-19.) The sequence-number fields in I-frames and supervisory frames can be reset by these two Protocol Spreadsheet actions. Sequence numbers are not reset *automatically* during a test by any frame that is sent or received.

RESET_NS also clears the transmit window.

33.6 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 2 protocol trace (see Section 33.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE, DCE, and RCV conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE, DCE, or RCV condition comes true at Layer 2, the frame that satisfied the condition can be enhanced on the X.25 Layer 2 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—F2 on the third rack of action softkeys. Figure 33-30 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

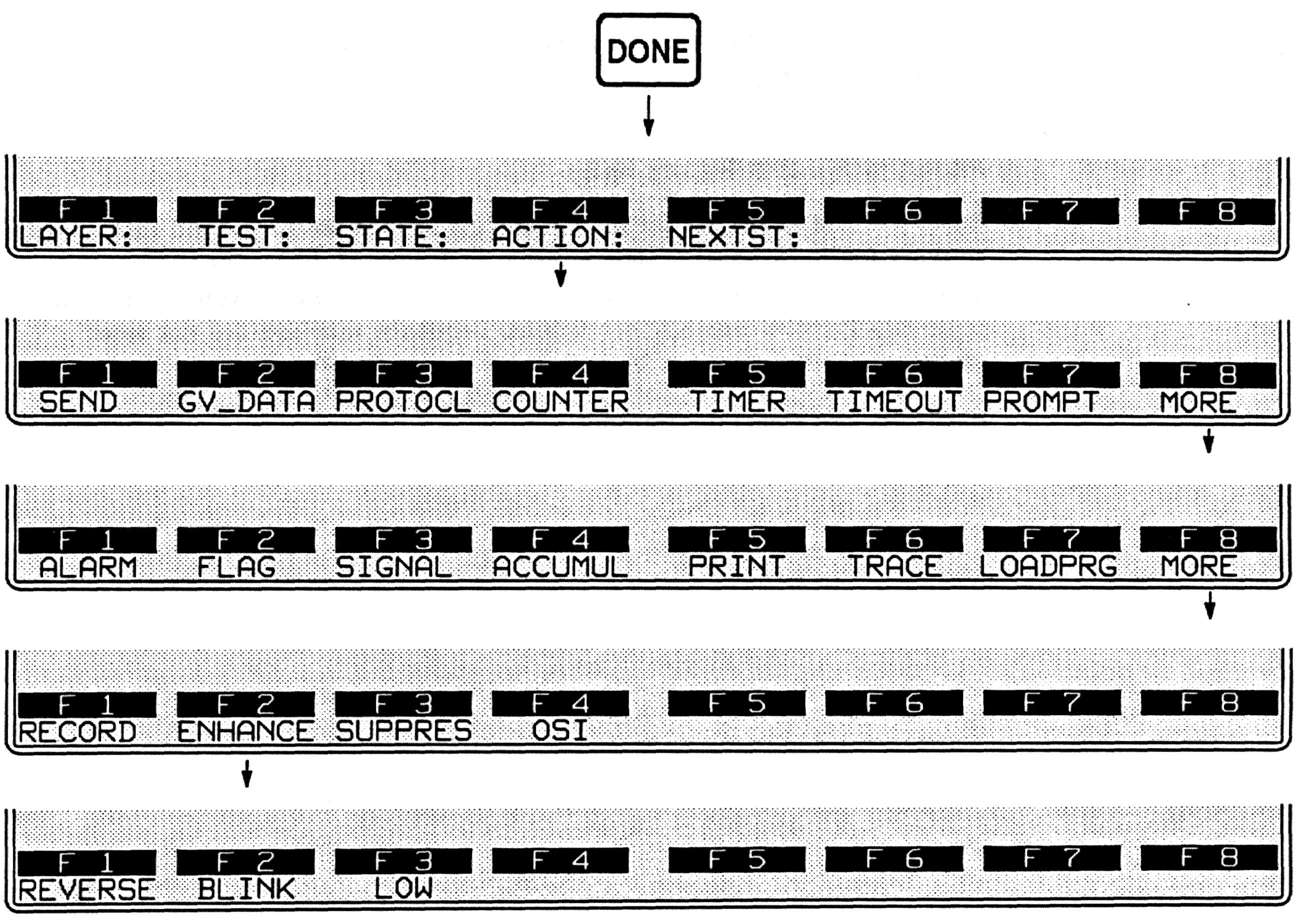


Figure 33-30 Selected frames on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

MON/DISK/FD2 BLK=00838 P 06/16/89 17:06
ASCII/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	01	RR	2		0	0002	1706:03.062	G
DCE	03	INFO	2	0	0	0030	1706:03.179	G
DTE	03	RR	1		0	0002	1706:03.213	G
DCE	03	INFO	2	1	0	0008	1706:03.444	G
DTE	03	RR	2		0	0002	1706:03.485	G
DTE	01	INFO	2	2	0	0009	1706:03.727	G
DCE	01	RR	3		0	0002	1706:03.842	G
DTE	01	INFO	2	3	0	0021	1706:03.910	G
DTE	01	INFO	2	3	1	0021	1706:04.163	G
DCE	01	RR	4		1	0002	1706:04.202	G
DCE	03	INFO	4	2	0	0007	1706:04.384	G
DTE	03	RR	3		0	0002	1706:04.505	G
DCE	03	INFO	4	3	0	0018	1706:04.696	G
DTE	03	RR	4		0	0002	1706:04.741	G
DTE	01	INFO	4	4	0	0007	1706:04.844	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 33-31 A retransmitted DTE I-frame has been enhanced.

Figure 33-31 shows one screen of a Layer 2 protocol trace in which DTE INFO frames with the poll bit set to 1—retransmitted DTE INFO frames, in other words—have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE INFO P/F= 1
ACTIONS: ENHANCE REVERSE

(B) Suppress

Individual frames that are suppressed in Layer 2 actions are deleted from the trace display. Figure 33-30 shows the softkey path to SUPPRES.

33.7 Automatic Primitives

A table in a previous section (Table 30-2) listed the OSI service primitives that are monitored at the boundaries of Layer 2 as trigger conditions and sent up to Layer 3 or down to Layer 1 as user-entered spreadsheet actions. These primitives are layer-specific rather than protocol-specific and are not part of the personality package for X.25 Layer 2; but a few of the primitives are set in motion automatically by X.25 Layer 2 spreadsheet actions. These *automatic* primitives can be thought of as part of the Layer 2 actions themselves, and by extension as part of the X.25 protocol package.

Table 33-2 gives the set of X.25 Layer 2 actions that have action-primitives built into them. For example, whenever a GIVE_DATA action occurs at Layer 2, a DL_DATA IND primitive is forwarded to Layer 3, where a DL_DATA IND condition may be waiting to monitor it.

Whenever a SEND or RESEND action is initiated at Layer 2, a PH_DATA REQ primitive is sent downward along with the PH data (the entire frame).

If a SEND or RESEND action is triggered at Layer 2 while the physical connection at Layer 1 is inactive, Layer 2 will sense the absence of a physical connection and delay the PH_DATA REQ. Instead it will send a PH_ACTIVATE REQ primitive. Only when a PH_ACTIVATE CONF has been returned by Layer 1 will Layer 2 release the data and the data primitive.

> **NOTE:** The RS-232 interface does not distinguish active/inactive status at the physical level. This interface returns PH_ACTIVATE CONF automatically whenever it sees PH_ACTIVATE REQ.

Table 33-2
Automatic Primitives Generated at X.25 Layer 2

X.25 Layer 2 Action	Automatic Primitive	To Layer
GIVE_DATA	DL_DATA IND	3
SEND {TYPE}	(PH_ACTIVATE REQ*)	1
	PH_DATA REQ	1
RESEND	(PH_ACTIVATE REQ*)	1
	PH_DATA REQ	1

*Sent if Layer 1 shows inactive status. PH_DATA REQ delayed until PH_ACTIVATE CONF returned by Layer 1.

33.8 Programming Example: Converting Protocol Bytes to Hexadecimal

Listed below is a simple, four-trigger test that enhances the "readability" of the raw display of X.25 data. When this test is entered on the trigger menus or anywhere in the Protocol Spreadsheet program at *Layer 1*, frame-level and packet-level protocol bytes on the raw-data display are converted automatically to hexadecimal, while all user-data is translated into ASCII characters. Figure 33-32 shows the same data both *before* and *after* the test has been applied.

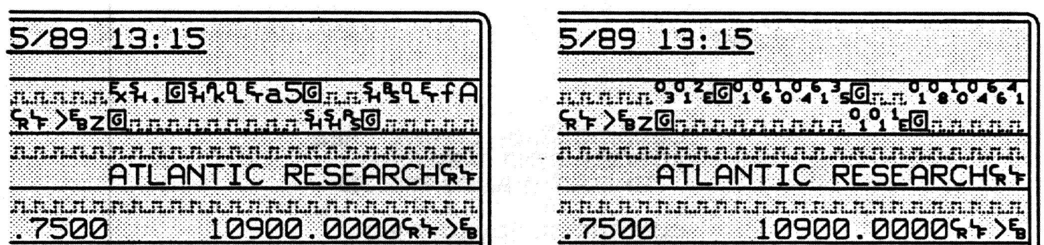


Figure 33-32 In the X.25 data on the right, a simple enhancement program has converted protocol bytes to hexadecimal.

Because it occupies a single state, the protocol-hex test can be entered on the trigger menus; or it may be included in the Protocol Spreadsheet program in this form:

```
LAYER: 1
  TEST: ptcl_hex
    STATE: enhance
      CONDITIONS: DTE STRING "F≠F((XXXXXXX0)) ((0XXXXXXX))☒((XXXXXXX0)) "
      ACTIONS: ENHANCE DTE HEX OFF
      CONDITIONS: DTE GOOD_BCC
      ACTIONS: ENHANCE DTE HEX ON
      CONDITIONS: DCE STRING "F≠F((XXXXXXX0)) ((0XXXXXXX))☒((XXXXXXX0)) "
      ACTIONS: ENHANCE DCE HEX OFF
      CONDITIONS: DCE GOOD_BCC
      ACTIONS: ENHANCE DCE HEX ON
```

In the strings, F ≠F (FLAG NOT EQUAL FLAG) looks for the beginning of the frame. The first bit mask—((XXXXXXX0))—looks for I-frames. The second bit mask looks for a Q ("*data-qualified*") bit that equals zero. The ☒ entry (DON'T CARE) causes the search string to skip one byte, the LCN byte in the packet header. The third bit mask looks for data packets. Only *unqualified* data packets satisfy the string and turn the hex enhancement *off*. The user data that follows is translated into ASCII.

The test in this form makes two assumptions: the numbering mode is MOD 8 and apart from X.29, no protocol is implemented above Layer 3.

33.9 Programming Example: A Simple "Automatic" Layer 2 X.25 Test

Here is a simplified test that makes Layer 2 "automatic" and "transparent" when you are working at Layer 3 or higher.

The test initiates a link-startup sequence when a DL_CONNECT REQ primitive arrives from Layer 3. This primitive will be sent down automatically at Layer 3 as soon as a SEND RESTART or other Layer 3 SEND action is attempted.

Automatic Layer 2 X.25 Test:

```
LAYER: 2

    STATE: init

      CONDITIONS: DL_CONNECT REQ
      ACTIONS: SEND SABM P/F=1
         TIMEOUT t1 RESTART 3.000

      CONDITIONS: RCV UA P/F=1
      ACTIONS: DL_CONNECT CONF
         TIMEOUT t1 STOP
         RESET_NR
         RESET_NS
      NEXT_STATE: info_xfr

      CONDITIONS: TIMEOUT t1
      ACTIONS: SEND SABM P/F=1
         TIMEOUT t1 RESTART 3

      CONDITIONS: RCV SABM
      ACTIONS: DL_CONNECT IND
         TIMEOUT lyr3_resp RESTART 1

      CONDITIONS: DL_CONNECT RESP
      ACTIONS: SEND UA P/F= LOOPBACK
         RESET_NR
         RESET_NS
      NEXT_STATE: info_xfr

      CONDITIONS: TIMEOUT lyr3_resp
      ACTIONS: PROMPT "Layer 3 not responding"

    STATE: info_xfr

      CONDITIONS: DL_DATA REQ
      ACTIONS: SEND INFO " ((DL_DATA)) "

      CONDITIONS: RCV INFO
      ACTIONS: SEND RR RESP
         GIVE_DATA

      CONDITIONS: T1_EXPIRED
      ACTIONS: RESEND FIRST P/F= 1

      CONDITIONS: RCV REJ RESP
      ACTIONS: RESEND FIRST
      NEXT_STATE: xmt_wndw
```

```
STATE: xmt_wndw

    CONDITIONS: FRAME_SENT
      MORE_TO_RESEND
    ACTIONS: RESEND NEXT

    CONDITIONS: FRAME_SENT
      NO_MORE_TO_RESEND
    NEXT_STATE: Info_xfr
```

The link startup also can be initiated from "below," by a SABM received from the other side of the link. Note that in this Layer 2 program, the UA response to a SABM is made contingent on a Layer 3 program above that acknowledges the link-startup (DL_CONNECT) indication. The link establishment is designed to fail (while displaying the operator prompt, "Layer 3 not responding") unless the following minimum Layer 3 program is included on the Protocol Spreadsheet:

```
LAYER: 3

    STATE: dl_connect

        CONDITIONS: DL_CONNECT IND
        ACTIONS: DL_CONNECT RESP
```

Here is a fuller Layer 3 program that initiates link setup and also handles the transfer of Restart packets that brings the interface to the Ready (for calls) state.

```
LAYER: 3

    STATE: dl_connect

        CONDITIONS: ENTER_STATE
        ACTIONS: DL_CONNECT REQ

        CONDITIONS: DL_CONNECT CONF
        NEXT_STATE: packet_level_ready

        CONDITIONS: DL_CONNECT IND
        ACTIONS: DL_CONNECT RESP
        NEXT_STATE: packet_level_ready


    STATE: packet_level_ready

        CONDITIONS: ENTER_STATE
        ACTIONS: SEND RESTART

        CONDITIONS: RCV RESTART
        ACTIONS: RESET_PR_PS
        NEXT_STATE: ready_to_call

        CONDITIONS: RCV RESTART_CONF
        ACTIONS: RESET_PR_PS
        NEXT_STATE: ready_to_call

    STATE: ready_to_call
```

In **info_xfr** state, the test receives DL_DATA from Layer 3 and *sends* it down to Layer 2. It *gives* DL_DATA up to Layer 3. Recovery actions are taken, as follows: when T1 expires, the test resends the first frame in the window. When a REJ frame is received, the test moves to **xmt_wndw** state and resends the entire window before returning to **info_xfr** state.

34 X.25 Layer 3

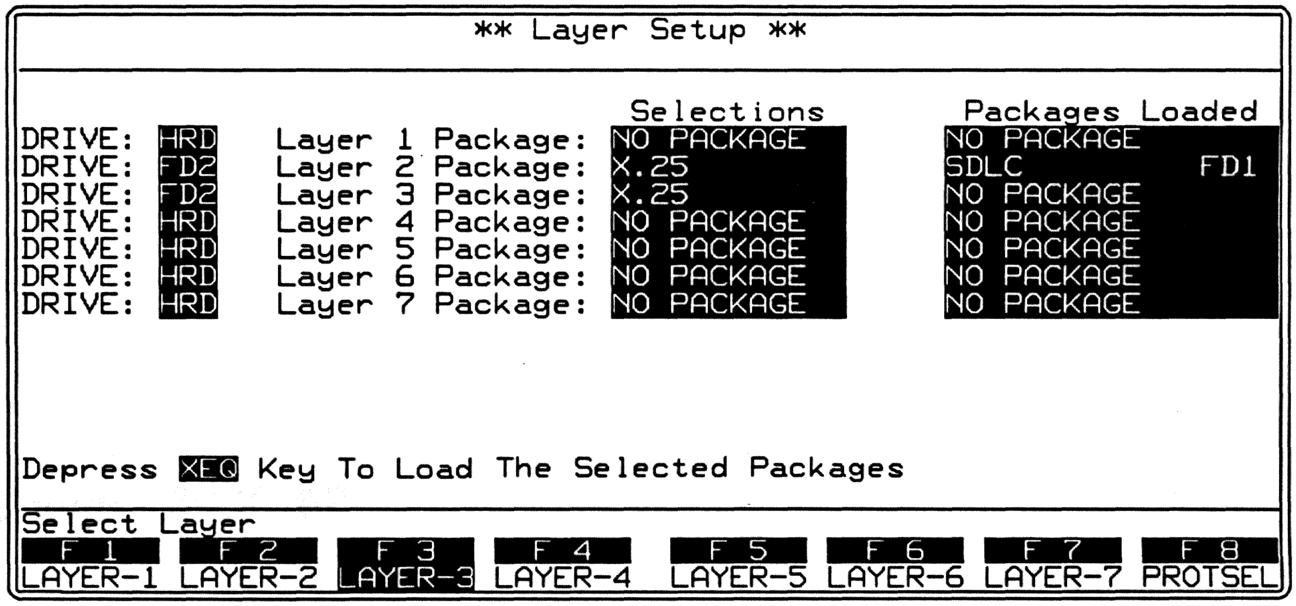


Figure 34-1 The X.25 personality package for Layer 3 is loaded from the Layer Setup screen.

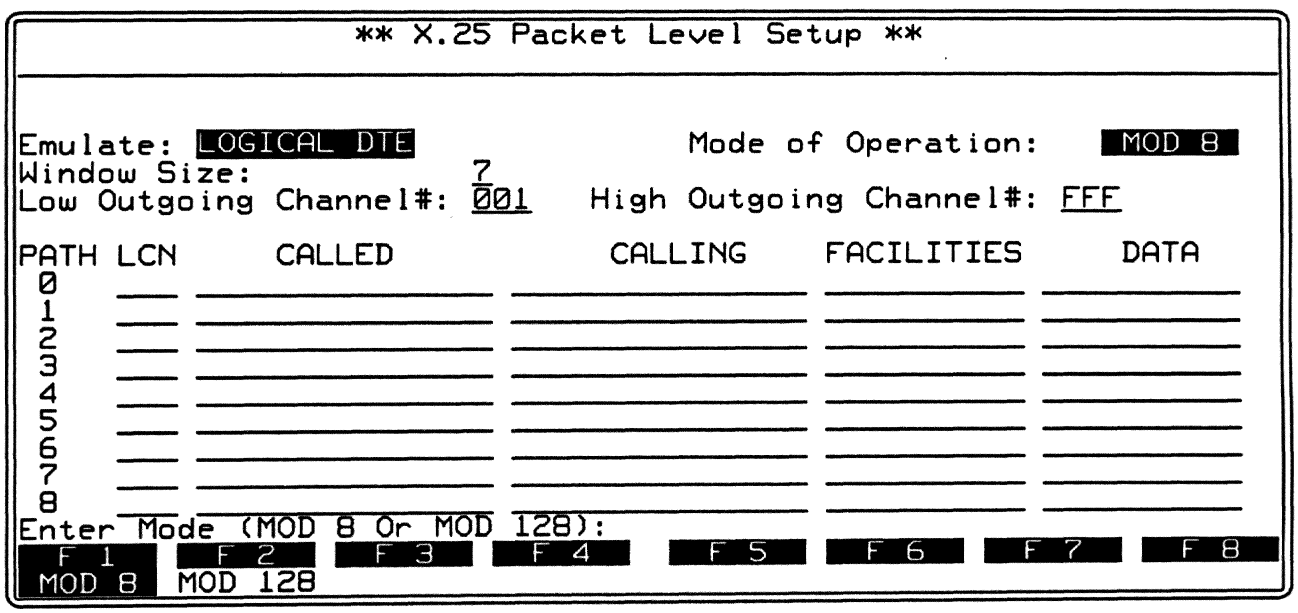


Figure 34-2 Protocol configuration screen for X.25 Layer 3.

34 X.25 Layer 3

Layer 3 X.25 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 34-1 shows the Layer Setup screen configured to load in the Layer 2 and Layer 3 X.25 packages from floppy-disk drive #2. Refer to Section 6 for details on operating the Layer Setup screen.

The Layer 3 X.25 package consists of the following:

- A special X.25 Packet Level Setup screen (shown in Figure 34-2) that controls certain parameters when the unit is tracing or emulating X.25.
- A protocol trace (illustrated in Figure 34-4) that distills from X.25 data the packet-level events that have protocol significance. This trace is accessible by softkey in Run mode at all times.
- A group of conditions and actions at Layer 3 on the Protocol Spreadsheet that facilitate X.25 programming. Figure 34-9 shows the softkey path to the first rack of condition softkeys when the X.25 package is loaded in at Layer 3.

34.1 Packet-Level Setup

The X.25 Packet Level Setup screen must be configured correctly for an accurate trace display and for proper emulation.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the X.25 selection at Layer 3: **X.25** should appear in the **Packages Loaded** column. Press F8 (labeled PROTSEL) to bring up the prompt to **Select Protocol Configuration Screen**. Then press F3 (LAYER-3) to call up the X.25 Packet Level Setup screen.

The five parameter fields on this screen as well as the path-data entry fields are shown in Figure 34-2. **Emulate, Window Size, Low Outgoing Channel #, High Outgoing Channel #,** and the entire path-data area apply only to interactive (emulate) tests. **Mode of Operation** must be configured correctly for the protocol trace as well as for proper emulation.

(A) Emulate Logical DTE/DCE

There are two selections in the **Emulate** field on the X.25 Packet Level Setup screen, LOGICAL DTE and LOGICAL DCE. The entry in this field determines the order of assignment when LCNs are assigned dynamically to call requests during interactive testing.

Configured as a logical DTE, the INTERVIEW assigns LCNs in a descending sequence beginning with the High Outgoing Channel #. See Section (D), below. Configured as a logical DCE, the INTERVIEW assigns LCNs in ascending sequence beginning with the Low Outgoing Channel #.

(B) Mode of Operation

The **Mode of Operation** field selects the mode of numbering DATA and supervisory packets. There are two options, MOD 8 and MOD 128.

MOD 8 uses sequence numbers 0–7. MOD 128 adds an extra byte to the control field in DATA, RR, RNR, and REJ packets. See Figure 34-6. This extra byte allows sequence numbers in a range of 0–127.

The correct "modulus" must be selected in this field in order to conduct interactive communications and also to generate an accurate X.25 Layer 3 trace.

(C) Window Size

Any window size may be entered up to the current modulus minus one: 7 or 127. The window size is the maximum number of unacknowledged data packets that Layer 3 will buffer for retransmission. When the limit is reached, any further data packets that are named in SEND actions triggered at Layer 3 will be passed to Layer 2 but not buffered for resending.

According to CCITT Recommendation X.25, the standard window size is 2. This means that two packets can be outstanding (unacknowledged) at a time.

The window is a queue that buffers packets for retransmission in case one or more transmissions are lost or in error. A RESEND action will resend the first (earliest) packet in the window. Successive RESENDs will send successive packets until there are no more packets to resend; or until the window is reset by an acknowledgment or by a RESEND FIRST action.

(D) Low Outgoing Channel#/High Outgoing Channel#

Logical Channel Numbers (LCNs) may be assigned dynamically on a per-call basis; or they may be reserved during Program mode for a particular call destination (or "path") by means of an entry in the **LCN** column on the X.25 Packet Level Setup screen.

If the **LCN** column on the Packet Level Setup screen is left blank with respect to a particular call destination ("path"), an LCN will be assigned dynamically each time the INTERVIEW initiates a call on that network path, as follows:

If the INTERVIEW has been configured as a logical DCE on the Layer 3 Protocol Configuration screen, it will select the Low Outgoing Channel number for the first call to the DTE. Assuming that the first call still is in session, the next call initiated by the INTERVIEW will have the next higher LCN, and so forth, to the upper limit for LCNs established in the **High Outgoing Channel#** menu field.

If the INTERVIEW has been configured as a logical DTE, the first call initiated by the INTERVIEW will receive the High Outgoing Channel number. If the first call remains in session, the second call will have the second-highest LCN, and so forth, to the lower limit for LCNs set in the **Low Outgoing Channel#** field.

(E) Path

"Path" is the route of a Call Request packet through the X.25 network, on the way to its destination address. Call Request packets establish the path of a call. When data packets enter the network, they carry the same LCN as the call packet. They use the LCN to identify themselves at each network node, where they are routed along the path already established for the call.

Packets that are programmed to be "sent" on the Protocol Spreadsheet must indicate their destination—that is, they must declare the call that they belong to. In the network, they will use the LCN to identify their call. But the LCN cannot be used for identification on the INTERVIEW's Protocol Spreadsheet, since LCNs usually are assigned dynamically at the time of the call—in which case they cannot be pre-programmed.

Instead, packets on the spreadsheet are provided with a "path" number that ties them, on the X.25 Packet Level Setup screen, to a particular set of Call Request parameter values. Here is an example of how the procedure works:

On the Packet Level Setup screen (see Figure 34-3), the following entry is made in the CALLED column for Path #0: 300170345678. On the Protocol Spreadsheet, this Actions entry is made: SEND CALL PATH= 0.

When the SEND action is triggered, a Call Request packet will be formed with the Called address given for Path #0 on the Packet Level Setup screen: 300170345678. An LCN will be assigned to this call packet dynamically, according to the rules for low and high outgoing channel numbers outlined in Section 34.1(D), above. As long as the call is active, data packets and other packets sent on this *path*—for example, SEND DATA PATH= 0—will carry the same LCN.

(F) LCN

Normally the LCN field for a particular call (or "path") is left blank. During Run mode when the Call Request is created, the LCN is assigned dynamically according to the rules for low and high outgoing channel numbers described above. For the duration of the call, data packets and other packets are constructed with the same LCN.

```
                    ** X.25 Packet Level Setup **

Emulate: LOGICAL DTE                     Mode of Operation:    MOD 8
Window Size:              2
Low Outgoing Channel#: 001   High Outgoing Channel#: 1F

PATH LCN      CALLED              CALLING       FACILITIES       DATA
 0   ___  300170345678                           01              01000
 1
 2
 3
 4
 5
 6
 7
 8
Enter called address for entry #0 (decimal): 300170345678
  F 1    F 2    F 3    F 4    F 5    F 6    F 7    F 8
```

Figure 34-3 Packet-level setup screen with sample data.

An LCN also can be predefined by the user. This designation is made in the LCN column of the Packet Level Setup screen, not on the Protocol Spreadsheet. The SEND action on the spreadsheet still references only the path number. On the Packet Level Setup screen, that path number is correlated to the LCN that the user enters on the same row.

The LCN field is referred to as a "hex" field. This means that each column (character space) in the data-entry field will equate to one 4-bit, hexadecimal digit on the actual data screen. For example, a data screen may show the two-character sequence $^0{}_1{}^2{}_3$, where the second, third, and fourth digits represent the LCN. The LCN entry on on the Packet Level Setup screen was 123. Or the character data may show this sequence: $^0{}_0{}^1{}_E$. The LCN on the setup screen was 1E (also 01E).

(G) CALLED

Enter the called address in this field. Addresses are considered "decimal" entries. This means that each column or character space in the data-entry field will equate to a 4-bit, binary-coded decimal (BCD) digit on the actual data screen. Use the numbered keys to make this entry—do not use the [HEX] key to turn on the hex function. A sample address entry is shown in Figure 34-3.

(H) CALLING

Enter the calling address in this field. (Logical DTEs often omit this address: the network knows the addresses of dedicated lines coming into the node and may not require them.)

Addresses are considered "decimal" entries. This means that each column or character space in the data-entry field will equate to a 4-bit, binary-coded decimal (BCD) digit on the actual data screen. Use the numbered keys to make this entry—do not use the [HEX] key to turn on the hex function. A sample address entry is shown in Figure 34-3.

Do not make any allowance in this field for the Address Length byte (see Figure 34-6). That byte is provided automatically.

(I) FACILITIES

Enter the entire Facilities field as it will appear in the Call Request packet. *Omit the Facilities Length byte*; that is handled automatically.

The FACILITIES field is referred to as a "character" field. This means that characters—including hexadecimal characters—in the data-entry field will equate one-for-one with the characters on the actual data screen.

The Facilities entry in Figure 34-3 will be transmitted in a Call Request packet exactly as it appears in this field. With a Facilities Length byte preceding it, it will look like this on the data display: 02 01 01.

(J) DATA

Enter the Data field as it will appear in the Call Request packet. If you want a Data field that is longer than the ten character spaces in the DATA field, you can append a *string* to your Call packet on the Protocol Spreadsheet.

The Data field on the Packet Level Setup screen is a "character" field. This means that the Data entry in Figure 34-3 will be transmitted exactly as it appears in this field. (As in any transmit string on an INTERVIEW screen, in normal bit order the *rightmost* bit in the *leftmost* byte will be the first bit transmitted.)

Based on the entries for Path #0 in Figure 34-3, the INTERVIEW will send the following Call Request *packet* in a SEND CALL PATH= 0 action. Frame-level bytes are not shown. Assume an LCN of 01E.

hex:

10 1E 0B 0C 30 01 70 34 56 78 02 01 01 01 00 00 00

ASCII:

DL RS VT FF 0 SH p 4 V x SX SH SH SH NU NU NU

34.2 Protocol Trace

The Layer 3 X.25 package includes an automatic packet-trace display that summarizes packet-level activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

MON/LINE BLK=00000 S 06/24/89 17:55
ASCII/8/NONE/BOP

SRC	LCN	TYPE	Pr	Ps	QDM	MISC	SIZE	TIME	BCC
DTE	004	CALL				087940010102010101000000	0015	1751:18.233	G
DCE	004	CALLACC					0003	1751:18.454	G
DCE	004	DATA	0	0	Q		0030	1751:18.484	G
DTE	004	RR	1				0003	1751:18.608	G
DCE	004	DATA	0	1			0030	1751:18.629	G
DCE	004	DATA	0	2	Q		0008	1751:18.728	G
DTE	004	RR	2				0003	1751:18.754	G
DTE	004	RR	3				0003	1751:18.804	G
DTE	004	DATA	3	0	Q		0008	1751:18.834	G
DTE	004	DATA	3	1			0009	1751:19.047	G
DCE	004	RR	2				0003	1751:19.178	G
DCE	004	DATA	2	3	Q		0006	1751:19.319	G
DTE	004	RR	4				0003	1751:19.359	G
DCE	004	DATA	2	4			0027	1751:19.384	G
DTE	004	RR	5				0003	1751:19.494	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 34-4 Each horizontal row on the trace display represents a packet.

While the unit is in Run mode, press the softkey for PROTOCL (F2 on the primary rack of display-mode softkeys) and then the softkey for L3TRACE (F2)to bring the protocol trace for X.25 Layer 3 to the screen. Figure 34-4 is an example of this trace display. Each horizontal row in the trace represents a packet.

(A) The Protocol Trace in Freeze Mode

Press FREEZE to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing ROLL FWD or ↓ moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing ROLL BACK or ↑ moves the viewing window up to add a line of older data to the top of the screen.

Depression of the NEXT PAGE key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of PREV PAGE adds fifteen lines of older frames.

The packet displayed on the top line of frozen trace-data will appear in the first frame in the raw-data or data-plus-leads display. To view the character data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

For example, the Call Request packet traced on the top line of the display in Figure 34-4 also is contained in the frame at the *top left* of the *data* display in Figure 34-5. This correlation is automatic.

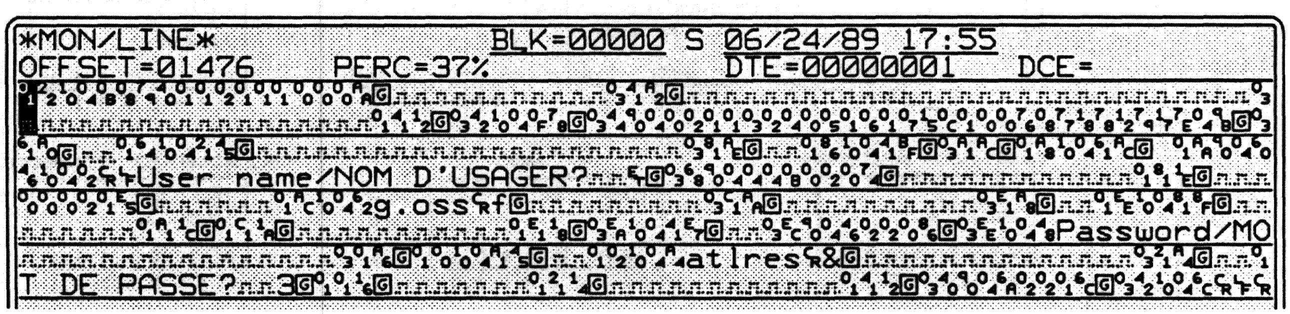


Figure 34-5 Data-display of Protocol Trace shown in Figure 34-4.

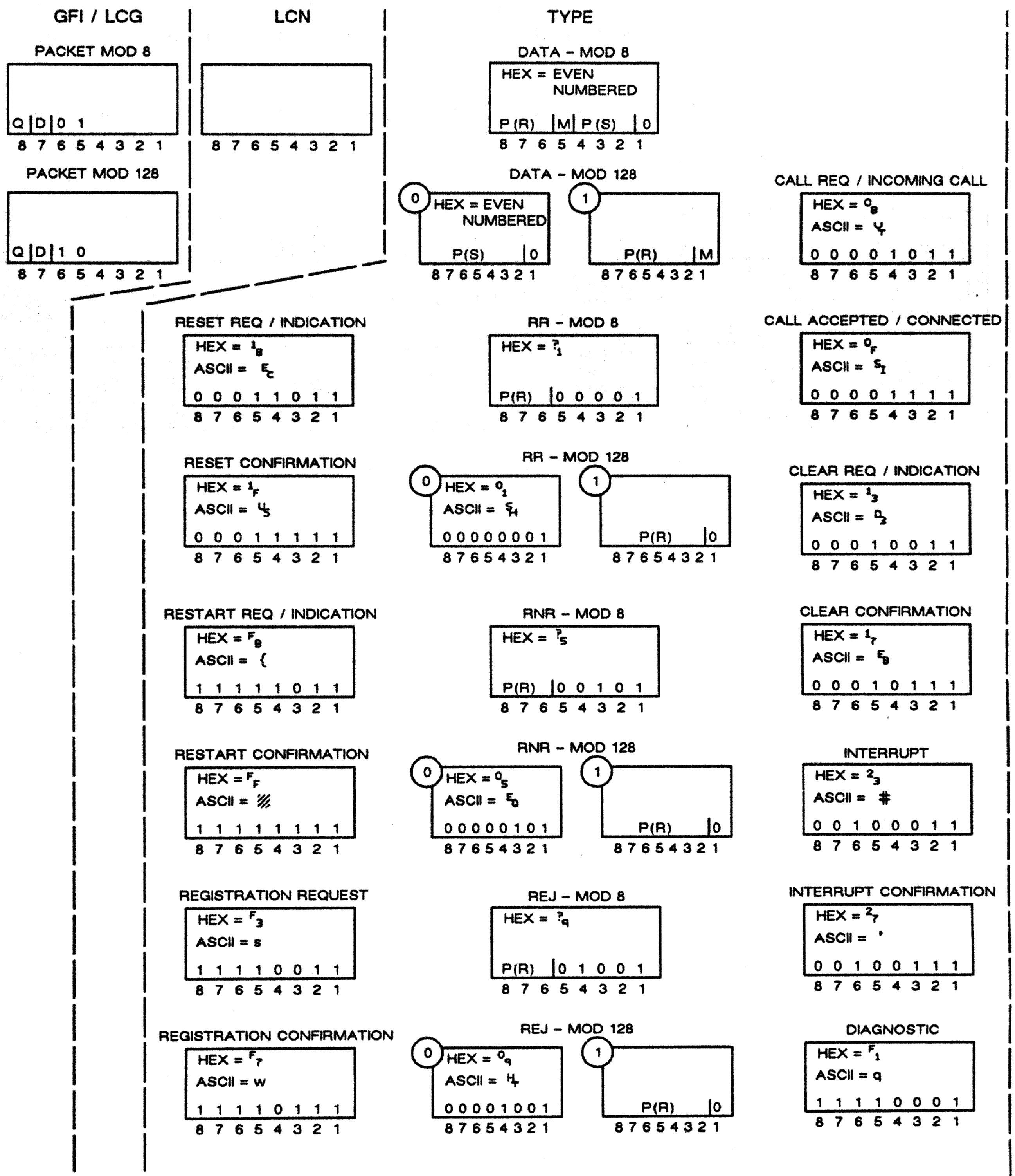
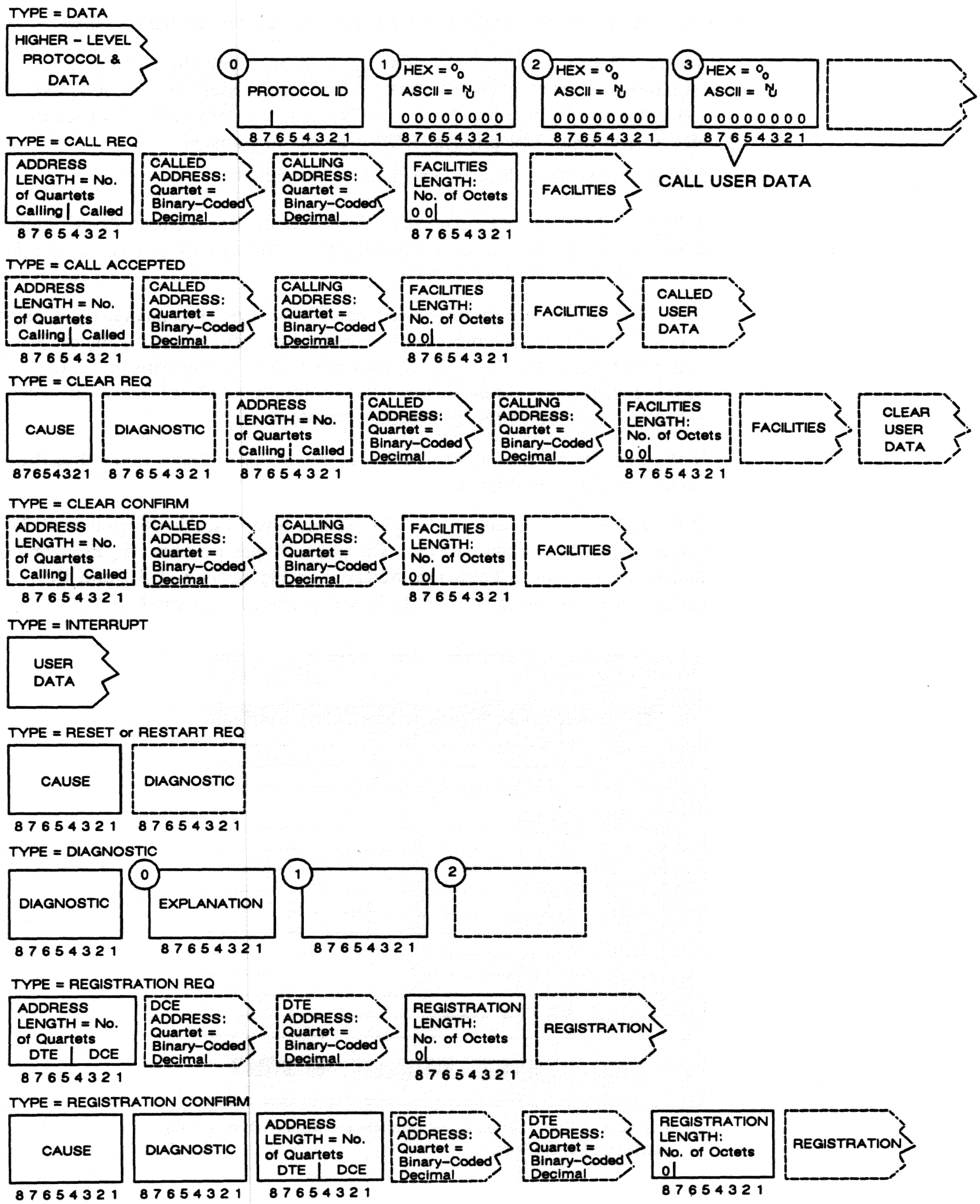


Figure 34-6 X.25 packet fields.

DATA


TYPE = DATA
HIGHER – LEVEL PROTOCOL & DATA
0
PROTOCOL ID
1
HEX = 0
ASCII =
00000000
2
HEX = 0
ASCII =
00000000
3
HEX = 0
ASCII =
00000000
87654321
CALL USER DATA
TYPE = CALL REQ
ADDRESS LENGTH = No. of Quartets
Calling | Called
CALLED ADDRESS: Quartet = Binary-Coded Decimal
CALLING ADDRESS: Quartet = Binary-Coded Decimal
FACILITIES LENGTH: No. of Octets
0 0
FACILITIES
TYPE = CALL ACCEPTED
ADDRESS LENGTH = No. of Quartets
Calling | Called
CALLED ADDRESS: Quartet = Binary-Coded Decimal
CALLING ADDRESS: Quartet = Binary-Coded Decimal
FACILITIES LENGTH: No. of Octets
0 0
FACILITIES
CALLED USER DATA
TYPE = CLEAR REQ
CAUSE
DIAGNOSTIC
ADDRESS LENGTH = No. of Quartets
Calling | Called
CALLED ADDRESS: Quartet = Binary-Coded Decimal
CALLING ADDRESS: Quartet = Binary-Coded Decimal
FACILITIES LENGTH: No. of Octets
0 0
FACILITIES
CLEAR USER DATA
TYPE = CLEAR CONFIRM
ADDRESS LENGTH = No. of Quartets
Calling | Called
CALLED ADDRESS: Quartet = Binary-Coded Decimal
CALLING ADDRESS: Quartet = Binary-Coded Decimal
FACILITIES LENGTH: No. of Octets
0 0
FACILITIES
TYPE = INTERRUPT
USER DATA
TYPE = RESET or RESTART REQ
CAUSE
DIAGNOSTIC
TYPE = DIAGNOSTIC
DIAGNOSTIC
0
EXPLANATION
1
2
TYPE = REGISTRATION REQ
ADDRESS LENGTH = No. of Quartets
DTE | DCE
DCE ADDRESS: Quartet = Binary-Coded Decimal
DTE ADDRESS: Quartet = Binary-Coded Decimal
REGISTRATION LENGTH: No. of Octets
0
REGISTRATION
TYPE = REGISTRATION CONFIRM
CAUSE
DIAGNOSTIC
ADDRESS LENGTH = No. of Quartets
DTE | DCE
DCE ADDRESS: Quartet = Binary-Coded Decimal
DTE ADDRESS: Quartet = Binary-Coded Decimal
REGISTRATION LENGTH: No. of Octets
0
REGISTRATION
87654321

(B) Trace Columns

The columns in the protocol trace for Layer 3 X.25 are explained below.

1. *Source*. The **SRC** column identifies the lead on which the packet was monitored, TD (DTE) or RD (DCE). This column identifies the *physical* source of the packet, not the *logical* source. The physical DTE uses the TD lead to transmit. The physical DCE uses RD to transmit.

   Just as on the data display, RD data is underlined.

2. *LCN*. The LCN for each packet is given in this three-column "hex" field. Each column displays a hexadecimal *digit* (0 through F) that represents four bits out of the twelve-bit LCN.

3. *Type*. The mnemonic (abbreviated) names for seventeen packet types as they appear in the **TYPE** column of the protocol trace are shown in Figure 34-6 under "TYPE." If a Type octet does not fit any of the patterns in the figure, the packet it listed in the **TYPE** column as UNKWN followed by the hexadecimal value of the type byte: UNKWN=03.

   If the number of bytes in the packet is below the required minimum, the packet is posted as INVALID.

4. *P(R) and P(S)*. One column on the packet-level trace is devoted to P(R) values, and one column to P(S). The packet types that include P(R) or P(S) fields in their control fields are indicated in Figure 34-6. P(R) and P(S) occupy three bits each in modulo 8, seven bits each in modulo 128.

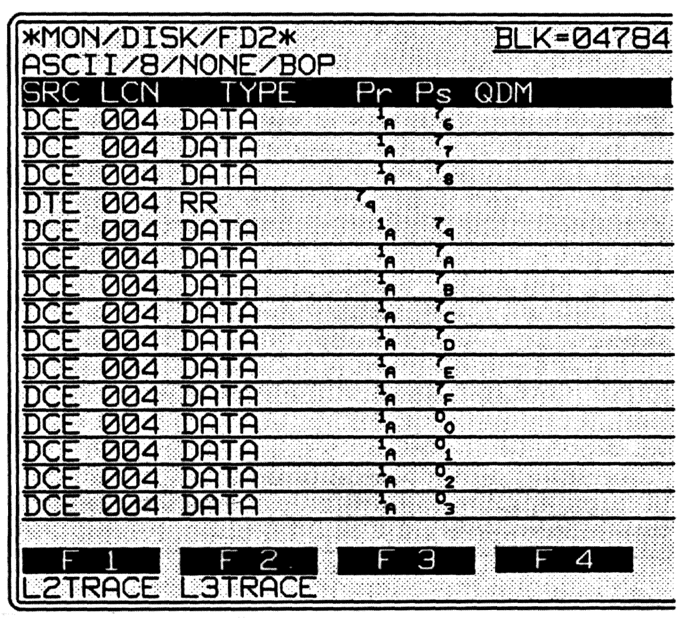


Figure 34-7 **MOD 128 sequence numbers are displayed in two-digit hexadecimal characters.**

P(R) and P(S) values are presented in decimal format in modulo-8 traces. Each column displays a single digit that represents a 3-bit binary value (0 through 7). For modulo 128, the values 00 to 7F are given in "character" format, where the columns contain a two-digit hexadecimal character (see Figure 34-7).

Note that the **Pr** and **Ps** columns on the trace are staggered to suggest four columns. The two outside columns, comprised of the DTE's P(R) value and the DCE's P(S) value, form a numbering sequence for DCE data packets. The arrows in Figure 34-8 indicate the sequence: the DCE sends packet 4, the DTE acknowledges 4 by returning P(R) 5; the DCE sends 5, the DTE expects 6; the DCE sends 6, the DTE expects 7; the DCE sends 7, the DTE expects 0; the DCE sends 0.

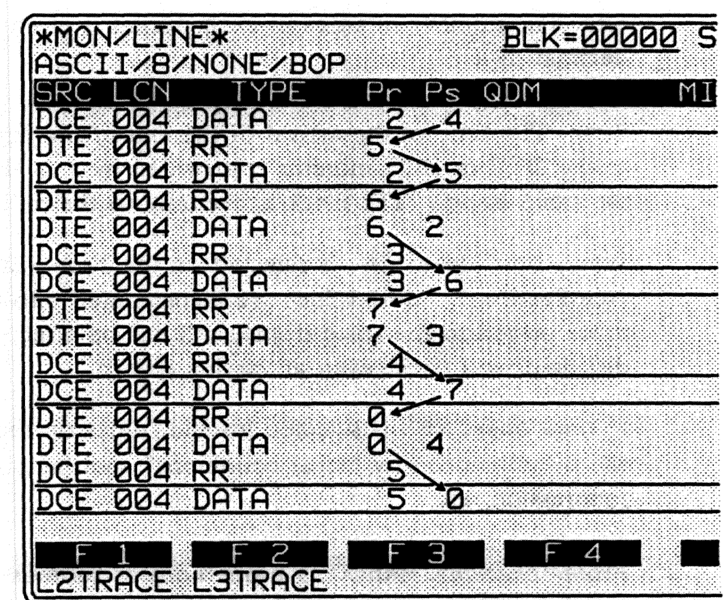


Figure 34-8 ***Pr*** **and** ***Ps*** **columns are staggered, with the** ***outside*** **columns representing the sequence of** ***DCE*** **numbered data packets.**

The two inside columns reveal a similar pattern for DTE data packets (and DCE acknowledgements).

5. *Q, D, and M.* **QDM** is a three-column field. If the Q (data-*q*ualified) bit is set in a data packet, a **Q** will appear in the **Q** column for that row. See Figure 34-4 for examples of this letter-Q display. The position of the Q bit in the first packet byte is indicated at the top left of Figure 34-6.

   When the D (*d*elivery) bit is set in a Call, Call Accept/Connect, or Data packet, the letter **D** appears in the **D** column. The position of the D bit in the first packet byte is indicated in Figure 34-6.

When the M (*m*ore) bit is set in a data packet, the letter **M** appears in the **M** column on the trace display. The position of the M bit in the Type field of data packets is shown in Figure 34-6.

6. *Misc.* The **MISC** field presents up to sixteen bytes of character data (decoded in hex) for all packet types *other than data packets* that contain data beyond the Type octet. All such packets and their "miscellaneous" fields are indicated on the right half of Figure 34-6.

   Twelve bytes of "miscellaneous" data were expanded for the Call packet in the trace in Figure 34-4. The data in this example includes the address-length byte, four called-address bytes, the facilities-length byte, two facilities bytes, and four bytes of call-user data.

7. *Size.* The number of bytes in each packet is given in this field in four decimal digits.

8. *Time.* The time of the arrival of the *end of the frame containing the packet* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks: ON** is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when data captured to disk is played back, even at varying speeds.

   If **Time Ticks: OFF** is selected instead, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

9. *Frame checking.* An X.25 frame ends as soon as a $^{F}{}_{E}$ flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the **BCC** column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

   A for abort is posted to the trace row when a frame is ended by seven 1-bits.

34.3 Monitor Conditions

When the Layer 3 X.25 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 3. See Figure 34-9.

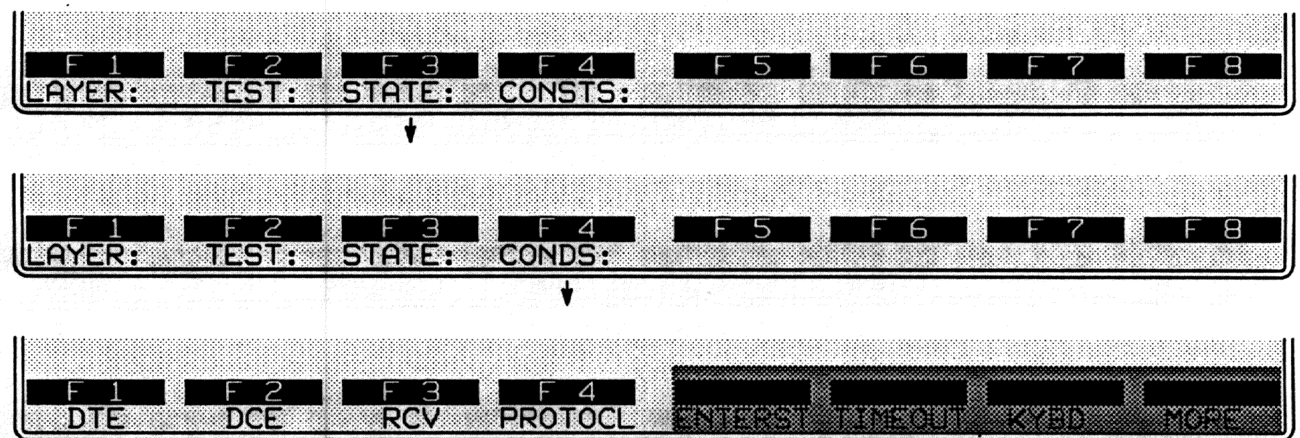


Figure 34-9 Unlike *RCV* conditions, the softkeys for *DTE* and *DCE* are valid when the INTERVIEW is monitoring the line passively.

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represents *types* of packets: DATA, RR, RNR, REJ, CALL, and so forth.

(A) Packet Type

The softkeys for data, supervisory, unnumbered, and "other" packets are illustrated in Figure 34-10.

Press a softkey to write one of these packet types to the Layer 3 spreadsheet. DTE or DCE followed by a packet-type mnemonic—DTE DATA, for example, or DCE CLEAR—is a complete condition and will come true if a matching packet is monitored. An LCN condition may be added to the simple packet mnemonic, but it is optional. Other optional conditions that may apply are Q-bit value, D-bit value, M-bit value, cause code, and diagnostic code.

> **NOTE:** A packet-type condition will not come true with respect to a packet that is inside of a frame with a bad frame check, or inside of an aborted frame.

1. *Data packets.* Data packets differ for MOD 8 and MOD 128 numbering schemes. (See Figure 34-6.) For spreadsheet conditions to match data

packets accurately, the correct numbering system ("**Mode of Operation**") should be selected on the Packet Level Setup screen.

Figure 34-10 Packet types.

When DTE or DCE is monitored for a data packet, a specific LCN *may* be specified in the spreadsheet condition. A specific value for the Q, D, or M bit also may be indicated in the rack of spreadsheet softkeys just below DATA. (Refer to Figure 34-12.)

2. *Supervisory packets*. The three supervisory-packet types that can be searched for on the data leads are RR (Receive Ready), RNR (Receive Not Ready), and REJect. These packets always contain P(R) fields (see Figure 34-6) and serve mainly to acknowledge or reject data packets.

   Like data packets, supervisory packets are constructed differently according to the numbering scheme, MOD 8 or MOD 128.

   When DTE or DCE is monitored for a supervisory packet, a specific LCN may be specified in the spreadsheet condition. See Figure 34-11.

3. *Unnumbered packets*. Unnumbered packets generally assist in call setup, call management, call clearing, and subscription services.

The thirteen unnumbered packet types are laid out consecutively from CALL to DIAG on the softkey racks in Figure 34-10. Because these packets lack P(R) and P(S) sequence numbers, they are constructed identically for MOD 8 and MOD 128.

All unnumbered-packet conditions may be made specific to a particular LCN. Call and Call Confirm conditions may specify a D-bit value (Figure 34-13). Restart, Reset, Clear, and Registration Confirm conditions may optionally test for causes and diagnostic codes (see Figure 34-14, Figure 34-15, and Figure 34-16). Diagnostic packets (F5 on on the bottom rack of softkeys in Figure 34-10) also may specify a diagnostic code.

4. *Other packets*. Any packet type may be entered as a hexadecimal value instead of by name. Press the softkey for OTHER. (See F6 in the bottom rack of softkeys in Figure 34-10.) Then enter the hex byte in the form of two alphanumerics. Here, for example, is a Clear Request entered as a hexadecimal:

   CONDITIONS: DCE OTHER 13

(B) LCN

All DTE and DCE conditions that name a packet type may specify one particular LCN (logical channel number) as an added condition. For example, a spreadsheet condition may be satisfied by *any* DTE Clear Request packet:

CONDITIONS: DTE CLEAR

Or it may be satisfied by a DTE Clear Request packet only if it carries an LCN of, say, 005:

CONDITIONS: DTE CLEAR LCN= 005

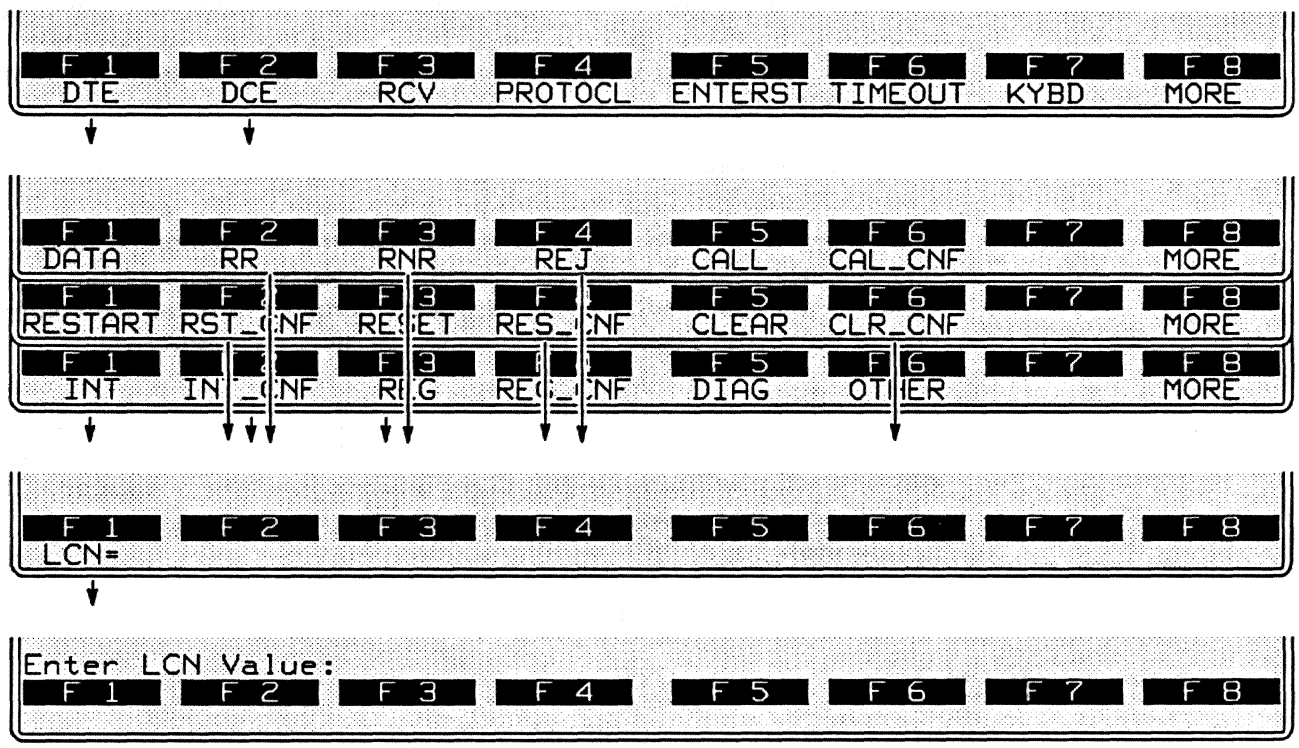


Figure 34-11 LCN is the Condition option available for these nine packet types.

Figure 34-11 indicates the packet types that offer LCN as their only Condition option.

Enter the LCN as one, two, or three hexadecimal digits. Type each digit as an alphanumeric in the range *0–9* and *A–F* (or *a–f*): *do not use the* [HEX] *key.* Each digit will represent four bits of the twelve-bit LCN. A single-digit or two-digit entry will represent the low-order bits, with the high-order bits zero-filled. Thus LCN= 005 is the same entry as LCN= 05 or LCN= 5.

(C) Q, D, and M Bits

Q–, D–, and M–bit values of 0 or 1 may be specified in Layer 3 conditions that search for DATA packets. See Figure 34-12.

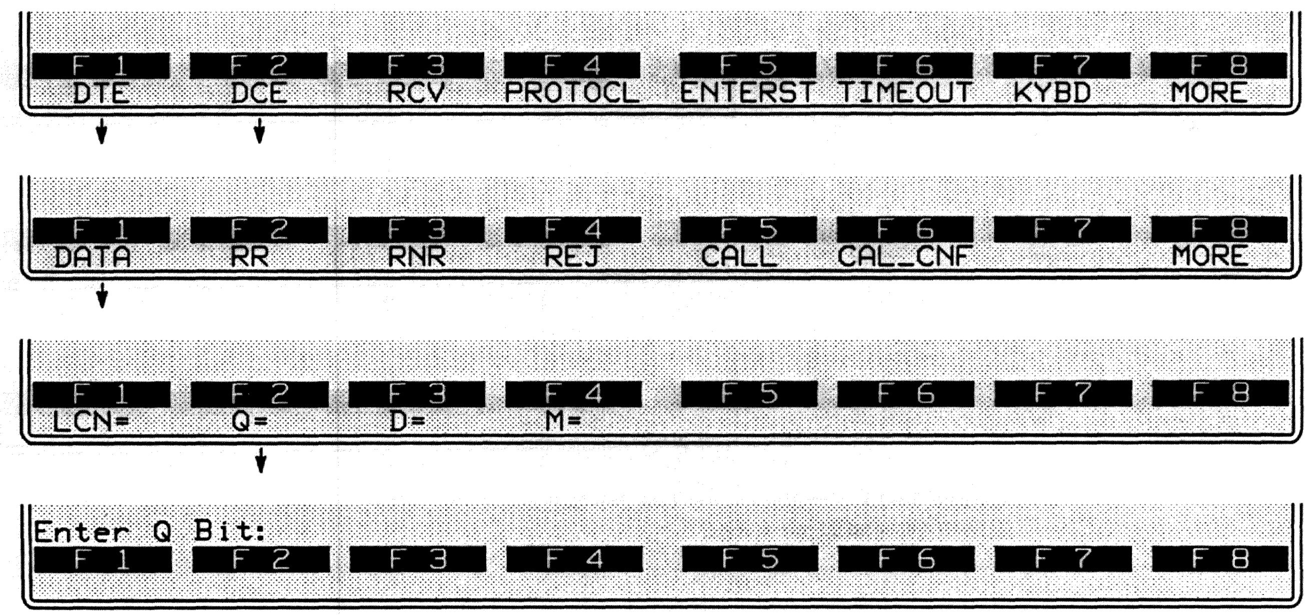


Figure 34-12 When data packets are monitored, Q, D, and M values of 1 (along with LCN values) *may* be specified.

A D-bit value also may be specified for Call and Call Confirm packets: see Figure 34-13.

The positions of the Q, D, and M bits in the packet header are illustrated in Figure 34-6.

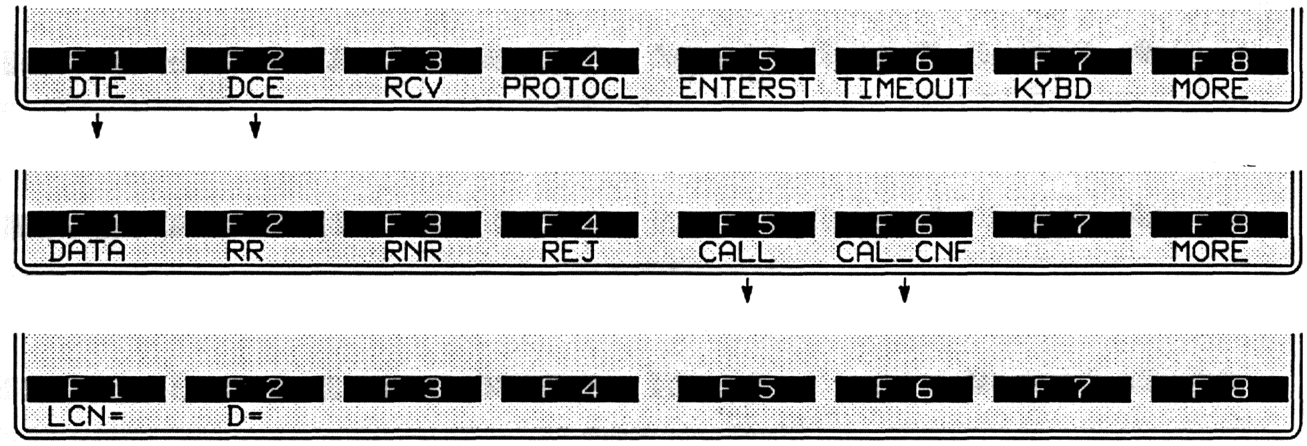


Figure 34-13 Conditions that look for Call and Call Confirm packets also can test for LCN and D-bit values.

(D) Cause and Diagnostic Value

Conditions that look for Restart, Reset, Clear, and Registration Confirm packets may be refined further to test for a particular cause code and/or diagnostic code.

1. *Cause*. The names of causes as well as their hexadecimal values are indicated on the softkey-prompt line near the bottom of the Protocol Spreadsheet screen. To specify a particular cause, the user does not have to memorize cause codes or consult a table. He simply presses [F2], ROLL, and repeats the keystroke to cycle through the list of cause names for a given packet type. Figure 34-14 shows the cycle of causes that pertain to Restart packets. The user presses [F1], SELECT, when the right cause has "rolled" up onto the prompt line. The SELECT softkey writes the current cause onto the spreadsheet screen.

   Here is an example of a cause-code entry on the Protocol Spreadsheet:

   CONDITIONS: DCE CLEAR CAUSE= NOT_OBTAINABLE

   Causes also may be entered into the spreadsheet test as two hexadecimal digits, as in this example:

   CONDITIONS: DCE CLEAR CAUSE= 0D

   Notice that each digit is an alphanumeric in the range *0–9* and *A–F* (or *a–f*): *do not use the* [HEX] *key.*

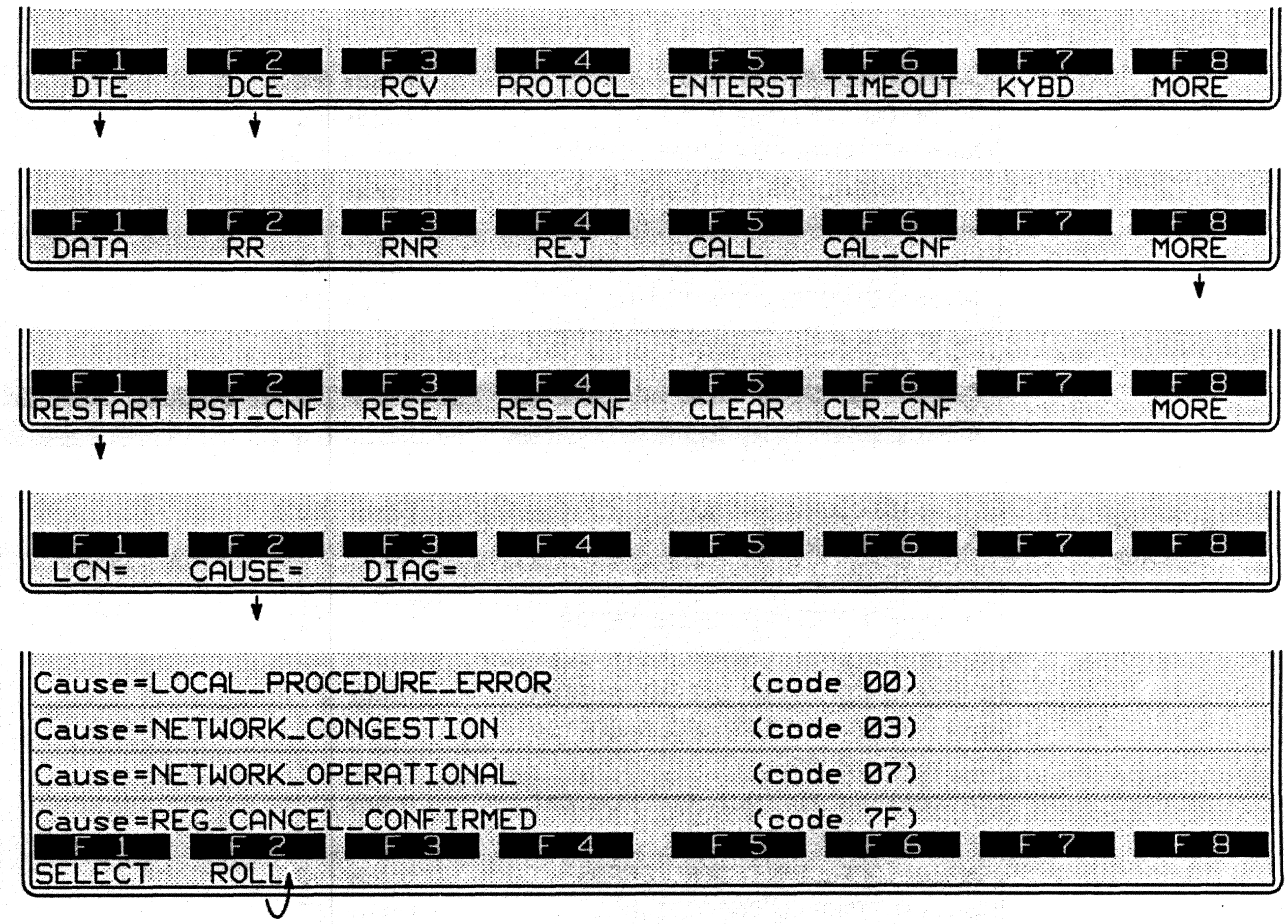


Figure 34-14 A Restart packet may be tested for one of these four causes.

(a) Reset causes

```
Cause=DTE_ORIGINATED                    (code 00)
Cause=OUT_OF_ORDER                      (code 01)
Cause=REMOTE_PROCEDURE_ERROR            (code 03)
Cause=LOCAL_PROCEDURE_ERROR             (code 05)
Cause=NETWORK_CONGESTION                (code 07)
Cause=REMOTE_DTE_OPERATIONAL            (code 09)
Cause=NETWORK_OPERATIONAL               (code 0F)
Cause=INCOMPATIBLE_DESTINATION          (code 11)
Cause=NETWORK_OUT_OF_ORDER              (code 1D)
 F 1   F 2   F 3   F 4   F 5   F 6   F 7   F 8
SELECT ROLL
```

(b) Clear causes

```
Cause=DTE_ORIGINATED                    (code 00)
Cause=NUMBER_BUSY                       (code 01)
Cause=OUT_OF_ORDER                      (code 09)
Cause=REMOTE_PROCEDURE_ERROR            (code 11)
Cause=REVERSE_CHARGE_NOT_ACCEPTED       (code 19)
Cause=INCOMPATIBLE_DESTINATION          (code 21)
Cause=FAST_SELECT_NOT_ACCEPTED          (code 29)
Cause=SHIP_ABSENT                       (code 39)
Cause=INVALID_FACILITY_REQUEST          (code 03)
Cause=ACCESS_BARRED                     (code 0B)
Cause=LOCAL_PROCEDURE_ERROR             (code 13)
Cause=NETWORK_CONGESTION                (code 05)
Cause=NOT_OBTAINABLE                    (code 0D)
Cause=RPOA_OUT_OF_ORDER                 (code 15)
 F 1   F 2   F 3   F 4   F 5   F 6   F 7   F 8
SELECT ROLL
```

(c) Registration Confirmation causes

```
Cause=REG_CANCEL_CONFIRMED              (code 7F)
Cause=INVALID_FACILITY_REQUEST          (code 03)
Cause=LOCAL_PROCEDURE_ERROR             (code 13)
Cause=NETWORK_OPERATIONAL               (code 05)
 F 1   F 2   F 3   F 4   F 5   F 6   F 7   F 8
SELECT ROLL
```

Figure 34-15 The various causes available for *(a)* Reset, *(b)* Clear, and *(c)* Registration Confirm packets.

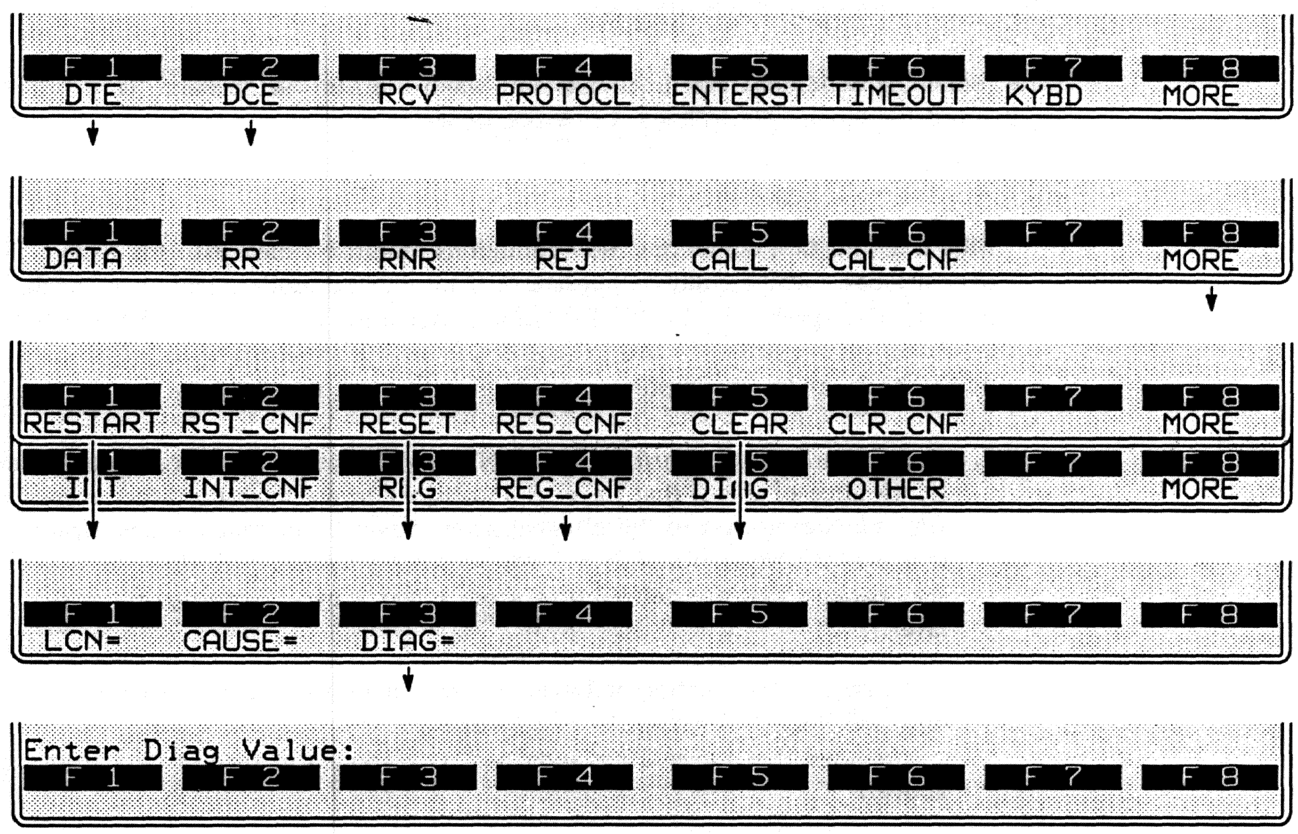


Figure 34-16 These four packet types (plus *Diagnostic*) allow you to enter a diagnostic-code value as a spreadsheet condition.

2. *Diagnostic code.* Diagnostic-code values are optional conditions for the following packet types: Restart, Reset, Clear, Diagnostic, and Registration Confirm. Figure 34-16 shows the softkey sequences that branch down to the diagnostic-code condition for most of these packet types.

   Enter the diagnostic code as two hexadecimal digits. Type each digit as an alphanumeric in the range *0–9* and *A–F* (or *a–f*): *do not use the* [HEX] *key.* Here is an example of a spreadsheet condition that specifies both a cause and a diagnostic code:

   DCE RESET CAUSE= LOCAL_PROCEDURE_ERROR DIAGNOSTIC= 01

34.4 Emulate-Mode Conditions

The remaining conditions are functional only when the Line Setup menu is configured for **Mode:** EMULATE DTE or EMULATE DCE.

(A) Receive Conditions

Like DTE and DCE conditions, RCV conditions monitor a data path for X.25 packet types. RCV conditions operate only in emulate modes, and they check only the data path that the INTERVIEW is not using to transmit. While a RCV condition may look like a DTE or DCE condition—RCV DATA Q looks the same as DCE DATA Q—there are important differences that are noted below.

1. *Access to the data interface.* The INTERVIEW is a *layered* emulator. The significance of this is that Layer 3 and higher layers have no direct access (in Emulate modes) to the physical layer, Layer 1. In practice this means that a RCV condition at Layer 3 *does not see packets on the line.* It only sees packets that are delivered up from Layer 2 by a *user program* at that layer.

   (Similarly, a SEND action at Layer 3 does not in itself send a packet out onto the line. A SEND action merely delivers the packet to Layer 2—provided that Layer 2 has indicated its readiness to receive data from above.)

   The following program is not any sort of complete Layer 2 emulation. It is the *minimum* program that must be entered at spreadsheet Layer 2 (with the X.25 personality package installed) in order for a Layer 3 program to have access to the data line. Once this Layer 2 program is entered, Layer 3 can send packets out onto the line and receive packets from the line.

   ```
   LAYER: 2
        STATE: datalink
           CONDITIONS: DL_CONNECT REQ
           ACTIONS: DL_CONNECT CONF
           CONDITIONS: DL_DATA REQ
           ACTIONS: SEND INFO "《DL_DATA》"
           CONDITIONS: RCV INFO
           ACTIONS: GIVE_DATA
   ```

   The elements of this program are discussed in Section 30 (OSI Primitives on the Protocol Spreadsheet) and the programming example in Section 33.9.

2. *Valid packet sequencing.* To satisfy RCV conditions, numbered packets must have correct P(R) and P(S) sequencing.

3. *Path.* All RCV conditions that name a packet type may specify one particular "path" as an added condition. Like LCN in DTE and DCE conditions, this path number serves to associate a packet with a particular

call. On the X.25 Packet Level Setup screen, up to nine path numbers may be tied to individual sets of Call Request parameter values, including packet-network "phone" numbers. Refer back to Figure 34-3 for the Packet Level Setup screen.

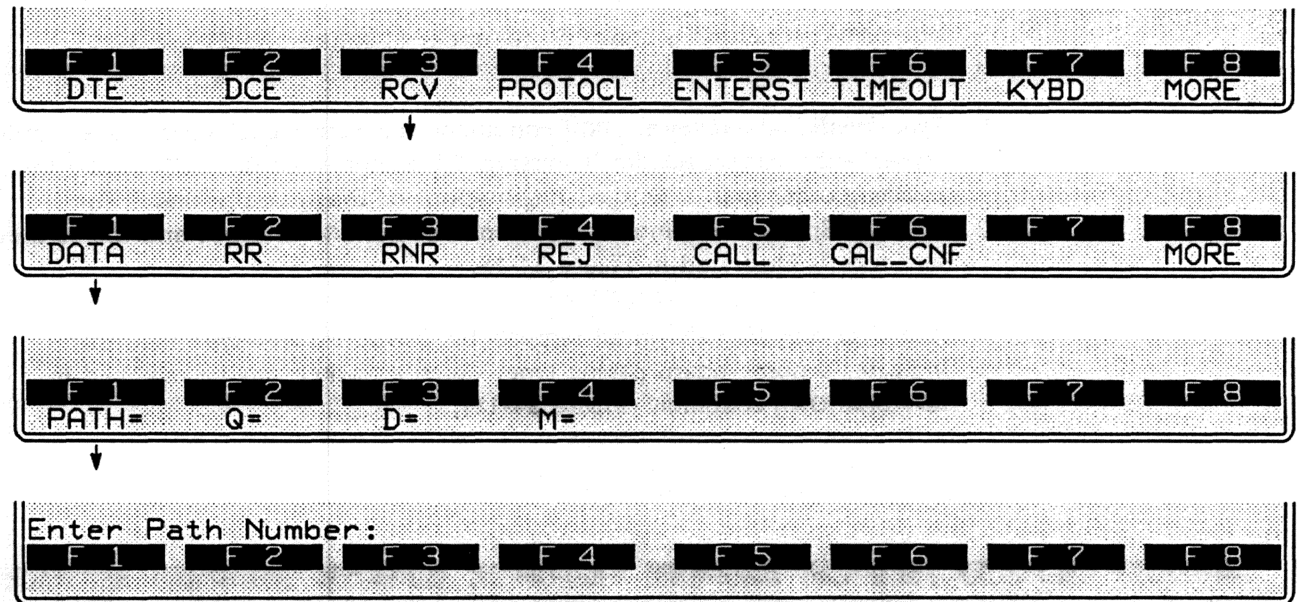


Figure 34-17 ***PATH=*** **replaces** ***LCN=*** **as an added condition when the lead is identified as** ***RCV*** **rather than** ***DTE*** **or** ***DCE.***

As a packet identifier, the PATH= condition in RCV conditions is more programmable than the LCN= conditions that are available inside of DTE and DCE conditions. LCNs usually are assigned dynamically, by the INTERVIEW as well as by other devices, at the time of the call request. By then the test has started running, and it is too late to specify the LCN in the spreadsheet program.

The path number, by contrast, may be pre-programmed on the Protocol Spreadsheet. When the call request is sent or received by the INTERVIEW, the call parameters are correlated to the Packet Level Setup screen. If the INTERVIEW sends a call request that specifies a path number, or if the INTERVIEW receives a call request that matches one of the path entries on the setup screen, the LCN of the call request is tied to the path number (path #3, say), and any subsequent packets with the same LCN will satisfy packet-type conditions that stipulate PATH= 3.

A RCV condition that specified a path number as a further condition might be the following:

```
CONDITIONS: RCV DATA PATH= 3
```

A data packet would satisfy this condition if (1) it had the same LCN as a call request packet with the Calling, Called, Facilities, and Data fields that are entered across from Path 3 on the setup screen; and (2) the call still was active. The call-request parameters on the setup screen may refer to calls that originate at the INTERVIEW or to call requests that are incoming.

The PATH= condition is shown in the racks of softkeys in Figure 34-17.

4. *Type invalid or unknown.* RCV conditions can detect packets that are invalid "types"—the packet header is missing, for example, or the LCN is 000 for anything other than a Restart, Registration, or Diagnostic packet. The Protocol Spreadsheet entry for this condition is RCV INVALID, and the softkey sequence is illustrated in Figure 34-18.

   A packet may be valid in all respects but have a packet-type field that indicates a nonstandard packet type. Such a packet may be matched by a RCV UNKNOWN condition (Figure 34-18).

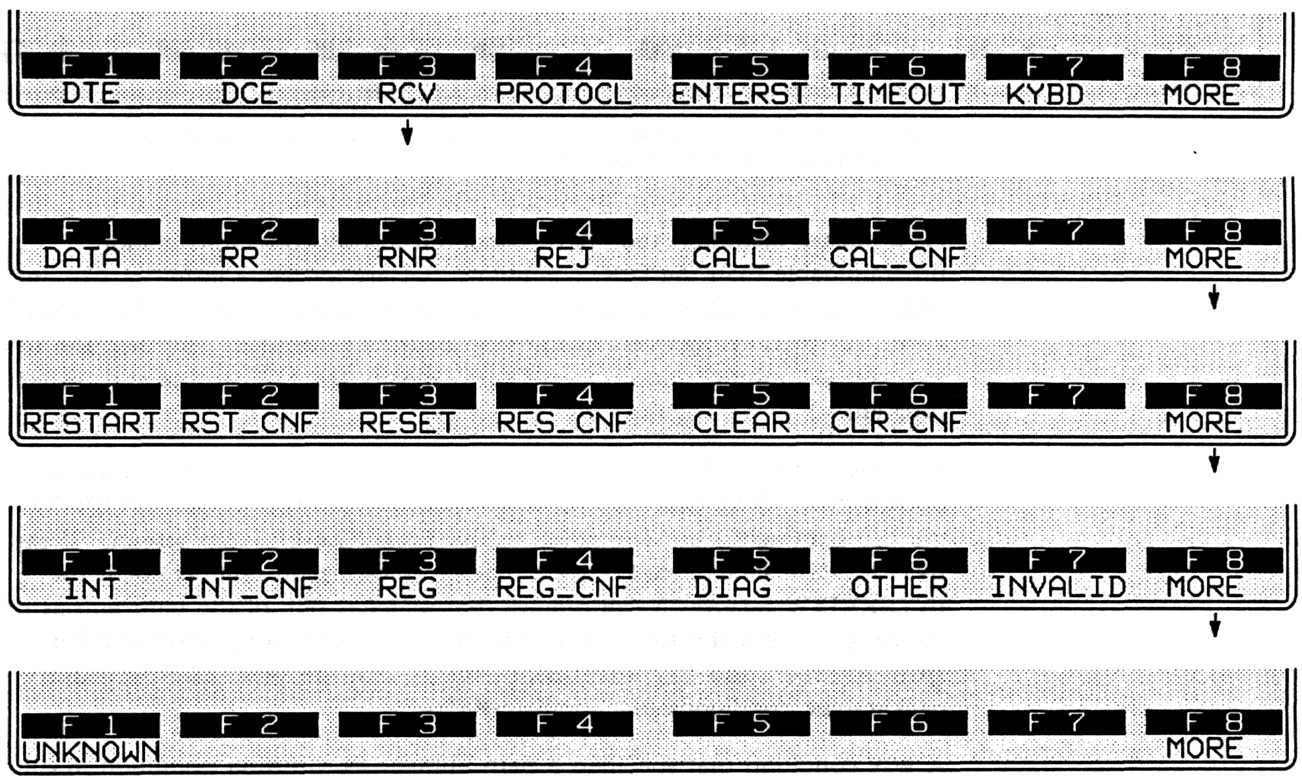


Figure 34-18 *INVALID* **and** *UNKNOWN* **appear on the bottom two racks of** *RCV* **packet-type softkeys.**

(B) P(S) Error

When you emulate at Layer 3, data packets with P(S) errors are detected as PS_ERR conditions, not as RCV DATA conditions.

PS_ERR applies only to packets received when you are emulating. The same packet that triggers a PS_ERR condition also may satisfy a DTE DATA or DCE DATA condition—but not a RCV DATA condition.

PS_ERR will come true for any received data packet whose P(S) value is not one higher than the previous P(S).

In the first rack of condition softkeys at Layer 3, press PROTOCL. Then press the softkey for PS_ERR. See Figure 34-19.

(C) P(R) Error

Received data or supervisory packets may have P(R) errors. Such errors are detected as PR_ERR conditions, not as RCV DATA or RR (or RNR or REJ) conditions.

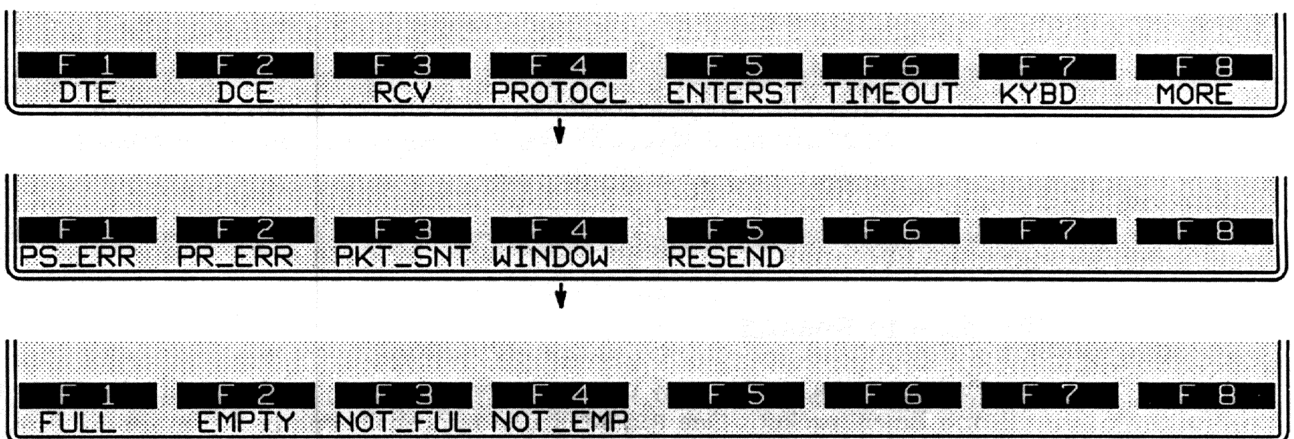


Figure 34-19 The *PROTOCL* key brings up five X.25 Layer 3 emulate conditions.

A valid P(R) is any value that (1) acknowledges a packet that is *outstanding* (waiting for acknowledgment); or (2) repeats the last acknowledgment. Any other P(R) value is detected as an error.

(D) Packet Sent

This condition is true when, as a result of a SEND or RESEND action, a packet has been passed down to Layer 2. This condition may be useful for certain timing measurements, since merely SENDing a packet *does not actually pass the packet down to the next layer* if, for example, the link is not established at Layer 2.

(E) Window Conditions

The size of the Layer 3 window is configured on the X.25 Packet Level Setup screen; see Section 34.1(C). There are four conditions that test the current status of this window. They are WINDOW FULL, WINDOW EMPTY, WINDOW NOT_FULL, and WINDOW NOT_EMPTY. The softkey sequence for the WINDOW options is shown in Figure 34-19.

WINDOW FULL is true when the window is full of unacknowledged packets and the Layer 3 personality package will not buffer additional packets until some acknowledgment is received.

Each time an acknowledgment is received, the window is flushed to the extent of the acknowledgment. WINDOW EMPTY means that the latest acknowledgment was complete and left no packets outstanding (unacknowledged). If an RR response is received and the acknowledgment is only partial, this condition will be true:

```
CONDITIONS: RCV RR
  WINDOW NOT_EMPTY
```

> *CAUTION: Window conditions are status conditions (see Section 27.2) and* must *always be used in combination with a transitional condition such as a RCV condition.*

(F) More to Resend

Packets in the window may have to be resent, usually as the result of a timeout or a Reject packet. One RESEND action retransmits one packet in the window, beginning with the earliest. Subsequent RESEND actions retransmit subsequent packets. The MORE_TO_RESEND and NO_MORE_TO_RESEND conditions allow you to retransmit the entire window, as in the "recover" state in this example:

```
  CONDITIONS: RCV REJ
  ACTIONS: RESEND FIRST
  NEXT_ST: recover
STATE: recover
  CONDITIONS: PACKET_SENT
    MORE_TO_RESEND
  ACTIONS: RESEND NEXT
  CONDITIONS: PACKET_SENT
    NO_MORE_TO_RESEND
  NEXT_ST: xfer
```

MORE_TO_RESEND and NO_MORE_TO_RESEND conditions may be written to the Protocol Spreadsheet by the softkeys shown in Figure 34-20.

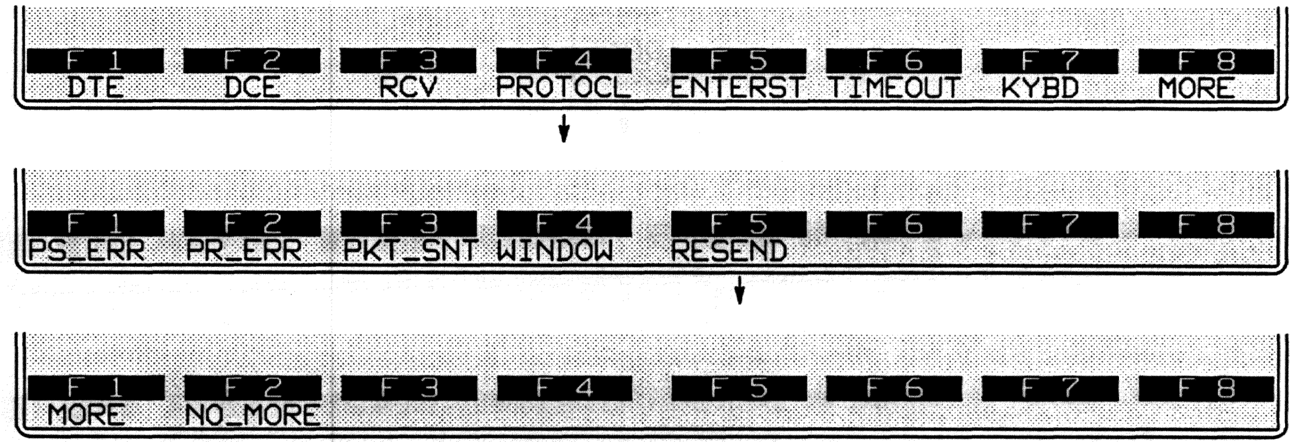


Figure 34-20 The *MORE_TO_RESEND* condition allows you to resend the entire window of packets and then stop when there are *NO_MORE_TO_RESEND*.

CAUTION: MORE_TO_RESEND and NO_MORE_TO_RESEND are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as PACKET_SENT.*

34.5 Emulate Actions

When you have completed a block of conditions in a Protocol Spreadsheet test at Layer 3, press [DONE], then [F4] (ACTION:), to access the set of actions that can be taken as a result of the block of conditions coming true. The set of actions that are specific to the X.25 Layer 3 personality package are shown in the four lower racks of softkeys in Figure 34-21. Except for ENHANCE and SUPPRES, the actions shown have meaning only when the INTERVIEW is emulating DTE or DCE, and not when it is monitoring the line passively.

(A) Send Actions

Press the softkey for SEND to access three racks of softkeys with names of packet types that may be named in SEND actions. All data generated by the Layer 3 X.25 package must be enclosed in a packet that is identified in a SEND action by *type*. (Only at Layer 1 can data be generated as a simple character string without any protocol building blocks.) The complete set of packet types is given in Figure 34-22.

When conditions are true for a SEND action, packets are sent immediately down to Layer 2 to be processed there.

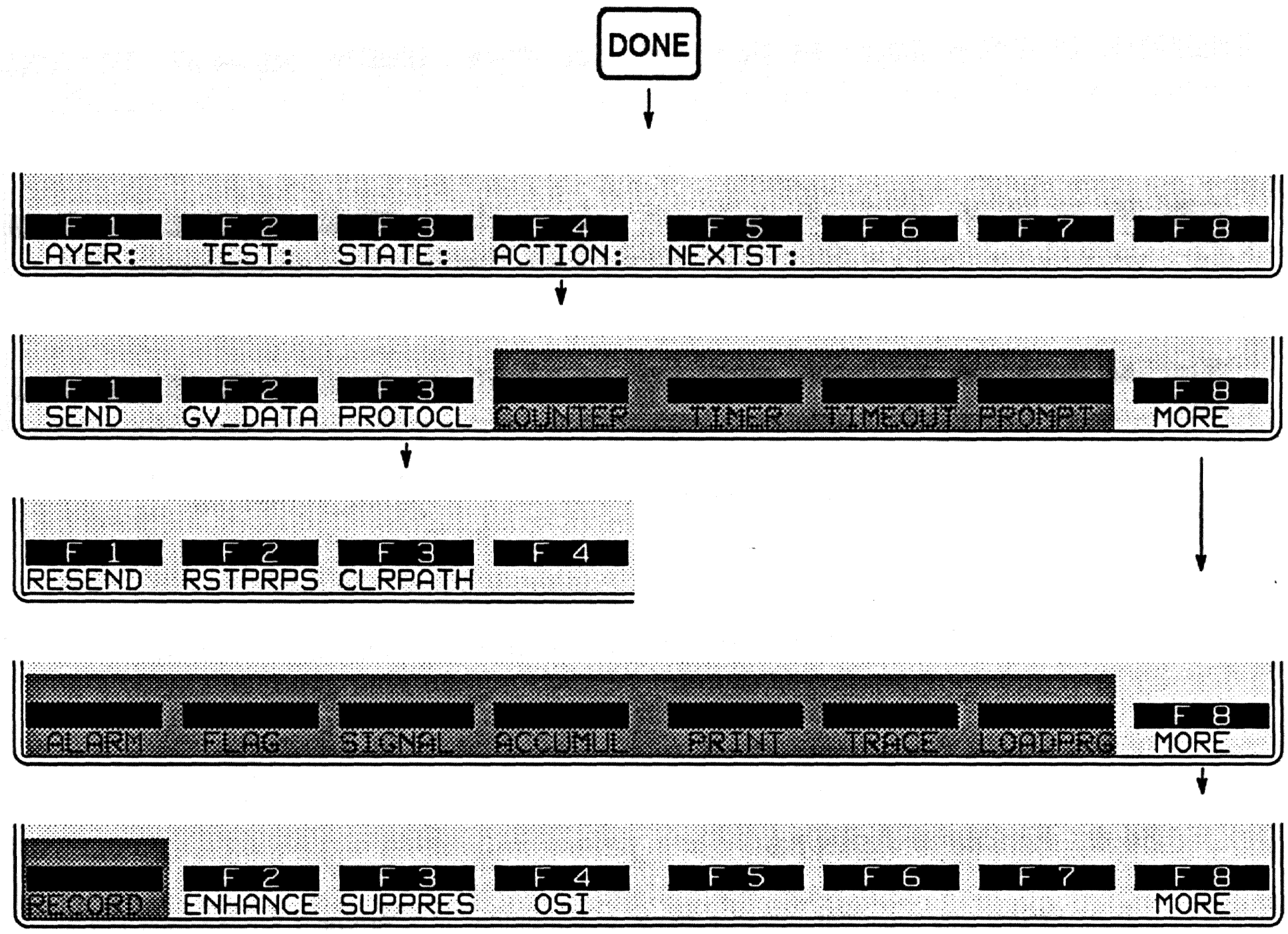


Figure 34-21 Action softkeys specific to X.25 Layer 3.

NOTE: The INTERVIEW is a *layered* emulator. The significance of this is that Layer 3 and higher layers have no direct access (in Emulate modes) to the physical layer, Layer 1. In practice this means that a SEND action at Layer 3 does not in itself send a packet out onto the line. A SEND action merely delivers the packet to Layer 2—provided that Layer 2 has indicated its readiness to receive data from above.

Refer to the Layer 2 program in Section 34.4(A)1. This is the *minimum* program that must be entered at spreadsheet Layer 2 (with the X.25 personality package installed) in order for a Layer 3 program to have access to the data line. Once this Layer 2 program is entered, Layer 3 can send packets directly out onto the line (and receive packets from the line).

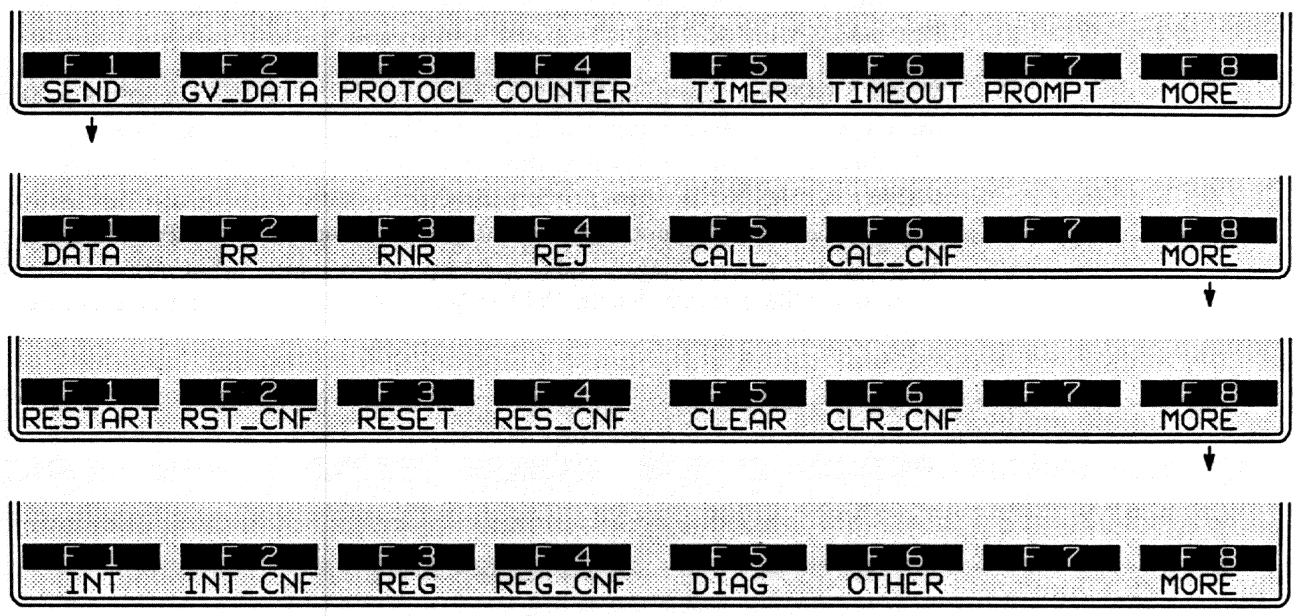


Figure 34-22 ***SEND*** **actions always specify a packet type.**

1. *Data packets.* SEND DATA is a complete action-entry. Path, P(S), P(R), Q, D, M, and string parameters may be added to a data packet, but they are optional.

   SEND DATA actions pass the data packet immediately to the next layer down. If the retransmit window is full, the packet is still sent—but it is not buffered in the window and can not be *re*sent.

   A data packet will be buffered for retransmission regardless of the status of the window if a specific value is entered for the PS= parameter. See "*P(S),*" below. The specific P(S) value will clear the window so that the data packet will be buffered in the first window position.

2. *Supervisory packets.* SEND RR, SEND RNR, and SEND REJ are complete action-entries. Path and P(R) parameters may be added to a supervisory packet, but they are optional.

   Figure 34-23 shows the parameter options for supervisory SEND packets.

3. *Call Request packets.* SEND CALL and SEND CALL_CONF are complete action-entries. Normally a Call Request packet will be entered with additional parameters. Parameters that are available are PATH=, D, FAC=, and STRING.

   When a SEND CALL action does not specify a path, it yields a packet with the LCN that is next in the assignment series: see Section 34.1(D). This is true also when a Call Request specifies a path but the LCN column is blank for that path on the X.25 Packet Level Setup screen.

When a PATH= value is included in a SEND CALL or SEND CALL_CONF packet, the packet will be sent with the LCN, Called Address, Calling Address, Facilities, and Data entries that the operator has provided for that path number on the Packet Level Setup screen. A SEND CALL action that is not linked by a PATH= number to a set of call parameters on the Packet Level Setup screen cannot yield a valid call request no matter what string is added to it, since the address-length field (Figure 34-6) in such a packet will be fixed automatically at %.

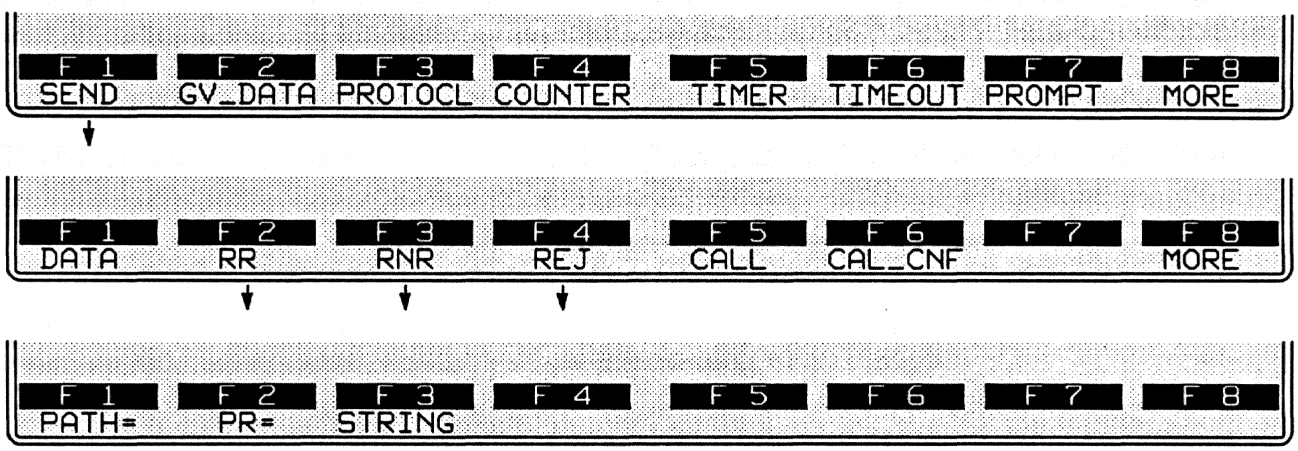


Figure 34-23 **Path and P(R) components may be selected for *SEND RR*, *SEND RNR*, and *SEND REJ* actions.**

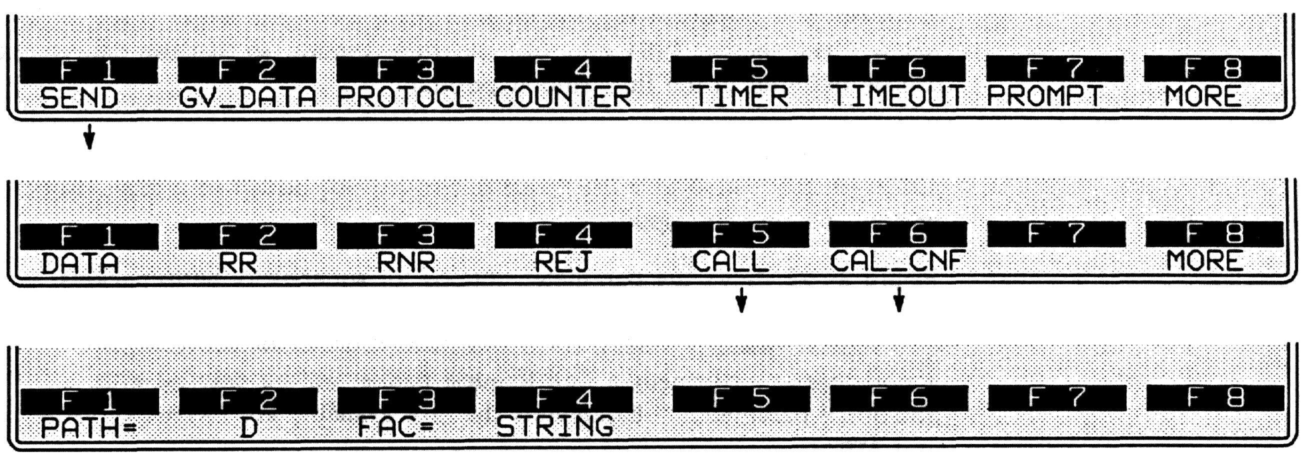


Figure 34-24 ***SEND CALL* actions *should* include a path number and *may* set the D bit; they also may append facilities and a data string to the parameters already listed on the Packet Level Setup menu.**

The FAC= option provided on the Protocol Spreadsheet is intended to supplement the **FACILITIES** field on the Packet Level Setup screen. A FAC= string in a spreadsheet action will be *appended* to the Facilities string on the setup screen. This is in case the facilities entry must be longer than the ten bytes permitted on the setup screen. Do not *repeat* your setup-screen Facilities entry on the Protocol Spreadsheet.

Similarly, any STRING entry on the spreadsheet will be appended to the string in the DATA field on the Packet Level Setup screen.

4. *Other unnumbered packets.* The rest of the unnumbered-packet types have softkey options appropriate to their protocol fields (see Figure 34-6). Available softkey parameters for these packet types are PATH=, CAUSE=, DIAG=, and STRING.

   Figure 34-25 shows the softkey rack under Registration Confirm, an unnumbered-packet type with the four possible softkey parameters.

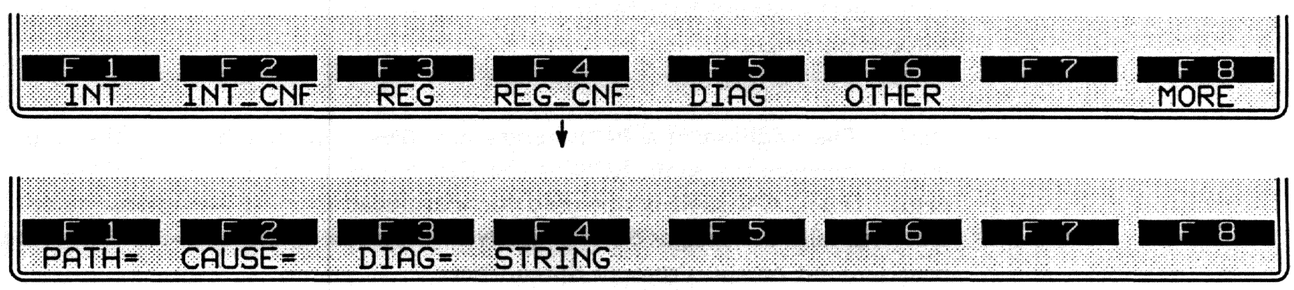


Figure 34-25 **Four optional parameters may be added to a *SEND REG_CONF* action.**

5. *"Other" packets.* Any packet type may be entered in a SEND action as a hexadecimal value instead of by name. Press the softkey for OTHER, on the bottom rack in Figure 34-22. Enter the hex value in the form of two alphanumerics. Here is a Call Confirm packet entered as a SEND OTHER action:

   ACTIONS: SEND OTHER 0F

   This SEND OTHER 0F action is a good way to send a "stripped down" Call Accepted packet that does not include the additional address and facilities parameters that you may have entered on the Packet Level Setup screen. These parameters sometimes are not used in Call Accepted packets in specific network implementations of X.25.

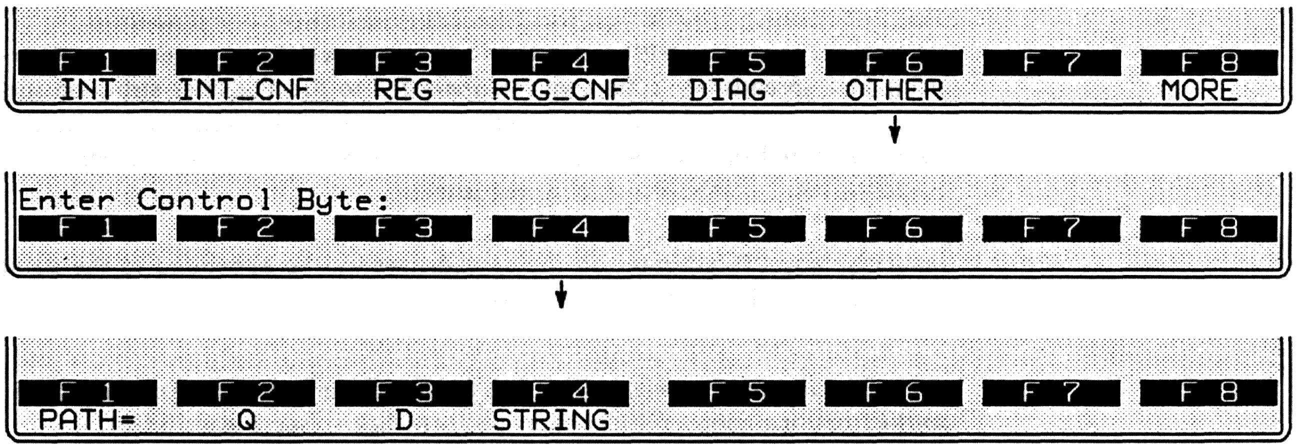


Figure 34-26 Use the *SEND OTHER* action to customize a packet type.

Additional parameters for SEND OTHER actions are PATH=, Q, D, and STRING. (See Figure 34-26.) Since M, P(R), and P(S) fields are embraced already in the user-entered hexadecimal control field, these fields are not given as softkey parameters.

6. *Path.* The addition of a PATH= entry in a SEND action will insure that the packet receives the same LCN as the Call Request with the same PATH= value. The LCN itself is not used for identification in SEND actions, since LCNs usually are assigned dynamically at the time of the call—too late to be programmed on the Protocol Spreadsheet.

   Each path number is tied to a particular set of Call Request parameter values on the X.25 Packet Level Setup screen. See Figure 34-3.

   All packet types permit SEND actions that have PATH= options except Restart, Diagnostic, and Registration. These packets do not refer to a specific call or path. They always receive LCN 000.

   As a general rule, path numbers are used at a given layer in the INTERVIEW if (1) the protocol at that layer is multiaddress or multichannel; or (2) the protocol at a layer *below* the given layer is multiaddress or multichannel. Use the same path number at each layer for a given call.

7. *P(S).* P(S) fields are transmitted in data packets only. (See the packet-field diagrams in Figure 34-6.) The softkeys that open below PS= are illustrated in Figure 34-27.

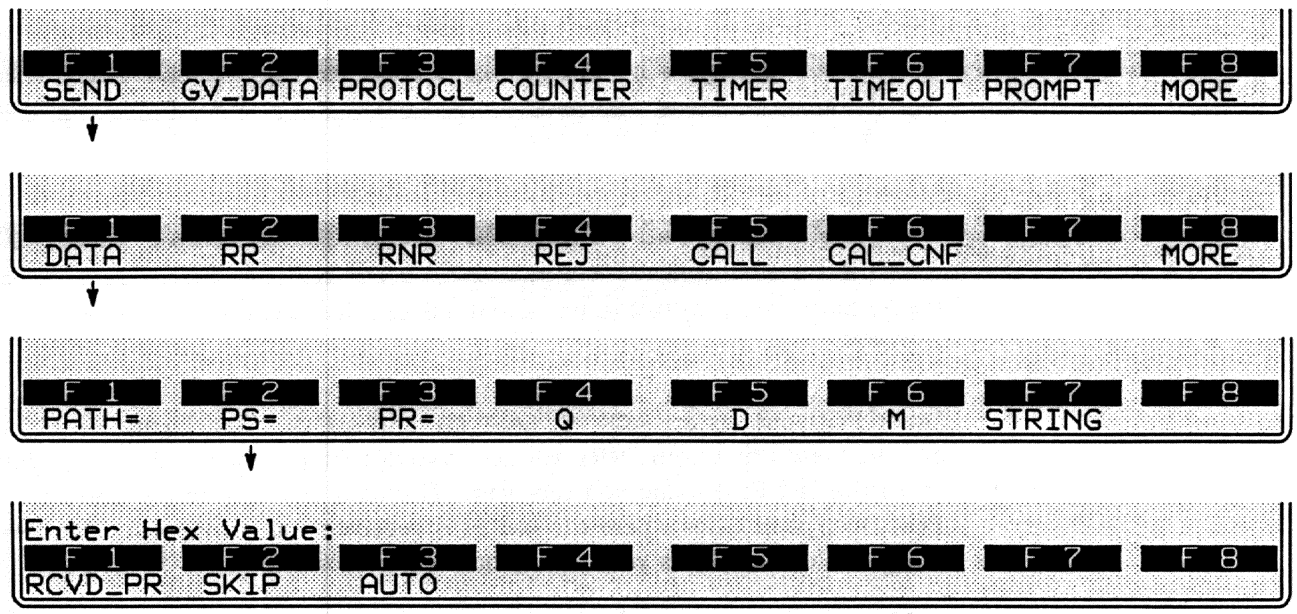


Figure 34-27 The P(S) field may be specified in a *SEND DATA* action.

To specify a P(S) value, press the softkey for PS=, then enter a hexadecimal in the form of one or two alphanumerics. An entry that represented the highest valid P(S) in MOD 8 would be PS= 7. The highest valid entry in MOD 128 is PS= 7F. A SEND DATA action that *specifies* a P(S) value—PS= 0, for example—will clear the window so that the data packet is passed immediately to Layer 2.

Other P(S) options are RCVD_PR, SKIP, and AUTO. RCVD_PR means that you send the P(S) value that the other side says it is expecting. This is the valid P(S) in most cases, but not when you send two or more data packets in a row without waiting for acknowledgment.

SKIP means that you *add one* to your correct P(S). This will look to the other side as though a packet has been lost in transmission. This selection causes the window to be cleared.

PS_AUTO is the default setting for SEND DATA actions. AUTO means that every *new* data packet sent will have a P(S) value of one higher than the previous.

8. *P(R)*. To specify a P(R) value, press the softkey for PR= (see Figure 34-28). Enter a hexadecimal value written as one or two alphanumeric digits. Valid hex entries are the same as for P(S).

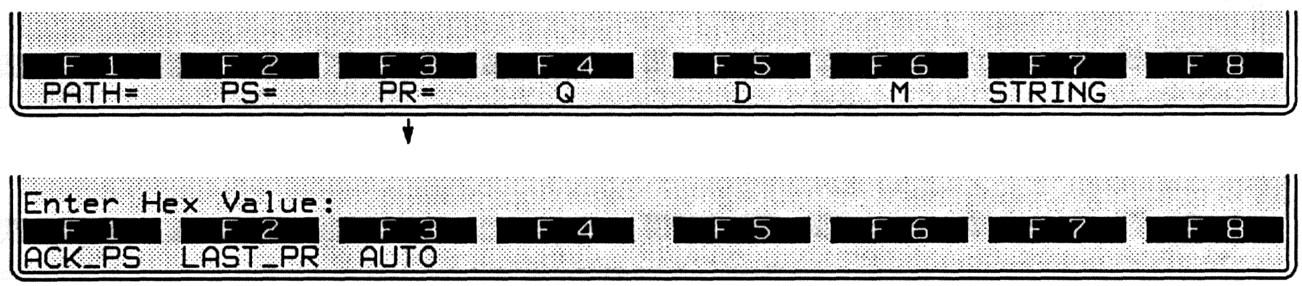


Figure 34-28 The P(R) field may be specified in data and supervisory packets to be sent.

Other P(R) options are ACK_PS, LAST_PR, and AUTO. (See Figure 34-28.) ACK_PS means that your P(R) will acknowledge (that is, it will be *one higher than*) the last P(S) value you received. Normally this will be the correct P(R), except in cases where the last P(S) received was erroneous. The PR= ACK_PS selection allows you to overlook P(S) errors.

LAST_PR means that you simply repeat the last P(R) you sent. Normally this is the correct P(R) following a bad P(S). The PR= LAST_PR option allows you to force the other side to initiate recovery.

AUTO means that you will behave as a normal X.25 Layer 3 PAD, acking valid P(S) values and repeating your last P(R) whenever an invalid P(S) is received.

9. *Q, D, and M.* Softkeys for Q, D, and M are included in the full set of optional parameters for a SEND DATA action in the top rack of Figure 34-28.

   Q and D bits also may be set in SEND OTHER actions. The D bit alone is selectable in Call Request and Call Accepted packet types.

10. *Cause.* Actions that send Restart, Reset, Clear, and Registration Confirmation packets may be refined to send a particular cause code and/or diagnostic code.

    Press the softkey for one of these SEND actions, then press [F2], CAUSE. See Figure 34-29. The names of the causes as well as their hexadecimal values are indicated on the softkey-prompt line near the bottom of the screen.

    To specify a particular cause, the user does not have to memorize cause codes or consult a table. Instead he presses [F2], ROLL, and repeats the keystroke to cycle through the list of cause names for a given packet type. Figure 34-29 shows the cycle of causes that pertain to Clear Request packets. The user presses [F1], SELECT, when the right cause has "rolled" onto the prompt line. The SELECT softkey writes the current cause onto the spreadsheet screen.

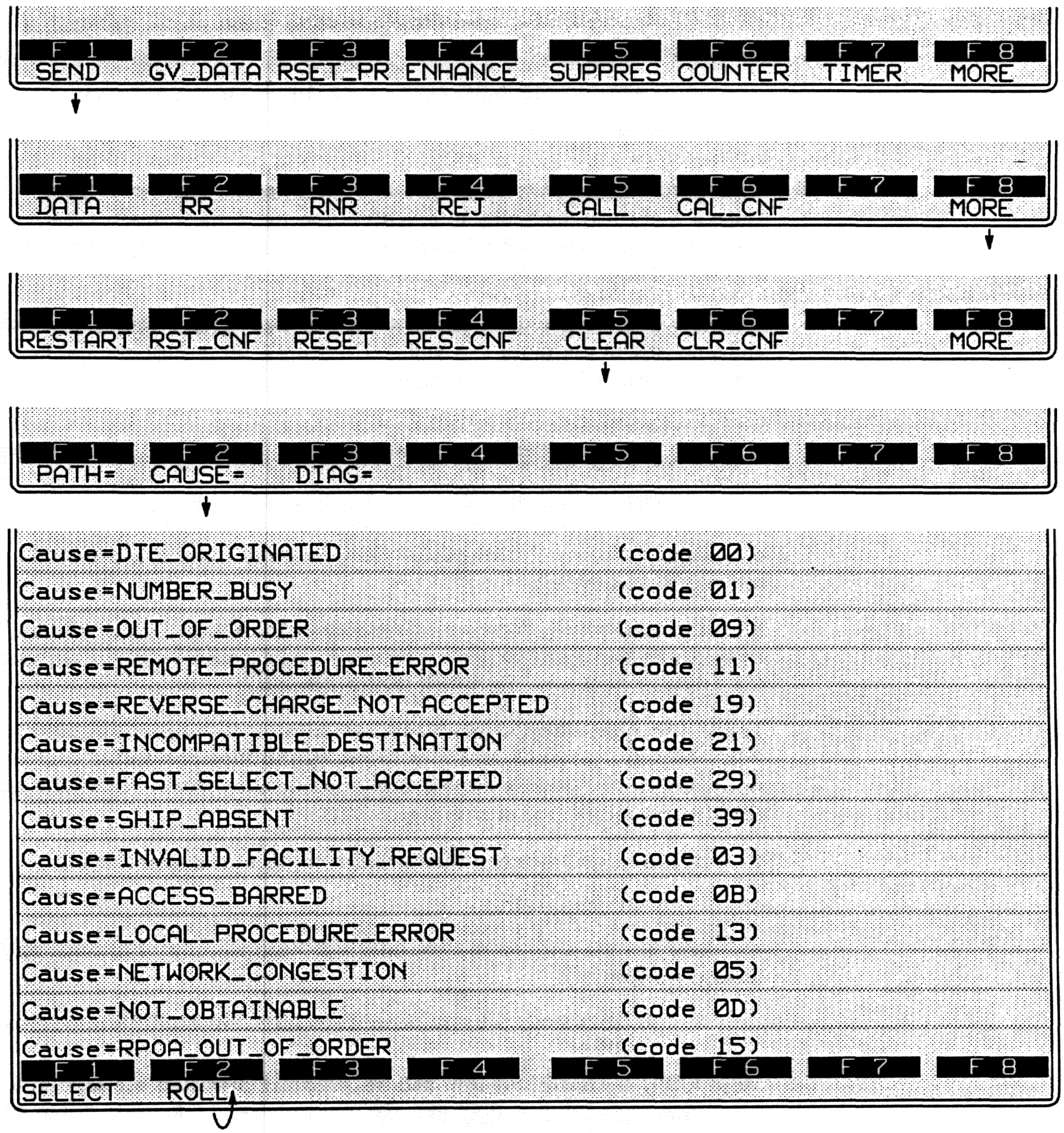


Figure 34-29 These causes are available for a *SEND CLEAR* action.

Causes for Restart, Reset, and Registration Confirmation packets were listed in Figure 34-14 and Figure 34-15.

Here is an example of a cause entry in a SEND action on the Protocol Spreadsheet.

ACTIONS: SEND RESTART CAUSE= NETWORK_OPERATIONAL

Causes may be entered into the spreadsheet test as numeric values.

11. *Diagnostic.* Two digits representing the one-byte diagnostic-code field (Figure 34-6) may be added to a SEND action for Restart, Reset, Clear, Diagnostic, and Registration Confirmation packets. Refer to [F3], DIAG=, in Figure 34-29 or in the lower rack of Figure 34-25.

    Enter the diagnostic code as two hexadecimal digits. Type each digit as an alphanumeric in the range *0–9* and *A–F* (or *a–f*): do not use the [HEX] key. Here is an example of a SEND action that specifies both a cause and a diagnostic code:

    ACTIONS: SEND RESET CAUSE= LOCAL_PROCEDURE_ERROR DIAG= 01

12. *String.* Strings are sent at X.25 Layer 3 only as adjuncts to packet-types when they are named in SEND actions. If you want to send a string of raw data without a protocol "envelope," you must go to Layer 1 and send the raw string from there.

    Press the SEND softkey followed by the softkey for a packet type. Add any necessary or desired SEND options for the particular packet type. Then press the STRING softkey (see Figure 34-28, for example).

    There is no spreadsheet keyword that identifies send-strings at any layer. *The spreadsheet compiler identifies strings by the quotation marks surrounding them.* Always enclose strings in quotation marks. (To send an actual " -character in your string, type \" .)

    Here is a simple SEND action that includes no options besides a string:

    ACTIONS: SEND INT "°o"

    And here is a SEND action that includes a full complement of optional fields, including a string:

    ACTIONS: SEND DATA PATH= 4 PS= AUTO PR= AUTO "$^C_R$$^L_F$ This is user data."

    Most ASCII-keyboard, control, and hexadecimal characters are legal in a send-string. Special keys ([FLAG], [DON'T CARE], [BIT MASK]) are not legal. Refer to Table 29-2.

    To insert a canned fox message into a transmit string, type FOX inside of double parens, as follows: ((FOX)). Remember that the double parens are special characters produced by the [CTRL]-[9] and [CTRL]-[0] combinations. Constants, counters, and flags can also be embedded in a string. See Section 29, Strings.

(B) Give Data

GIVE_DATA is the F2 action on the first rack of action softkeys (refer to Figure 34-21). This action takes the data field from a received data packet and passes it up to Layer 4 along with an N_DATA IND primitive. (See Section 30, OSI Primitives on the Protocol Spreadsheet.) In an emulate mode, data normally arrives up at Layer 4 via GIVE_DATA actions at Layer 3.

(C) Resend

The RESEND function is mapped to F1 on the second layer of action softkeys at Layer 3 for X.25 (below the PROTOCL softkey: see Figure 34-30). A RESEND action will resend the first packet in the window. The window is a queue that buffers data packets for retransmission in case one or more transmissions are lost or in error.

The first packet in the window always is the *earliest outstanding* (unacknowledged) packet. Every time an acknowledgment is received, the window is cleared to the extent of the acknowledgment and a new "first-packet" position is established. The first RESEND after an acknowledgment always sends the first window packet.

The *second and subsequent* RESENDs following an acknowledgment also will send the first window packet, provided that the keyword FIRST is appended directly to the RESEND entry. Otherwise, they send the NEXT (second) and subsequent window packets. Figure 34-31 shows the position of the the resend "pointer" after four consecutive RESEND NEXT actions. RESEND NEXT is the default resend when neither FIRST nor NEXT is specified.

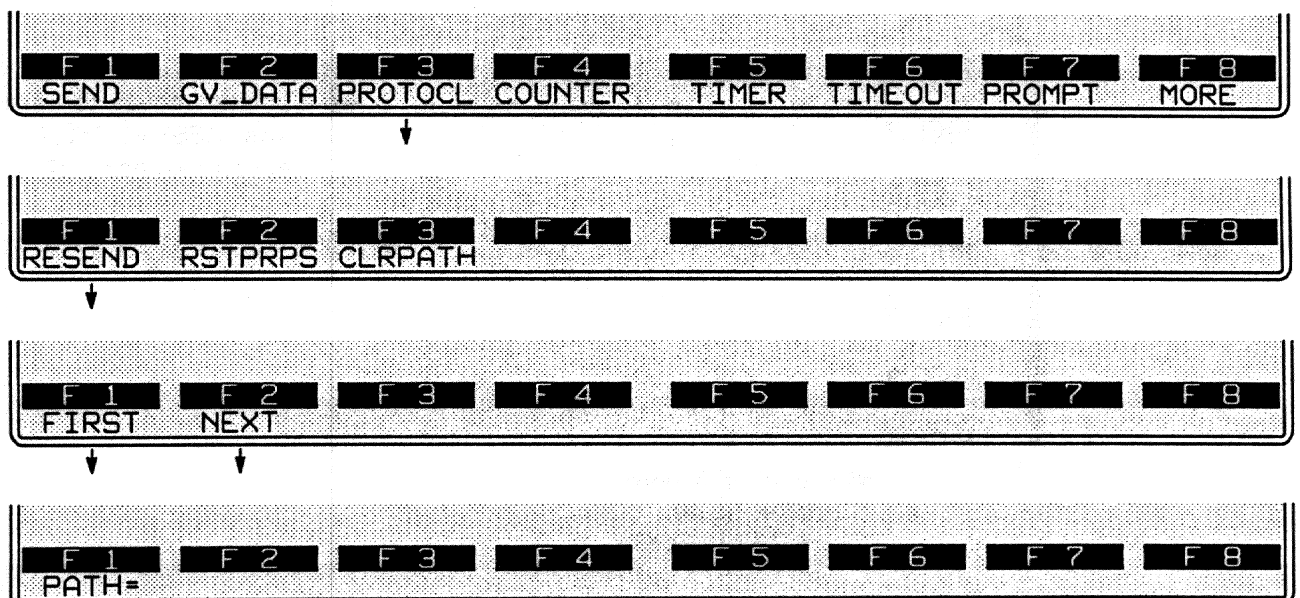


Figure 34-30 The *RESEND* action allows you to recover from sequence errors.

The resend-pointer is reset to the beginning of the window automatically by any acknowledgment, or by a RESEND FIRST action in the spreadsheet program.

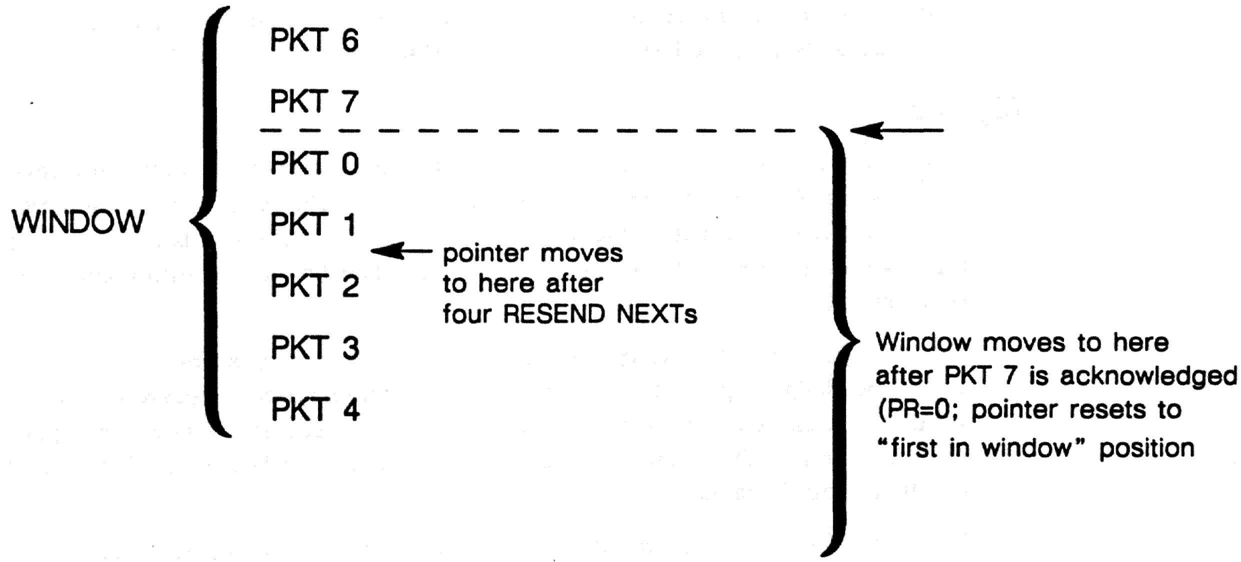


Figure 34-31 Resends cause the pointer to move, while acknowledgments move the pointer *and the entire window*.

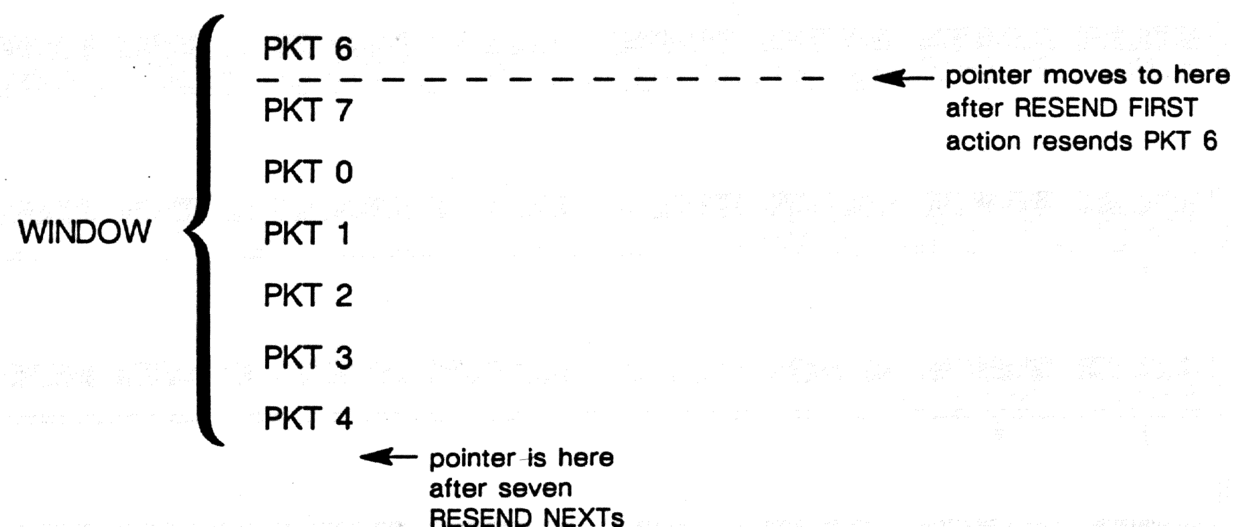


Figure 34-32 *RESEND FIRST* resets the pointer, allowing you to resend the entire window *repeatedly*.

1. *Resend first/next.* RESEND FIRST means that the resend–pointer is reset to the beginning of the window, the first packet in the window is resent, and the pointer is advanced to the second position in the window. The effect of a RESEND FIRST action is illustrated in Figure 34-32.

   The RESEND FIRST action makes it possible for you to resend all the packets in the window one by one, and then *resend them again* if necessary.

2. *Path=* . The path in the resend packet can be set by this optional action. (Default is 0 in a RESEND action.)

(D) Reset P(R) and P(S)

RSTPRPS is the F2 action on the rack of action softkeys below PROTOCL. (Refer again to Figure 34-21.) The sequence–number fields in data packets and supervisory packets can be reset by this Protocol Spreadsheet action. Sequence numbers are not reset *automatically* during a test by any packet that is sent or received.

The path number can be set by an optional PATH= selection.

RSTPRPS also clears the transmit window.

(E) Clear Path

Each call that is established in emulated mode is assigned to one of nine independent "paths," each with its own P(R) and P(S) numbering. Thus nine LCNs may be active at once. The CLRPATH action (Figure 34-21) allows you to return a path to the pool to be used again.

In the example below, a Clear request is expected. The actions that result will be to send a Clear confirmation and to clear the path.

```
LAYER: 3
   STATE: clearing
      CONDITIONS: RCV CLEAR
      ACTIONS: SEND CLEAR_CONF
         CLRPATH
```

The path number can be set by an optional PATH= selection. Without this selection, the path that is cleared will be that of the most recent packet received.

34.6 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 3 protocol trace (see Section 34.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE, DCE, and RCV conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE, DCE, or RCV condition comes true at Layer 3, the packet that satisfied the condition can be enhanced on the X.25 Layer 3 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey. Figure 34-33 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

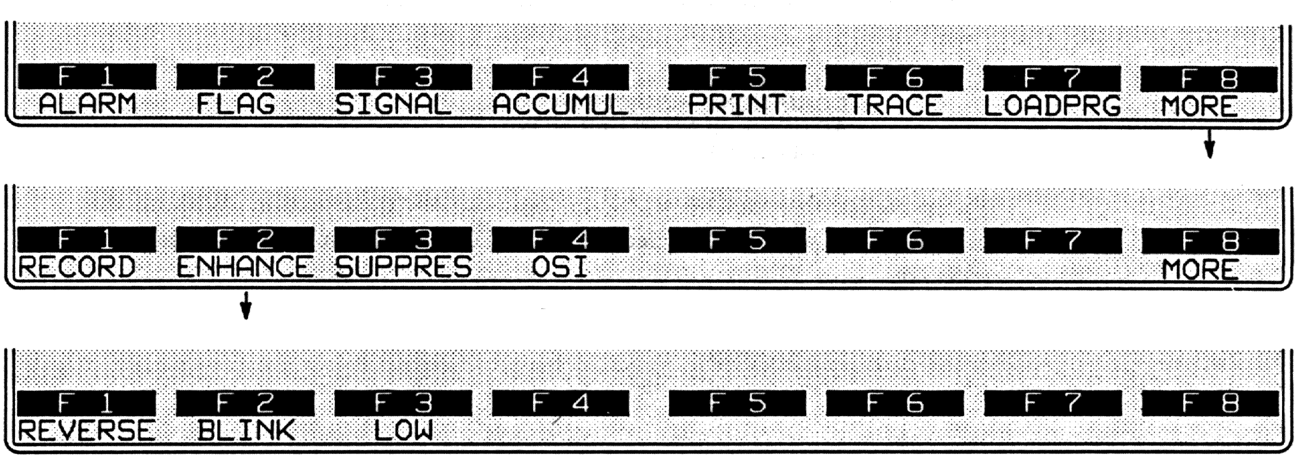


Figure 34-33 Selected packets on the protocol trace may be enhanced or suppressed.

Figure 34-34 shows one screen of a Layer 3 protocol trace in which an Interrupt packet has been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE INT
ACTIONS: ENHANCE REVERSE

```
*MON/DISK/FD1*                     BLK=00169 P 06/29/89 16:14
ASCII/8/NONE/BOP
SRC LCN  TYPE      Pr Ps QDM      MISC       SIZE     TIME      BCC
DTE 004 RR         6                         0003 1614:50.300  G
DCE 004 DATA        7  6                     0073 1614:50.504  G
DTE 004 RR         7                         0003 1614:50.563  G
DCE 004 DATA        7  7                     0029 1614:50.621  G
DTE 004 RR         0                         0003 1614:50.680  G
DCE 004 DATA        7  0                     0010 1614:50.708  G
DTE 004 RR         1                         0003 1614:50.764  G
DTE 004 INT                       %          0004 1614:50.960  G
DTE 004 DATA       1  7  Q                   0006 1614:51.000  G
DCE 004 INTCONF                              0003 1614:51.091  G
DCE 004 DATA        0  1 Q                   0042 1614:51.376  G
DTE 004 RR         2                         0003 1614:51.434  G
DCE 004 DATA        0  2                     0012 1614:51.436  G
DTE 004 DATA       2  0  Q                   0042 1614:51.594  G
DTE 004 RR         3                         0003 1614:51.625  G

 F 1     F 2     F 3     F 4     F 5     F 6     F 7     F 8
L2TRACE L3TRACE
```

Figure 34-34 An interrupt packet has been highlighted.

(B) Suppress

Individual packets that are suppressed in Layer 3 actions are deleted from the trace display. Figure 34-33 shows the softkey path to SUPPRES.

34.7 Automatic Primitives

A table in a previous section (Table 30-2) listed the OSI service primitives that are monitored at the boundaries of Layer 3 as trigger conditions and sent up to Layer 4 or down to Layer 2 as user-entered spreadsheet actions. These primitives are layer-specific rather than protocol-specific and are not part of the personality package for X.25 Layer 3; but a few of the primitives are set in motion automatically by X.25 Layer 3 spreadsheet actions. These *automatic* primitives can be thought of as part of the Layer 3 actions themselves, and by extension as part of the X.25 protocol package.

Table 34-1 gives the set of X.25 Layer 3 actions that have action-primitives built into them. For example, whenever a GIVE_DATA action occurs at Layer 3, an N_DATA IND primitive is forwarded to Layer 4, where an N_DATA IND condition may be waiting to monitor it.

Table 34-1
Automatic Primitives Generated at X.25 Layer 3

X.25 Layer 3 Action	Automatic Primitive	To Layer
GIVE_DATA	N_DATA IND	4
SEND {TYPE}	(DL_CONNECT REQ*)	2
	DL_DATA REQ	2
RESEND	(DL_CONNECT REQ*)	2
	DL_DATA REQ	2

*Sent if Layer 2 shows inactive status. DL_DATA REQ delayed until DL_CONNECT CONF returned by Layer 2.

Whenever a SEND or RESEND action is initiated at Layer 3, a DL_DATA REQ primitive is sent downward along with the DL data (the entire packet). This automatic primitive, which was nowhere entered by the user as an action at Layer 3, still will cause a DL_DATA REQ condition to be true at Layer 2.

If a SEND or RESEND action is triggered at Layer 3 while the data link at Layer 2 is inactive, Layer 3 will sense the absence of a link and delay the DL_DATA REQ. Instead it will send a DL_CONNECT REQ primitive. Only when a DL_CONNECT CONF has been returned by Layer 2 will Layer 3 release the data and the data primitive.

34.8 Programming Example: Forcing Data Packets Out on the Line

This program is constructed around the "line-access" program that was given at the beginning of Section 34.4(A). It has elements in common with the Layer 2 emulation in Section 33.9.

The program allows you to send data packets containing fox messages out onto the line interface (and up on the display) *even when you are not connected to another device*. In other words, it allows you to get the feel of layered programming before you attempt a live emulation.

The bulk of the program is entered at Layer 2. Personality packages for X.25 must be loaded in at Layers 2 and 3.

Sample Test: Force Data-Packet Transmit:

```
LAYER: 3

    STATE: fox

       CONDITIONS: KEYBOARD " Ff"
       ACTIONS: SEND DATA " ((FOX)) "

LAYER: 2

    STATE: LINK

       CONDITIONS: DL_CONNECT REQ
       ACTIONS: DL_CONNECT CONF
       NEXT_STATE: info_xfr

    STATE: info_xfr

       CONDITIONS: DL_DATA REQ
       ACTIONS: SEND INFO " ((DL_DATA)) "

       CONDITIONS: RCV INFO
       ACTIONS: SEND RR RESP
          GIVE_DATA

       CONDITIONS: T1_EXPIRED
       ACTIONS: RESEND FIRST
       NEXT_STATE: xmt_wndw

    STATE: xmt_wndw

       CONDITIONS: FRAME_SENT
          MORE_TO_RESEND
       ACTIONS: RESEND NEXT

       CONDITIONS: FRAME_SENT
          NO_MORE_TO_RESEND
       ACTIONS: ALARM
       NEXT_STATE: info_xfr
```

At Layer 3, you simply enter a KEYBOARD condition and a SEND action. During Run mode, you will press the F key in order to send a fox message inside a data packet.

The DL_CONNECT REQ primitive is sent automatically by Layer 3 before he hands the first data packet down to Layer 2. The DL_CONNECT CONF action-primitive is entered "manually" at Layer 2. It is meant to fool Layer 3 into thinking that there is a link.

When Layer 2 does not receive an acknowledgment to his first INFO frame before a T1 timeout expires, he resends the INFO frames containing the data packet (containing the fox message). The RESEND action restarts the T1 timer automatically. Subsequent timeouts will cause additional resends.

Each time the user presses the F key, a new data packet is added to the retransmit window at Layer 2. With each T1 timeout, the entire window is resent.

35 SDLC

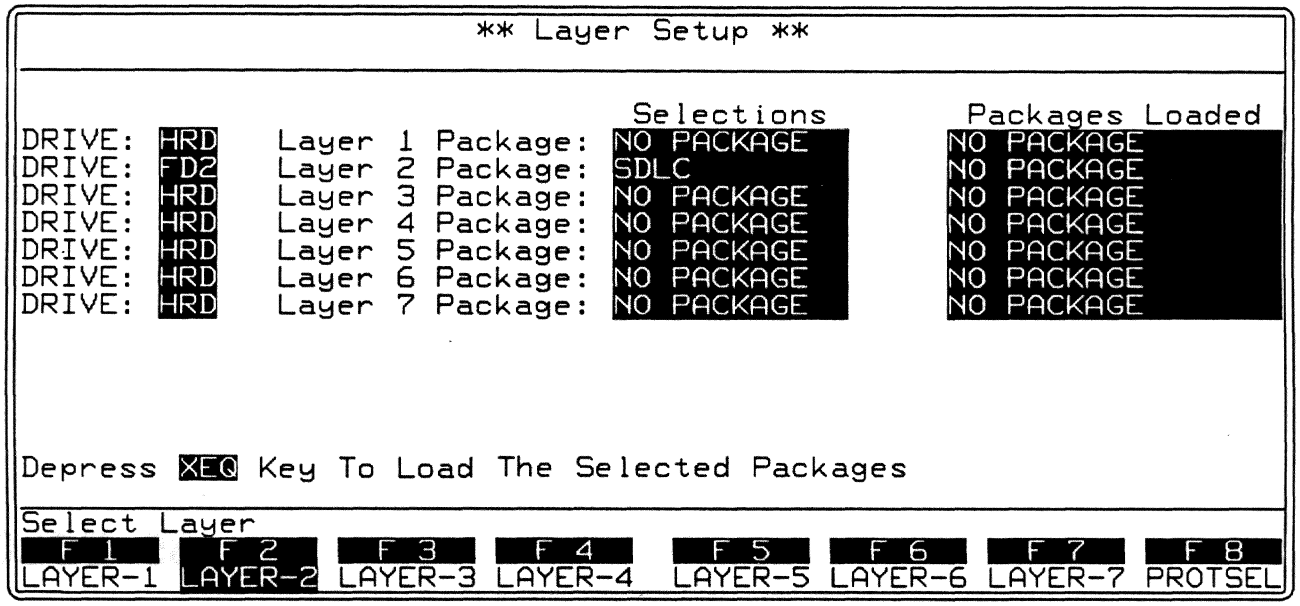


Figure 35-1 The SDLC personality package for Layer 2 is loaded from the Layer Setup screen.

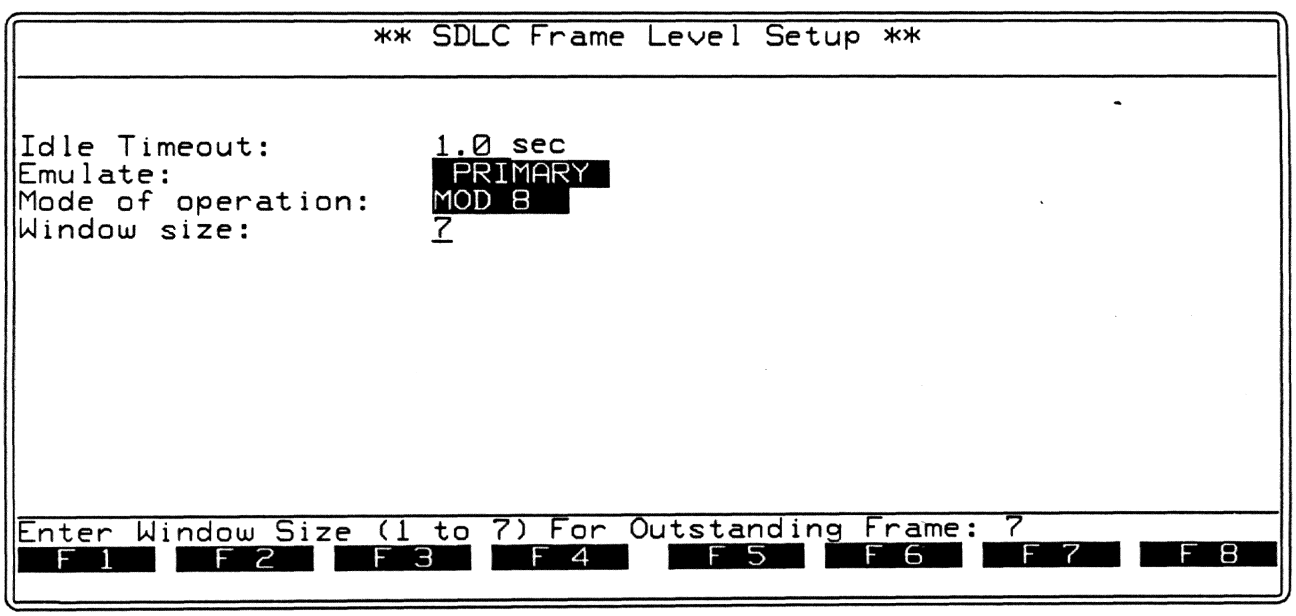


Figure 35-2 Protocol Configuration screen for SDLC.

35 SDLC

SDLC is a "layer personality package" of Layer 2 functions that are loaded into memory from disk via the Layer Setup screen. Figure 35-1 shows the Layer Setup screen configured to load in the SDLC package from floppy-disk drive #2. Refer to Section 6 for details on operating the Layer Setup screen.

The SDLC package consists of the following:

- A special SDLC Frame Level Setup screen that controls certain parameters when the unit is tracing or emulating SDLC.
- A protocol trace (illustrated in Figure 35-3) that displays significant SDLC events. This trace is accessible by softkey in Run mode at all times.
- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate SDLC programming. Figure 35-8 shows the softkey path to the first rack of condition softkeys when the SDLC package is loaded in at Layer 2.

35.1 Frame-Level Setup

The parameters on the SDLC Frame Level Setup screen must be configured correctly for an accurate trace display and for proper emulation.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the SDLC selection at Layer 2: **SDLC** should appear in the **Packages Loaded** column. Press F8 (labeled **PROTSEL**) to bring up a prompt to **Select Protocol Configuration Screen**. Then press F2 (**LAYER-2**) to call up the SDLC Frame Level Setup screen.

The four parameter fields on this screen are shown in Figure 35-2. **Idle Timeout, Emulate,** and **Window Size** apply to interactive (emulate) tests only. **Mode of Operation** must be configured correctly for the protocol trace as well as for proper emulation.

(A) Idle Timeout

Enter a four-digit (including decimal point) timeout value in this field. The largest valid entry is 65.5 seconds. The smallest entry is .001 second, or 1 millisecond.

Idle timer is the retransmission timer for SDLC INFO and supervisory command frames. When **Emulate:** PRIMARY is selected on the SDLC Frame Level Setup screen and a value is entered in the **Idle Timeout** field on this menu, the layer 2 package will handle timings as follows:

- Whenever the INTERVIEW sends a command INFO or supervisory frame with the P bit set and there are no previous polling frames sent by the INTERVIEW currently outstanding (unacknowledged) to the same address, the timer starts timing down from the value entered on the Frame Level Setup screen.
- An acknowledgment by the secondary of the most recent polling INFO or supervisory frame transmitted by the INTERVIEW *stops* the timer (so that it does not expire). This acknowledgment *must* occur in a frame with the F bit set.
- If F = 0 in the acknowledgment by the secondary of the most recent polling frame sent by the primary, the idle timer restarts at the value selected on the configuration screen.
- An acknowledgment by the secondary of a frame that is not the most recent polling frame transmitted by the INTERVIEW is an incomplete acknowledgment, even if F = 1. This acknowledgment also will restart the idle timer.

Expiration of this Frame Level Setup timeout can only be detected by a T1_EXPIRED condition on the Protocol Spreadsheet at Layer 2.

(B) Emulate Primary/Secondary

There are two selections in the **Emulate** field on the SDLC Frame Level Setup screen, PRIMARY and SECONDARY. The difference between these two modes is that the primary device makes use of the idle timer. The secondary does not.

(C) Mode of Operation

The **Mode of Operation** field refers to the mode of numbering INFO and supervisory frames. There are two options, MOD 8 and MOD 128.

MOD 8 uses sequence numbers 0-7. MOD 128 adds an extra byte to the control field in INFO, RR, RNR , REJ, and SREJ frames. See Figure 35-5. This extra byte allows sequence numbers in a range of 0-127.

The correct "modulus" must be selected in this field in order to conduct interactive communications and also to generate an accurate SDLC Layer 2 trace.

(D) Window Size

Any window size may be entered up to the current modulus minus one: 7 or 127. The window size is the maximum number of unacknowledged I-frames that Layer 2 will buffer for retransmission. When the limit is reached, any further INFO frames that are named in SEND actions triggered at Layer 2 will be passed to Layer 1 for transmission but not buffered for retransmission.

The window is a queue that buffers frames for retransmission in case one or more transmissions are lost or in error. A RESEND action will resend the first (earliest) frame in the window. Successive RESENDs will send successive frames until there are no more frames to resend; or until the window is reset by an acknowledgment or by a RESEND FIRST action.

35.2 Protocol Trace

The SDLC package includes an automatic frame-trace display that summarizes link-level activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE ([F2] on the primary rack of display-mode softkeys) to bring the protocol trace for SDLC Layer 2 to the screen. Figure 35-3 is an example of this trace display. Each horizontal row in the trace represents a frame.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

MON/LINE BLK=00000 S 04/21/89 22:22
ASCII/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DTE	C1	INFO	7	3	0	0264	2220:06.206	G
DTE	C2	SNRM			1	0002	2220:06.230	G
DTE	C1	INFO	7	0	0	0011	2220:06.276	G
DTE	C1	INFO	7	1	0	0046	2220:06.441	G
DTE	C1	INFO	7	2	0	0236	2220:07.247	G
DTE	C1	INFO	7	3	0	0264	2220:08.151	G
DTE	C1	INFO	7	4	0	0264	2220:09.059	G
DTE	C1	INFO	7	5	0	0264	2220:09.976	G
DTE	C1	INFO	7	6	0	0136	2220:10.445	G
DTE	C1	RR	7		1	0002	2220:10.466	G
DCE	C1	INFO	7	7	1	0012	2220:10.788	G
DTE	C1	RR	0		1	0002	2220:10.812	G
DTE	C1	INFO	0	7	0	0015	2220:10.872	G
DTE	C1	INFO	0	0	0	0041	2220:11.021	G
DCE	C1	INFO	7	0	1	0011	2220:11.115	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
DATA	L2TRACE			STATS		NO DISP	

Figure 35-3 Each horizontal row on the trace display represents a frame.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or ↑ or ↓) to move the line in question to the top of the screen. Then press one of the data softkeys. Figure 35-4 shows part of a dual-line data screen in Freeze mode. The first frame in the display is the same one that is traced at the top of Figure 35-3.

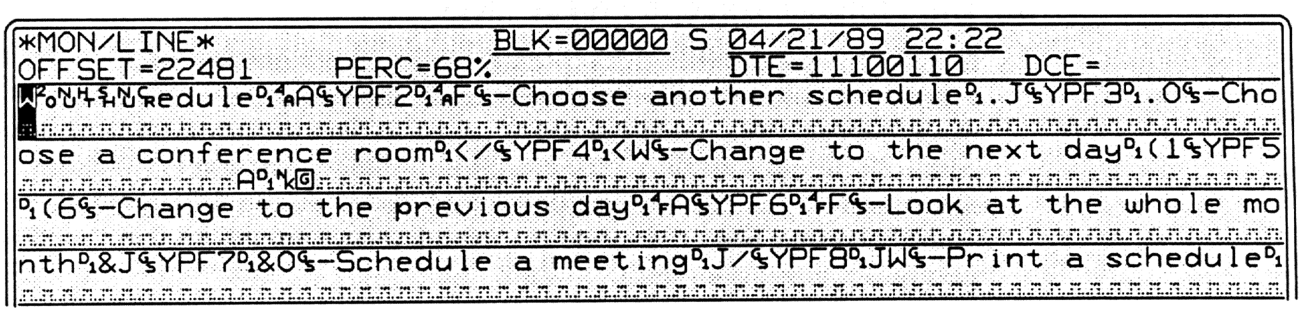


Figure 35-4 Data-display of Protocol Trace shown in Figure 35-3.

(B) Trace Columns

The columns in the protocol trace for SDLC are explained below.

1. *Source.* The **SRC** column identifies the lead on which the frame was monitored, TD (DTE) or RD (DCE).

   Just as on the data display, RD data is underlined.

2. *Address.* The address byte (see Figure 35-5) is given in the **ADDR** column, with its two hexadecimal digits presented as full-size alphanumerics.

   The address in SDLC always belongs to the secondary.

3. *Type.* The mnemonic (abbreviated) names for twenty frame types as they appear in the **TYPE** column of the protocol trace are shown in Figure 35-5 under "CONTROL." The control field, therefore, indicates the frame type. If a control octet does not fit any of the patterns in the figure, the frame is listed in the **TYPE** column as UNKWN followed by the hexadecimal value of the control byte: UNKWN=3F.

   If the number of bytes in the frame is below the required minimum, the frame is posted as INVALID.

4. *N(R) and N(S).* One column on the frame-level trace is devoted to N(R) values, and one column to N(S). The frame types that include N(R) or N(S) fields in their control fields are indicated in Figure 35-5. N(R) and N(S) occupy three bits each in modulo 8, seven bits each in modulo 128.

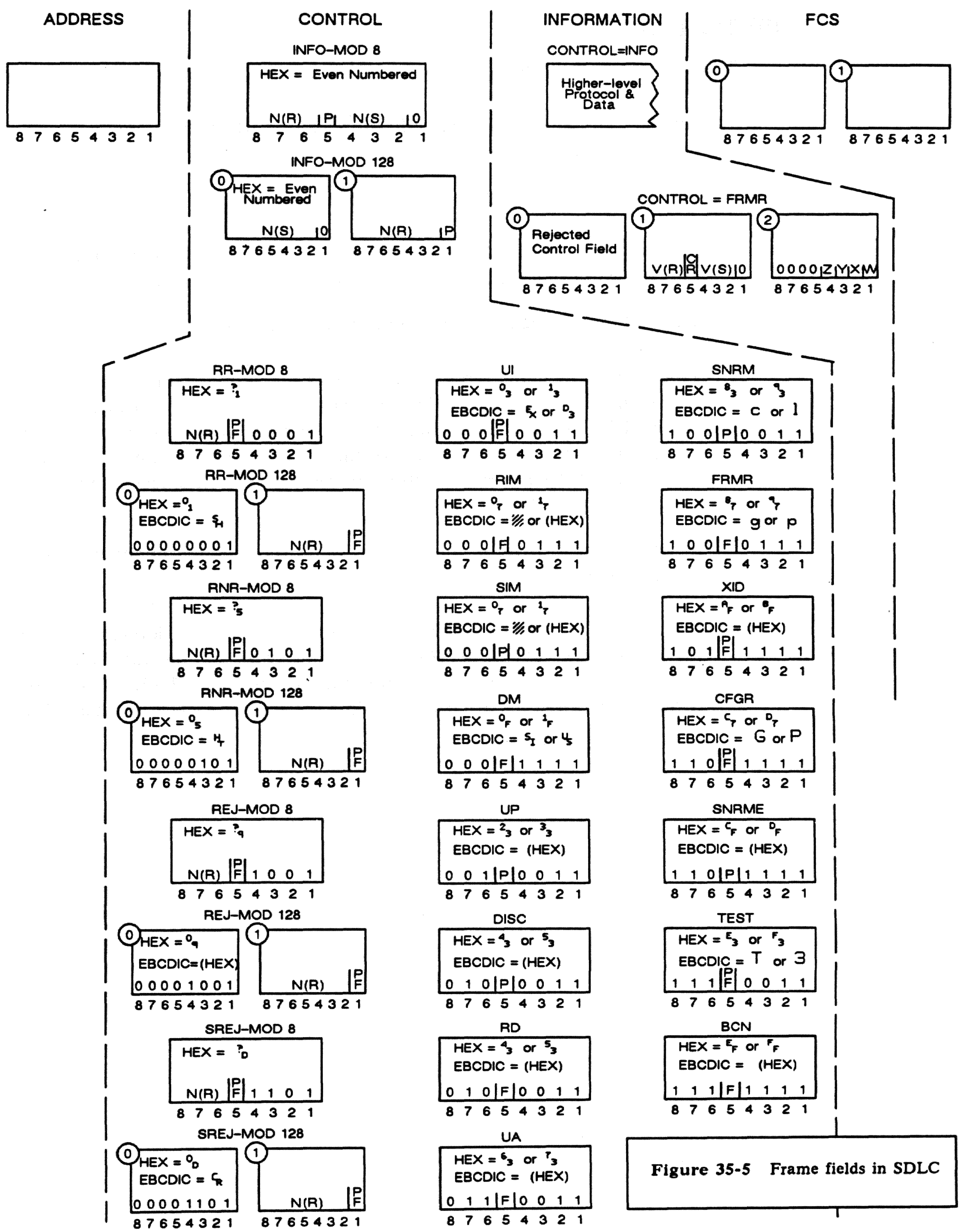


Figure 35-5 Frame fields in SDLC

MON/LINE BLK=
EBCDIC/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns
DTE	C1	INFO	7F	79
DTE	C1	INFO	7F	7A
DTE	C1	INFO	7F	7B
DTE	C1	INFO	7F	7C
DTE	C1	INFO	7F	7D
DTE	C1	INFO	7F	7E
DTE	C1	INFO	7F	7F
DTE	C1	INFO	7F	00
DTE	C1	INFO	7F	01
DTE	C1	INFO	7F	02
DCE	C1	RR	03	
DTE	C1	INFO	7F	03
DTE	C1	INFO	7F	04
DTE	C1	INFO	7F	05
DTE	C1	INFO	7F	06

F 1 DATA | F 2 L2TRACE | F 3 | F 4

Figure 35-6 **MOD 128 sequence numbers are displayed in two-digit hexadecimal *characters*.**

N(R) and N(S) values are presented in decimal format in modulo-8 traces. Each column displays a single digit that represents a 3-bit binary value. For modulo 128, the values 00 to 7F are given in "character" format, where the columns contain a two-digit hexadecimal character (see Figure 35-6).

SRC	ADDR	TYPE	Nr	Ns	P/F
DTE	C1	INFO	7	0	0
DTE	C1	INFO	7	1	0
DTE	C1	INFO	7	2	0
DTE	C1	INFO	7	3	0
DTE	C1	INFO	7	4	0
DTE	C1	INFO	7	5	0
DTE	C1	INFO	7	6	0
DTE	C1	RR	7		1
DCE	C1	INFO	7	7	1
DTE	C1	RR	0		1
DTE	C1	INFO	0	7	0
DTE	C1	INFO	0	0	0

Figure 35-7 **Nr and Ns columns are staggered, with the *inside* columns representing the sequence of *DTE* numbered I-frames.**

Note that the **Nr** and **Ns** columns on the trace are staggered to suggest four columns. The two inside columns, comprised of the DCE's N(R) value and the DTE's N(S), form a numbering sequence for DTE I-frames. The arrows in Figure 35-7 indicate the sequence: the DTE sends a window full of frames 0 through 6; the DCE acknowledges frames through 6 (NR=7); the DTE begins a new window with frame 7; and so on.

The two outside columns reveal a similar pattern for DCE I-frames.

5. *P and F*. The status of the poll or the final bit is given in the **P/F** column. Whether this bit is the P or F bit is indicated for most frame types in Figure 35-5 (under "CONTROL").

6. *Size*. The number of bytes in each frame is given in this column in four decimal digits. The count begins with the address byte and excludes the two-byte FCS. Frames without I-fields show a count of two.

7. *Time*. The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

8. *Frame checking*. An SDLC frame ends as soon as a $^{F}{}_{E}$ flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the **BCC** column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

   A for abort is posted to the displays when a frame is ended by seven 1-bits.

35.3 Monitor Conditions

When the SDLC personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 2. See Figure 35-8.

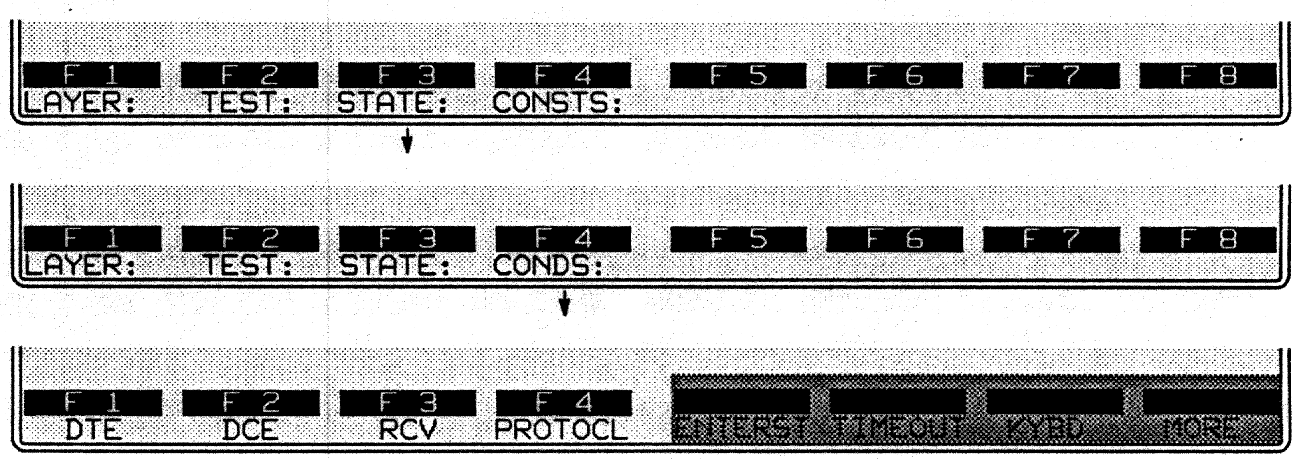


Figure 35-8 Unlike *RCV* conditions, the softkeys for *DTE* and *DCE* are valid when the INTERVIEW is monitoring the line passively.

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represent *types* of frames: INFO, SNRM, UA, and so forth.

(A) Frame Types

The softkeys for INFO, supervisory, unnumbered, and "other" frames are illustrated in Figure 35-9. Press a softkey to write one of these frame types to the Layer 2 spreadsheet. DTE or DCE followed by a frame-type mnemonic—DCE INFO, for example, or DTE SNRM—is a complete condition and will come true if a matching frame is monitored. Address, poll/final, and BCC conditions may be added to the simple frame mnemonic, but they are optional.

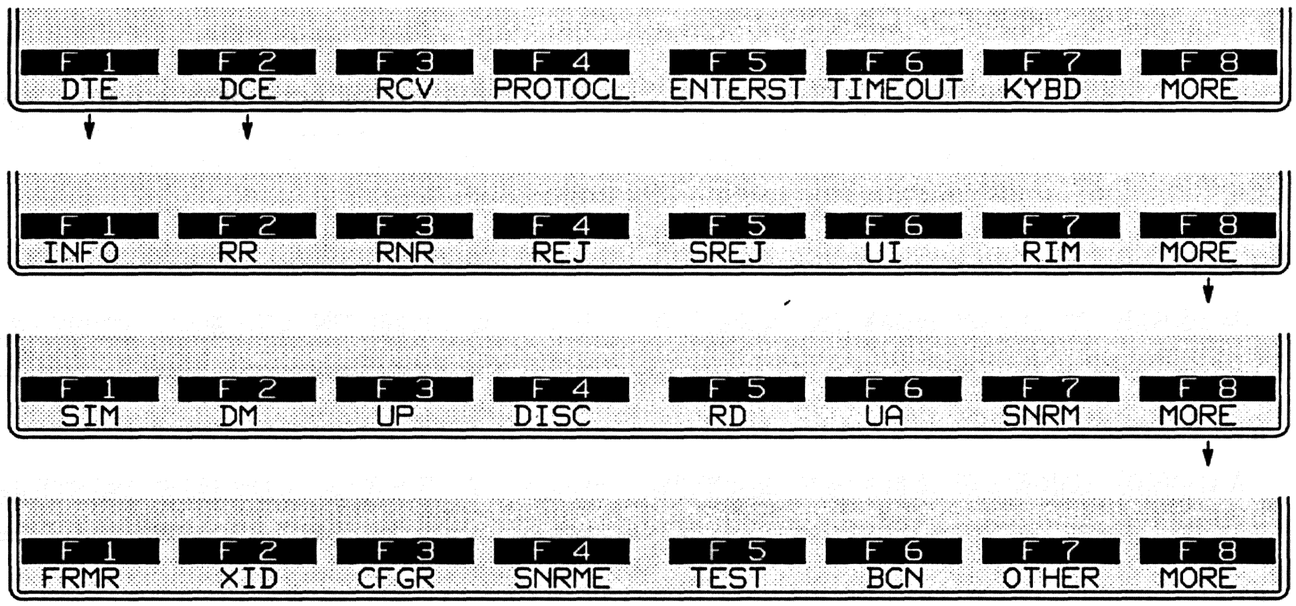


Figure 35-9 Frame types.

1. *Info frames.* INFO frames differ for MOD 8 and MOD 128 numbering schemes. (See Figure 35-5.) For spreadsheet conditions to match I-frames accurately, the correct numbering system ("**Mode of Operation**") should be selected on the Frame Level Setup screen.

2. *Supervisory frames.* The four supervisory-frame types that can be searched for on the data leads are RR (Receive Ready), RNR (Receive Not Ready), REJect, and SREJ (Selective Reject). These frames always contain N(R) fields (see Figure 35-5) and serve mainly to acknowledge or reject INFO frames.

   Like INFO frames, supervisory frames are constructed differently according to the numbering scheme, MOD 8 or MOD 128.

3. *Unnumbered frames.* Unnumbered frames generally assist in link-setup and takedown. These contain neither N(R) nor N(S) fields. Fifteen unnumbered-frame types are shown in Figure 35-9, from UI in the second rack of softkeys through BCN in the bottom rack.

4. *Other frames.* Any frame type may be entered as a hexadecimal value instead of by name. Press the softkey for OTHER. See Figure 35-10. Then enter the hex byte in the form of two alphanumerics. Here, for example, is a SNRM (with the P bit set) entered as a hexadecimal:

   CONDITIONS: DCE OTHER 93

Address, poll/final, and BCC conditions may be appended to OTHER conditions. In MOD 8, the P/F bit is already specified in the hex entry, and a P/F condition will be ignored.

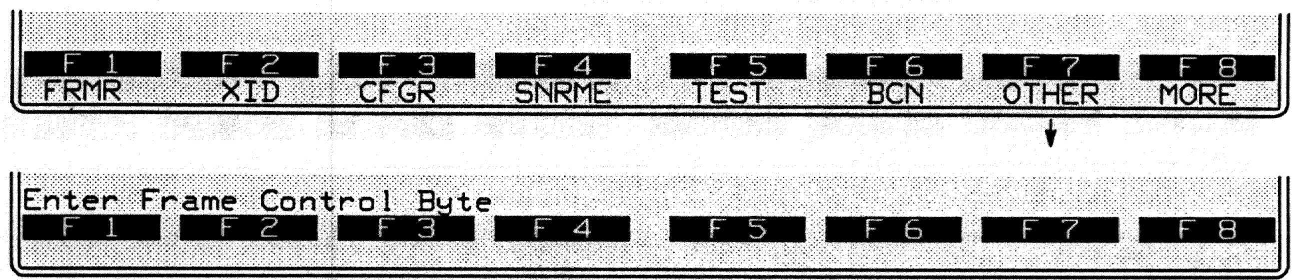


Figure 35-10 The hex value of any frame may be specified under *OTHER*.

5. *Address*. An address condition may be added to INFO, supervisory, unnumbered, and OTHER conditions. Press the softkey for ADR=, shown in Figure 35-11. Then enter the hexadecimal address octet as two alphanumerics. The address octet C1, for example, appears as follows:

CONDITIONS: DTE INFO ADR= C1

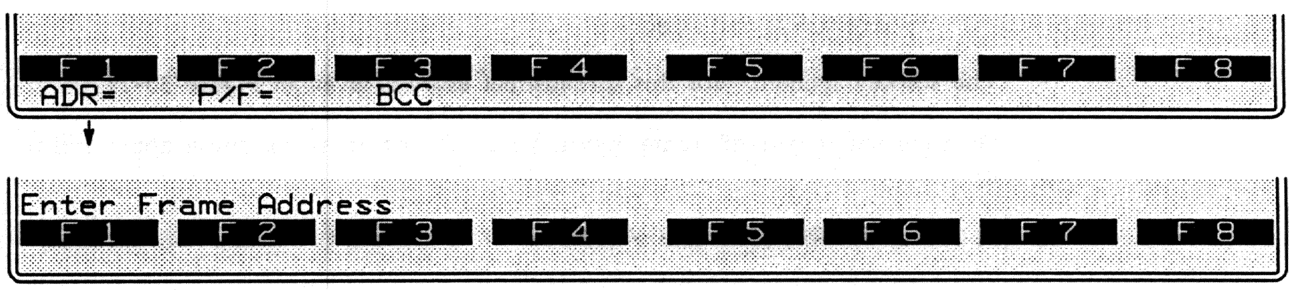


Figure 35-11 The hex value of the address byte is entered as two alphanumerics for *all* frame types.

To bypass the ADR= selection (as well as the other options on the same rack of softkeys in Figure 35-11) press DONE.

6. *Poll/final bit.* P/F conditions are optional for all frame types. P/F values of 0 or 1 are entered by the softkey sequence in Figure 35-12.

   Press DONE to bypass the P/F= condition and the other conditions on the same softkey level in Figure 35-12.

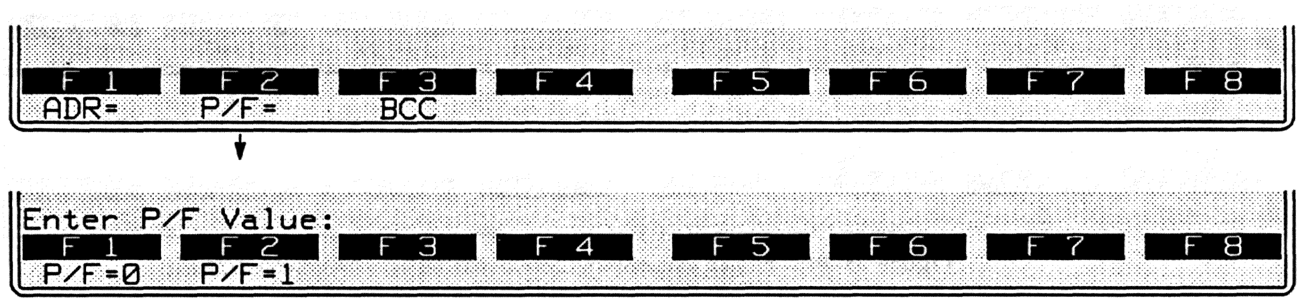


Figure 35-12 The value of the P/F bit may be chosen as a condition.

(B) BCC Conditions

DTE and DCE frames may be monitored for good and bad frame checks and for aborts. *All* DTE or DCE frames may be monitored with respect to frame checking, as in this example:

CONDITIONS: DTE BDBCC

The softkey sequence for this spreadsheet entry is given in Figure 35-13.

Or a particular *type* of frame may have a BCC or abort condition appended to it:

CONDITIONS: DCE INFO ABORT

Figure 35-13 **A condition may search for *all* good, bad, or aborted frames.**

35.4 Emulate-Mode Conditions

The remaining conditions are functional only when the Line Setup menu is configured for **Mode:** EMULATE DTE or EMULATE DCE.

(A) Receive Conditions

Like DTE and DCE conditions, RCV conditions monitor a data lead for SDLC frame types. RCV conditions operate only in emulate modes, and they check only the data lead that the INTERVIEW is not using to transmit. While a RCV condition may look like a DTE or DCE condition—RCV INFO P/F=1 looks the same as DCE INFO P/F=1—there are important differences that are noted below.

1. *Valid frame sequencing.* To satisfy RCV conditions, numbered frames must have correct N(R) and N(S) sequencing.

2. *Good BCC.* RCV conditions cannot match frames with bad frame checks, nor can they match aborted frames. (Emulate-mode conditions are designed for ease of programming, and the assumption is that as an SDLC emulator, you are not required to acknowledge—or negative-acknowledge—bad or aborted frames.)

   If you wish to count bad BCCs or aborts, use DTE or DCE conditions instead of RCV conditions.

3. *Type invalid or unknown.* RCV conditions can detect frames that are invalid "types"—the control field is missing, for example, or the I-field is missing in an I-frame. The Protocol Spreadsheet entry for this condition is RCV INVALID, and the softkey sequence is illustrated in Figure 35-14.

   A frame may be valid in all respects but have a control field that indicates a nonstandard frame type. Such a frame may be matched by a RCV UNKNOWN condition (Figure 35-14).

Figure 35-14 ***INVALID*** **and** ***UNKNOWN*** **are frame types for** ***RCV*** **conditions.**

(B) N(S) Error

As a Layer 2 emulator, you do respond to INFO frames that have N(S) errors. These are detected as NS_ERR conditions, not as RCV INFO conditions.

NS_ERRs apply only to frames received when you are emulating. The same frame that triggers an NS_ERR condition also may satisfy a DTE INFO or DCE INFO condition—but not a RCV INFO condition.

NS_ERR will come true for any received frame whose N(S) value is not one higher than the previous N(S).

In the first rack of condition softkeys at Layer 2, press PROTOCL. Then press the softkey for NS_ERR. See Figure 35-15.

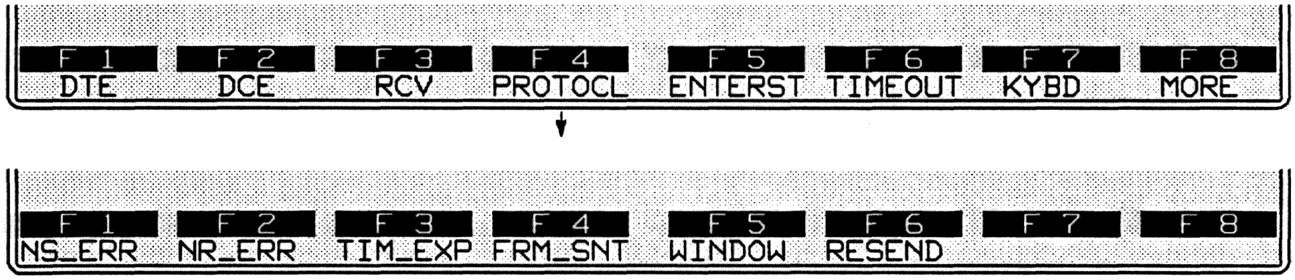


Figure 35-15 The *PROTOCL* key brings up six SDLC emulate conditions.

(C) N(R) Error

Received INFO or supervisory frames may have N(R) errors. Such errors are detected as NR_ERR conditions, not as RCV INFO or RR (or RNR or REJ) conditions.

A valid N(R) is any value that (1) acknowledges a frame that is *outstanding* (waiting for acknowledgment); or (2) repeats the last acknowledgment. Any other N(R) value is detected as an error.

(D) Timeout Expired

This condition detects the expiration of the idle timeout that is regulated on the SDLC Frame Level Setup screen. See Section 35.1(A), above.

(E) Frame Sent

This condition is true when, as a result of a SEND or RESEND action, a frame has been passed down to Layer 1.

(F) Window Conditions

The size of the Layer 2 retransmit window is configured on the SDLC Frame Level Setup screen. See Section 35.1(D). There are four conditions that test the current status of this window. They are WINDOW FULL, WINDOW EMPTY, WINDOW NOT_FULL, and WINDOW NOT_EMPTY. The softkey sequence for the WINDOW options is shown in Figure 35-16.

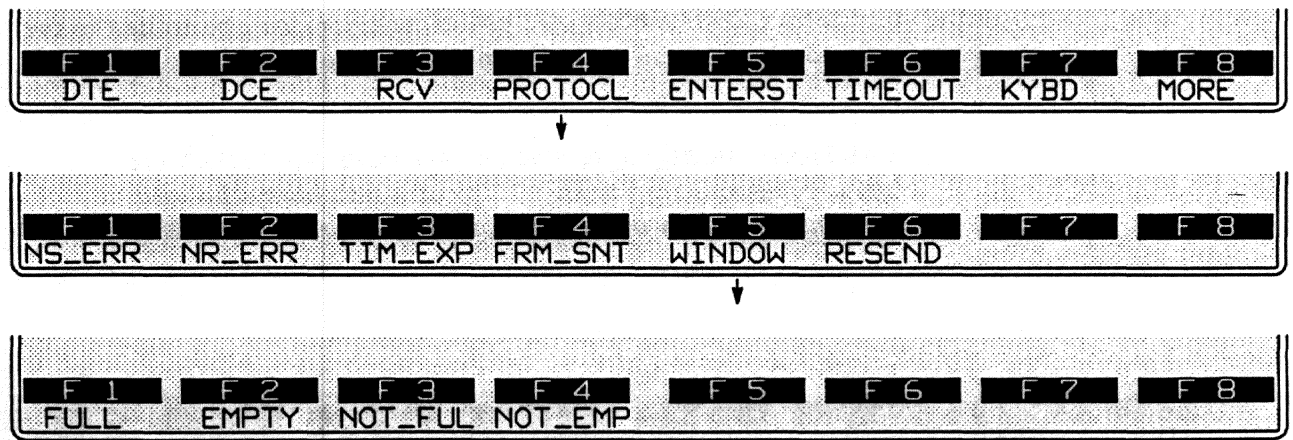


Figure 35-16 When the retransmit window fills, Layer 2 stops passing frames down to Layer 1.

WINDOW FULL is true when the window is full of unacknowledged frames and the Layer 2 protocol package will not buffer additional frames until some acknowledgment is received.

Each time an acknowledgment is received, the window is flushed to the extent of the acknowledgment. WINDOW EMPTY means that the latest acknowledgment was complete and left no frames outstanding (unacknowledged). If an RR response is received and the acknowledgment is only partial, this condition will be true:

```
CONDITIONS: RCV RR
  WINDOW NOT_EMPTY
```

CAUTION: Window conditions are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as a* RCV *condition.*

(G) More to Resend

Frames in the window may have to be resent, usually as the result of an idle-timer timeout or a Reject frame. One RESEND action retransmits one frame in the window, beginning with the earliest. Subsequent RESEND actions retransmit subsequent frames. The MORE_TO_RESEND and NO_MORE_TO_RESEND conditions allow you to retransmit the entire window, as in the "recover" state in this example:

```
  CONDITIONS: RCV REJ
  ACTIONS: RESEND
  NEXT_ST: recover
STATE: recover
  CONDITIONS: FRAME_SENT
    MORE_TO_RESEND
  ACTIONS: RESEND
  CONDITIONS: FRAME_SENT
    NO_MORE_TO_RESEND
  NEXT_ST: xfer
```

MORE_TO_RESEND and NO_MORE_TO_RESEND conditions may be written to the Protocol Spreadsheet by the softkeys shown in Figure 35-17.

CAUTION: MORE_TO_RESEND and NO_MORE_TO_RESEND are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as FRAME_SENT.*

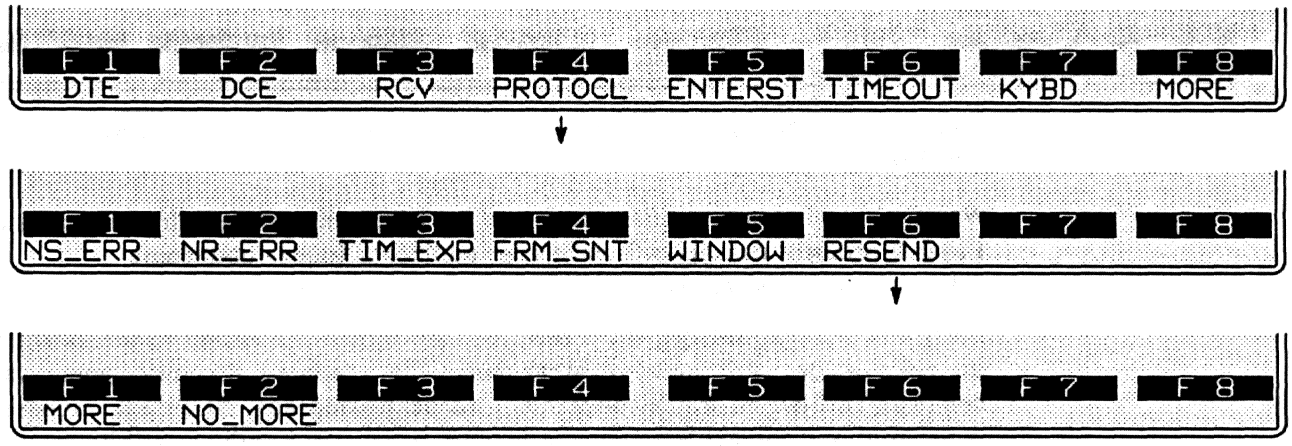


Figure 35-17 **The *MORE_TO_RESEND* condition allows you to resend the entire window of frames and then stop when there are *NO_MORE_TO_RESEND*.**

35.5 Emulate Actions

When you have completed a block of conditions in a Protocol Spreadsheet test at Layer 2, press [DONE] to access the set of actions that can be taken as a result of the block of conditions coming true. The set of actions that are specific to the SDLC personality package are shown in the racks of softkeys in Figure 35-18. Except for ENHANCE and SUPPRES, the actions shown have meaning only when the INTERVIEW is emulating DTE or DCE, and not when it is monitoring the line passively.

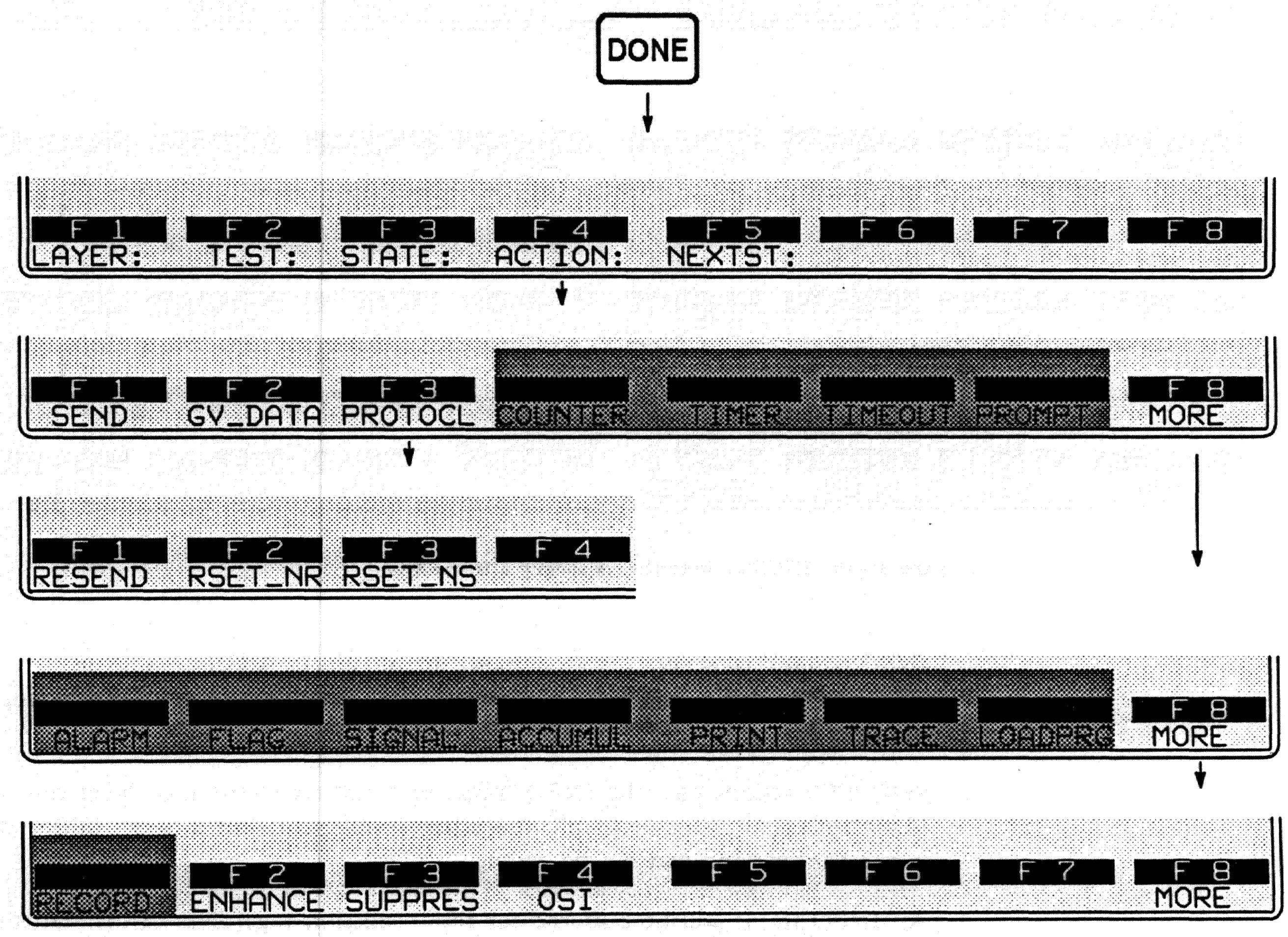


Figure 35-18 Action softkeys specific to SDLC.

(A) Send Actions

Press the softkey for SEND to access three racks of softkeys with names of frame types that may be named in SEND actions. All data generated by the SDLC package must be enclosed in a frame that is identified in a SEND action by *type*.

(Only at Layer 1 can data be generated as a simple character string without any protocol building blocks.) The complete set of frame types is given in Figure 35-19.

When conditions are true for a SEND action, frames are sent immediately down to Layer 1 to be transmitted there.

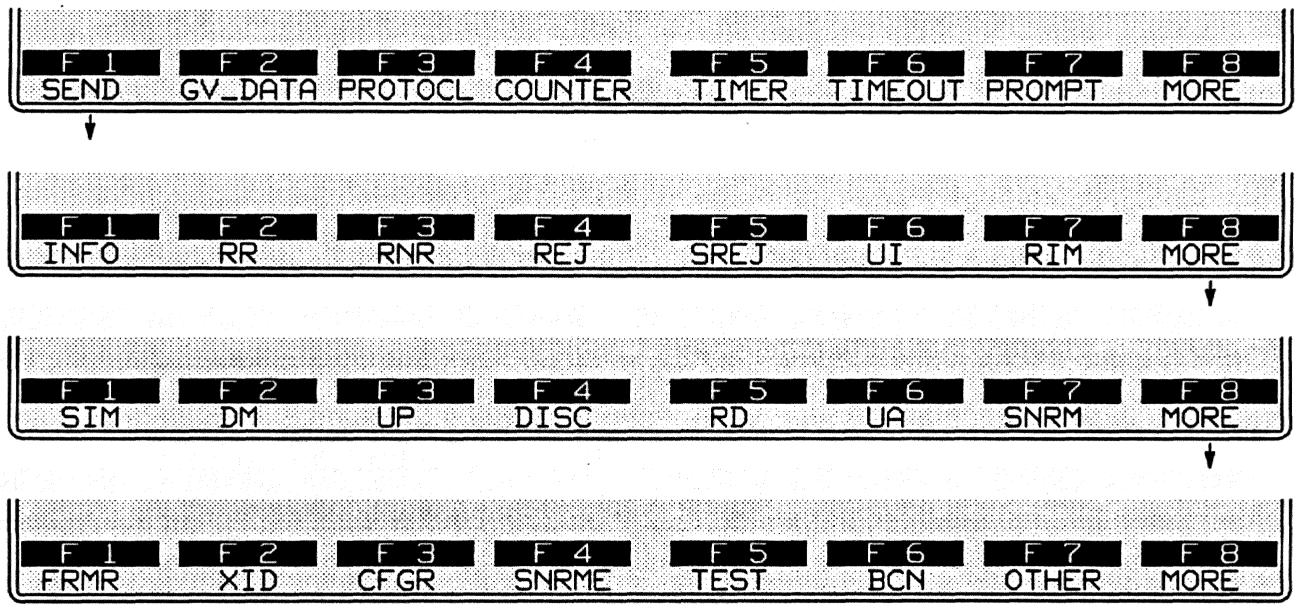


Figure 35-19 ***SEND*** **actions always specify a frame type.**

1. *INFO frames*. SEND INFO is a complete action-entry. Address, poll-bit, N(R), N(S), string, and BCC parameters may be added to an INFO frame, but they are optional.

   SEND INFO actions pass the INFO frame immediately to the next layer down. If the retransmit window is full, the frame is still sent—but it is not buffered in the window and can not be *re*sent.

   An INFO frame will be buffered for retransmission regardless of the status of the window if a specific value is entered for the NS= parameter (see "*N(S)*," below). The specific N(S) value will clear the window and the INFO frame will be buffered in the first window position.

2. *Unnumbered frames*. SEND SNRM, SEND UA, and so forth, are complete action-entries. Address, P/F-bit, string, and BCC parameters may be added to the SEND action, but they are optional.

3. *Supervisory frames*. SEND RR, SEND RNR, SEND REJ, and SEND SREJ are complete action-entries. Address, P/F-bit, string, and BCC parameters may be added to the SEND action, but they are optional.

   The address in SDLC always belongs to the secondary.

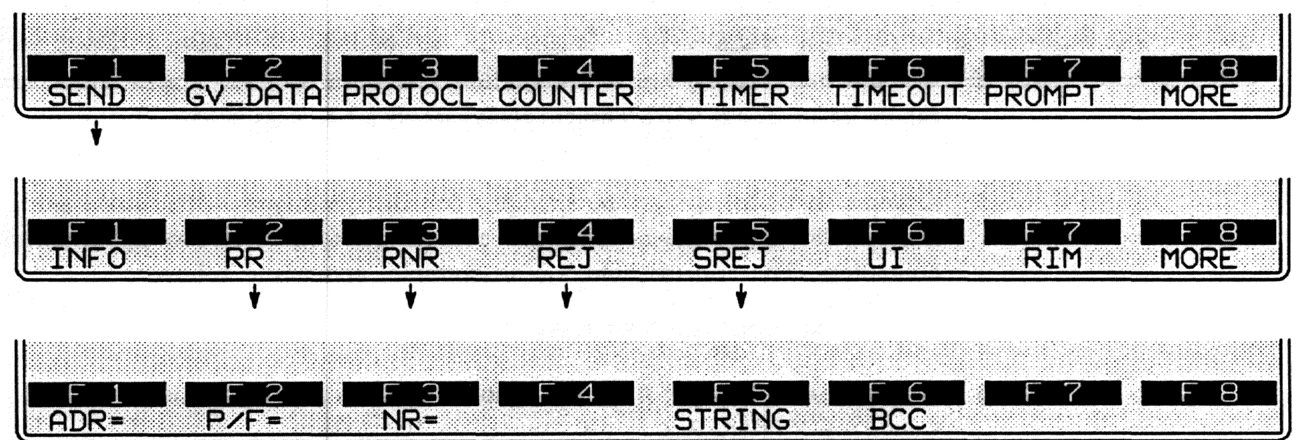


Figure 35-20 Address, P/F, N(R), and block-check parameters as well as data strings may be added to *SEND SUPERVISORY* actions.

4. *Other frames*. Any frame type may be entered in a SEND action as a hexadecimal value instead of by name. Press the softkey for OTHER, on the bottom rack in Figure 35-19. Enter the hex value in the form of two alphanumerics. Here is a DISConnect command entered as a SEND OTHER action:

   ACTIONS: SEND OTHER 43 ADR= C3

   Since P/F, N(R), and N(S) fields are implied already in the user-entered hexadecimal control field, *valid* optional parameters in a SEND OTHER action are address and BCC. (In MOD 128, P/F is not included in the hex entry and is a valid optional entry.)

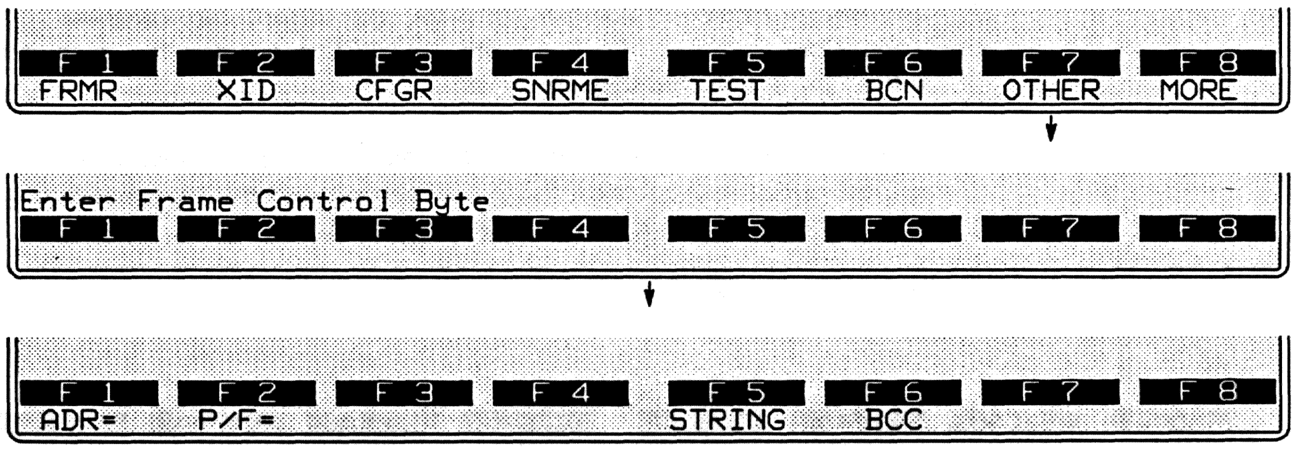


Figure 35-21 ***SEND OTHER*** **actions always specify a *type* value in hex.**

5. *Address*. An address may be specified for all frame types. The ADR= entry is always followed by the hexadecimal address octet typed as two alphanumeric characters. The address field C3, for example, appears as follows:

   ACTIONS: SEND RR ADR= C3

6. *Poll/final bit*. The P/F bit is an optional entry in all SEND actions. A P/F value of LOOPBAK, 0, or 1 are entered by the softkeys in Figure 35-22. If P/F= LOOPBACK, the bit will echo the last P/F bit received. (Looping the P/F bit is appropriate for UAs and supervisory frames.)

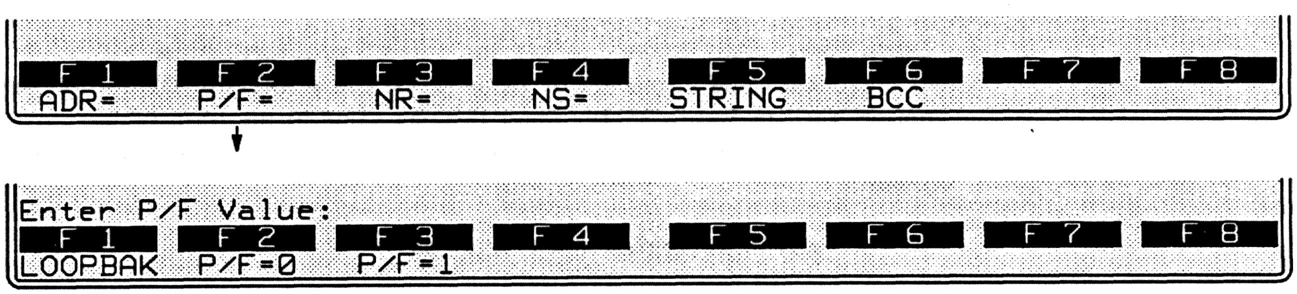


Figure 35-22 A P/F value is optional in all ***SEND*** **entries.**

7. *N(R)*. N(R) fields are transmitted in INFO and supervisory frames.

   To specify an N(R) value, press the softkey for NR= (see Figure 35-23). Enter a hexadecimal value written as one or two alphanumeric digits. For example, an entry that represented the highest valid N(R) in MOD 8 would be NR= 7. The highest valid entry in MOD 128 would be NR= 7F.

   Other N(R) options are ACK_NS, LAST_NR, and AUTO. (See Figure 35-23.) ACK_NS means that your N(R) will acknowledge (that is, it will be *one higher* *than*) the last N(S) value you received *for the same frame address*. Normally this will be the correct N(R), except in cases where the last N(S) received was erroneous. The NR= ACK_NS selection allows you to overlook N(S) errors.

LAST_NR means that you simply repeat the last N(R) you sent to the same address. Normally this is the correct N(R) following a bad N(S). The NR= LAST_NR option allows you to force the other side to initiate recovery.

AUTO means that you will behave as a normal SDLC station, acking valid N(S) values and repeating your last N(R) whenever an invalid N(S) is received. AUTO is the default N(R) selection in SEND INFO, SEND RR, SEND REJ, and SEND SREJ actions.

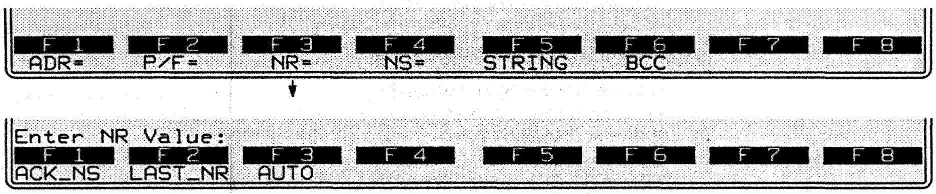


Figure 35-23 **The N(R) field may be specified in INFO and supervisory frames to be sent.**

8. *N(S)*. N(S) fields are transmitted in INFO frames only. (See the frame-field diagrams in Figure 35-5.) Entries for N(S) in SEND INFO actions are optional. The softkeys that open below NS= are illustrated in Figure 35-24.

   To specify an N(S) value, press the softkey for NS=, then enter a hexadecimal in the form of one or two alphanumerics. Valid hex entries are the same as for N(R). A SEND INFO action that *specifies* an N(S) value—NS= 0, for example—will clear the window so that the INFO frame is passed immediately to Layer 1.

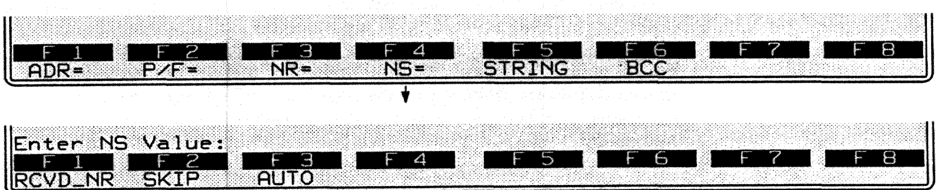


Figure 35-24 **The N(S) field may be specified in a *SEND INFO* action.**

Other N(S) options are RCVD_NR, SKIP, and AUTO. RCVD_NR means that you send the N(S) value that the other side says it is expecting. This is the valid N(S) in many cases, but not when you send two or more I-frames in a row without waiting for acknowledgment.

SKIP means that you *add one* to your correct N(S). This will look to the other side as though the line has taken a "hit" and a frame has been lost. This selection causes the window to be cleared.

NS= AUTO is the default setting for SEND INFO actions. AUTO means that every *new* INFO frame sent will have an N(S) value of one higher than the previous N(S) to the same frame address.

9. *String*. Strings are sent at Layer 2 only as adjuncts to frame-types when they are named in SEND actions. If you want to send a string of raw data without a protocol "envelope," you must go to Layer 1 and send the raw string from there.

   Press the SEND softkey followed by the softkey for a frame type. Add any necessary or desired SEND options for the particular frame type. Then press the STRING softkey (Figure 35-24).

   There is no spreadsheet keyword that identifies send-strings at any layer. *The spreadsheet compiler identifies strings by the quotation marks surrounding them*. Always enclose strings in quotation marks. (To send an actual " -character in your string, type \" .)

   Here is a simple SEND action that includes no options besides a string:

   ACTIONS: SEND FRMR "$^1_1{}^6_6{}^0_8$"

   And here is a SEND action that includes a full complement of optional fields, including a string:

   ACTIONS: SEND INFO ADR= C3 P/F= 0 NR= AUTO NS= AUTO
   "$^2_C{}^0_0{}^0_2{}^0_0{}^0_0{}^0_0{}^0_3{}^8_0{}^0_0{}^1_S$This is user data.$^1_S$" GDBCC

   Most ASCII-keyboard, control, and hexadecimal characters are legal in a send-string. Special keys ([FLAG], [DON'T CARE], [BIT MASK]) are not legal. Refer to Table 29-2.

   To insert a canned fox message into a transmit string, type FOX inside of double parens, as follows: ((FOX)). Remember that the double parens are special characters produced by the [CTRL]-[9] and [CTRL]-[0] combinations. Constants, counters, and flags can also be embedded in a string. See Section 29, Strings.

10. *BCC*. There are three BCC options for every SEND action at Layer 2 SDLC. One of the options, GDBCC, is the default. Any frame that does not request

a bad BCC or an abort will have a good frame–check sequence calculated for it and appended to it. BCC also is an option for SEND actions at Layer 1; but it does not occur at Layer 3 or higher.

The three softkey selections for BCC are shown in Figure 35-25. A sixteen–bit CCITT frame check is selected automatically for BOP protocols and cannot be changed or disabled. A bad BCC will be CRC–16 instead of CCITT.

When ABORT is the BCC selection, instead of appending a proper frame check the transmitter will hold the lead at mark for eight bits (or longer if the transmitter is idling F). Inside of a frame, seven 1–bits in a row are sufficient to signal an abort.

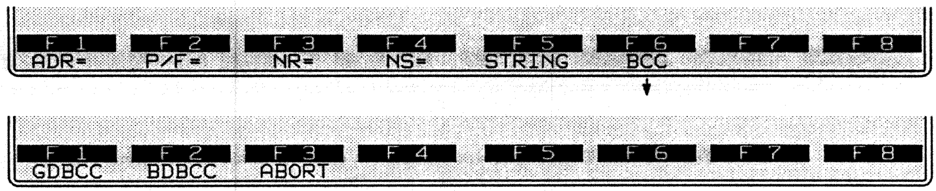


Figure 35-25 Type of BCC is a *SEND* option for frames at Layer 2.

(B) Give Data

GIVE_DATA is the F2 action on the first rack of action softkeys (refer to Figure 35-18). This action takes the I–field from a received INFO frame and passes it up to Layer 3 along with a DL_DATA IND primitive. (See Figure 30-5 in the section, OSI Primitives on the Protocol Spreadsheet.) In an emulate mode, data is delivered up to Layer 3 only by one of two actions at Layer 2: GIVE_DATA, or else a DL_DATA IND primitive followed by the data string.

(C) Resend

The RESEND function is mapped to F1 on the second layer of action softkeys at Layer 2 for SDLC. See Figure 35-26. A RESEND action will resend the first frame in the window. The window is a queue that buffers INFO frames for retransmission in case one or more transmissions are lost or in error.

The first frame in the window always is the *earliest outstanding* (unacknowledged) frame. Every time an acknowledgment is received, the window is cleared to the extent of the acknowledgment and a new "first–frame" position is established. The first RESEND after an acknowledgment always sends the first window frame.

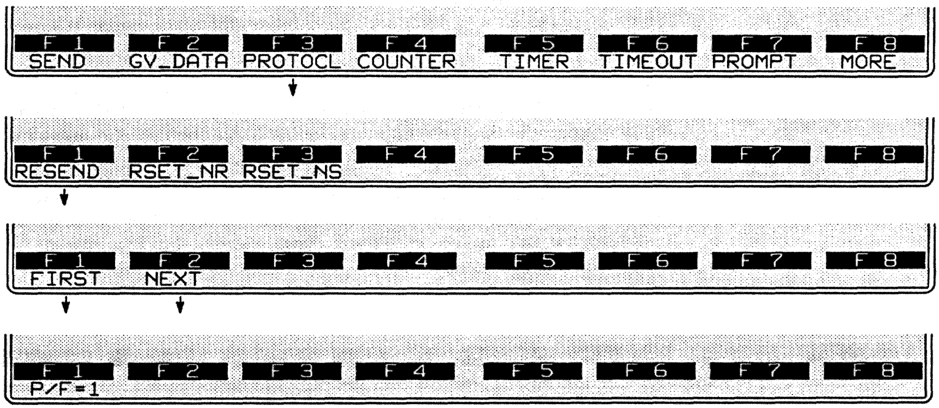


Figure 35-26 The *RESEND* action allows you to recover from sequence errors.

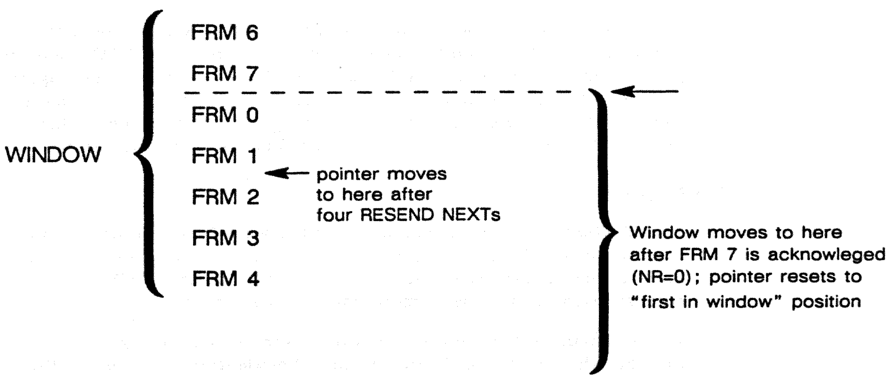


Figure 35-27 Resends cause the pointer to move, while acknowledgments move the pointer *and the entire window*.

The *second and subsequent* RESENDs following an acknowledgment also will send the first window frame, provided that the keyword FIRST is appended directly to the RESEND entry. Otherwise, they send the NEXT (second) and subsequent window frames. Figure 35-27 shows the position of the the resend "pointer" after four consecutive RESEND actions. RESEND NEXT is the default resend when neither FIRST nor NEXT is specified.

The resend-pointer is reset to the beginning of the window automatically by any acknowledgment, or by a RESEND FIRST action in the spreadsheet program.

1. *Resend first/next.* RESEND FIRST means that the resend-pointer is reset to the beginning of the window, the first frame in the window is resent, and the pointer is advanced to the second position in the window. The effect of a RESEND FIRST action is illustrated in Figure 35-28.

   The RESEND FIRST action makes it possible for you to resend all the frames in the window one by one, and then *resend them again* if necessary.

2. *P/F=1*

   The P/F bit in the resend-frame can be set to 1 by this optional action. (Default is 1 in a RESEND action.)

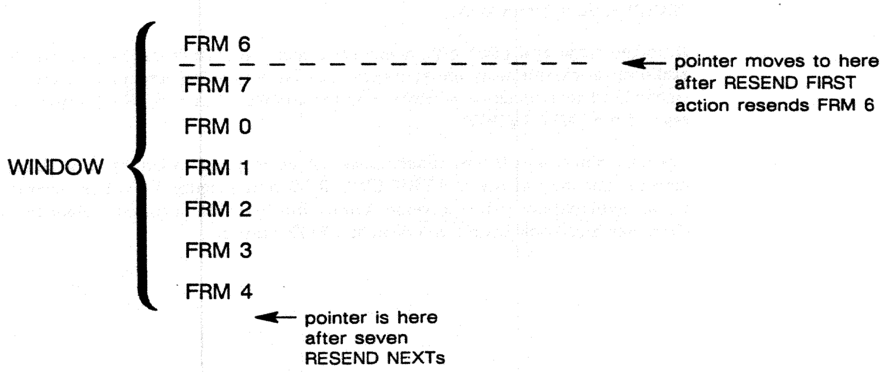


Figure 35-28 *RESEND FIRST* resets the pointer, allowing you to resend the entire window *repeatedly*.

(D) Reset N(R) and Reset N(S)

RESET_NR and RESET_NS are the [F2] and [F3] actions on the second rack of action softkeys for SDLC. (Refer to Figure 35-26.) The sequence-number fields in I-frames and supervisory frames can be reset by these two Protocol Spreadsheet actions. Sequence numbers are not reset *automatically* during a test by any frame that is sent or received.

RESET_NS also clears the transmit window.

35.6 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 2 protocol trace (see Section 35.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE, DCE, and RCV conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE, DCE, or RCV condition comes true at Layer 2, the frame that satisfied the condition can be enhanced on the SDLC protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—[F2] on the third rack of action softkeys. Figure 35-29 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

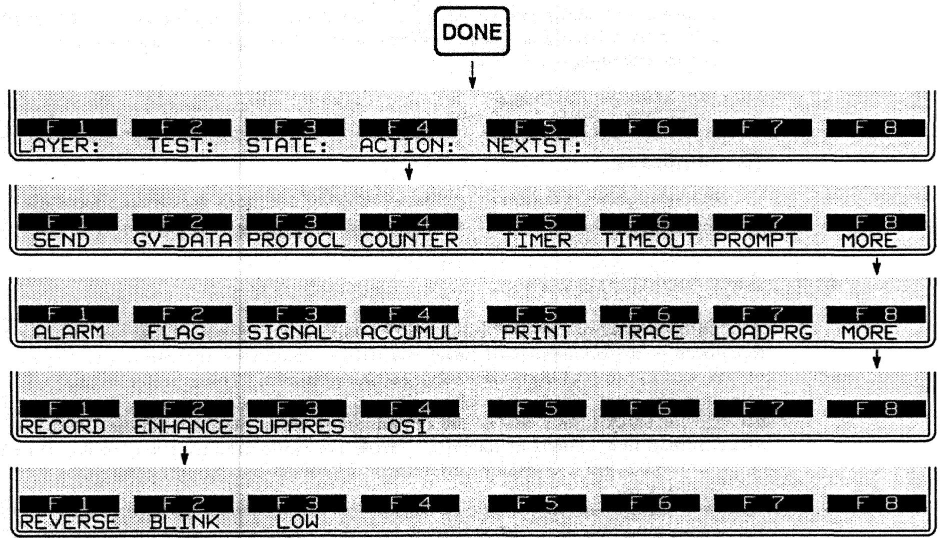


Figure 35-29 Selected frames on the protocol trace may be enhanced (or suppressed).

MON/LINE BLK=00000 S 04/21/89 22:22
EBCDIC/8/NONE/BOP

SRC	ADDR	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DTE	C1	INFO	7	3	0	0264	2220:06.206	G
DTE	C2	SNRM			1	0002	2220:06.230	G
DTE	C1	INFO	7	0	0	0011	2220:06.276	G
DTE	C1	INFO	7	1	0	0046	2220:06.441	G
DTE	C1	INFO	7	2	0	0236	2220:07.247	G
DTE	C1	INFO	7	3	0	0264	2220:08.151	G
DTE	C1	INFO	7	4	0	0264	2220:09.059	G
DTE	C1	INFO	7	5	0	0264	2220:09.976	G
DTE	C1	INFO	7	6	0	0136	2220:10.445	G
DTE	C1	RR	7		1	0002	2220:10.466	G
DCE	C1	INFO	7	7	1	0012	2220:10.788	G
DTE	C1	RR	0		1	0002	2220:10.812	G
DTE	C1	INFO	0	7	0	0015	2220:10.872	G
DTE	C1	INFO	0	0	0	0041	2220:11.021	G
DCE	C1	INFO	7	0	1	0011	2220:11.115	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
DATA	L2TRACE			STATS		NO DISP	

Figure 35-30 Set Normal Response Mode (SNRM) commands have been enhanced on the DTE side.

Figure 35-30 shows one screen of a Layer 2 protocol trace in which DTE SNRM frames have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE SNRM
ACTIONS: ENHANCE REVERSE

(B) Suppress

Individual frames that are suppressed in Layer 2 actions are deleted from the trace display. Figure 35-29 shows the softkey path to SUPPRES.

35.7 Automatic Primitives

A table in a previous section (Table 30-2) listed the OSI service primitives that are monitored at the boundaries of Layer 2 as trigger conditions and sent up to Layer 3 or down to Layer 1 as user-entered spreadsheet actions. These primitives are layer-specific rather than protocol-specific and are not part of the personality package for SDLC; but a few of the primitives are set in motion automatically by SDLC spreadsheet actions at Layer 2. These *automatic* primitives can be thought of as part of the Layer 2 actions themselves, and by extension as part of the SDLC protocol package.

Table 35-1 gives the set of SDLC actions that have action-primitives built into them. For example, whenever a GIVE_DATA action occurs at Layer 2, a DL_DATA IND primitive is forwarded to Layer 3, where a DL_DATA IND condition may be waiting to monitor it.

Whenever a SEND or RESEND action is initiated at Layer 2, a PH_DATA REQ primitive is sent downward along with the PH data (the entire frame).

If a SEND or RESEND action is triggered at Layer 2 while the physical connection at Layer 1 is inactive, Layer 2 will sense the absence of a physical connection and delay the PH_DATA REQ. Instead it will send a PH_ACTIVATE REQ primitive. Only when a PH_ACTIVATE CONF has been returned by Layer 1 will Layer 2 release the data and the data primitive.

NOTE: The RS-232 interface does not distinguish active/inactive status at the physical level. This interface returns PH_ACTIVATE CONF automatically whenever it sees PH_ACTIVATE REQ.

Table 35-1
Automatic Primitives Generated at Layer 2 SDLC

SDLC Layer 2 Action	Automatic Primitive	To Layer
GIVE_DATA	DL_DATA IND	3
SEND {TYPE}	(PH_ACTIVATE REQ*)	1
	PH_DATA REQ	1
RESEND	(PH_ACTIVATE REQ*)	1
	PH_DATA REQ	1

*Sent if Layer 1 shows inactive status. PH_DATA REQ delayed until PH_ACTIVATE CONF returned by Layer 1.

36 SNA

```
                          ** Layer Setup **

                                     Selections        Packages Loaded
DRIVE: HRD   Layer 1 Package: NO PACKAGE        NO PACKAGE
DRIVE: FD1   Layer 2 Package: SNA               NO PACKAGE
DRIVE: HRD   Layer 3 Package: NO PACKAGE        NO PACKAGE
DRIVE: HRD   Layer 4 Package: NO PACKAGE        NO PACKAGE
DRIVE: HRD   Layer 5 Package: NO PACKAGE        NO PACKAGE
DRIVE: HRD   Layer 6 Package: NO PACKAGE        NO PACKAGE
DRIVE: HRD   Layer 7 Package: NO PACKAGE        NO PACKAGE



Depress XEQ Key To Load The Selected Packages
Select Layer
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4  LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 36-1 The *SNA* personality package for Layer 2 is loaded from the Layer Setup screen.

```
                 ** SNA/SDLC Frame Level Setup **


Idle Timeout:           1.Ø sec
Emulate:                 PRIMARY
Mode of operation:      MOD 8
Window size:            7
Using LU 6.2?           NO
Host Port:              DCE






Using LU 6.2?
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
  NO       YES
```

Figure 36-2 Protocol Configuration screen for SNA.

36 SNA

SNA is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 36-1 shows the Layer Setup screen configured to load in the SNA package from floppy-disk drive #1. Refer to Section 6 for details on operating the Layer Setup screen.

The SNA package consists of the following:

- A special SNA Frame Level Setup screen that controls certain parameters when the unit is emulating SDLC or tracing SNA and SDLC.
- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate SDLC programming. *This is the same set of conditions and actions that is documented in Section 35 of this manual.* Refer to Section 35 for a discussion of the spreadsheet conditions and actions that are specific to the SDLC and SNA layer-2 packages.
- A protocol trace (illustrated in Figure 36-3) that distills from SNA data the SDLC and SNA events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

36.1 Frame-Level Setup

The parameters on the SNA Frame Level Setup screen must be configured correctly for an accurate trace display and for proper emulation.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the SNA selection at Layer 2: **SNA** should appear in the **Packages Loaded** column. Press F8 (labeled PROTSEL) to bring up a prompt to **Select Protocol Configuration Screen**. Then press F2 (LAYER-2) to call up the SNA Frame Level Setup screen.

The six parameter fields on this screen are shown in Figure 36-2. **Idle Timeout, Emulate, Mode of Operation,** and **Window Size** are covered in Section 35.1 and will not be discussed here.

Using LU 6.2? allows you to set up the SNA trace to monitor LU 6.2 sessions correctly. The default selection in this field is NO.

Selection of DTE or DCE in the **Host Port** field allows the SNA protocol trace to distinguish properly between two kinds of FMD headers—NS headers and FM headers—in SNA Request Units.

36.2 SDLC Conditions and Actions

The same set of special conditions and actions documented for the SDLC Layer 2 package is implemented on the Protocol Spreadsheet in SNA. Refer to subsections 35.3 through 35.7.

36.3 Protocol Trace

The SNA package includes an automatic real-time trace that summarizes link-level, TH, RH, and RU activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE ([F2] on the primary rack of display-mode softkeys) to bring the protocol trace for SNA to the screen. Figure 36-3 is an example of this trace display. Each horizontal row in the trace represents a frame.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds sixteen lines—one full page—of newer trace data to the frozen trace screen. Depression of [PREV PAGE] adds sixteen lines of older data.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

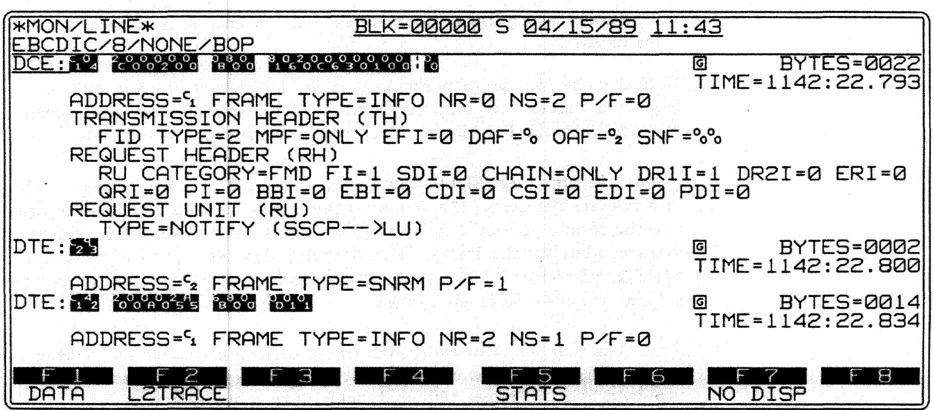


Figure 36-3 Each *DTE* or *DCE* entry on the SNA trace marks the beginning of a frame.

(B) Trace Fields Common to All Frames

1. *Source*. On the initial line in each frame expansion, the source of the frame (DTE or DCE) is identified. This is the only field on the frame-trace that begins at the left border of the screen, and it acts as a visible separator of frame expansions that take up varying amounts of display space. Note on the screen in Figure 36-3 that two whole frame expansions and part of a third are presented.

   In the leftmost ("Source") column in the trace, DCE is always underlined.

2. *Character data*. Character data decoded in hexadecimal is presented in reverse video immediately following the source field. See Figure 36-3. Character data is presented in blocks separated by spaces. These blocks correspond to the following protocol fields:

   - Frame header
   - Transmission header (TH)
   - Request/response header (RH)
   - Request/response unit (RU)

   When an individual block is longer than ten bytes, another separator is used: the vertical bar (⁝). Bars occur after every ten bytes within a block. Note the bar in the RU block of the DCE frame at the top of Figure 36-3.

The hex-character display does not exceed two lines on the trace, or 70 bytes of RU.

Note that the four protocol blocks may not be present in every unit. Non-Info frames have only the frame header. Middle- and last-segment messages lack the RH block. Many response messages lack the RU.

3. *Frame checking*. An SDLC frame ends as soon as a FE flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC field on the first trace line for the frame. The symbol [G] denotes a good frame check, while [B] symbolizes a bad frame. [A] for abort is posted to the displays when a frame is ended by seven 1-bits.

4. *Size*. The number of bytes in each frame is given in the BYTES= field in four decimal digits. The count begins with the address byte and excludes the two-byte FCS. Frames without I-fields show a byte-count of two.

5. *Time*. The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks: ON** is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display are the original times and will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks: OFF** was selected instead during live recording, times on the trace during playback will reflect the current "clock on the wall" and will be influenced by conditions such as playback speed, idle suppression, etc.

6. *Address*. The address byte is given as a hexadecimal character (from 00 to FF) in the ADDRESS= field.

7. *Frame type*. The mnemonic (abbreviated) name for the frame type is given in the FRAME TYPE= field.

8. *P/F*. The status of the poll or the final bit is given in the P/F= field.

(C) Other Trace Fields

Most of the fields on the SNA trace are not common to all frames, but are specific to the type of frame (Info, for example), FID type, request messages, response messages, RU type, and so forth. These fields are included in Table 36-1.

Table 36-1

Fields in SNA Trace Display

Mnemonic	Name	Data Columns: # cols in field	Data Columns: value each column	Meaning
Frame header				
(SOURCE=)			ASCII	DTE, DCE
(BCC=)		1	symbol	G, B, A
BYTES=		4	0-9	
TIME=		9	0-9	time of end of frame, given as hhmm:ss.mmm
ADDRESS=		1	$^{0}_{0}-^{F}_{F}$	
FRAME TYPE=			ASCII	SNRM, INFO, etc.
NR= (mod 8)	number (next) receive frame	1	0-F	present only if frame type=info, rr, rnr, rej, or srej
NR= (mod 128)	number (next) receive frame	2	0-F	present only if frame type=info, rr, rnr, rej, or srej
NS= (mod 8)	number (frame) sent	1	0-F	present only if frame type=info
NS= (mod 128)	number (frame) sent	2	0-F	present only if frame type=info
P/F=	poll/final	1	0-1	
Transmission header, FID 0 or 1				
FID TYPE=0, 1	format identifier			10-byte th
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
DAF=	destination address field	2	$^{0}_{0}-^{F}_{F}$	
OAF=	origin address field	2	$^{0}_{0}-^{F}_{F}$	
SNF=	sequence number field	2	$^{0}_{0}-^{F}_{F}$	
DCF=	data count field	2	$^{0}_{0}-^{F}_{F}$	
Transmission header, FID 2				
FID TYPE=2	format identifier			6-byte th
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
DAF=	destination address field	1	$^{0}_{0}-^{F}_{F}$	
OAF=	origin address field	1	$^{0}_{0}-^{F}_{F}$	
SNF=	sequence number field	2	$^{0}_{0}-^{F}_{F}$	
Transmission header, FID 3				
FID TYPE=3	format identifier			2-byte th
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
SESSION=			ASCII	SSCP-PU, SSCP-LU, RESERVD, LU-LU
LAF=	local address field	6	0-1	

Table 36-1 (continued)

Mnemonic	Name	Data Columns *# cols in field*	 *value each column*	Meaning
Transmission header, FID 4				
FID TYPE=4	format identifier			26-byte th
TGSI=	transmission group sweep indicator	1	0-1	1=piu order maintained in tg
VRSI=	er & vr support indicator	1	0-1	1=one or more nodes does not support er, vr
VRPCI=	virtual route pacing count indicator	1	0-1	0=vr pacing count not equal to zero
NP=	network priority	1	0-1	1=piu flows at network priority, not tpf
IERN=	initial explicit route number	1	0-F	same as vrn
ERN=	explicit route number	1	0-F	ern + vrn + tpf = vrid
VRN=	virtual route number	1	0-F	
TPF=	transmission priority field	1	0-3	0=low 1=medium 2=high
VRCWI=	vr change window indicator	1	0-1	0=increment 1=decrement
TGNFI=	tg non-fifo indicator	1	0-1	0=tg fifo required
VRSTI=	vr sequence & type indicator	1	0-3	0=nonseq, nonsupv 1=nonseq, supv 2=singly seq
TGSNF=	tg sequence number field	3	0-F	used when tgnfi=0
VRPRQ=	virtual route pacing request	1	0-1	1=vr pacing response requested
VRPRS=	virtual route pacing response	1	0-1	1=vr pacing response sent in response to vrprq=1
VRCWRI=	vr change window reply indicator	1	0-1	when vrprs=1, 0=increment 1=decrement
VRRWI=	virtual route reset window indicator	1	0-1	0=do not reset 1=reset window to minimum size
VRSSN=	virtual route send sequence number	3	0-F	piu sequencing for vrsti=2
DSAF=	destination subarea address field	4	$^{0}{}_{0}-{}^{F}{}_{F}$	dsaf + osaf + vrn = vr
OSAF=	origin subarea address field	4	$^{0}{}_{0}-{}^{F}{}_{F}$	
SNAI=	sna indicator	1	0-1	0=destination is non-sna device, convert to fid 0
MPF=	mapping field		ASCII	MIDDL, LAST, FIRST, ONLY
EFI=	expedited flow indicator	1	0-1	0=normal 1=expedited
DEF=	destination element field	2	$^{0}{}_{0}-{}^{F}{}_{F}$	dsaf + def = destination network address
OEF=	origin element field	2	$^{0}{}_{0}-{}^{F}{}_{F}$	osaf + oef = origin network address
SNF=	sequence number field	2	$^{0}{}_{0}-{}^{F}{}_{F}$	biu sequence number, segments have same snf
DCF=	data count field	2	$^{0}{}_{0}-{}^{F}{}_{F}$	biu or biu segment length for piu blocking
Transmission header, FID F				
FID TYPE=F	format identifier			26-byte th
CF=	command format	1	$^{0}{}_{0}-{}^{F}{}_{F}$	$^{0}{}_{1}$
CT=	command type	1	$^{0}{}_{0}-{}^{F}{}_{F}$	$^{0}{}_{1}$=t6 snf wrap acknowledgment
CSN=	command sequence number	2	$^{0}{}_{0}-{}^{F}{}_{F}$	
DCN=	data count number	2	$^{0}{}_{0}-{}^{F}{}_{F}$	

Table 36-1 (continued)

Mnemonic	Name	Data Columns # cols in field	Data Columns value each column	Meaning
Request header				
RU CATEGORY=			ASCII	FMD, NC, DFC, SC
FI=	format indicator	1	0-1	ru category=fmd, lu-lu session: 1=fm header follows ru category=fmd, sscp session: 0=character-coded ru 1=field-formatted ru ru category=nc, dfc, sc: fi always = 1
SDI=	sense data indicator	1	0-1	1=sense data included
CHAIN=			ASCII	MIDDL, LAST, FIRST, ONLY
DR1I=	definite response 1 indicator	1	0-1	0=no response requested (but may be requested by dr2i) 1=response requested
DR2I=	definite response 2 indicator	1	0-1	0=no response requested (but may be requested by dr1i) 1=response requested
ERI=	exception response indicator	1	0-1	if response requested by dr1i or dr2i 0=definite response 1=exception response
QRI=	queued response indicator	1	0-1	0=bypass tc queues
PI=	pacing indicator	1	0-1	1=pacing request
BBI=	begin bracket indicator	1	0-1	1=begin bracket
EBI=	end bracket indicator	1	0-1	configured for non-LU 6.2 (see Sec. 36.1), 1=end bracket
CDI=	change direction indicator	1	0-1	1=change direction
CSI=	code selection indicator	1	0-1	0=code 0 1=code 1
EDI=	enciphered data indicator	1	0-1	1=ru is enciphered
PDI=	padded data indicator	1	0-1	1=ru was padded before encipherment
CEBI=	conditional end bracket indicator	1	0-1	configured for lu 6.2, 1=conditional end bracket
Response header				
RU CATEGORY=			ASCII	FMD, NC, DFC, SC
FI=	format indicator	1	0-1	ru category=fmd, lu-lu session: 1=fm header follows ru category=fmd, sscp session: 0=character-coded ru 1=field-formatted ru ru category=nc, dfc, sc: fi always = 1
SDI=	sense data indicator	1	0-1	1=sense data included
CHAIN=			ASCII	ONLY
DR1I=	definite response 1 indicator	1	0-1	1=dr1i response
DR2I=	definite response 2 indicator	1	0-1	1=dr2i response
RTI=	response type indicator	1	0-1	0=positive response 1=negative response
QRI=	queued response indicator	1	0-1	0=response bypasses tc queues 1=enqueue response in tc queues
PI=	pacing indicator	1	0-1	1=pacing response

Table 36-1 (continued)

Mnemonic Name	Data Columns: *# cols in field*	Data Columns: *value each column*	Meaning
Request unit			
(REQUEST CODE=)		ASCII	ACTLU, BIND, etc. (present if ru category=nc, dfc, or sc)
(FMD NS HEADER=)		ASCII	CONTACT, NOTIFY, etc. (sscp session only: present if ru category=fmd and fi=1)
(FM HEADER) TYPE=	1	0–9	lu-lu session only: present if ru category=fmd and fi=1
(BIND TYPE=)		ASCII	NEGOTIABLE, NONNEGOTIABLE (this field and remaining request-unit fields present only if request code=bind)
FM PROFILE =	1	$^{0}_{0}$–$^{F}_{F}$	
TS PROFILE=	1	$^{0}_{0}$–$^{F}_{F}$	
FM USAGE PRIMARY LU PROTOCOLS FOR FM DATA=	1	$^{0}_{0}$–$^{F}_{F}$	
FM USAGE SECONDARY LU PROTOCOLS FOR FM DATA=	1	$^{0}_{0}$–$^{F}_{F}$	
FM USAGE COMMON LU PROTOCOLS=	2	$^{0}_{0}$–$^{F}_{F}$	
TS USAGE=	6	$^{0}_{0}$–$^{F}_{F}$	
MAX RU FROM SLU=	6	0–9, UNKNOWN	
MAX RU FROM PLU=	6	0–9, UNKNOWN	
PS PROFILE=	1	$^{0}_{0}$–$^{F}_{F}$	
PS CHARACTERISTICS	11	$^{0}_{0}$–$^{F}_{F}$	
USER COUNT	1	$^{0}_{0}$–$^{F}_{F}$	length of user data in bind ru
Response unit			
(REQUEST CODE=)		ASCII	ACTLU, BIND, etc. (present if ru category=nc, dfc, or sc)
(FMD NS HEADER=)		ASCII	ADDLINK, CDINIT, etc. (present if ru category=fmd and fi=1)
SENSE DATA=	4	$^{0}_{0}$–$^{F}_{F}$	this and the following 3 fields present only if sdi=1
CATEGORY=		ASCII	USER SENSE DATA ONLY, REQUEST REJECT, REQUEST ERROR, STATE ERROR, RH USAGE ERROR, PATH ERROR
MODIFIER=	1	$^{0}_{0}$–$^{F}_{F}$	
SENSE INFORMATION=	2	$^{0}_{0}$–$^{F}_{F}$	

37 DDCMP Layer 1

DDCMP is a "layer personality package" of functions loaded into memory from disk via the Layer Setup screen. Figure 37-1 shows the Layer Setup screen with the DDCMP package loaded in from the hard-disk drive. Refer to Section 6 for information on operating the Layer Setup screen.

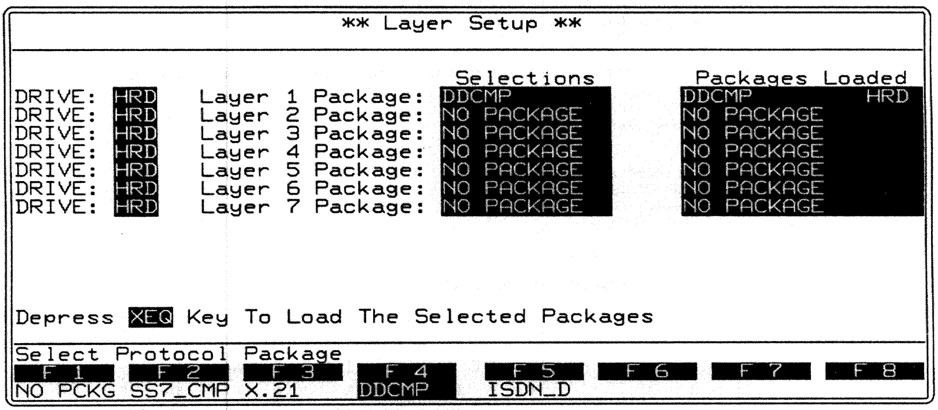


Figure 37-1 DDCMP is a "layer-personality package" of softkey functions at Layer 1.

The DDCMP package takes control of two functions that normally are configured by the user on the Line Setup menu: outsync and block checking. Control of these functions from the Line Setup menu is disabled when the DDCMP package is loaded in.

37.1 Outsync

In synchronous format, the sync pattern is selectable by the user in the Sync Char field on the Line Setup menu. Outsync parameters are not selectable. Outsync cannot be turned off. A receiver will go out of sync at the end of a message unless the first byte of the new message is $^{S}_{H}$, $^{E}_{Q}$, or $^{D}_{L}$ with the correct parity.

37.2 Block Checking

Screen display of good and bad BCCs is automatic when DDCMP is loaded in at Layer 1, and cannot be disabled on the Line Setup screen. The BCC setup for DDCMP cannot be modified or controlled in any way from the BCC Setup menu.

The results of both header and data block checks are displayed on the screen. If you want your program to detect good or bad BCCs, you may use the BCC selections on the trigger menus and at Layer 1 of the Protocol Spreadsheet to interrogate the header block check only.

If you want to detect a good or bad data block check, you must use one of the following C event variables:

```
extern fast_event fevar_gd_bcc2_td;
extern fast_event fevar_gd_bcc2_rd;
extern fast_event fevar_bd_bcc2_td;
extern fast_event fevar_bd_bcc2_rd;
```

Here is a program that counts bad DTE BCCs for both header and data:

```
{
   extern fast_event fevar_bd_bcc2_td;
}
LAYER: 1
   STATE: count_all_bad_dte_bccs
      CONDITIONS: DTE BAD_BCC
      ACTIONS: COUNTER t_bdbcc INC
      CONDITIONS:
      {
         fevar_bd_bcc2_td
      }
      ACTIONS: COUNTER t_bdbcc INC
```

Note to C programmers: the DDCMP Layer 1 package takes every message and places it in an IL buffer for use at Layer 2 and above. At the same time, it triggers the event *m_lo_ph_prmtv* and updates the variables associated with upward-going monitor-path primitives at Layer 2 (see Table 63-3). As a result, the OSI condition PH_TD_DATA IND (or PH_RD_DATA IND) comes true at Layer 2.

38 ISDN D Channel

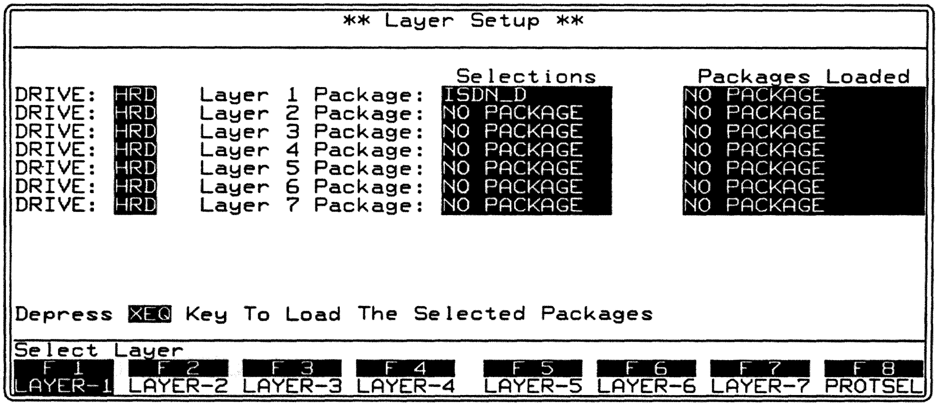


Figure 38-1 The ISDN_D personality package is loaded from the Layer Setup screen.

38 ISDN D Channel

The Basic Rate ISDN service provides an aggregate data rate of 192 Kbps, with 144 Kbps available to users: two 64 Kbps B-channels and one 16 Kbps D-channel per interface (2B+D). The additional 48 Kbps are used for framing and maintenance. The INTERVIEW 7000 Series, with the ISDN TIM and its multiplexer board in place (OPT-951-15-1 or OPT-951-15-2), supports Basic Rate ISDN testing. (See Section 48.) Primary Rate ISDN data is carried over T1 (Section 49) and G.703 (Section 50) circuits.

ISDN_D is a "layer personality package" of functions loaded into memory from disk at Layer 1 via the Layer Setup screen. Figure 38-1 shows the Layer Setup screen configured to load in the ISDN_D package from the hard drive. Refer to Section 6 for information on operating the Layer Setup screen.

The ISDN_D package consists of a set of three C-language event variables and two C routines (see Section 76). These variables and routines allow the C programmer to construct Q.921 (LAPD) and Q.931 functions for use on the D channel. The ISDN trace application package (available as OPT-951-35) is built upon the D-channel variables and routines provided at Layer 1 by the ISDN_D package.

The ISDN_D layer package allows the user to send, receive, and monitor frames on the D channel via an application program written in C. Meanwhile, the line setup, data display, and layer packages can be focused on channel B1 or B2, whichever is selected on the ISDN Interface Setup menu (Section 48.5). For Primary Rate ISDN in T1 or G.703, the ISDN_D layer package is also loaded at Layer 1 for the same use on the D channel as in Basic Rate ISDN; the B channel is selectable on their respective Interface Control screens.

> **NOTE:** The ISDN_D package should *not* be loaded when the D channel is selected for single-channel monitoring or emulating; that is, when the D channel is selected in the **Channel:** field on the ISDN Interface Setup menu.

39 LAPD

```
                              ** Layer Setup **

                                      Selections              Packages Loaded
DRIVE: HRD    Layer 1 Package:  NO PACKAGE             NO PACKAGE
DRIVE: FD2    Layer 2 Package:  LAPD                   SDLC                 FD1
DRIVE: FD2    Layer 3 Package:  X.25                   NO PACKAGE
DRIVE: HRD    Layer 4 Package:  NO PACKAGE             NO PACKAGE
DRIVE: HRD    Layer 5 Package:  NO PACKAGE             NO PACKAGE
DRIVE: HRD    Layer 6 Package:  NO PACKAGE             NO PACKAGE
DRIVE: HRD    Layer 7 Package:  NO PACKAGE             NO PACKAGE



Depress XEQ Key To Load The Selected Packages
Select Layer
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4  LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 39-1 The LAPD personality package is loaded from the Layer Setup screen.

```
                        ** LAPD Frame Level Setup **

T1 (for INFO frame):   1.0 sec
Emulate:               LOGICAL DTE
Mode of operation:     MOD 128
Window size:           127




Select Frame Sequencing Modulus
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
 MOD 8   MOD 128
```

Figure 39-2 Protocol Configuration screen for LAPD.

39 LAPD

LAPD is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 39-1 shows the Layer Setup screen configured to load in the Layer 2 LAPD package from floppy-disk drive #2. Refer to Section 6 for details on operating the Layer Setup screen.

The LAPD package consists of the following:

- A special LAPD Frame Level Setup screen that controls certain parameters when the unit is tracing or emulating LAPD.

- A protocol trace (illustrated in Figure 39-3) that distills from LAPD data the Level 2 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate LAPD programming. Figure 39-5 shows the softkey path to the first rack of condition softkeys when the LAPD package is loaded in at Layer 2.

39.1 Frame-Level Setup

The parameters on the LAPD Frame Level Setup screen must be configured correctly for an accurate trace display and for proper emulation.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the LAPD selection at Layer 2: **LAPD** should appear in the **Packages Loaded** column. Press F8 (labeled **PROTSEL**) to bring up a prompt to **Select Protocol Configuration Screen**. Then press F2 (**LAYER-2**) to call up the LAPD Frame Level Setup screen.

The four parameter fields on this screen are shown in Figure 39-2. **T1**, **Emulate**, and **Window Size** apply to interactive (emulate) tests only. **Mode of Operation** must be configured correctly for the protocol trace as well as for proper emulation.

(A) T1

Enter a four-digit (including decimal point) T1 timeout value in this field. The largest valid entry is 65.5 seconds. The smallest entry is .001 second, or 1 millisecond.

T1 is the name given to the retransmission timer for INFO frames. When a value is entered in the **T1** field on this menu, the layer 2 package will handle T1 timings correctly, as follows:

- Whenever the INTERVIEW sends an I-frame at Layer 2 and *there are no previous frames sent by the INTERVIEW currently outstanding (unacknowledged)*, the timer starts timing down from the value entered on the Frame Level Setup screen.
- An acknowledgment by the device under test of the most recent frame transmitted by the INTERVIEW *stops* the timer (so that it does not expire).
- An acknowledgment by the device under test of a frame that is not the most recent frame transmitted by the INTERVIEW—an "incomplete" acknowledgment—restarts the T1 timer to the value selected on the configuration screen.

Expiration of this Frame Level Setup timeout can only be detected by a T1_EXPIRED condition on the Protocol Spreadsheet at Layer 2. This particular timeout cannot be detected by a generic condition of TIMEOUT T1.

According to the protocol, a T1_EXPIRED condition should result in a RESEND action.

(B) Emulate Logical DTE/DCE

There are two selections in the **Emulate** field on the LAPD Frame Level Setup screen, LOGICAL DTE and LOGICAL DCE. Usually a logical DTE represents the user side of a link and a logical DCE is the network side of the link.

Use the **Mode** selection (EMULATE DTE or EMULATE DCE) on the Line Setup menu to regulate the *physical* interface—whether to use pin 2 or pin 3 to transmit, and so on.

(C) Mode of Operation

The **Mode of Operation** field refers to the mode of numbering INFO and supervisory frames. There are two options, MOD 8 and MOD 128.

MOD 8 uses sequence numbers 0-7. MOD 128 adds an extra byte to the control field in INFO, RR, RNR , and REJ frames. See Figure 39-4. This extra byte allows sequence numbers in a range of 0-127.

The correct "modulus" must be selected in this field in order to program successfully in Monitor mode and also to generate an accurate LAPD trace.

(D) Window Size

Any window size may be entered up to the current modulus minus one: 7 or 127. The window size is the maximum number of unacknowledged I-frames that Layer 2 will buffer for retransmission. When the limit is reached, any further INFO frames that are named in SEND actions triggered at Layer 2 will be passed to Layer 1 for transmission but not buffered for retransmission.

The window is a queue that buffers frames for retransmission in case one or more transmissions are lost or in error. A RESEND action will resend the first (earliest) frame in the window. Successive RESENDs will send successive frames until there are no more frames to resend; or until the window is reset by an acknowledgment or by a RESEND FIRST action.

39.2 Protocol Trace

The LAPD package includes an automatic frame-trace display that summarizes link-level activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE to bring the protocol trace for LAPD to the screen. (If the Q.931 package for Layer 3 is also loaded in, the L2TRACE softkey will appear after you have pressed PROTOCL, [F2] on the primary rack of display-mode softkeys.)

Figure 39-3 is an example of the Layer 2 trace display. Each horizontal row in the trace represents a frame.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

MON/LINE BLK=00000 S 06/23/89 09:15
ASCII/8/NONE/BOP

SRC	SAPI	TEI	C/R	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	04	1A	1	DISC			0	0003	0915:08.021	G
DTE	04	1A	1	UA			0	0003	0915:08.172	G
DTE	04	1A	0	SABM			1	0003	0915:08.212	G
DCE	04	1A	0	UA			1	0003	0915:08.440	G
DTE	04	1A	0	INFO	0	0	0	0007	0915:08.482	G
DCE	04	1A	1	INFO	0	0	0	0008	0915:08.723	G
DTE	04	1A	1	RR	1		0	0003	0915:08.842	G
DCE	04	1A	0	RR	1		0	0003	0915:08.915	G
DTE	04	1A	0	INFO	1	1	0	0019	0915:08.916	G
DCE	04	1A	0	RR	2		0	0003	0915:08.959	G
DCE	04	1A	1	INFO	2	1	0	0006	0915:09.033	G
DTE	04	1A	1	RR	2		0	0003	0915:09.362	G
DCE	04	1A	1	INFO	2	2	0	0018	0915:09.505	G
DTE	04	1A	1	RR	3		0	0003	0915:09.667	G
DTE	04	1A	0	INFO	3	2	0	0006	0915:09.747	G

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
L2TRACE	L3TRACE						

Figure 39-3 Each horizontal row on the trace display represents a frame.

(B) Trace Columns

The columns in the protocol trace for Layer 2 LAPD are explained below.

1. *Source*. The **SRC** column identifies the lead on which the frame was monitored, TD (DTE) or RD (DCE). This column identifies the *physical* source of the frame, not the *logical* source. The physical DTE uses the TD lead to transmit. The physical DCE uses RD to transmit.

   Just as on the data display, RD data is underlined.

2. *SAPI*. The Service Access Point Identifier (**SAPI**) is given in the next column. The SAPI is a network link-station address that appears in a six-bit field in the first frame-address byte: see Figure 39-4.

   The SAPI is presented on the trace display as two hex digits, with the righthand digit expressing the four low-order bits of the SAPI and the lefthand digit expressing the two remaining bits.

3. *TEI*. The Terminal Endpoint Identifier (**TEI**) is the address of a link station on the user side. It occupies seven bits in the second frame byte inside the leading flag (see Figure 39-4).

   The TEI is presented on the trace display as two hex digits, with the righthand digit expressing the four low-order bits of the TEI and the lefthand digit expressing the three remaining bits.

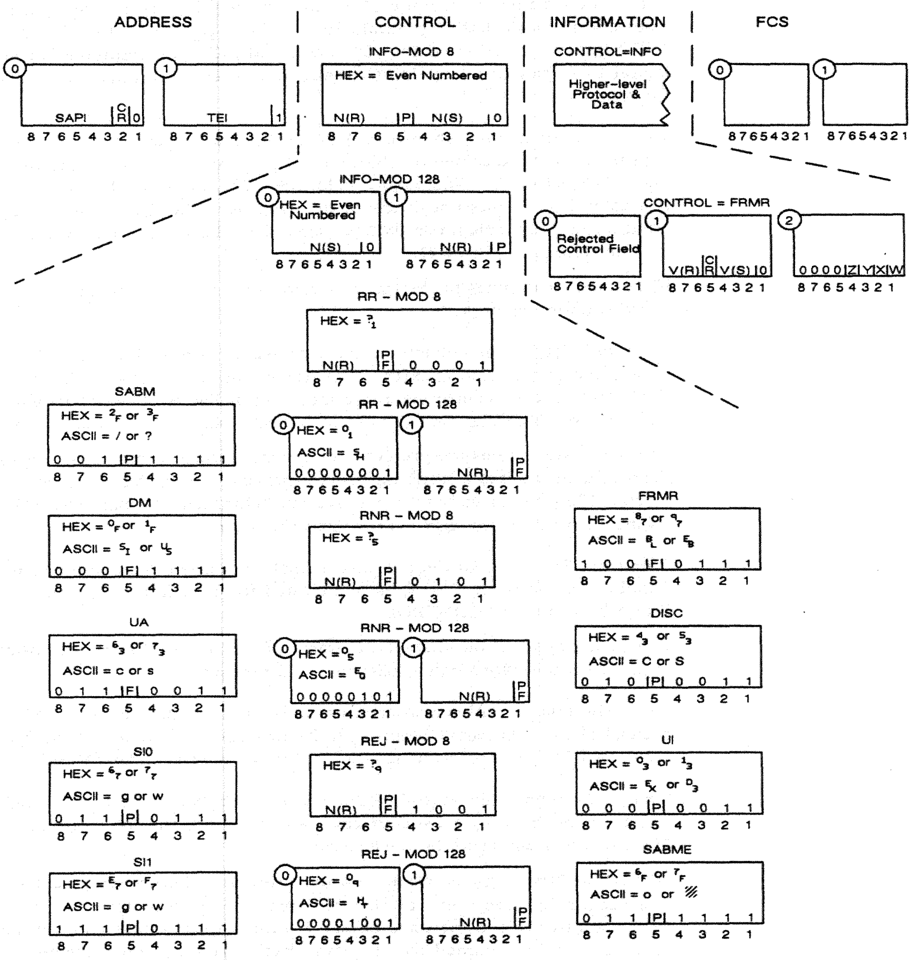


Figure 39-4 Frame fields in LAPD.

4. *C/R*. The Command/Response (**C/R**) column identifies the logical DTE (user side) and the logical DCE (network side). The logical DTE uses C/R 0 for INFO frames and other command frames, and C/R 1 for responses. The logical DCE uses C/R 1 for INFO frames and other commands, and C/R 0 for responses.

5. *Type*. The mnemonic (abbreviated) names for thirteen frame types as they appear in the **TYPE** column of the protocol trace are shown in Figure 39-4 under "CONTROL." The control field, therefore, indicates the frame type. If a control octet does not fit any of the patterns in the figure, the frame is listed in the **TYPE** column as UNKWN followed by the hexadecimal value of the control byte: UNKWN=47.

   If the number of bytes in the frame is below the required minimum, the frame is posted as INVALID.

6. *N(R) and N(S)*. One column on the frame-level trace is devoted to N(R) values, and one column to N(S). The frame types that include N(R) or N(S) fields in their control fields are indicated in Figure 39-4. N(R) and N(S) occupy three bits each in modulo 8, seven bits each in modulo 128.

   N(R) and N(S) values are presented in decimal format in modulo-8 traces. Each column displays a single digit that represents a 3-bit binary value. For modulo 128, the values $^{0}_{0}$ to $^{7}_{F}$ are given in "character" format, where the columns contain a two-digit hexadecimal character.

7. *P and F*. The status of the poll or the final bit is given in the **P/F** column. Whether this bit is the P or F bit is indicated for most frame types in Figure 39-4 (under "CONTROL").

   The setting of the P bit in an INFO frame often denotes the retransmission of an unacknowledged frame following a T1 timeout.

8. *Size*. The number of bytes in each frame is given in this column in four decimal digits. The count begins with the first address byte and excludes the two-byte FCS. Frames without I-fields show a count of three (MOD 8).

9. *Time*. The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks: ON** is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display are the original values and will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks: OFF** was selected instead during live recording, times on the trace during playback will be "wall time" and will be influenced by local conditions such as playback speed, idle suppression, etc.

10. *Frame Checking*. A LAPD frame ends as soon as a 7E flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

A for abort is posted to the displays when a frame is ended by seven 1-bits.

39.3 Monitor Conditions

When the LAPD personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 2. See Figure 39-5.

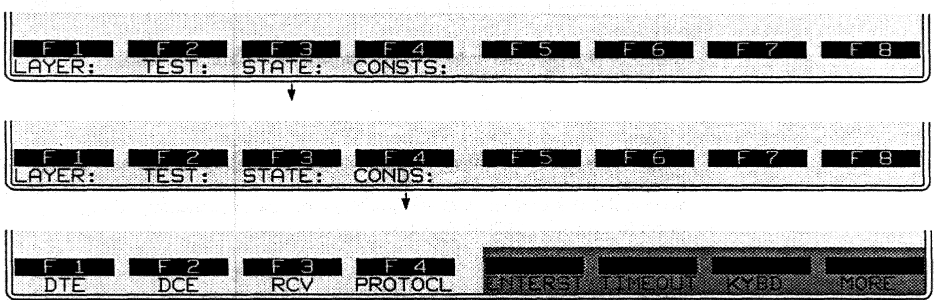


Figure 39-5 The softkeys for *DTE* and *DCE* are used to monitor LAPD protocol events at Layer 2.

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represent *types* of frames: INFO, SABM, UA, and so forth.

(A) Frame Types

The softkeys for INFO, supervisory, unnumbered, sequenced information, and "other" frames are illustrated in Figure 39-6. Press a softkey to write one of these frame types to the Layer 2 spreadsheet. DTE or DCE followed by a frame-type mnemonic—DTE INFO, for example, or DCE SABM—is a complete condition and will come true if a matching frame is monitored. SAPI, TEI, C/R, poll/final, and BCC conditions may be appended to the simple frame mnemonic, but they are optional.

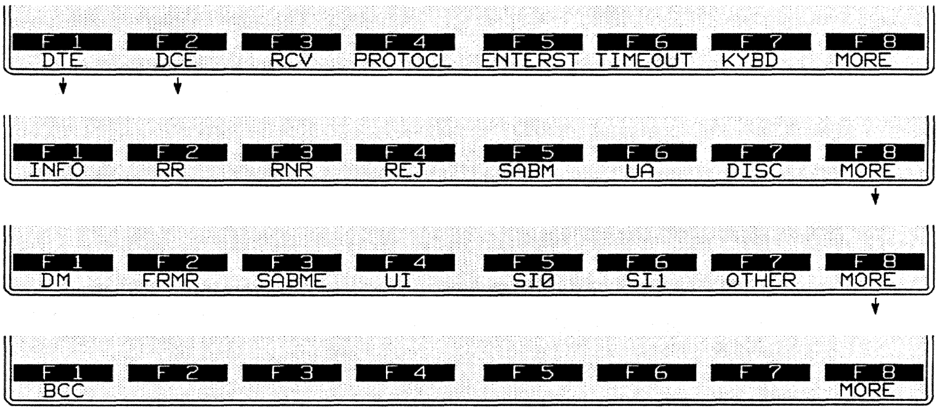


Figure 39-6 Frame type or block-check type may be specified as a complete condition for *DTE* or *DCE*.

1. *Info frames*. INFO frames differ for MOD 8 and MOD 128 numbering schemes. (See Figure 39-4.) For spreadsheet conditions to match I-frames accurately, the correct numbering system (**Mode of Operation**) should be selected on the LAPD Frame Level Setup screen.

2. *Supervisory frames*. The three supervisory–frame types that can be searched for on the data leads are RR (Receive Ready), RNR (Receive Not Ready), and REJect. These frames always contain N(R) fields (see Figure 39-4) and serve mainly to acknowledge or reject INFO frames.

   Like INFO frames, supervisory frames are constructed differently according to the numbering scheme, MOD 8 or MOD 128.

3. *Unnumbered frames*. Unnumbered frames generally assist in link–setup and takedown.

4. *Sequenced information frames*. Sequenced information frames (SI0 and SI1) have a 1–bit sequence–numbering field that toggles 0 (SI0) and 1 (SI1). (See Figure 39-4.) These frames are used instead of INFO frames in MOD 2 operation where the limit for outstanding information frames is 1.

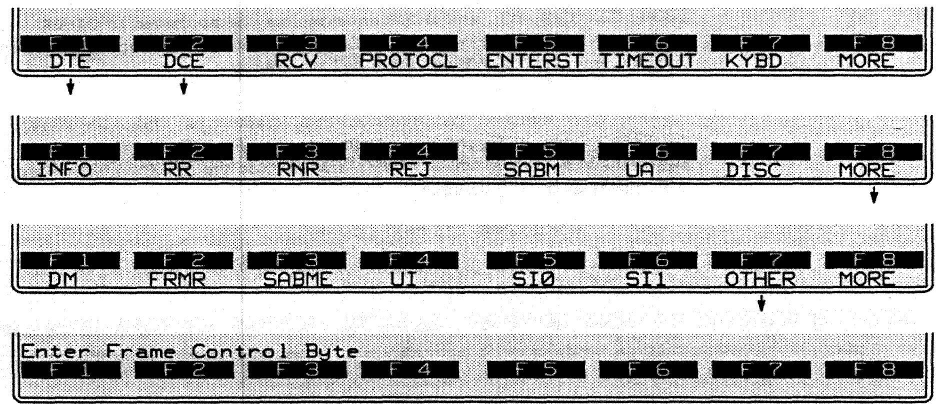


Figure 39-7 The hex value of any frame may be specified under *OTHER*.

5. *Other frames*. Any frame type may be entered as a hexadecimal value instead of by name. Press the softkey for OTHER. See Figure 39-7. Then enter the hex byte in the form of two alphanumerics. Here, for example, is a SABM (with the P bit set) entered as a hexadecimal:

CONDITIONS: DCE OTHER 3F

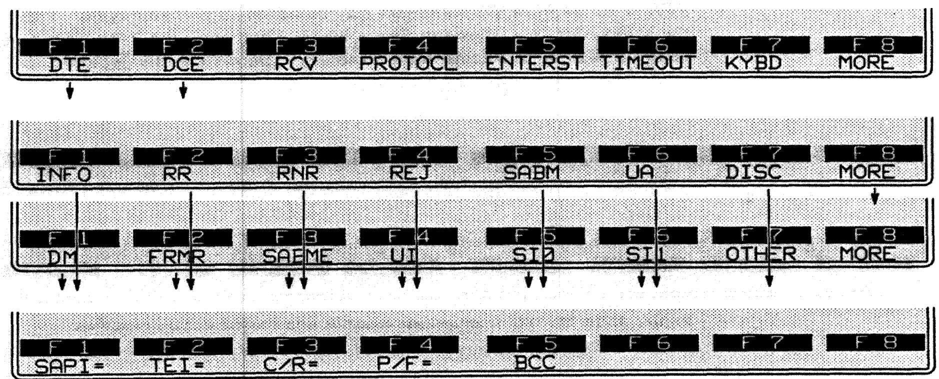


Figure 39-8 The bottom softkey rack shows conditions that may be linked to frame-type conditions.

SAPI, TEI, C/R, P/F, and BCC conditions may be appended to OTHER conditions (see Figure 39-8). In MOD 8, the P/F bit is already specified in the hex entry, and a P/F condition will be ignored.

6. *SAPI.* A SAPI condition may be added to all frame types. Press the softkey for SAPI=, shown in Figure 39-9. Then enter the 6-bit SAPI value as two hex digits in a range from 00 to 3F. (Do *not* use the HEX key.) The entry will appear as in this example:

CONDITIONS: DTE INFO SAPI= 15

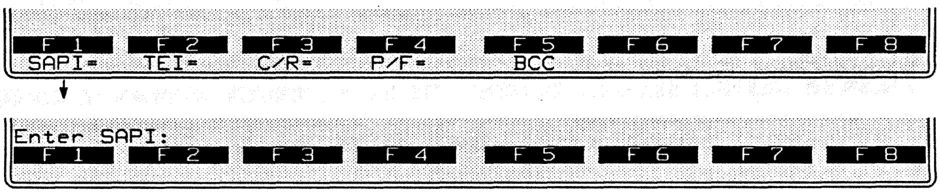


Figure 39-9 **The hex value of the SAPI is entered as two alphanumerics.**

To bypass the SAPI= selection (as well as the other options on the same rack of softkeys in Figure 39-9) press DONE.

7. *TEI.* Like SAPI, a TEI condition may be added to all frame types. Press the softkey for TEI=, shown in Figure 39-10. Then enter the 7-bit TEI value as two hex digits in a range from 00 to 7F. (Do *not* use the HEX key.)

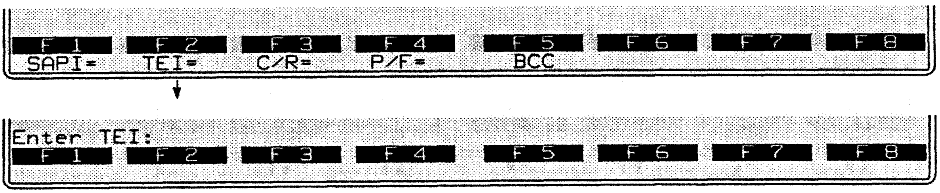


Figure 39-10 **The TEI is an optional condition within all frame-type conditions.**

8. *C/R.* A C/R value of 0 or 1 may be entered as an optional condition added to any frame-type condition.

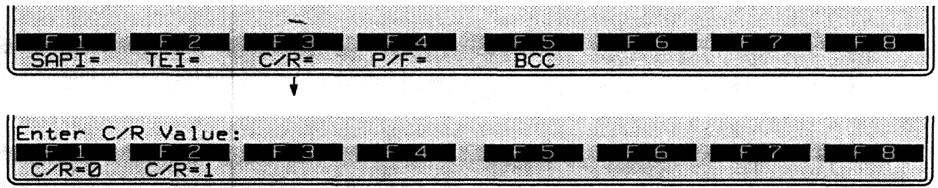


Figure 39-11 The value of the C/R bit may be chosen as a condition.

Press DONE to bypass the C/R= condition and the other conditions on the same softkey level in Figure 39-11.

9. *Poll/final bit*. P/F conditions are optional for all frame types. P/F values of 0 or 1 are entered by the softkey sequence in Figure 39-12.

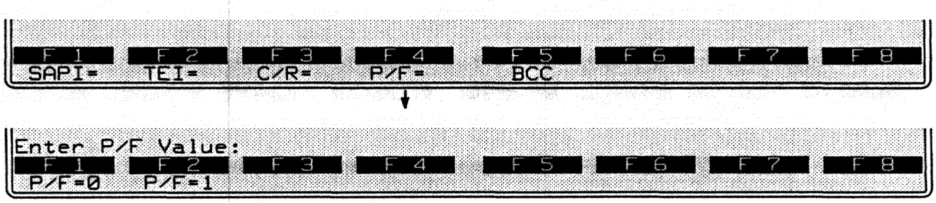


Figure 39-12 The value of the P/F bit may be chosen as a condition for any frame type.

Press DONE to bypass the P/F= condition and the other conditions on the same softkey level in Figure 39-12.

(B) BCC Conditions

DTE and DCE frames may be monitored for good and bad frame checks and for aborts. *All* DTE or DCE frames may be monitored with respect to frame checking, as in this example:

CONDITIONS: DTE BDBCC

The softkey sequence for this spreadsheet entry is given in Figure 39-13.

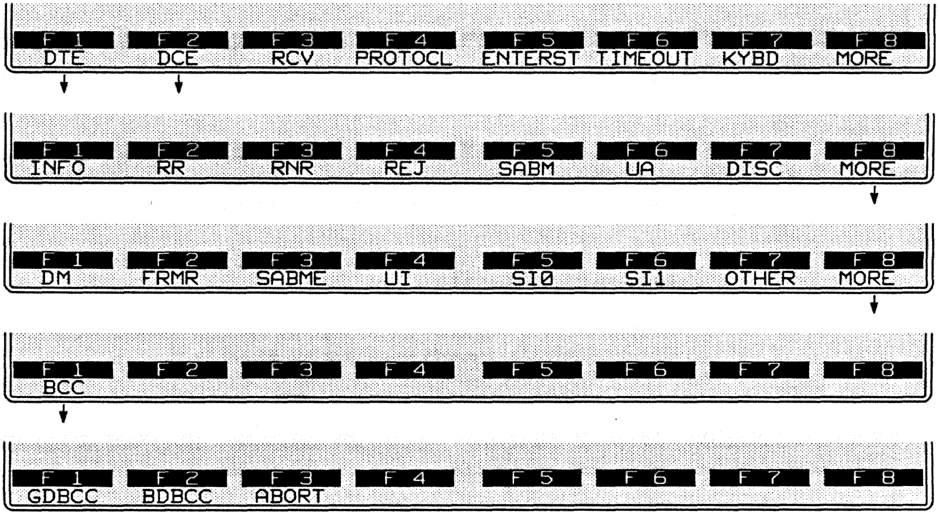


Figure 39-13 A condition may search for *all* good, bad, or aborted frames.

Or a particular *type* of frame may have a BCC or abort condition appended to it:

CONDITIONS: DCE INFO ABORT

39.4 Emulate–Mode Conditions

The remaining conditions are functional only when the Line Setup menu is configured for **Mode:** EMULATE DTE or EMULATE DCE .

(A) Receive Conditions

Like DTE and DCE conditions, RCV conditions monitor a data lead for LAPD frame types. RCV conditions operate only in emulate modes, and they check only the data lead that the INTERVIEW is not using to transmit. While a RCV condition may look like a DTE or DCE condition—RCV INFO P/F=1 looks the same as DCE INFO P/F=1—there are important differences that are noted below.

1. *Valid frame sequencing.* To satisfy RCV conditions, numbered frames must have correct N(R) and N(S) sequencing.

2. *Good BCC.* RCV conditions cannot match frames with bad frame checks, nor can they match aborted frames. (Emulate–mode conditions are designed for ease of programming, and the assumption is that as a LAPD emulator, you are not required to acknowledge—or negative–acknowledge—bad or aborted frames.)

   If you wish to count bad BCCs or aborts, use DTE or DCE conditions instead of RCV conditions.

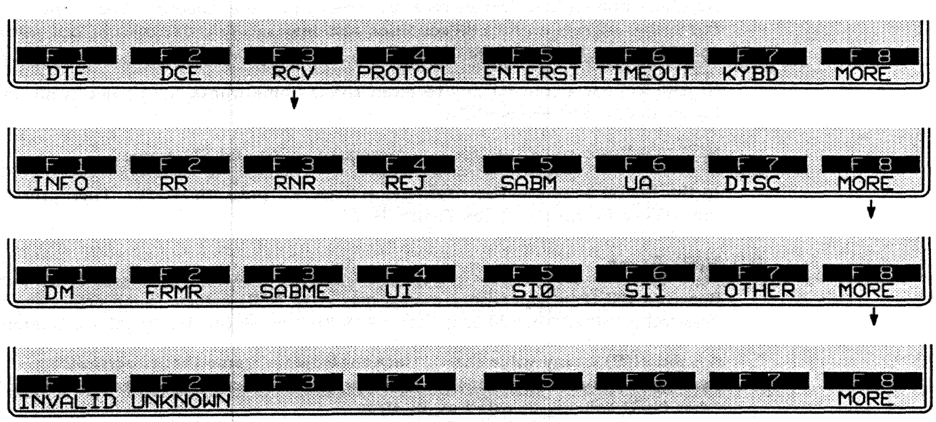


Figure 39-14 ***INVALID* and *UNKNOWN* are frame types for *RCV* conditions.**

3. *Type invalid.* RCV conditions can detect frames that are invalid "types"—the control field is missing, for example, or the I–field is missing in an I–frame.

The Protocol Spreadsheet entry for this condition is RCV INVALID, and the softkey sequence is illustrated in Figure 39-14.

4. *Type unknown.* A frame may be valid in all respects but have a control field that indicates a nonstandard frame type. Such a frame may be matched by a RCV UNKNOWN condition (Figure 39-14).

(B) N(S) Error

As a Layer 2 emulator, you do respond to INFO frames that have N(S) errors. These are detected as NS_ERR conditions, not as RCV INFO conditions.

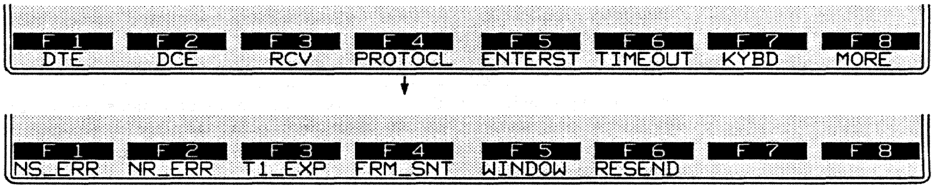


Figure 39-15 The *PROTOCL* key brings up six LAPD emulate conditions.

NS_ERRs apply only to frames received when you are emulating. The same frame that triggers an NS_ERR condition also may satisfy a DTE INFO or DCE INFO condition—but not a RCV INFO condition.

NS_ERR will come true for any received INFO frame whose N(S) value is not one higher than the previous N(S).

NS_ERR will not come true for out-of-sequence SI0 and SI1 frames.

In the first rack of condition softkeys at Layer 2, press PROTOCL. Then press the softkey for NS_ERR. See Figure 39-15.

(C) N(R) Error

Received INFO or supervisory frames may have N(R) errors. Such errors are detected as NR_ERR conditions, not as RCV INFO or RR (or RNR or REJ) conditions.

A valid N(R) is any value that (1) acknowledges a frame that is *outstanding* (waiting for acknowledgment); or (2) repeats the last acknowledgment. Any other N(R) value is detected as an error.

(D) T1 Expired

This condition detects the expiration of the T1 timeout-timer that is regulated on the LAPD Frame Level Setup screen. See Section 39.1(A), above.

(E) Frame Sent

This condition is true when, as a result of a SEND or RESEND action, a frame has been passed down to Layer 1.

(F) Window Conditions

The size of the Layer 2 retransmit window is configured on the LAPD Frame Level Setup screen. See Section 39.1(D). There are four conditions that test the current status of this window. They are WINDOW FULL, WINDOW EMPTY, WINDOW NOT_FULL, and WINDOW NOT_EMPTY. The softkey sequence for the WINDOW options is shown in Figure 39-16.

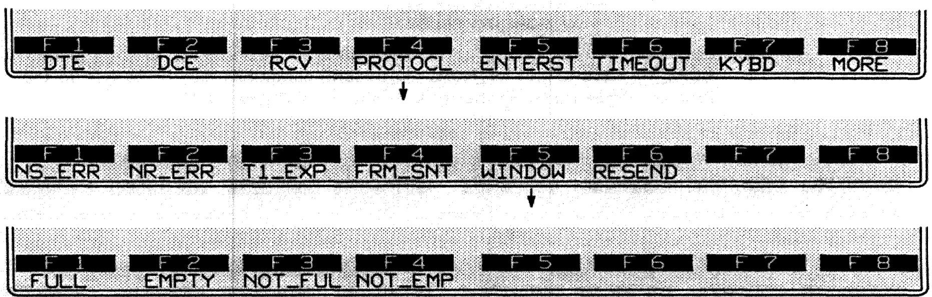


Figure 39-16 When the retransmit window fills, Layer 2 stops buffering frames for retransmission.

WINDOW FULL is true when the window is full of unacknowledged frames and the Layer 2 protocol package will not buffer additional frames until some acknowledgment is received.

Each time an acknowledgment is received, the window is flushed to the extent of the acknowledgment. WINDOW EMPTY means that the latest acknowledgment was complete and left no frames outstanding (unacknowledged). If an RR response is received and the acknowledgment is only partial, this condition will be true:

```
CONDITIONS: RCV RR
   WINDOW NOT_EMPTY
```

CAUTION: Window conditions are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as a RCV condition.*

(G) More to Resend

Frames in the window may have to be resent, usually as the result of a T1 timeout or a Reject frame. One RESEND action retransmits one frame in the window, beginning with the earliest. Subsequent RESEND actions retransmit subsequent frames. The MORE_TO_RESEND and NO_MORE_TO_RESEND conditions allow you to retransmit the entire window, as in the "recover" state in this example:

```
  CONDITIONS: RCV REJ
  ACTIONS: RESEND FIRST
  NEXT_ST: recover
STATE: recover
  CONDITIONS: FRAME_SENT
    MORE_TO_RESEND
  ACTIONS: RESEND NEXT
  CONDITIONS: FRAME_SENT
    NO_MORE_TO_RESEND
  NEXT_ST: xfer
```

MORE_TO_RESEND and NO_MORE_TO_RESEND conditions may be written to the Protocol Spreadsheet by the softkeys shown in Figure 39-17.

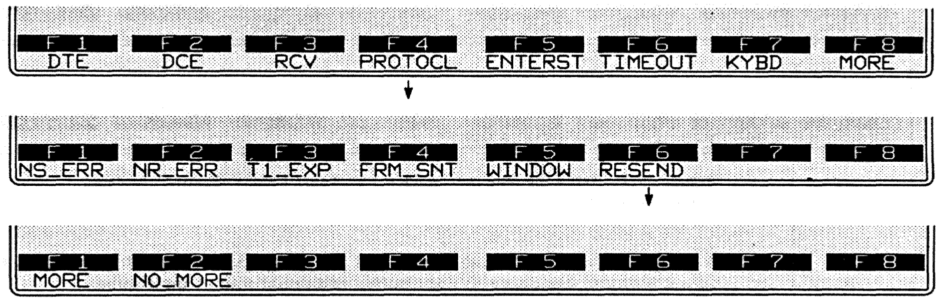


Figure 39-17 The *MORE_TO_RESEND* condition allows you to resend the entire window of frames and then stop when there are *NO_MORE_TO_RESEND*.

CAUTION: MORE_TO_RESEND and NO_MORE_TO_RESEND are status conditions (see Section 27.2) and must *always be used in combination with a transitional condition such as FRAME_SENT.*

39.5 Emulate Actions

When you have completed a block of conditions in a Protocol Spreadsheet test at Layer 2, press DONE to access the set of actions that can be taken as a result of the block of conditions coming true. The set of actions that are specific to the LAPD personality package are shown in the racks of softkeys in Figure 39-18. Except for ENHANCE and SUPPRES, the actions shown have meaning only when the INTERVIEW is emulating DTE or DCE, and not when it is monitoring the line passively.

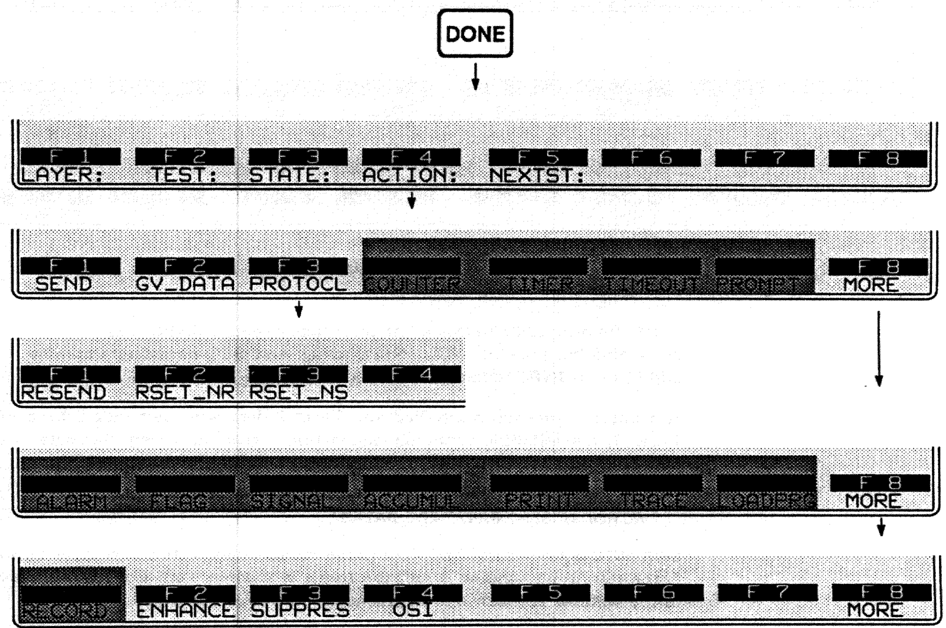


Figure 39-18 Action softkeys specific to LAPD.

(A) Send Actions

Press the softkey for SEND to access two racks of softkeys with names of frame types that may be named in SEND actions. All data generated by the LAPD package must be enclosed in a frame that is identified in a SEND action by *type*.

(Only at Layer 1 can data be generated as a simple character string without any protocol building blocks.) The complete set of frame types is given in Figure 39-19.

When conditions are true for a SEND action, frames are sent immediately down to Layer 1 to be transmitted there.

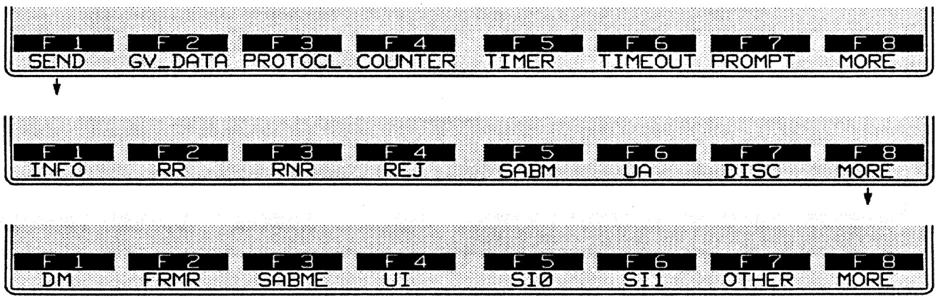


Figure 39-19 ***SEND*** **actions always specify a frame type.**

1. *INFO frames*. SEND INFO is a complete action-entry. SAPI, TEI, command-bit, poll-bit, N(R), N(S), string, and BCC parameters may be added to an INFO frame, but they are optional.

   If a Layer 3 package is installed and Layer 3 data is being handed down to Layer 2, the following condition-and-action trigger will accept this data and convey it properly to Layer 1:

   CONDITIONS: DL_DATA REQ
   ACTIONS: SEND INFO "《DL_DATA》"

   SEND INFO actions pass the INFO frame immediately to the next layer down. If the retransmit window is full, the frame is still sent—but it is not buffered in the window and can not be *re*sent.

   An INFO frame will be buffered for retransmission regardless of the status of the window if a specific value is entered for the NS= parameter (see "*N(S)*," below). The specific N(S) value will clear the window and the INFO frame will be buffered in the first window position.

2. *Supervisory frames*. SEND RR, SEND RNR, and SEND REJ are complete action entries. SAPI, TEI, C/R-bit, P/F-bit, N(R), string, and BCC parameters may be added to the SEND action, but they are optional.

3. *Unnumbered frames*. SAPI, TEI, C/R–bit, P/F–bit, string, and BCC parameters values may be included as adjuncts to a SEND action for an unnumbered frame.

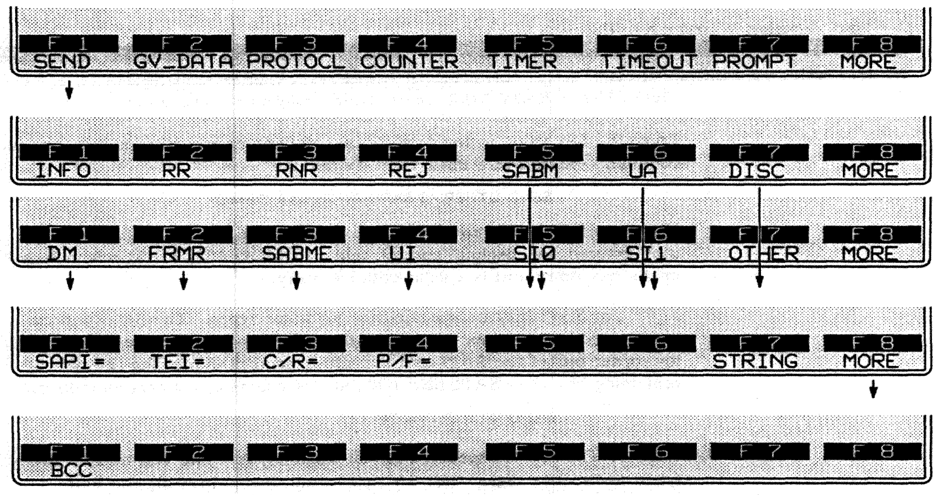


Figure 39-20 **SAPI, TEI, C/R, P/F, string, and BCC options may be added to *SEND* unnumbered-type and SI-type actions.**

4. *Sequenced information frames*. SAPI, TEI, C/R–bit, P/F–bit, string, and BCC values also may be added to SEND SI0 and SEND SI1 actions.

   Figure 39-20 shows the optional fields that may be specified inside of unnumbered and SI send–actions.

5. *Other frames*. Any frame type may be entered in a SEND action as a hexadecimal value instead of by name. Press the softkey for OTHER, on the bottom rack in Figure 39-19.

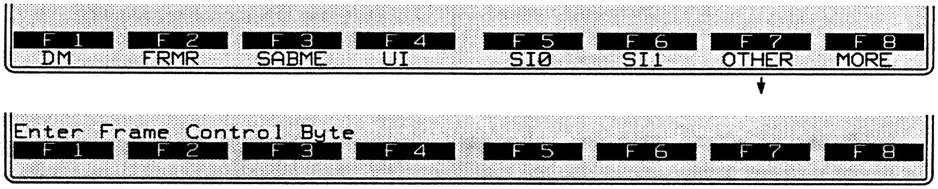


Figure 39-21 *SEND OTHER* **actions always specify a** ***type*** **value in hex.**

Enter the hex value in the form of two alphanumerics. Here is a DISConnect command entered as a SEND OTHER action:

SEND OTHER 43 SAPI= 04 TEI= 1A C/R= 0

Note that P/F, N(R), and N(S) fields are implied already in the user-entered hexadecimal control field. In MOD 128, P/F is not included in the hex entry and is a valid optional entry.

6. *SAPI.* An SAPI may be specified for all frame types. The SAPI= entry is always typed as two hex digits, with the right-hand digit expressing the four low-order bits of the SAPI and the left-hand digit expressing the two remaining bits. The SAPI field 000100, for example, appears as follows:

   SEND RR SAPI= 04 TEI= 1A

7. *TEI.* A TEI may be specified for all frame types. The TEI= entry is always typed as two hex digits, with the right-hand digit expressing the four low-order bits of the TEI and the left-hand digit expressing the three remaining bits. The TEI field 0011010 is illustrated in the SEND RR example above.

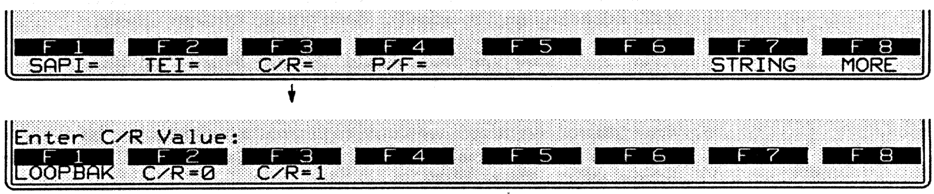


Figure 39-22 The correct Command/Response bit will depend on the logical emulation.

8. *Command/response bit.* The C/R bit may be specified for all frame types. The logical DTE uses C/R 0 for INFO frames and other command frames, and C/R 1 for responses. The logical DCE uses C/R 1 for INFO frames and other commands, and C/R 0 for responses. Since the response bit echoes the command bit, a C/R= LOOPBACK selection is provided (see Figure 39-22).

9. *Poll/final bit*. The P/F bit is an optional entry in all SEND actions. P/F values of 0, 1, or LOOPBAK are entered by the softkeys in Figure 39-23. If P/F= LOOPBAK, the bit will echo the last P/F bit received. (Looping the P/F bit is appropriate for UAs and supervisory frames.)

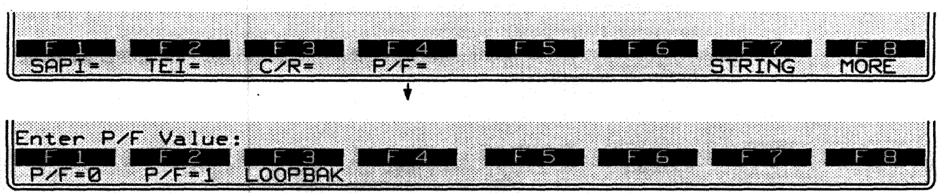


Figure 39-23 A P/F value is optional in all *SEND* entries.

10. *N(R)*. N(R) fields are transmitted in INFO and supervisory frames.

To specify an N(R) value, press the softkey for NR= (see Figure 39-24). Enter a hexadecimal value written as one or two alphanumeric digits. For example, an entry that represented the highest valid N(R) in MOD 8 would be NR= 7. The highest valid entry in MOD 128 would be NR= 7F.

Other N(R) options are ACK_NS, LAST_NR, and AUTO. (See Figure 39-24.) ACK_NS means that your N(R) will acknowledge (that is, it will be *one higher than*) the last N(S) value you received. Normally this will be the correct N(R), except in cases where the last N(S) received was erroneous. The NR= ACK_NS selection allows you to overlook N(S) errors.

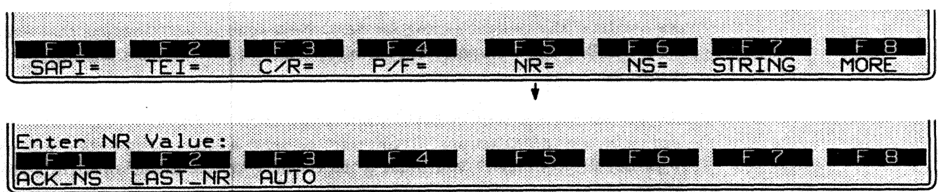


Figure 39-24 The N(R) field may be specified in INFO and supervisory frames to be sent.

LAST_NR means that you simply repeat the last N(R) you sent. Normally this is the correct N(R) following a bad N(S). The NR= LAST_NR option allows you to force the other side to initiate recovery.

AUTO means that you will behave as a normal LAPD station, acking valid N(S) values and repeating your last N(R) whenever an invalid N(S) is received.

11. *N(S)*. N(S) fields are transmitted in INFO frames only. (See the frame-field diagrams in Figure 39-4.) Entries for N(S) in SEND INFO actions are optional. The softkeys that open below NS= are illustrated in Figure 39-25.

    To specify an N(S) value, press the softkey for NS=, then enter a hexadecimal in the form of one or two alphanumerics. Valid hex entries are the same as for N(R). A SEND INFO action that *specifies* an N(S) value—NS= 0, for example—will clear the window so that the INFO frame is buffered immediately.

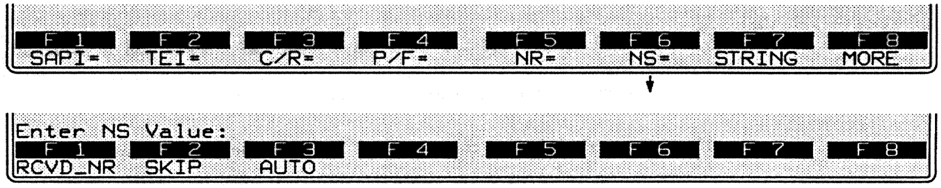


Figure 39-25 The N(S) field may be specified in a *SEND INFO* action.

Other N(S) options are RCVD_NR, SKIP, and AUTO. RCVD_NR means that you send the N(S) value that the other side says it is expecting. This is the valid N(S) in most cases, but not when you send two or more I-frames in a row without waiting for acknowledgment.

SKIP means that you *add one* to your correct N(S). This will look to the other side as though the line has taken a "hit" and a frame has been lost. This selection causes the window to be cleared.

NS= AUTO is the default setting for SEND INFO actions. AUTO means that every *new* INFO frame sent will have an N(S) value of one higher than the previous.

12. *String*. Strings are sent in LAPD only as adjuncts to frame-types when they are named in SEND actions. If you want to send a string of raw data without a protocol "envelope," you must go to Layer 1 and send the raw string from there.

    Press the SEND softkey followed by the softkey for a frame type. Add any necessary or desired SEND options for the particular frame type. Then press the STRING softkey (labeled F7 in Figure 39-25).

    There is no spreadsheet keyword that identifies send-strings at any layer. *The spreadsheet compiler identifies strings by the quotation marks surrounding them*. Always enclose strings in quotation marks. (To send an actual " -character in your string, type \" .) See Section 29 for more information on strings.

Here is a simple SEND action that includes no options besides a string:

ACTIONS: SEND FRMR " ${}^{1}_{1}{}^{6}_{6}{}^{0}_{8}$ "

And here is a SEND action that includes a full complement of optional fields, including a string:

ACTIONS: SEND INFO SAPI= 04 TEI= 1A C/R= 0 P/F= 0 NR= AUTO NS= AUTO
" ${}^{7}_{8}{}^{2}_{C}{}^{0}_{A}$7036449000" GDBCC

Most ASCII-keyboard, control, and hexadecimal characters are legal in a send-string. Special keys ([FLAG], [DON'T CARE], [BIT MASK]) are not legal. Refer to Table 29-2.

To insert a canned fox message into a transmit string, type FOX inside of double parens, as follows: ((FOX)). Remember that the double parens are special characters produced by the [CTRL]-[9] and [CTRL]-[0] combinations. Constants, counters, and flags can also be embedded in a string. See Section 29, Strings.

13. *BCC*. There are three BCC options for every SEND action in LAPD. One of the options, GDBCC, is the default. Any frame that does not request a bad BCC or an abort will have a good frame-check sequence calculated for it and appended to it. BCC also is an option for SEND actions at Layer 1; but it does not occur at Layer 3 or higher.

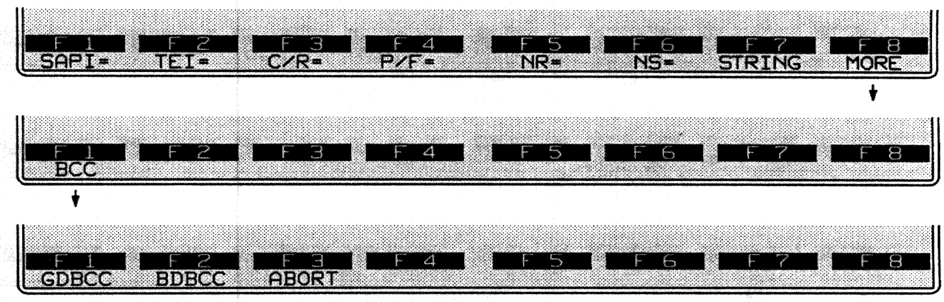


Figure 39-26 Type of BCC is a *SEND* option for frames at Layer 2.

The three softkey selections for BCC are shown in Figure 39-26. A sixteen-bit CCITT frame check is selected automatically for BOP protocols and cannot be changed or disabled. A bad BCC will be CRC-16 instead of CCITT.

When ABORT is the BCC selection, instead of appending a proper frame check the transmitter will hold the lead at mark for eight bits (or longer if the transmitter is idling ${}^{F}_{F}$). Inside of a frame, seven 1-bits in a row are sufficient to signal an abort.

(B) Give Data

GIVE_DATA is the F2 action on the first rack of action softkeys (refer to Figure 39-18). This action takes the I-field from a received INFO frame and passes it up to Layer 3 along with a DL_DATA IND primitive. (See Figure 30-5 in the section, OSI Primitives on the Protocol Spreadsheet.) In an emulate mode, data is delivered up to Layer 3 only by one of two actions at Layer 2: GIVE_DATA, or else a DL_DATA IND primitive followed by the data string.

(C) Resend

The RESEND function is mapped to F1 on the second layer of action softkeys. See Figure 39-27. The first RESEND action will resend the first frame in the window. The window is a queue that buffers INFO frames for retransmission in case one or more transmissions are lost or in error.

The first frame in the window always is the *earliest outstanding* (unacknowledged) frame. Every time an acknowledgment is received, the window is cleared to the extent of the acknowledgment and a new "first-frame" position is established. The first RESEND after an acknowledgment always sends the first window frame.

Figure 39-27 The *RESEND* action allows you to recover from sequence errors.

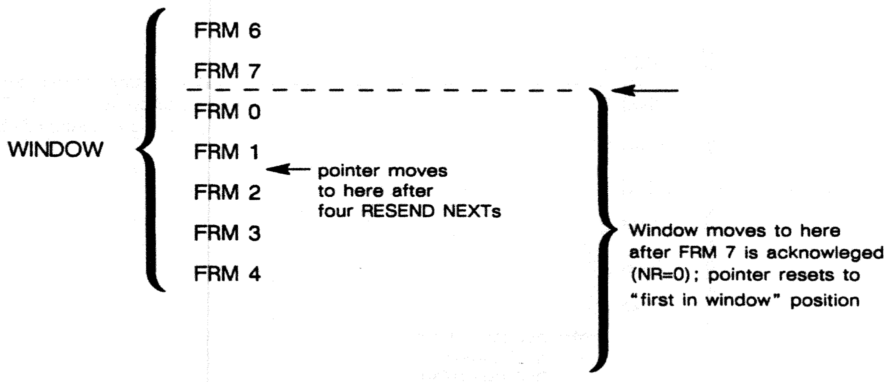


Figure 39-28 **Resends cause the pointer to move, while acknowledgments move the pointer** ***and the entire window.***

The *second and subsequent* RESENDs following an acknowledgment also will send the first window frame, provided that the keyword FIRST is appended directly to the RESEND entry. Otherwise, they send the NEXT (second) and subsequent window frames. Figure 39-28 shows the position of the the resend "pointer" after four consecutive RESEND NEXT actions. RESEND NEXT is the default resend when neither FIRST nor NEXT is specified.

The resend–pointer is reset to the beginning of the window automatically by any acknowledgment, or by a RESEND FIRST action in the spreadsheet program.

1. *Resend first/next.* RESEND FIRST means that the resend–pointer is reset to the beginning of the window, the first frame in the window is resent, and the pointer is advanced to the second position in the window. The effect of a RESEND FIRST action is illustrated in Figure 39-29.

   The RESEND FIRST action makes it possible for you to resend all the frames in the window one by one, and then *resend them again* if necessary.

2. *P/F=loopback/0/1.* The P/F bit in the resend–frame can be set to 0 or 1 by this optional action. If PF= LOOPBACK, the bit will echo the last P/F bit received. (Default is 1 in a RESEND action.)

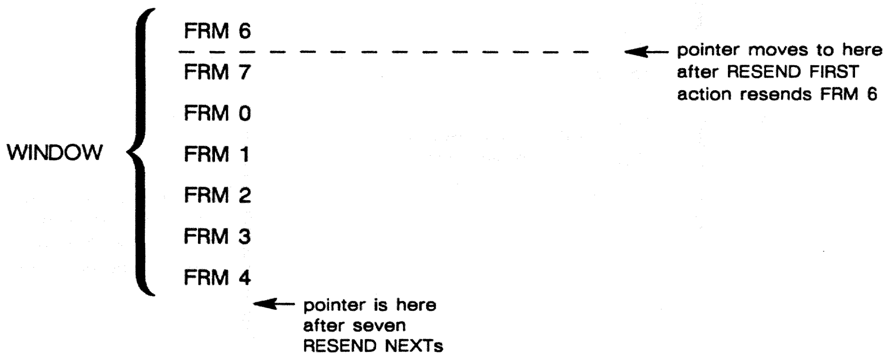


Figure 39-29 *RESEND FIRST* resets the pointer, allowing you to resend the entire window *repeatedly*.

(D) Reset N(R) and Reset N(S)

RESET_NR and RESET_NS are the F2 and F3 actions on the second rack of action softkeys in the LAPD personality package. (Refer again to Figure 39-18.) The sequence-number fields in I-frames and supervisory frames can be reset by these two Protocol Spreadsheet actions. Sequence numbers are not reset *automatically* during a test by any frame that is sent or received.

RESET_NS also clears the transmit window.

39.6 Display Actions

ENHANCE and **SUPPRESS** pertain to lines of data on the Layer 2 protocol trace (see Section 39.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE, **DCE**, and **RCV** conditions can trigger an **ENHANCE** or **SUPPRESS** action.

(A) Enhance

Whenever a **DTE**, **DCE**, or **RCV** condition comes true at Layer 2, the frame that satisfied the condition can be enhanced on the LAPD protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the **ENHANCE** softkey—F2 on the third rack of action softkeys. Figure 39-30 shows the three softkey subselections beneath **ENHANCE**. They are **REVERSE**, **BLINK**, and **LOW**.

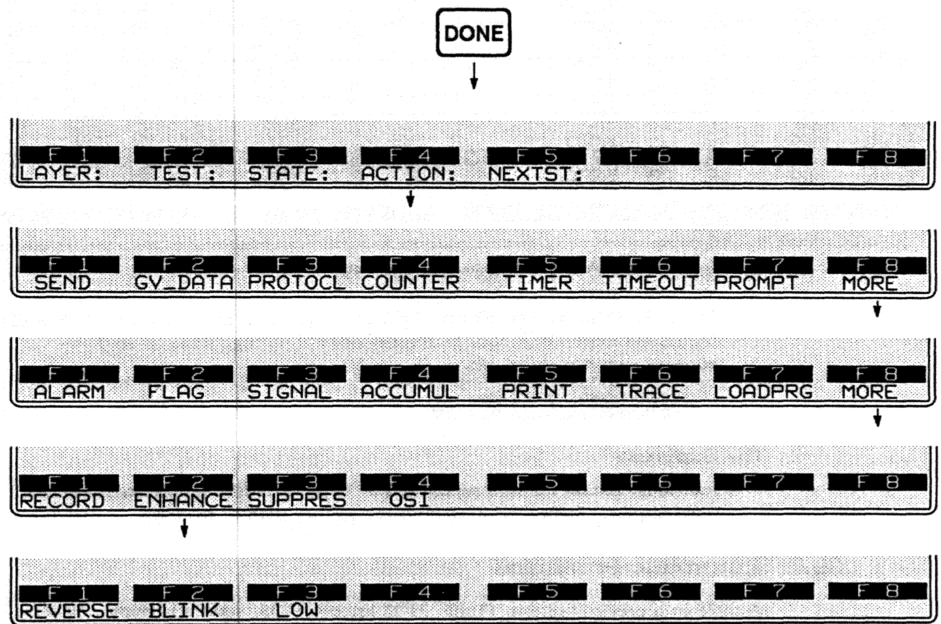


Figure 39-30 Selected frames on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

MON/DISK/FD1 BLK=00019 P 06/23/89 11:14
ASCII/8/NONE/BOP

SRC	SAPI	TEI	C/R	TYPE	Nr	Ns	P/F	SIZE	TIME	BCC
DCE	04	1A	1	DISC			0	0003	0915:08.021	G
DTE	04	1A	1	UA			0	0003	0915:08.172	G
DTE	04	1A	0	SABM			1	0003	0915:08.212	G
DCE	04	1A	0	UA			1	0003	0915:08.440	G
DTE	04	1A	0	INFO	0	0	0	0007	0915:08.482	G
DCE	04	1A	1	INFO	0	0	0	0008	0915:08.723	G
DTE	04	1A	1	RR	1		0	0003	0915:08.842	G
DCE	04	1A	0	RR	1		0	0003	0915:08.915	G
DTE	04	1A	0	INFO	1	1	0	0019	0915:08.916	G
DCE	04	1A	0	RR	2		0	0003	0915:08.959	G
DCE	04	1A	1	INFO	2	1	0	0006	0915:09.033	G
DTE	04	1A	1	RR	2		0	0003	0915:09.362	G
DCE	04	1A	1	INFO	2	2	0	0018	0915:09.505	G
DTE	04	1A	1	RR	3		0	0003	0915:09.667	G
DTE	04	1A	0	INFO	3	2	0	0006	0915:09.747	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 39-31 A DTE SABM has been enhanced.

Figure 39-31 shows one screen of a Layer 2 protocol trace in which DTE SABM frames have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE SABM
ACTIONS: ENHANCE REVERSE

(B) Suppress

Individual frames that are suppressed in Layer 2 actions are deleted from the trace display. Figure 39-30 showed the softkey path to SUPPRES.

39.7 Automatic Primitives

A table in a previous section (Table 30-2) listed the OSI service primitives that are monitored at the boundaries of Layer 2 as trigger conditions and sent up to Layer 3 or down to Layer 1 as user-entered spreadsheet actions. These primitives are layer-specific rather than protocol-specific and are not part of the personality package for LAPD; but a few of the primitives are set in motion automatically by LAPD spreadsheet actions. These *automatic* primitives can be thought of as part of the Layer 2 actions themselves, and by extension as part of the LAPD protocol package.

Table 39-1 gives the set of LAPD actions that have action-primitives built into them. For example, whenever a GIVE_DATA action occurs at Layer 2, a DL_DATA IND primitive is forwarded to Layer 3, where a DL_DATA IND condition may be waiting to monitor it.

Whenever a SEND or RESEND action is initiated at Layer 2, a PH_DATA REQ primitive is sent downward along with the PH data (the entire frame).

If a SEND or RESEND action is triggered at Layer 2 while the physical connection at Layer 1 is inactive, Layer 2 will sense the absence of a physical connection and delay the PH_DATA REQ. Instead it will send a PH_ACTIVATE REQ primitive. Only when a PH_ACTIVATE CONF has been returned by Layer 1 will Layer 2 release the data and the data primitive.

> NOTE: Currently, all Layer 1 interfaces for the INTERVIEW 7000 Series will return PH_ACTIVATE CONF automatically whenever they see PH_ACTIVATE REQ.

Table 39-1
Automatic Primitives Generated in LAPD

LAPD Layer 2 Action	Automatic Primitive	To Layer
GIVE_DATA	DL_DATA IND	3
SEND {TYPE}	(PH_ACTIVATE REQ*)	1
	PH_DATA REQ	1
RESEND	(PH_ACTIVATE REQ*)	1
	PH_DATA REQ	1

*Sent if Layer 1 shows inactive status. PH_DATA REQ delayed until PH_ACTIVATE CONF returned by Layer 1.

40 Q.931

```
                              ** Layer Setup **
-------------------------------------------------------------------------------
                                          Selections          Packages Loaded
DRIVE: HRD    Layer 1 Package:   NO PACKAGE          NO PACKAGE
DRIVE: FD2    Layer 2 Package:   NO PACKAGE          LAPD                FD1
DRIVE: HRD    Layer 3 Package:   Q.931               Q.931               HRD
DRIVE: HRD    Layer 4 Package:   NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 5 Package:   NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 6 Package:   NO PACKAGE          NO PACKAGE
DRIVE: HRD    Layer 7 Package:   NO PACKAGE          NO PACKAGE



Depress XEQ Key To Load The Selected Packages
-------------------------------------------------------------------------------
Select Layer
  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
LAYER-1  LAYER-2  LAYER-3  LAYER-4  LAYER-5  LAYER-6  LAYER-7  PROTSEL
```

Figure 40-1 The Q.931 personality package is loaded from the Layer Setup screen at Layer 3.

40 Q.931

Q.931 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 40-1 shows the Layer Setup screen configured to load in the Q.931 package from the hard disk. Refer to Section 6 for details on operating the Layer Setup screen.

The Q.931 package consists of the following:

- A protocol trace (illustrated in Figure 40-2) that distills from Q.931 data the Level 3 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

- A group of conditions and actions at Layer 3 on the Protocol Spreadsheet that facilitate ISDN programming. Figure 40-4 shows the softkey path to the first rack of condition softkeys when the Q.931 package is loaded in at Layer 3 and a LAYER: 3 programming block has been opened on the spreadsheet.

40.1 Protocol Trace

The Q.931 package includes an automatic message-trace display that summarizes Layer 3 activity. This trace mode is enabled whenever the unit is in Run mode, both real-time and frozen.

While the unit is in Run mode, press the softkey for PROTOCL (F2 on the primary rack of display-mode softkeys) and then the softkey for L3TRACE (F2) to bring the protocol trace for Q.931 to the screen. Figure 40-2 is an example of this trace display. Each horizontal row in the trace represents a "message" as defined in CCITT Recommendation Q.931.

MON/LINE BLK=00000 S 06/29/89 17:30
ASCII/8/NONE/BOP

SRC	FLG	CALL-REF-VAL	MSG-TYPE	INFO-ELEMENT	TIME	BCC
DTE	0	01	SETUP	04 02 88 90 18 01 83 24 01 02	1645:19.237	G
DCE	0	01	SETUPACK	34 01 00 18 01 89	1645:19.314	G
DTE	0	01	INFO	2C 0A 37 30 33 36 34 34 39 30 30 30	1645:36.176	G
DCE	0	01	INFO	30 0A 37 30 33 36 34 34 39 30 30 30	1645:36.288	G
DCE	0	01	CALLPRO		1645:38.123	G
DCE	0	01	ALERT		1645:40.628	G
DCE	0	01	CONN		1645:42.689	G
DTE	0	01	SUSP	10 03 41 52 43	1713:16.271	G
DCE	0	01	SUSPACK		1713:16.281	G
DTE	0	01	SETUP	04 02 88 90 18 01 83 24 01 02	1713:18.142	G
DCE	0	01	RELCOM		1713:18.315	G
DTE	0	01	RES	10 03 41 52 43	1713:45.565	G
DCE	0	01	RESACK		1713:45.715	G
DCE	1	81	SETUP	04 02 88 90 18 01 8A	1730:44.427	G
DTE	1	81	CONN	24 01 02	1730:44.883	G

F 1 L2TRACE | F 2 L3TRACE | F 3 | F 4 | F 5 | F 6 | F 7 | F 8

Figure 40-2 Each horizontal row on the trace display represents a message.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

(B) Trace Columns

The columns in the protocol trace for Q.931 are explained below.

1. *Source*. The **SRC** column identifies the lead on which the message was monitored, TD (DTE) or RD (DCE). This column identifies the *physical* source of the message, not the *logical* source. The physical DTE uses the TD lead to transmit. The physical DCE uses RD to transmit.

   Just as on the data display, RD data is underlined.

2. *Flag*. The **FLG** column refers to the call–reference flag and is used to identify where the call originated. Calls originating on the user side of the link will show a flag value of 0 in every message from both the DTE and the DCE. (This is a *call*–origination flag, not a *message*–origination flag.)

   If a call originates from a remote user, every message that references that call will have a flag value of 1.

3. *Call reference value*. The number used by a message to reference a particular call is given in the **CALL–REF–VAL** column. This is a fifteen–column field that displays the variable–length call–reference value in from one to fifteen hexadecimal characters. This field is blank when the call–reference *length* value (see Figure 40-3) is zero.

   The flag bit (see "Flag," above) is not included in the display of the first byte of the call–reference value.

4. *Message type*. The thirty message types that are named in the **MSG–TYPE** column are shown in Figure 40-3. If a message type does not fit any of the patterns in the figure, it is listed in the **MSG–TYPE** column as UNKWN followed by the hexadecimal value of the message–type byte: UNKWN=7C.

   If the number of bytes in the message is below the required minimum, the message is posted as INVALID.

5. *Information element*. The **INFO–ELEMENT** field presents up to sixteen bytes of character data (decoded into hex) for all messages that contain information elements beyond the message–type field. Info elements are mandatory in some messages and optional in others.

   In the **INFO–ELEMENT** fields with data shown in Figure 40-2, the first byte always is an "identifier" byte, with a value that you can decode using the "Info Element 1" field diagrams on the right half of Figure 40-3. The second byte is a length byte, with a value that indicates the number of "contents" bytes that intervene before the next element–identifier.

The first info-element data in Figure 40-2, for example, begins with the hex character 04. This translates on the field diagrams in Figure 40-3 as a "Bearer Capability" info element. The next byte, 02, indicates that the remaining contents are two bytes long, followed by the end of the data or by another information element. This means that 18, "Channel ID," is the next info-element identifier in the string; and so forth.

Note in the field diagrams in Figure 40-3 that there are four types of single-byte information element.

6. *Time*. The time of the arrival of the *end of the frame containing the message* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

7. *Frame Checking*. A BOP frame ends as soon as a 7E flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the **BCC** column of the trace display. The symbol G denotes a good frame check, while B symbolizes a bad frame.

   A for abort is posted to the displays when a frame is ended by seven 1-bits.

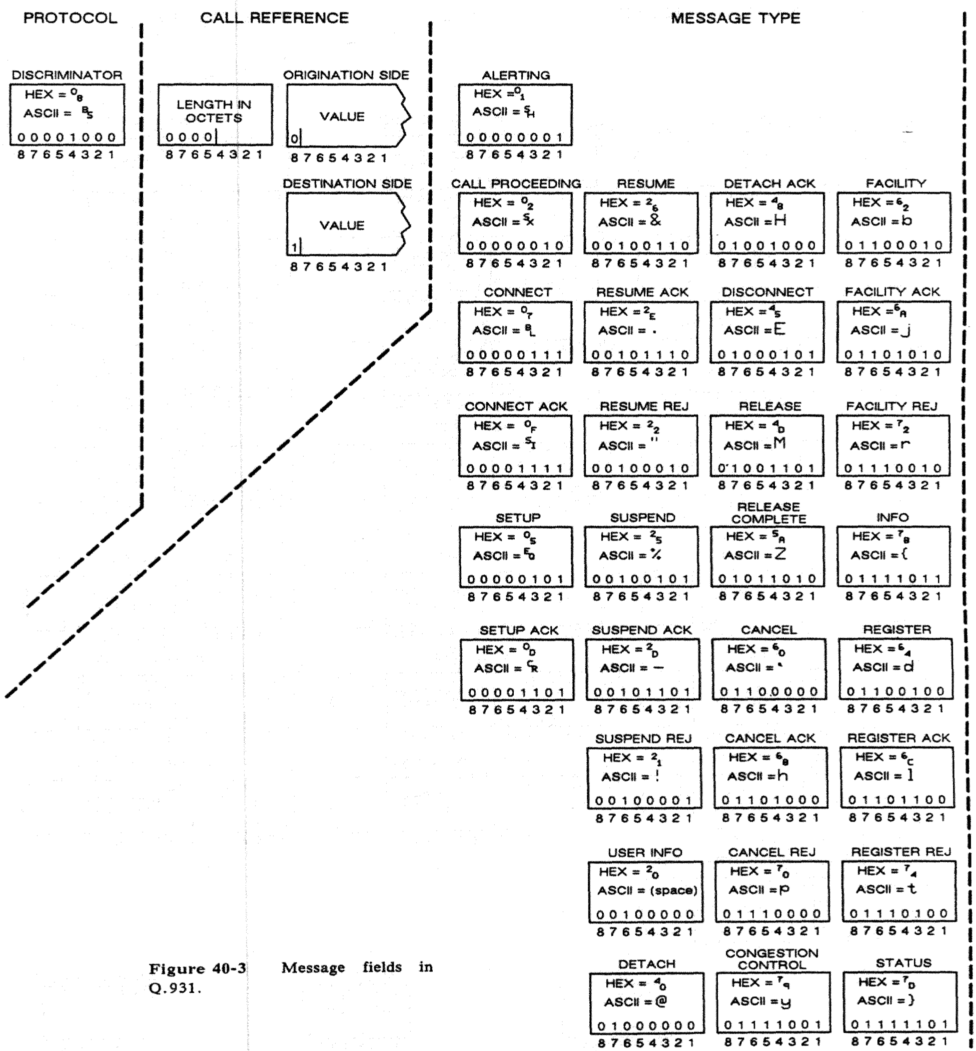
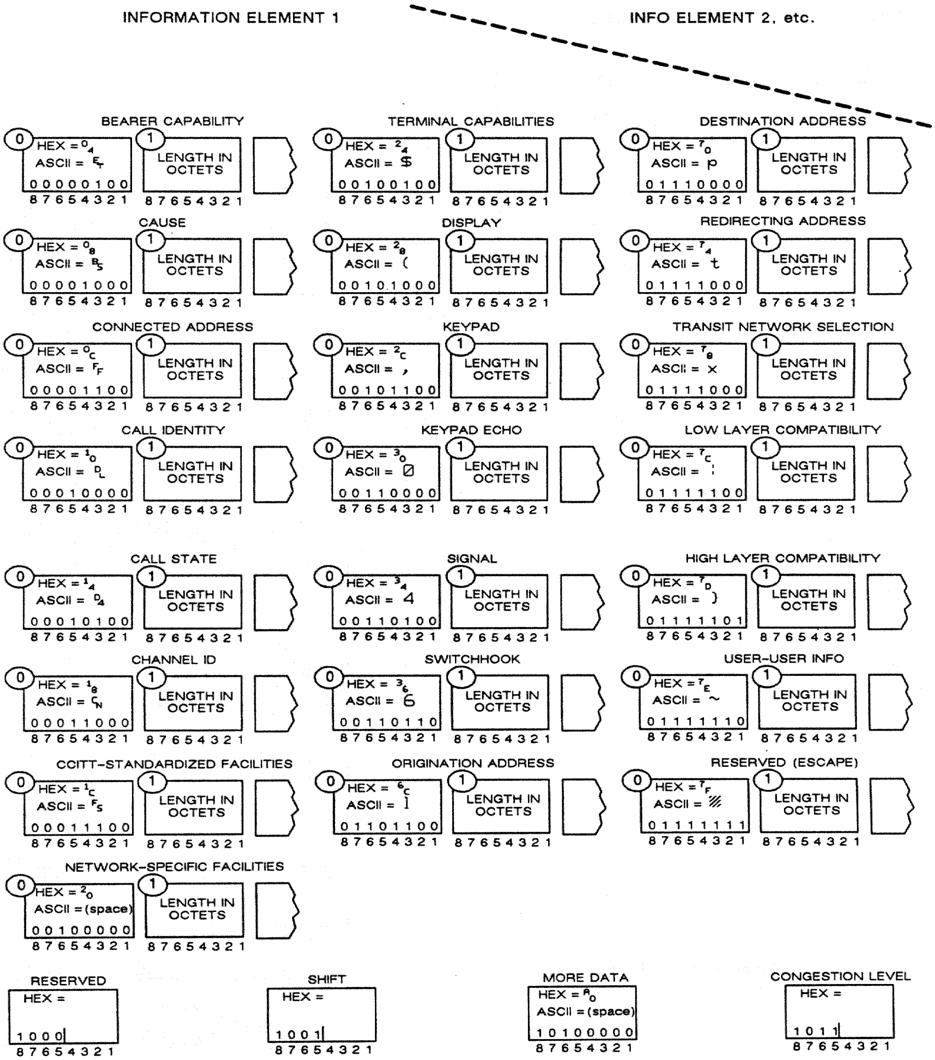


Figure 40-3 Message fields in Q.931.


INFORMATION ELEMENT 1
INFO ELEMENT 2, etc.
BEARER CAPABILITY
HEX = 04
00000100
TERMINAL CAPABILITIES
HEX = 24
ASCII = $
00100100
DESTINATION ADDRESS
HEX = 70
ASCII = p
01110000
CAUSE
HEX = 08
00001000
DISPLAY
HEX = 28
ASCII = (
00101000
REDIRECTING ADDRESS
HEX = 74
ASCII = t
01110100
CONNECTED ADDRESS
HEX = 0C
00001100
KEYPAD
HEX = 2C
ASCII = ,
00101100
TRANSIT NETWORK SELECTION
HEX = 78
ASCII = x
01111000
CALL IDENTITY
HEX = 10
00010000
KEYPAD ECHO
HEX = 30
ASCII = 0
00110000
LOW LAYER COMPATIBILITY
HEX = 7C
01111100
CALL STATE
HEX = 14
00010100
SIGNAL
HEX = 34
ASCII = 4
00110100
HIGH LAYER COMPATIBILITY
HEX = 7D
ASCII = }
01111101
CHANNEL ID
HEX = 18
00011000
SWITCHHOOK
HEX = 36
ASCII = 6
00110110
USER-USER INFO
HEX = 7E
ASCII = ~
01111110
CCITT-STANDARDIZED FACILITIES
HEX = 1C
00011100
ORIGINATION ADDRESS
HEX = 6C
ASCII = l
01101100
RESERVED (ESCAPE)
HEX = 7F
01111111
NETWORK-SPECIFIC FACILITIES
HEX = 20
ASCII = (space)
00100000
LENGTH IN OCTETS
87654321
RESERVED
HEX =
1000
SHIFT
HEX =
1001
MORE DATA
HEX = A0
ASCII = (space)
10100000
CONGESTION LEVEL
HEX =
1011

40.2 Monitor Conditions

When the Q.931 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 3. See Figure 40-4.

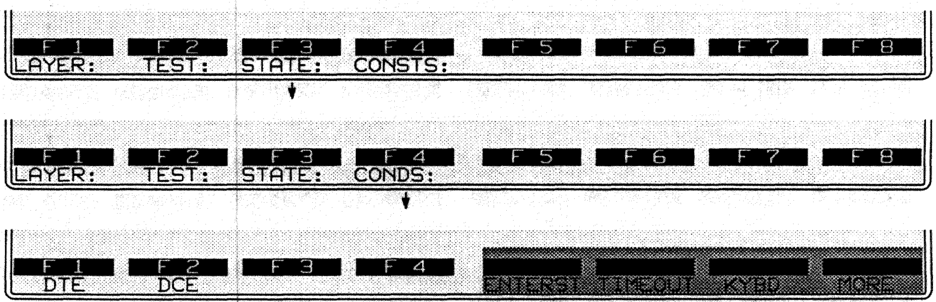


Figure 40-4 **The softkeys for *DTE* and *DCE* are used to monitor ISDN protocol events once *Layer: 3* has been entered on the Protocol Spreadsheet.**

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represent *types* of message: ALERT, CONN, STATUS, and so forth.

(A) Message Types

The softkeys for the thirty standard as well as "other" message types are illustrated in Figure 40-5. Press a softkey to write one of these message types to the Layer 3 spreadsheet. DTE or DCE followed by a message-type mnemonic—DTE SUSP, for example, or DCE REL—is a complete condition and will come true if a matching message-type is monitored. Call-reference, origination-link, and destination-link conditions may be added to the simple message-type mnemonic, but they are optional.

Figure 40-5 Message types.

(B) Call Reference Value

A specific call-reference value may be added as a condition to any of the message type conditions. Once you have pressed the softkey for a particular message type (or once you have touch-typed the message type followed by a space), the rack of softkeys shown in Figure 40-6 will appear.

Press the softkey for C_REF=, shown in Figure 40-6. Then enter the call-reference value as a sequence of hex digits inside of quotation marks. The sequence may be from one to twelve semi-octets long. Type each digit as an alphanumeric in the range *0–9* and *A–F* (or *a–f*), *without using the* [HEX] *key.* The call reference 7F with flag-bit 0, for example, appears as follows:

CONDITIONS: DTE SETUP C_REF= "7F"

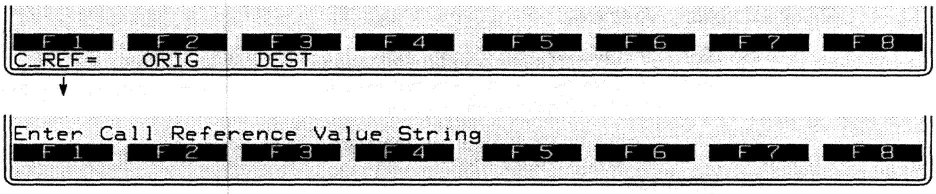


Figure 40-6 Call-reference, origination-link, and destination-link conditions may be added to a message-type condition.

Include the origination/destination-*flag* bit in your string. If the DCE, for example, gives call reference #4 to a call that originated at a remote link, the entry C_REF= "84" (with flag = 1) will detect this call reference, while the string "04" (flag = 0) will not detect it.

(C) Origination/Destination Link

A message-type condition may be set to come true only with respect to calls that originated *locally* (or *remotely*).

To make a message-type condition specific to calls that originated with a user on the link that is being monitored by the INTERVIEW, press the softkey for ORIG (F2 on the rack of softkeys in Figure 40-6). Only messages that have zero as the call-reference flag bit will satisfy this condition.

This condition, for example, looks for a Facility-type message that references a call that originated locally:

CONDITIONS: DTE FAC ORIG

Or a message-type condition may require remote origination of a call. In that case, the link being monitored is the "destination" of the call, and you will press the softkey for DEST, F3 on the rack of softkeys in Figure 40-6. Only messages that have 1 as the call-reference flag bit will satisfy this condition.

40.3 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 3 protocol trace (see Section 40.1). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE and DCE conditions can trigger an ENHANCE or SUPPRESS action.

(A) Enhance

Whenever a DTE or DCE condition comes true at Layer 3, the message that satisfied the condition can be enhanced on the Q.931 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—[F1] on the first rack of action softkeys. Figure 40-7 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

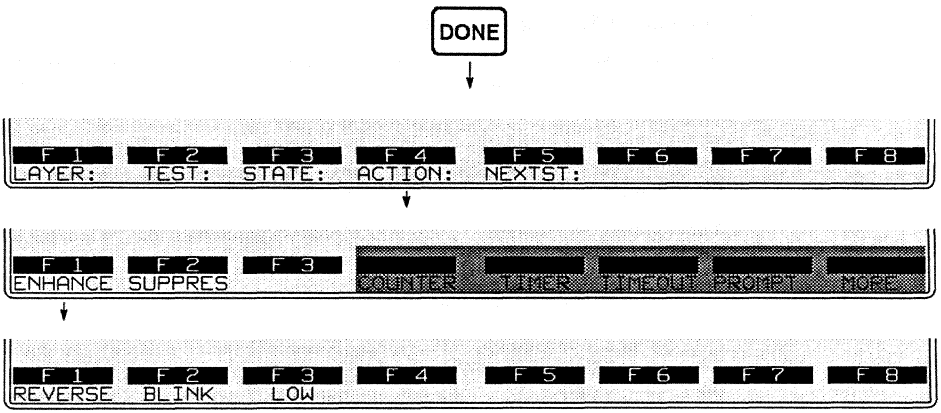


Figure 40-7 Selected messages on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

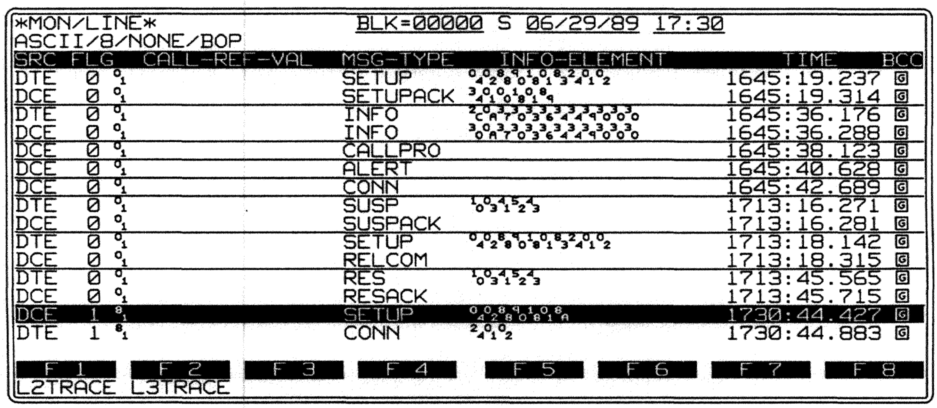


Figure 40-8 A DCE SETUP has been enhanced.

Figure 40-8 shows one screen of a Layer 3 protocol trace in which DCE SETUP messages have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

```
CONDITIONS: DCE SETUP
ACTIONS: ENHANCE REVERSE
```

(B) Suppress

Individual message-types that are suppressed in Layer 3 actions are deleted from the trace display. Here is an example of an action that suppresses all DTE Information messages:

```
CONDITIONS: DTE INFO
ACTIONS: SUPPRESS
```

41 SS#7 Layer 1

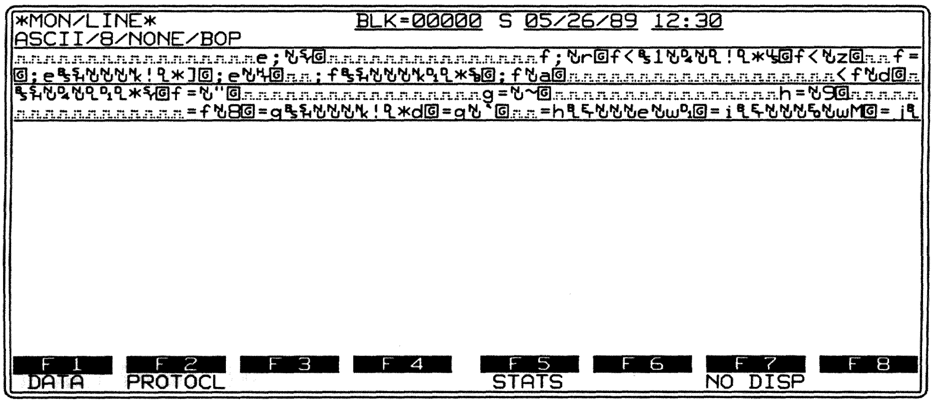


Figure 41-1 SS#7 Dual-line data display, with 7E flags suppressed and redundant LSU's and Fill-In's compressed.

41 SS#7 Layer 1

SS#7 (CCSS#7) is an abbreviation for the CCITT-defined Common Channel Signalling System #7. The INTERVIEW 7000 Series provides modifiable data display at Layer 1, a special display for Layer 2 (link) protocol and Layer 3 (network management) protocol. Automatic selections for SS#7 protocol appear at Layers 2 and 3 of the Protocol Spreadsheet when the correct protocol packages are loaded.

41.1 SS#7 Run-Time Displays

(A) Data Display

Figure 41-1 shows SS#7 data being monitored as dual-line data. 7E flags have been suppressed on the Line Setup screen and Fill-In's and LSU's have been compressed. As with all dual-line displays, TD and RD data appear on alternate lines, and RD data is always underlined. Time fill characters maintain the timing relationships between RD and TD characters, accurate to within one character on the display.

(B) SS#7 Layer Traces

An SS#7 Layer 2 trace is available when SS#7 protocol is loaded at Layer 2. A Layer 3 trace is available when SS#7 is loaded at Layer 3. If you select **PROTOCOL** and **Layer: 2** or **3** as the display, this trace will be active when you press **RUN**. Refer to Sections 42 and 43 for more information on and examples of these traces.

41.2 Setup for SS#7

Three steps are involved in setting up for SS#7 protocol. First, load the protocol from the Layer Setup screen as described in Section 6. Then select the correct **Mode** and data **Format** on the Line Setup menu, and, finally, select the options you prefer on the Display Setup menu.

(A) Layer Setup

SS#7 packages are available at Layers 1, 2, and 3. The Layer 1 package provides data compression and is described at the end of this section. Options available with the Layer 2 and the Layer 3 packages are discussed in Sections 42 and 43, respectively.

(B) Line Setup

The **Format** selection on the Line Setup menu should be BOP (Bit-Oriented Protocol) when SS#7 is analyzed. This and other Line Setup selections are described in Section 4.

(C) Display Setup

Select initial display options on the Display Setup menu. All available display modes are applicable to SS#7 data. Protocol displays specific to SS#7, which appear only when an SS#7 Personality Package has been loaded, are described in Sections 42 and 43. Data, Display Window, and Program Trace displays are described in Section 5.

You have the option of suppressing 7E flags on the Display Setup menu. See Section 5.3(C).

Data suppressed from the display is available for triggering in real-time. However, it is not available for triggering when character-oriented data from the screen buffer is played back.

It is also possible to suppress all occurrences of a particular type of frame from the display. Refer to the description of the SUPPRESS action in Section 42.

41.3 SS#7 Compression at Layer 1

When the Layer 1 package SS7_CMPRESN is loaded, redundant Fill-In and Link Status Signal Units are suppressed from the character display and also the Layer 2 trace display in Run mode. That is, only the first in a series of identical Link Status or Fill-In Signal Units is displayed and presented to the trigger program. Subsequent identical units are compressed, until a different type of signal unit is transmitted on the same side of the line. Compare Figure 41-2 to Figure 41-3 (in which Fill-In's and LSU's have been compressed).

> **NOTE**: The number of suppressed signal units and flags can be monitored via four C variables. Refer to Table 79-1.

Bit-image recording of data is not affected by Layer 1 suppression. Simply select and load NO_PACKAGE at Layer 1 and play the same bit-image data back again, to cancel the effects of suppression. All the original Link Status and Fill-In Signal Units will be presented to the screen display and the triggers.

MON/LINE BLK=00000 S 05/26/89 12:04
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DTE	FILL-IN	00	1	4D	1	3F	1204:31.257	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.280	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.303	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.327	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.346	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.375	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.395	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.423	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.441	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.461	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.515	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.546	G
DTE	FILL-IN	00	1	4D	1	3F	1204:31.577	G
DCE	MESSAGE	08	1	3F	1	4E	1204:31.598	G
DTE	FILL-IN	00	1	4D	1	3F	1204:32.019	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 41-2 All LSU's and Fill-In's detected are displayed on this screen.

MON/LINE BLK=00000 S 05/26/89 12:04
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DTE	FILL-IN	00	1	4D	1	3F	1204:31.222	G
DCE	FILL-IN	00	1	3F	1	4D	1204:31.576	G
DCE	MESSAGE	08	1	3F	1	4E	1204:31.593	G
DCE	FILL-IN	00	1	3F	1	4E	1204:32.021	G
DTE	FILL-IN	00	1	4E	1	3F	1204:32.048	G
DTE	MESSAGE	08	1	4E	1	40	1204:32.069	G
DCE	FILL-IN	00	1	40	1	4E	1204:32.080	G
DTE	FILL-IN	00	1	4E	1	40	1204:32.115	G
DTE	MESSAGE	08	1	4E	1	41	1204:32.130	G
DCE	FILL-IN	00	1	41	1	4E	1204:32.154	G
DTE	FILL-IN	00	1	4E	1	41	1204:32.177	G
DCE	MESSAGE	08	1	41	1	4F	1204:32.195	G
DCE	FILL-IN	00	1	41	1	4F	1204:32.208	G
DTE	FILL-IN	00	1	4F	1	41	1204:32.237	G
DCE	MESSAGE	08	1	41	1	50	1204:32.271	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 41-3 Redundant LSU's and Fill-In's have been compressed in this data.

42 SS#7 Layer 2

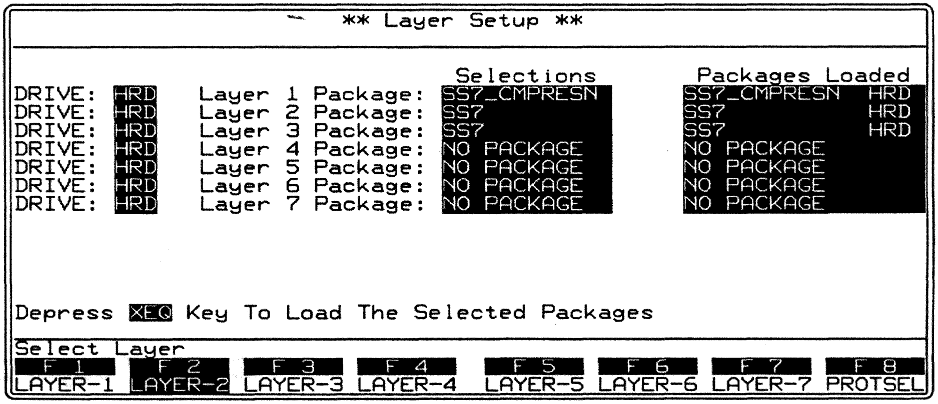


Figure 42-1 The SS#7 personality package for Layer 2 is loaded from the Layer Setup screen.

42 SS#7 Layer 2

SS#7 (CCSS#7) is an abbreviation for the CCITT–defined Common Channel Signalling System #7. At Layer 2, SS#7 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 42-1 shows the Layer Setup screen configured to load in the Layer 2 SS#7 package from the hard disk. Refer to Section 6 for details on operating the Layer Setup screen.

42.1 Set Up for SS#7

(A) Layer Setup

The SS#7 package at Layer 1 allows you to compress redundant frames, as explained in Section 41.

The Layer 2 SS#7 package consists of the following:

- A protocol trace (illustrated in Figure 42-2) that distills from SS#7 data the Level 2 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

- A group of conditions and actions at Layer 2 on the Protocol Spreadsheet that facilitate SS#7 programming. Figure 42-4 shows the softkey path to the first rack of condition softkeys when the SS#7 package is loaded in at Layer 2.

(B) Line and Display Setup

Be sure that the **Format** selection is BOP (for Bit–Oriented Protocol) when you are testing SS#7. Select display options on the Display Setup menu. These options are discussed in Section 41.2.

42.2 Protocol Trace

The Layer 2 SS#7 package includes an automatic frame–trace display that summarizes link–level activity. This trace mode is enabled whenever the unit is in Run mode, both real–time and frozen.

While the unit is in Run mode, press the softkey for L2TRACE to bring the protocol trace for SS#7 Layer 2 to the screen. (If the SS#7 package for Layer 3 is also loaded in, the L2TRACE softkey will appear after you have pressed PROTOCL, F2 on the primary rack of display–mode softkeys.)

Figure 42-2 is an example of the Layer 2 trace display. Each horizontal row in the trace represents a frame.

MON/LINE BLK=00000 S 05/26/89 12:30

ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DCE	MESSAGE	08	1	3B	1	66	1229:59.160	G
DCE	FILL-IN	00	1	3B	1	66	1229:59.203	G
DTE	FILL-IN	00	1	66	1	3B	1229:59.242	G
DTE	MESSAGE	08	1	66	1	3C	1229:59.278	G
DTE	FILL-IN	00	1	66	1	3C	1229:59.306	G
DCE	FILL-IN	00	1	3C	1	66	1229:59.352	G
DTE	MESSAGE	08	1	66	1	3D	1229:59.371	G
DTE	FILL-IN	00	1	66	1	3D	1229:59.421	G
DCE	FILL-IN	00	1	3D	1	66	1229:59.441	G
DCE	MESSAGE	08	1	3D	1	67	1229:59.470	G
DCE	FILL-IN	00	1	3D	1	67	1229:59.506	G
DTE	FILL-IN	00	1	67	1	3D	1229:59.521	G
DCE	MESSAGE	07	1	3D	1	68	1229:59.559	G
DTE	FILL-IN	00	1	68	1	3D	1229:59.588	G
DCE	MESSAGE	07	1	3D	1	69	1230:50.007	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8

L2TRACE L3TRACE

Figure 42-2 SS#7 Layer 2 Protocol Trace.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The frame displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. Compare Figure 42-2 with Figure 42-3. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys. Figure 42-3 shows part of a dual-line data screen in Freeze mode. The first frame in the display is the same one that is traced at the top of Figure 42-2.

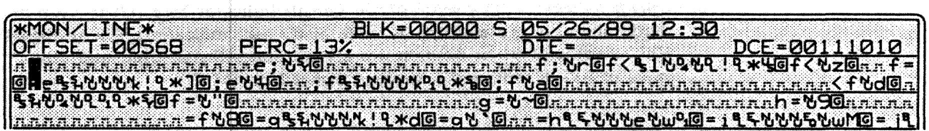


Figure 42-3 Data-display of Protocol Trace shown in Figure 42-2.

(B) Trace Columns

The columns in the protocol trace for Layer 2 SS#7 are explained below.

1. *Source*. The **SRC** column identifies the lead on which the signal unit was monitored, TD (DTE) or RD (DCE). Just as on the data-display, RD data is underlined.

2. *Type*. The second column, **TYPE**, lists the signal-unit type (STATUS= for a Link Status Signal Unit, FILL_IN for a Fill-In Signal Unit, or MESSAGE for a Message Signal Unit). For a Link Status Signal Unit, the status type is also given as an abbreviation.

   The format for Fill-In and Link Status Signal Units are shown at the end of this section, in Figure 42-10 and Figure 42-11. Abbreviations and values for Link Status Signal Units (LSU) types are defined in Table 42-1.

Table 42-1
LSU Status Field
(Bits 2-0 of first Status Field Octet)

Acronym	Definition	Binary Value
O	Out of Align	000
N	Normal	001
E	Emergency	010
OS	Out of Service	011
PO	Processor Outage	100
B	Busy	101

Note: Bits 7-3 of the First Status Field Octet (SFO) are spare.

A second Status Field Octet may be present.

3. *Length indicator.* The value of the Length Indicator byte (**LI**) is given in the third column of the display. A value of 00 here indicates a Fill-In Signal Unit, a value of 01 or 02 indicates a Link Status Signal Unit, and a hex value of 03-3F indicates a Message Signal Unit (MSU).

4. *Backward indicator bit.* The fourth column, labeled **BIB**, provides the value of the Backward Indicator Bit.

5. *Backward sequence number.* The hex value of the Backward Sequence Number (**BSN**) is listed in the next column.

6. *Forward indicator bit.* The **FIB** column provides the Forward Indicator Bit.

7. *Forward sequence number.* The Forward Sequence Number (**FSN**) is displayed in hex in the next column.

8. *Time.* The time of the arrival of the *end of the frame* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

   When **Time Ticks:** **ON** is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

   If **Time Ticks:** **OFF** was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

9. *Frame checking.* An SS#7 frame ends as soon as a ᶠE flag or seven 1-bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the **BCC** column of the trace display. The symbol ◙ denotes a good frame check, while ■ symbolizes a bad frame.

   ■ for abort is posted to the displays when a frame is ended by seven 1-bits.

42.3 Monitor Conditions

When the Layer 2 SS#7 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the **DTE** and **DCE** selections on the first rack of condition softkeys at Layer 2. See Figure 42-4.

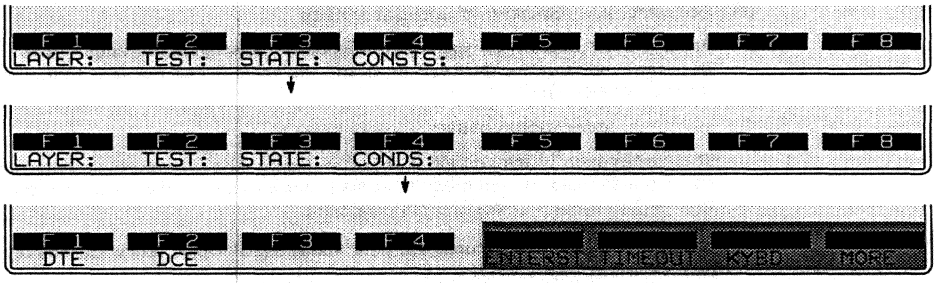


Figure 42-4 To monitor line conditions, first select *DTE* or *DCE*.

(A) Signal-Unit Types

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represents *types* of Signal Units.

1. *Fill-In and Message.* The softkeys for FILL_IN (Fill-In Status Unit), MESSAGE (Message Signal Unit), and STATUS= (Link Status Signal Unit) are illustrated in Figure 42-5. Press a softkey to write one of these signal-unit types to the Layer 2 spreadsheet.

   DTE (or DCE) FILL_IN and DCE (or DTE) MESSAGE are complete conditions and will come true if a matching frame is monitored. BIB, FIB, and BCC conditions may be added to the simple frame mnemonic, but they are optional.

2. *Link Status.* DTE (or DCE) STATUS= is not a complete condition. Select an LSU type from the third softkey rack shown in Figure 42-5. The full set of abbreviations and their meanings is given in Table 42-1.

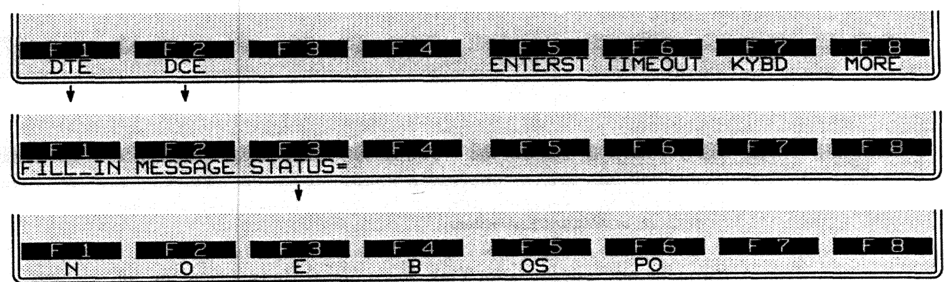


Figure 42-5 Frame types.

(B) Forward and Backward Indicator Bits

For any SS#7 frame type, you have the option of specifying the value of the Backward Indicator Bit (BIB= 0, BIB= 1) and the value of the Forward Indicator Bit (FIB= 0, FIB= 1):

CONDITIONS: DTE FILL_IN BIB= 1 FIB= 1

The softkey path to BIB and FIB is shown in Figure 42-6. If you omit either the FIB or the BIB field, the omitted FIB or BIB is not checked in the received frame. Press DONE to bypass the BIB and FIB conditions.

To make BIB and FIB selections for Link Status Signal Units, follow the softkey path shown in Figure 42-7.

(C) BCC Conditions

For any SS#7 frame type, you also have the option of specifying a BCC or abort condition:

CONDITIONS: DTE MESSAGE BD_BCC

The softkey path to BCC selections for Fill-In and Message Signal Units is shown in Figure 42-6. Press DONE to bypass the BCC condition.

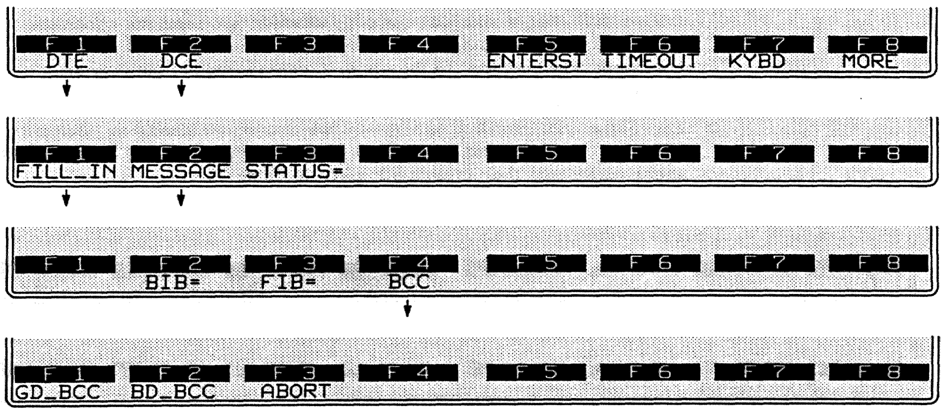


Figure 42-6 You may specify *BIB*, *FIB*, or *BCC* conditions immediately following *FILL_IN* or *MESSAGE* selections.

To make BCC selections for Link Status Signal Units, follow the softkey path shown in Figure 42-7.

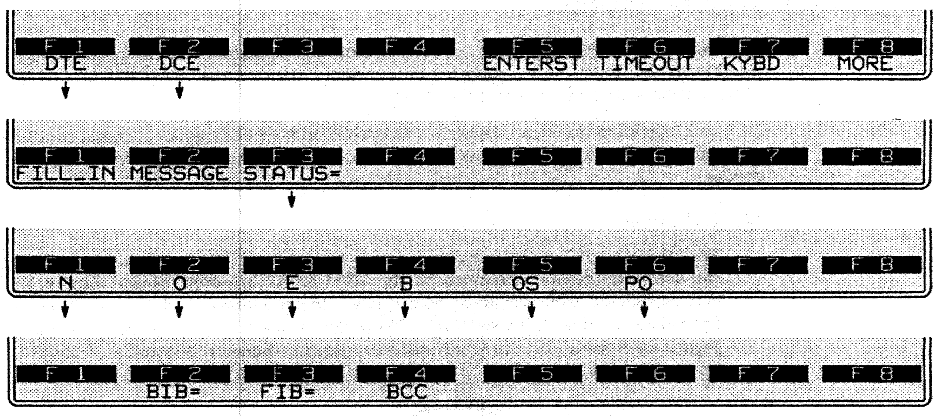


Figure 42-7 **You must specify the type of Link Status Unit for a** ***STATUS=*** **spreadsheet condition.** ***BIB, FIB,*** **and** ***BCC*** **conditions may then be selected.**

42.4 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 2 protocol trace (see Section 42.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE and DCE conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE or DCE condition comes true at Layer 2, the frame that satisfied the condition can be enhanced on the SS#7 Layer 2 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—F1 on the first rack of action softkeys. Figure 42-8 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

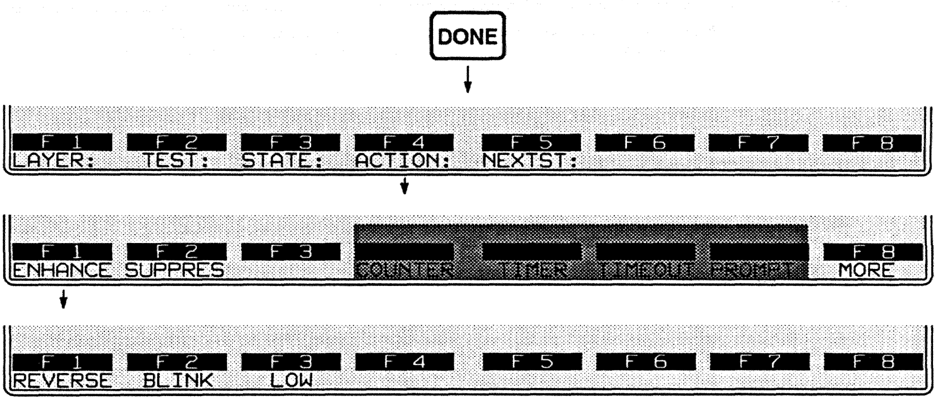


Figure 42-8 Selected frames on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

MON/LINE BLK=00000 S 05/26/89 12:30
ASCII/8/NONE/BOP

SRC	TYPE	LI	BIB	BSN	FIB	FSN	TIME	BCC
DCE	MESSAGE	08	1	3B	1	66	1229:59.160	G
DCE	FILL-IN	00	1	3B	1	66	1229:59.203	G
DTE	FILL-IN	00	1	66	1	3B	1229:59.242	G
DTE	MESSAGE	08	1	66	1	3C	1229:59.278	G
DTE	FILL-IN	00	1	66	1	3C	1229:59.306	G
DCE	FILL-IN	00	1	3C	1	66	1229:59.352	G
DTE	MESSAGE	08	1	66	1	3D	1229:59.371	G
DTE	FILL-IN	00	1	66	1	3D	1229:59.421	G
DCE	FILL-IN	00	1	3D	1	66	1229:59.441	G
DCE	MESSAGE	08	1	3D	1	67	1229:59.470	G
DCE	FILL-IN	00	1	3D	1	67	1229:59.506	G
DTE	FILL-IN	00	1	67	1	3D	1229:59.521	G
DCE	MESSAGE	07	1	3D	1	68	1229:59.559	G
DTE	FILL-IN	00	1	68	1	3D	1229:59.588	G
DCE	MESSAGE	07	1	3D	1	69	1230:50.007	G

F 1 F 2 F 3 F 4 F 5 F 6 F 7 F 8
L2TRACE L3TRACE

Figure 42-9 DTE Message Signal Units have been enhanced.

Figure 42-9 shows one screen of a Layer 2 protocol trace in which DTE MSUs have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

CONDITIONS: DTE MESSAGE
ACTIONS: ENHANCE REVERSE

(B) Suppress

Individual frames that are suppressed in Layer 2 actions are deleted from the trace display. Figure 42-8 shows the softkey path to SUPPRES.

42.5 SS#7 Emulation

You may use SS#7 protocol for interactive testing of a DTE or a DCE. However, transmitted strings must be entered manually, since no automatic selections are currently available for emulation, either at Layer 2 or Layer 3.

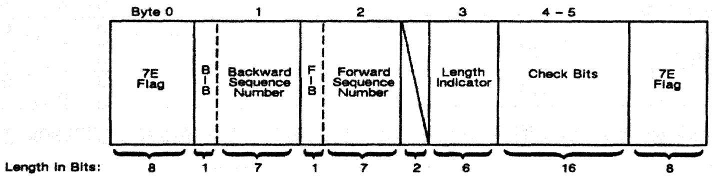
42.6 SS#7 Frame Structures and Values

The format for Fill-In Signal Units is given in Figure 42-10.

The format for Link Status Signal Units is given in Figure 42-11. Table 42-1 lists possible LSU status values.

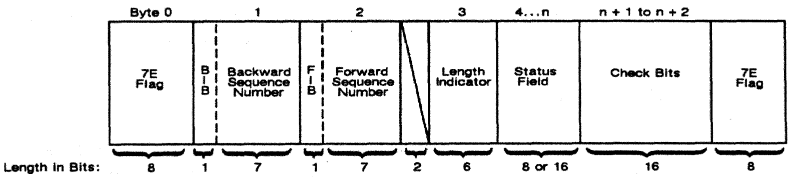
Refer to Section 43 for the structure of a Message Signal Unit and for the differences in CCITT and ANSI (US Standard) frame format. Also consult Section 43 for any information pertinent to SS#7 Level 3.

NOTE: Frame format, unless otherwise stated, reflects the frame as displayed on the screen, not the actual transmission order.



BIB: Backward Indicator Bit
FIB: Forward Indicator Bit
Length Indicator = 0 for Fill-in's
(LSB to right of each byte)

Figure 42-10 Format of Fill-in Signal Unit (FI).



BIB: Backward Indicator Bit
FIB: Forward Indicator Bit
Length Indicator for LSU's = 1 or 2
(LSB to right of each byte)

Figure 42-11 Format of Link Status Signal Unit (LSU).

43 SS#7 Layer 3

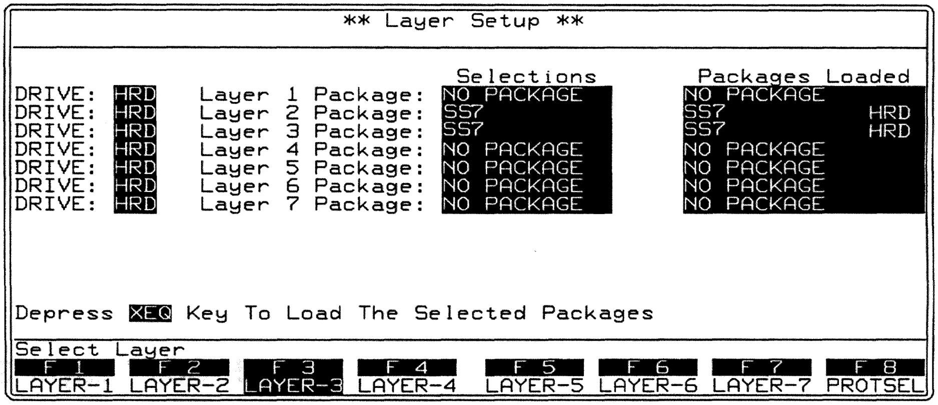


Figure 43-1 The SS#7 personality package for Layer 3 is loaded from the Layer Setup screen.

43 SS#7 Layer 3

SS#7 (CCSS#7) is an abbreviation for the CCITT–defined Common Channel Signalling System #7. At Layer 3, SS#7 is a "layer personality package" of functions that are loaded into memory from disk via the Layer Setup screen. Figure 43-1 shows the Layer Setup screen configured to load in the Layer 3 SS#7 package from the hard disk. Refer to Section 6 for details on operating the Layer Setup screen.

The Layer 3 SS#7 package consists of the following:

- A special SS#7 Packet Level Setup screen that controls certain parameters when the unit is tracing SS#7.

- A protocol trace (illustrated in Figure 43-2) that distills from SS#7 data the Layer 3 events that have protocol significance. This trace is accessible by softkey in Run mode at all times.

- A group of conditions and actions at Layer 3 on the Protocol Spreadsheet that facilitate SS#7 programming. Figure 43-3 shows the softkey path to the first rack of condition softkeys when the SS#7 package is loaded in at Layer 3.

43.1 Packet–Level Setup

The SS#7 Packet Level Setup screen must be configured correctly for an accurate trace display.

To bring up this screen, first go to the Layer Setup screen (press PROGRAM, F5). Execute the SS#7 selection at Layer 3: **SS7** should appear in the **Packages Loaded** column. Press F8 (labeled PROTSEL) to bring up the prompt to **Select Protocol Configuration Screen**. Then press F3 (LAYER-3) to call up the SS#7 Packet Level Setup screen.

The only parameter field on this screen is **National Format**. This field allows you to specify the format of the point codes in the label portion of a frame with a National Network Indicator (binary 10 or 11). Select CCITT or ANSI (US Standard). It is important that you select the correct format prior to testing, since the format which the INTERVIEW anticipates for national frames differs depending on your choice. Compare the two frame structures in Figure 43-9.

(A) CCITT Format

When you select CCITT, national frames are structured like international frames. These frames contain 14-bit point codes within a 32-bit routing label.

NOTE: The INTERVIEW represents a 14-bit CCITT point code as two hexadecimal bytes, and it pads the two most significant bit positions of the left-most byte with zeros.

(B) ANSI Format

The default selection is ANSI, which is US standard format, in which national frames contain 24-bit point codes within a 56-bit routing label.

43.2 Protocol Trace

While the unit is in Run mode, press the softkey for PROTOCL ([F2] on the primary rack of display-mode softkeys) and then the softkey for L3TRACE ([F2])to bring the protocol trace for SS#7 Layer 3 to the screen. Figure 43-2 is an example of this trace display. Each horizontal row in the trace represents an MSU.

(A) The Protocol Trace in Freeze Mode

Press [FREEZE] to prevent the addition of new data to *all* the display buffers, including the trace buffers. The frozen trace display may be scrolled through or paged through. The top line always is the cursor line (though there is no actual cursor on the trace display). Pressing [ROLL FWD] or [↓] moves the viewing "window" down relative to the data to add one line of fresher data to the bottom of the screen. Pressing [ROLL BACK] or [↑] moves the viewing window up to add a line of older data to the top of the screen.

Depression of the [NEXT PAGE] key adds fifteen lines—one full page—of newer frames to the frozen trace screen. Depression of [PREV PAGE] adds fifteen lines of older frames.

The MSU displayed on the top line of frozen trace-data will appear as the first frame in the raw-data or data-plus-leads display. To view the raw data that generated a particular line in the trace display, use [ROLL FWD] or [ROLL BACK] (or [↑] or [↓]) to move the line in question to the top of the screen. Then press one of the data softkeys.

(B) Trace Columns

There are eleven columns in the Layer 3 display.

1. *Source*. The first column (**SRC**) identifies the MSU source as DTE (TD) or DCE (RD). Just as on the data-display, RD data is underlined.

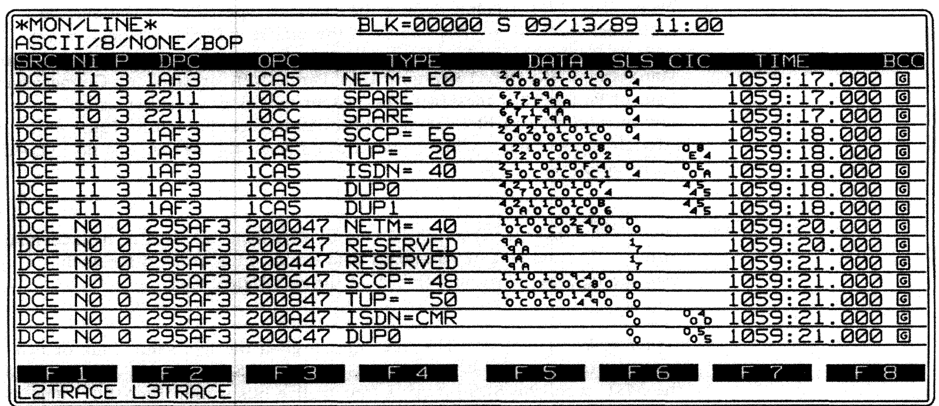


Figure 43-2 SS#7 Layer 3 Protocol Trace.

2. *Network indicator*. The second column (labeled **NI**) interprets the Network Indicator in a two-character field. The first bit in the two-bit network Indicator is always set to 0 in international signal units; the first bit is set to 1 in all national signal units. On the SS#7 trace, the bit value is represented as an "I" to indicate CCITT international format or "N" to represent national format, whether ANSI or CCITT. The value of the second bit in the Network Indicator is also displayed on the trace screen.

3. *Priority*. The third column (**P**) displays the value of the Priority code, regardless of format. The Priority code has a value of 0–3 for US Format. These bits are spare in CCITT International or National Format.

4. *Destination point code*. The next column (**DPC**) provides the Destination Point Code. When the **NI** field indicates ANSI format (**N**), three hex bytes are used in the **DPC** column. CCITT format (**I**) allocates only 14 bit positions. The 14 bits are displayed as two bytes, with the two left-most bit positions padded with zeros.

5. *Originating point code.* The next column (**OPC**) provides the Originating Point Code. When the **NI** field indicates ANSI format (N), three hex bytes are used in the **OPC** column. CCITT format (I) allocates only 14 bit positions. The 14 bits are displayed as two bytes, with the two left-most bit positions padded with zeros.

6. *Type.* The **TYPE** column defines the message type (that is, the Service Indicator) for MSUs. The values of the different Service Indicators are given in Table 43-1. For Integrated Services Data Network (ISDN), Network Management (NETM), Telephone User Part (TUP), or Signaling Connection Control Part (SCCP) messages, the header type is given either as an abbreviation or as a hex value. Abbreviations are defined in Table 43-2 through Table 43-5. A hex value appears when the header has no defined abbreviation.

7. *Data.* The **DATA** column displays up to eight bytes of data in hexadecimal format. The amount of additional data displayed is defined for each message type as shown in Table 43-2 through Table 43-5.

8. *Signaling link selection.* The **SLS** column gives the hex value (one or two bytes) of the signaling link selection when an SLS is present. Depending on the MSU type, the SLS occupies four or five bits within the MSU. The 4- or 5-bit SLS is always shown as a hex byte in the Layer 3 trace. The 3 or 4 remaining bit positions of the byte are padded with zeros.

9. *Circuit identifier code.* When a Circuit Identifier Code is present, it is listed in the next column. The **CIC** is a 16-bit field within the MSU and is represented on the trace screen as two hex characters.

10. *Time.* The time of the arrival of the *end of the MSU* at the DTE or DCE monitor is provided by a 24-hour clock and posted to the trace display. The clock is accurate to the millisecond.

    When **Time Ticks:** ON is selected on the Front-End Buffer Setup screen (see Section 7), time values are incorporated into the data itself. As a result, times posted to the trace display will not be affected when recorded data is played back, even at varying speeds.

    If **Time Ticks:** OFF was selected instead during live recording, times on the trace during playback will be influenced by "local conditions" such as playback speed, idle suppression, etc.

11. *Frame checking*. An SS#7 frame ends as soon as a TE flag or seven 1–bits in a row are detected. If a flag ends the frame, a frame check is performed and the result is posted both to the data display and to the BCC column of the trace display. The symbol [G] denotes a good frame check, while [B] symbolizes a bad frame.

[A] for abort is posted to the displays when a frame is ended by seven 1–bits.

NOTE: In MSU's which are incomplete, the header is expanded if sufficient information is present. Additional unexpanded bytes displayed may include the first FCS byte followed by FF bytes which pad to the end of the frame display.

43.3 Monitor Conditions

When the Layer 3 SS#7 personality package is loaded in (via the Layer Setup screen), a set of conditions checks DTE and DCE leads both in monitor and emulate modes. This set of conditions is accessed by the DTE and DCE selections on the first rack of condition softkeys at Layer 3. See Figure 43-3.

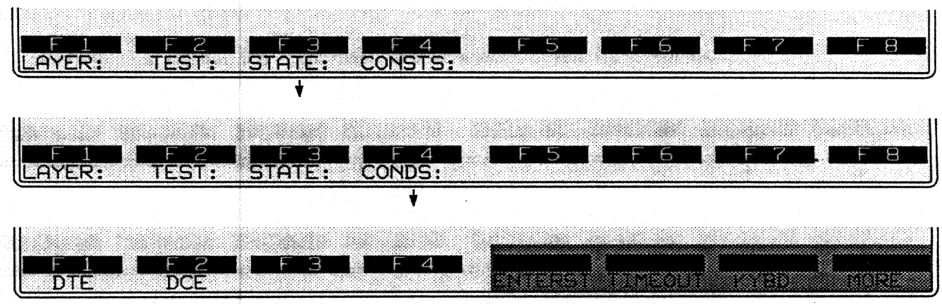


Figure 43-3 To monitor line conditions, first select *DTE* or *DCE*.

(A) Message Signal Unit Types

After the keyword DTE (or DCE) is written to the spreadsheet, a rack of softkeys appears that represents *types* of MSUs. See Figure 43-4.

The Message Signal Units which appear as automatic selections include NETM (Network Management), ISDN (Integrated Services Data Network User Part), SCCP (Signaling Connection Control Part), TUP (Telephone User Part), NTR (Network Test Regular), NTS (Network Test Special), DUP0 or DUP1 (Data User Part 0 and Data User Part 1), and OTHER (for user–specified MSU's). Values for the different MSU types are given in Table 43-1.

Press a softkey to write one of these MSU-types to the Layer 3 spreadsheet. DTE or DCE followed by an MSU-type mnemonic—DTE NETM, for example, or DCE ISDN—is a complete condition and will come true if a matching MSU is monitored.

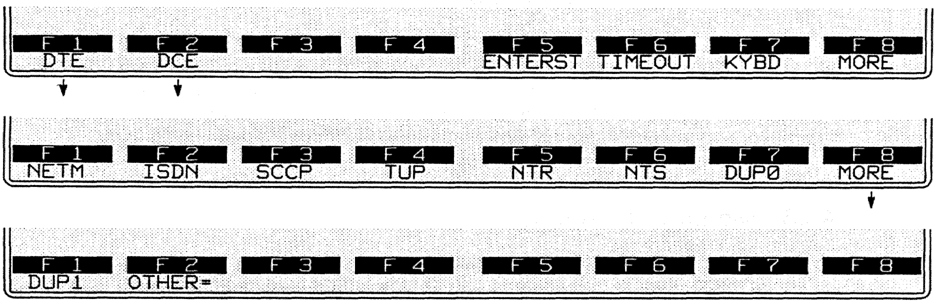


Figure 43-4 MSU types.

When you select OTHER as the MSU type, you must specify the value of the four low-order bits for the SIO (Service Indicator Octet). Enter the value of the four low-order bits as a single hexadecimal digit. (Do not use the [HEX] key.)

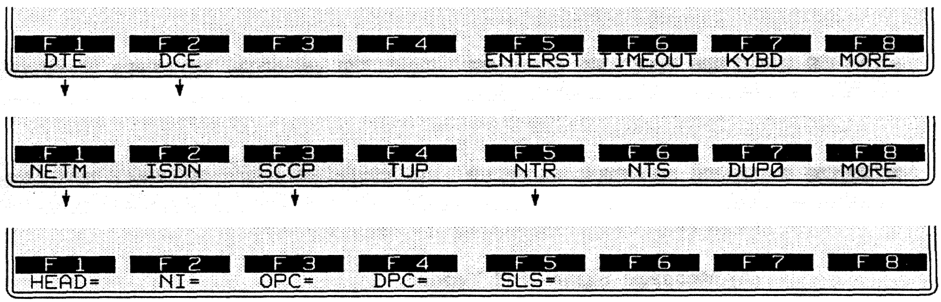


Figure 43-5 Selected MSU type determines subsequent softkey selections.

Certain secondary fields appear for the remaining MSU types. The fields for NETM, SCCP, and NTR selections are shown in Figure 43-5. These optional selections for MSUs permit you to specify Network Identifier, Originating Point Code, Destination Point Code, Signalling Link Selection (where applicable), Circuit Identification Code (where applicable), and Header (where applicable). See the spreadsheet example in Figure 43-6.

```
LAYER: 3
  TEST: l3check
    STATE: charge
      CONDITIONS: DTE SCCP HEAD= CC OPC= 1CA5 DPC= 1AF3
      ACTIONS: ENHANCE BLINK
```

Figure 43-6 Three optional conditions (*HEAD=* , *OPC=* , and *DPC=*) have been selected for SCCP Message Signal Units on the DTE side.

(B) MSU Header

When certain MSUs are selected, you may also specify the header in the MSU. Selectable headers are available when the MSU selection is NETM, NTR, SCCP, TUP, or ISDN. Header selections for NETM, SCCP, TUP, or ISDN MSUs, their meanings, and their values are given in Table 43-2 through Table 43-5. Header selections for NTR MSUs are given in Note 8.

(C) Network Indicator

Once you have specified an MSU type, you may specify the Network type. Select NI= N to signify a National network; select NI= I to indicate an International network.

> **NOTE:** National in this case refers to the value of the first two bits in the Service Indicator Octet. It does NOT distinguish between CCITT National and US Standard Format. To designate the appropriate frame structure, you MUST select CCITT or US Standard Format as a Layer Setup parameter as described in Section 43.1. Legal values in the OPC and DPC fields and the actual data strings anticipated as CONDITIONS on the Protocol Spreadsheet are determined by your Layer Setup selection for Network type.

(D) Originating Point Code

Type in the OPC as hexadecimal digits. (Do not use the [HEX] key.) The size of this field differs for a CCITT MSU or a US Standard MSU.

In CCITT format, the OPC is a 14-bit field. Type in a two-byte entry (four hex digits), and assume that the two high-order bits of the left-most byte are zeros. (Legal values are 0000 to 3FFF.)

In US standard format, the OPC is a three-byte field. (Legal values are 000000 to FFFFFF.)

(E) Destination Point Code

Type in the DPC as hexadecimal digits. (Do not use the [HEX] key.) As with the OPC, the size of this field varies, depending on the frame structure (CCITT or US Standard) selected as a Layer Setup parameter. Legal entries are the same as for Originating Point Codes.

(F) Signaling Link Selection

MSU's which contain an SLS are listed in Table 43-1.

The SLS occupies four bits in CCITT format. The four high-order bits of the same byte are always zero. Valid entries for CCITT format are 00 to 0F.

In US Standard format, the SLS occupies five low-order bits of a byte, and the three high-order bits of the same byte are set to zero. Valid entries for US format are 00 to 1F.

Enter two hexadecimal digits as the SLS. (Do not press [HEX].)

(G) Circuit Identifier Code

MSUs which contain a CIC are listed in Table 43-1. For ISDN MSUs, the CIC is a two-byte field. Enter the CIC as hexadecimal digits in the range 0 to FFFF. Do not use the [HEX] key. For TUP MSUs, enter up to three hexadecimal digits in the range 0 to FFF.

43.4 Display Actions

ENHANCE and SUPPRESS pertain to lines of data on the Layer 3 protocol trace (see Section 43.2). They do not suppress and enhance data on the raw-data display. Raw data is enhanced and suppressed at Layer 1.

DTE and DCE conditions can trigger an ENHANCE or SUPPRESS action. These conditions are active when the INTERVIEW is in monitor mode or in either of the emulate modes.

(A) Enhance

Whenever a DTE or DCE condition comes true at Layer 3, the MSU that satisfied the condition can be enhanced on the SS#7 Layer 3 protocol-trace display, or it can be deleted from the trace completely. In an actions block on the Protocol Spreadsheet, press the ENHANCE softkey—[F1] on the first rack of action softkeys. Figure 43-7 shows the three softkey subselections beneath ENHANCE. They are REVERSE, BLINK, and LOW.

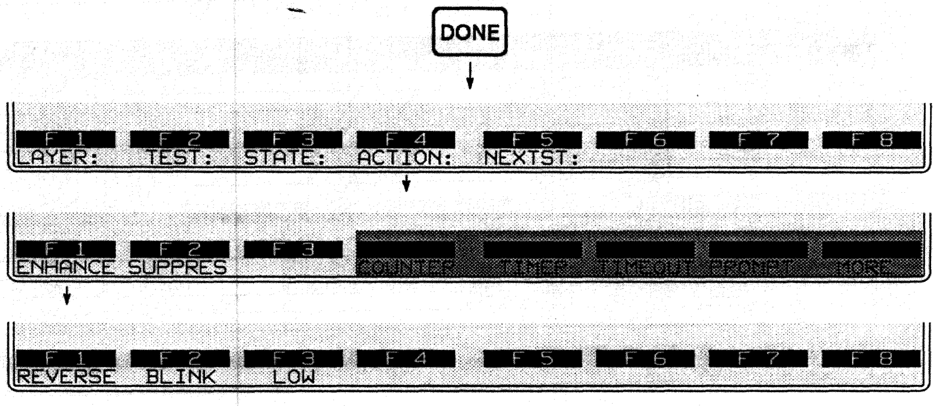


Figure 43-7 Selected MSUs on the protocol trace may be enhanced or suppressed.

Reverse-image and blink enhancements affect the plasma-display screen. In addition, a low-intensity enhancement can be applied to screens that are transmitted to a black-and-white monitor connected at the RS-170 port at the rear of the INTERVIEW.

Reverse, blink, and low enhancements can be mapped to colors on a color monitor attached at the INTERVIEW's RGB port (Figure 1-6). See Section 16.2 for an explanation of how reverse, blink, and low enhancements relate to character and background colors in the RGB output.

Figure 43-8 shows one screen of a Layer 3 protocol trace in which NETM MSUs have been enhanced in reverse video. The trigger that caused this enhancement was as follows:

```
CONDITIONS: DCE NETM
ACTIONS: ENHANCE REVERSE
```

(B) Suppress

Individual MSUs that are suppressed in Layer 3 actions are deleted from the trace display. Figure 43-7 shows the softkey path to SUPPRES.

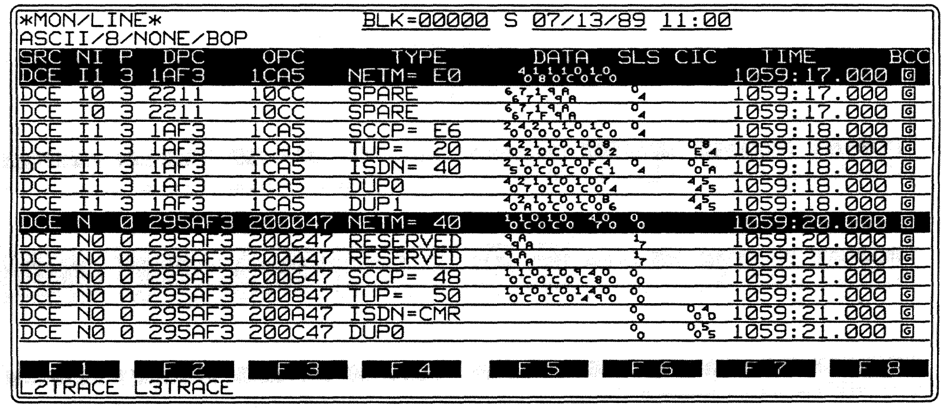


Figure 43-8 NETM Message Signal Units have been enhanced.

43.5 Structure of SS#7 Message Signal Units

Figure 43-9 shows the general structure of a Message Signal Unit. Figure 43-10 illustrates how CCITT International or National labels are entered and transmitted. MSU types are defined in Table 43-1. Table 43-2 through Table 43-5 define possible MSU headers for Network Management, SCCP, ISDN, and TUP MSU's.

> **NOTE:** Structure, unless otherwise stated, reflects the MSU as displayed on the screen, not the actual transmission order of data.

Consult Figure 42-10 and Figure 42-11 for the format of Fill-In and Link Status Signal Units. Any information pertinent to SS#7 Layer 2 is included in Section 42.

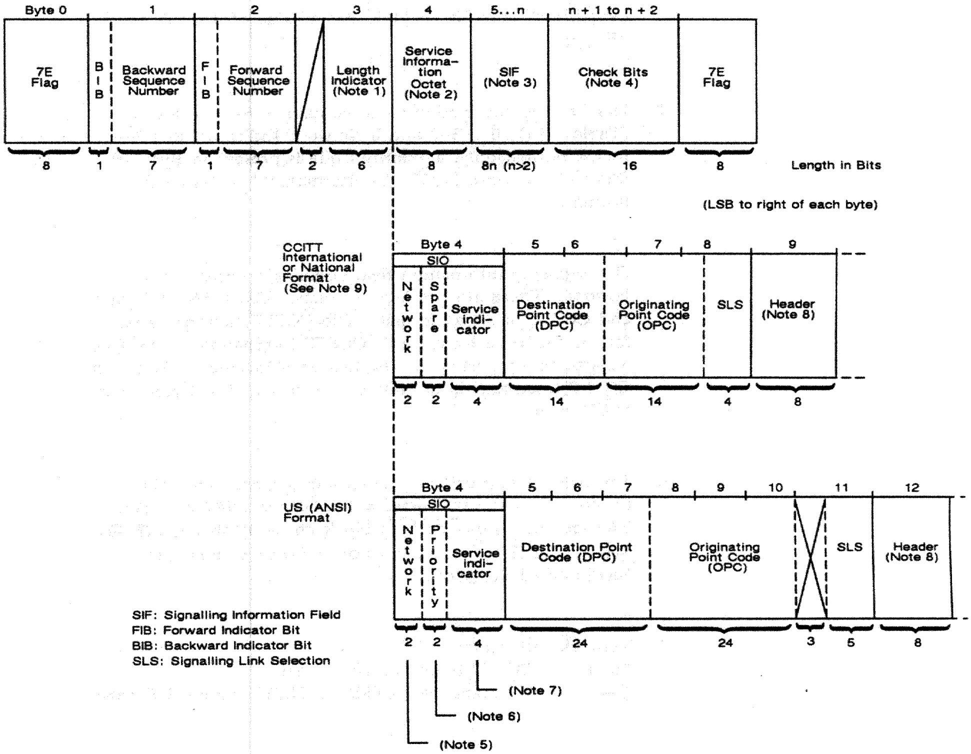


Figure 43-9 Format of a Message Signal Unit (MSU).

NOTES:

1. Length Indicator for an MSU has a value of 3 to 63 (3 to 3F, hex).

2. The Service Information Octet contains a Service Indicator (Table 43-1), Bits 3–0 and a Network Indicator, Bits 7–6. In US Format only, a Priority Code is present in Bits 5–4. Bits 5–4 are spare in CCITT International or National Format.

3. The Signaling Information field contains a Label and a Header. There are two label formats: US, a 56 bit format, and CCITT, a 32 bit format. The CCITT National label follows the same format as a CCITT International label (see expansions, this figure). The header is located at Octet 9 in CCITT International or National Format and at Octet 12 in US Format.

4. The two octets preceding the closing flag are block check results. Only the first octet will appear in SS#7 line data. The second is replaced by a block check symbol (G, B, R). See Section 8 for an explanation of block checking in Bit-Oriented Protocols.

5. Network Indicators
   00–01 = CCITT International Format
   10–11 = US Standard (ANSI) or CCITT National Format

6. The Priority Code has a value of 0–3 for US Format. These bits are undefined for International Format. They are also undefined in CCITT National Format.

7. A Service Indicator with Bits 3–2 = 01 (in either US or CCITT International or National Format) indicates a User Part. The subsequent structure of the signal unit is dependent on the User Part Type and is not reflected by this figure. Values for TUP and ISDN headers are given in Table 43-4 and Table 43-5.

8. The header gives the Network Management Header (Table 43-2), SCCP Message Header (Table 43-3), or Test Header.

   In Test Messages (SIO = 0001), the four low–order bits determine the type. A value of

   0001 = LTM (Link Test Message)

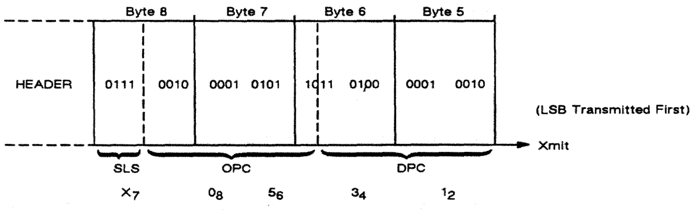
   0010 = LTA (Link Test Acknowledge).

   The four high–order bits are not defined.

9. Since the label in CCITT International or National Format is not byte–aligned, the values displayed in hexadecimal on the INTERVIEW screen are skewed. As a result, CCITT labels must be interpreted as shown in Figure 43-10.

Label values entered in spreadsheet conditions: DPC= 3412
OPC= 0856

Bit sequence that will satisfy the DPC= and OPC= Conditions:



Data as it appears (in hex) on INTERVIEW screen or in send string:

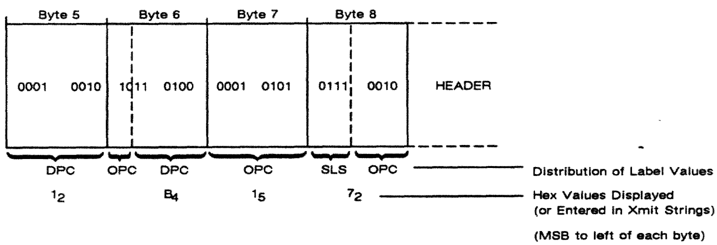


Figure 43-10 CCITT labels are entered and transmitted as shown.

Table 43-1
MSU Service Indicators
(Bits 3-0 of the SIO)

Mnemonic	Meaning	Binary Value
NETM (2)	Network Management	0000
NTR (2)	Regular Testing	0001
NTS (2)	Special Testing	0010
SCCP (2)	Signalling Connection Control Part	0011
TUP (1)	Telephone User	0100
ISDN (1) (2)	ISDN User	0101
DUP0	Data User (Call/Circuit)	0110
DUP1	Data User	0111
----	Spare	1000
----	Spare	1001
----	Spare	1010
----	Spare	1011
----	Spare	1100
----	Spare (3)	1101
----	Spare (4)	1110
----	Spare	1111

(1) Contains a CIC.
(2) Contains an SLS.
(3) ECIS6 for US Standard (ANSI) Format.
(4) Reserved, if US Standard (ANSI) Format.

Table 43-2
Network Management Headers
(Octet 9 for CCITT Format; Octet 12 for US-ANSI Format)

Mnemonic	Message	Hex	Added Bytes Shown	
			US	CCITT
COO	Changeover Order	11	2	1
COA	Changeover Acknowledge	21	2	1
CBD	Changeback Declaration	51	2	1
CBA	Changeback Acknowledge	61	2	1
ECO	Emergency Changeover Order	12	1	0
ECA	Emergency Changeover Acknowledge	22	1	0
RCT	Route-Set-Congestion-Test	13	0	0
TFC	Transfer Controlled	23	4	2
TFP	Transfer Prohibited	14	3	2
TCP (1)	Transfer Cluster Prohibited	24	3	–
TFR	Transfer Restricted	34	3	2
TCR (1)	Transfer Cluster Restricted	44	3	–
TFA	Transfer Allowed	54	3	2
TCA (1)	Transfer Cluster Allowed	64	3	–
RSP (1)	Route-Set-Test Destination Prohibited	15	3	–
RST (2)	Signaling-Route-Set-Test Signal	15	–	2
RSR (1)	Route-Set-Test Destination Restricted	25	3	–
RST (3)	Signaling-Route-Set-Test Signal	25	–	2
RCP (1)	Route-Set-Test Cluster Prohibited	35	3	–
RCR (1)	Route-Set-Test Cluster Restricted	45	3	–
LIN	Link Inhibited	16	1	0
LUN	Link Uninhibited	26	1	0
LIA	Link Inhibited Acknowledge	36	1	0
LUA	Link Uninhibited Acknowledge	46	1	0
LID	Link Inhibited Denied	56	1	0
LFU	Link Force Uninhibited	66	1	0
LLI (1)		76		–
LRI (1)		86		–
DLC	Data Link Connection Orders	18	2	2
CSS	Connection Successful	28	1	0
CNS	Connection Not Successful	38	1	0
CNP	Connection Not Possible	48	1	0

(1) US Format only.
(2) CCITT Format only.
(3) CCITT Format only, national option.

Table 43-3
SCCP Message Headers
(Octet 9 for CCITT International or National Format; Octet 12 for US-ANSI Format)

Mnemonic	Message	Hex	Added Bytes Shown	
			US	Int'l
CR	Connection Request	01	4+	4+
CC	Connection Confirm	02	7+	7+
CREF	Connection Refused	03	4+	4+
RLSD	Released	04	7+	7+
RLC	Release Complete	05	6	6
DT1	Data Form 1	06	6+	4+
DT2	Data Form 2	07	3+	5+
AK	Data Acknowledgment	08	4	5
UDT	Unitdata	09	1+	1+
UDTS	Unitdata Service	0A	1+	1+
ED	Expedited Data	0B	4+	3+
EA	Expedited Data Acknowledgment	0C	3	3
RSR	Reset Request	0D	7+	7+
RSC	Reset Confirmation	0E	6	6
ERR	Error	0F	4+	4+
IT	Inactivity Test	10	3	3

Table 43-4
Telephone User Part (TUP) Message Headers

Mnemonic	Message	Hex	Added Bytes Shown
IAM	Initial address message	11	3+
IAI	Initial address with information	21	3+
SAM	Subsequent address message	31	1+
SAO	Subsequent address with one signal	41	1
GSM	General forward setup information	12	2+
COT	Continuity signal	32	0
CCF	Continuity-failure signal	42	0
GRQ	General request message	13	1
ACM	Address complete message	14	1
CHG	Charging message	24	0+
SEC	Switching-equipment-congestion	15	0
CGC	Circuit-group-congestion	25	0
NNC	National-network-congestion	35	0
ADI	Address incomplete signal	45	0
CFL	Call-failure signal	55	0
SSB	Subscriber-busy signal	65	0
UNN	Unallocated-number signal	75	0
LOS	Line-out-of-service signal	85	0
SST	Send-special-information tone signal	95	0
ACB	Access barred signal	A5	0
DPN	Digital path not provided signal	B5	0
MPR	Misdialed trunk prefix	C5	0
EUM	Extended unsuccessful backward setup	F5	3
ANU	Answer signal, unqualified	06	0
ANC	Answer signal, charge	16	0
ANN	Answer signal, no charge	26	0
CBK	Clear-back signal	36	0
CLF	Clear-forward signal	46	0
RAN	Reanswer signal	56	0
FOT	Forward-transfer signal	66	0
CCL	Calling party clear signal	76	0
EAM	Extended answer message indication	F6	0
RLG	Release-guard signal	17	0
BLO	Blocking signal	27	0
BLA	Blocking-acknowledgment	37	0
UBL	Unblocking signal	47	0
UBA	Unblocking-acknowledgment	57	0
CCR	Continuity-check-request signal	67	0
RSC	Reset-circuit signal	77	0
MGB	Maintenance group blocking	18	1+
MBA	Maintenance group blocking acknowledge	28	1+
MGU	Maintenance group unblocking	38	1+
MUA	Maintenance group unblocking acknowledgment	48	1+

Table 43-4 (Continued)

Mnemonic	Message	Hex	Added Bytes Shown
HGB	Hardware failure group blocking	58	1+
HBA	Hardware failure group blocking acknowledgment	68	1+
HGU	Hardware failure group unblocking	78	1+
HUA	Hardware failure group unblocking acknowledge	88	1+
GRS	Circuit group reset	98	1+
GRA	Circuit group reset-acknowledge	A8	1+
SGB†	Software generated group blocking	B8	1+
SBA†	Software generated group blocking-acknowledge	C8	1+
SGU†	Software generated group unblocking	D8	1+
SUA†	Software generated group unblocking acknowledge	E8	1+
CFM	CCBS facility message	19	1+
CPM	Called party free message	29	0+
CPA	Called party answer	39	0+
CSV	Closed group selection/validation request	49	0+
CVM	Closed group validation check	59	3+
CRM	Closed group selection/validation response	69	5
CLI	Connection line identity	79	1+

† National option.

Table 43-5
ISDN Message Headers

Mnemonic	Message	Hex	Added Bytes Shown
IAM	Initial address	01	5+
SAM	Subsequent address	02	0+
INR	Information request	03	1+
INF	Information	04	1+
COT	Continuity	05	1
ACM	Address complete	06	2+
FOT	Forward transfer	08	0+
ANM	Answer	09	2+
UBM	Unsuccessful backward set-up information	0A	1+
REL	Release	0B	0+
PAU	Pause	0D	0+
RES	Resume	0E	0+
RLSD	Released	0F	0
RLC	Release complete	10	0
CCR	Continuity check request	11	0
RSC	Reset circuit	12	0
BLO	Blocking	13	0
UBL	Unblocking	14	0
BLA	Blocking acknowledgment	15	0
UBA	Unblocking acknowledge	16	0
GRS	Reset circuit group	17	0+
CGB	Circuit group blocking	18	1+
CGU	Circuit group unblocking	19	1+
CGBA	Circuit group blocking acknowledgment	1A	1+
CGUA	Circuit group unblocking acknowledgment	1B	1+
CMR	Call modification request	1C	1+
CMC	Call modification completed	1D	1+
RCM	Reject connect modify	1E	1+
FAR	Facility request	1F	1+
FAA	Facility accepted	20	1+
FRJ	Facility reject	21	2+
FAD	Facility deactivated	22	1+
FAI	Facility information	23	2+
CSVR	Closed group selection/validation request	25	0+
CSVS	Closed group selection/validation response	26	1+
DRS	Delayed release	27	0+
PAM	Pass along	28	0+
GRA	Reset circuit group acknowledgment	29	0+

44 V.35

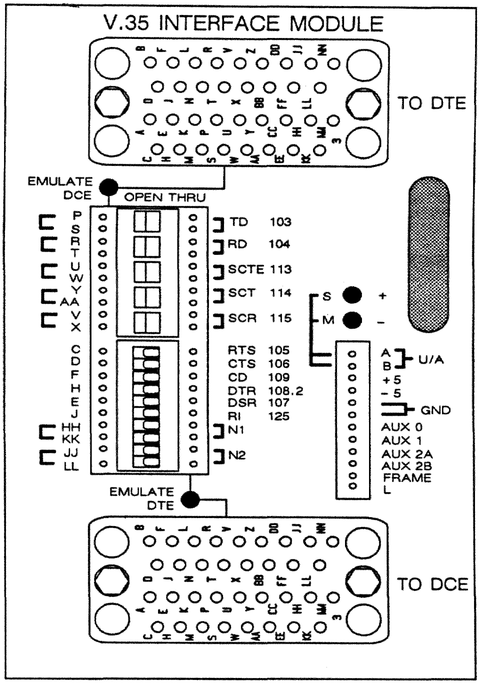


Figure 44-1 Breakout panel on V.35 Test Interface Module (TIM).

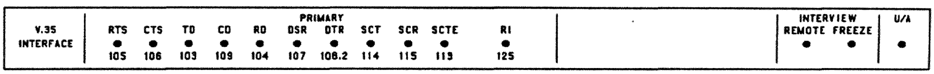


Figure 44-2 V.35 Green-Red LED Overlay.

44 V.35

Figure 44-1 and Figure 44-2 show the TIM and the LED overlay for the V.35 interface. Once the V.35 module is installed, the following EIA functions are enabled:

- Five balanced data and clock circuits and six single-wire, unbalanced control leads can be monitored on the front-panel green-red LEDs.
- Thirteen V.35 circuits can be switched, patched, and tested on the breakout box on the module.
- Up to five unbalanced control leads can be selected for real-time screen display.
- Seven unbalanced leads can be monitored by menu and spreadsheet triggers.
- Five single-wire, unbalanced V.35 leads, two single-wire, unbalanced auxiliary leads, and one two-wire, balanced auxiliary circuit come under spreadsheet *control* in emulate modes.
- Also in emulate modes, five single-wire, unbalanced V.35 leads, two single-wire, unbalanced auxiliary leads, one balanced, two-wire auxiliary circuit, six RTS-CTS handshake timers, and two transmit delays can be regulated via an Interface Control menu screen.

44.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 44-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE LED on the TIM is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector.

When **Mode:** EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE connector. The EMULATE DTE LED is red, and the EMULATE DCE LED is off.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

44.2 Green–Red LEDs

The V.35 LED overlay (Figure 44-2) identifies fourteen LED indicators. Eleven of these represent V.35 circuits monitored at either of the line interfaces (TO DTE, TO DCE) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated and red when the lead is at or above the *on* threshold.

For two-wire, balanced (data and clock) circuits, LEDs are red (*on*) for relative voltages of A over B of over +0.3 V. For single-wire, unbalanced leads, the indicators go red at signals more positive than +3 V with respect to signal ground.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE or phone-jack interface. The remote-control feature is not implemented.

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any lead or twisted pair of leads patched to the UA-input jack(s) on the module. See Figure 44-3. Any of the V.35 circuits that are not accounted for on the front overlay can be assigned to this LED by the user.

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data-plus-leads display; but playback data never drives the green-red LEDs.

44.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable-connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 44.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any V.35 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

Figure 10-3 in a previous section illustrated the position of the INTERVIEW's receivers and high-impedance monitors relative to the breakout and patching area of any TIM (including V.35) when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. *Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.*

The top five DIP switches on the breakout box (Figure 44-1) correspond to the V.35 balanced two-wire (data and clock) circuits. V.35 balanced circuits currently defined for international use are the following, with their pin designators in parentheses: TD (P,S), RD (R,T), SCTE (U, W), SCT (Y, AA), and SCR (V, X).

The next six DIP switches on the breakout box correspond to the V.35 unbalanced control leads. They are RTS (pin C), CTS (D), CD (F), DTR (H), DSR (E), and RI (J).

At the bottom of the breakout box are two additional balanced two-wire circuits, N1 (HH, KK) and N2 (JJ, LL). *N* stands for *National*: these circuits are reserved permanently for national use and may or may not be implemented in a network.

The DIP switches conduct signals straight through, or they open the circuits so that you can reroute them using one of the twisted-pair patch cords provided with the V.35 module. You may patch any of these pairs of leads to the leads on the opposite side of the DIP switches, or to the input or output jacks in the UA-input area on the TIM (Figure 44-3).

> **NOTE:** Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of V.35 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

> **NOTE ALSO:** Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

44.4 Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs are a voltmeter for any unbalanced lead or balanced pair of leads patched to one or both top pins (A and B) on the pin column. These are the user-assigned inputs. The LEDs light when the input exceeds the input thresholds.

For balanced signals patched to the A and B jacks, the red + LED will go on for relative voltages of A over B of over + 0.3 V (*S*pace). The green – LED will light for relative voltages of A over B of –0.3 V (*M*ark).

For unbalanced leads, use only the A jack for patching. When a signal is patched to the A jack only, B is assumed to be signal ground. The *on* threshold for the red + LED in that case is +3 V, and –3 V for the green – LED.

> *CAUTION: For unbalanced signals, patch only into pin A on the user-assigned input: never use pin B.*

The INTERVIEW's triggers can monitor the unassigned input, and actions can be initiated when the signal crosses the appropriate threshold (+3 V for unbalanced V.35 signals, or relative +0.3 V for balanced V.35 signals).

The user-assigned input can also catch glitches on any interface lead. Whenever the voltage crosses the +3 V threshold on an unbalanced lead or the +0.3 threshold (A over B) on a balanced circuit for at least one microsecond, the input latches until the trigger logic (the UA field on interface conditions) can check it.

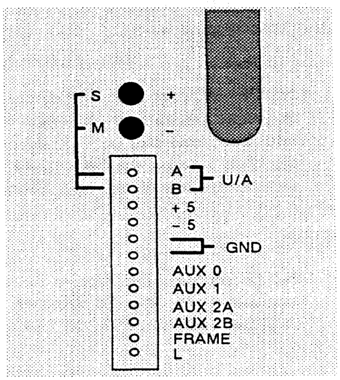


Figure 44-3 A separate column of patch jacks provides UA input and ten special output jacks.

Below the UA input are ten more patch jacks. See Figure 44-3. The first nine are output jacks. Two of the outputs supply +5 V and –5 V, respectively, through 1-kohm resistors.

The 5 V output pins may be used to patch steady spaces or marks out to the interface–access leads. For A–lead patching, +5 V is a space, and −5 V is a mark. For balanced patching, orienting both ends of the patch the same way (yellow on top, for instance) will output a space or *on* signal; while turning either end of the patch over will output a mark or *off* signal.

The third and fourth output pins are at signal ground. These are provided for balanced or unbalanced use.

The next four jacks allow you to patch the output of three auxiliary V.35 drivers that are controlled by trigger actions on the Protocol Spreadsheet and by selections on the Interface Control menu. Refer back to Sections 10.5 and 10.6 of the manual for a discussion of program control over AUX outputs.

Patch the AUX 0 and AUX 1 output jacks to *un*balanced leads that you wish to control via the program. Then use the AUX 0 and AUX 1 selections on the Protocol Spreadsheet and the Interface Control menu (refer to Figure 10-8 and Figure 10-14 in a previous section) to drive these leads on and off. AUX 2 on the spreadsheet and on the Interface Control menu controls the *balanced* output jacks AUX 2A and AUX 2B on the TIM.

> NOTE: The AUX pins on the test–interface module have nothing to do with the 25–pin TTL AUXILIARY connector on the rear of the unit.

The bottom pin in the input–output area of the TIM is a test point for pin L on the V.35 connectors. This is an unbalanced signal that is "reserved for future international use."

44.5 Screen Display of Lead Status

Five V.35 control leads can be selected for a data–plus–leads display, in which the control leads are represented by two–state timing lines drawn beneath TX and RX data. See Section 5.3(B).

44.6 Monitoring V.35 Control Leads

The status of seven V.35 leads can be tested by triggers. The leads are RTS, CTS, CD, DTR, DSR, RI, and a lead of the user's choosing patched to the UA–input jack (see 44.4 above). The status of the lead may be made a trigger–menu condition or a Spreadsheet condition.

44.7 Control of Lead Activity in Emulate Modes

Section 10 discussed the user's control over the standard (RS–232/V.24) interface in emulate modes. The mechanisms for this control were (1) actions on the Protocol Spreadsheet and (2) fields on the Interface Control menu. Refer to Sections 10.5 and 10.6. The same mechanisms apply in the same way to V.35.

45 RS–449

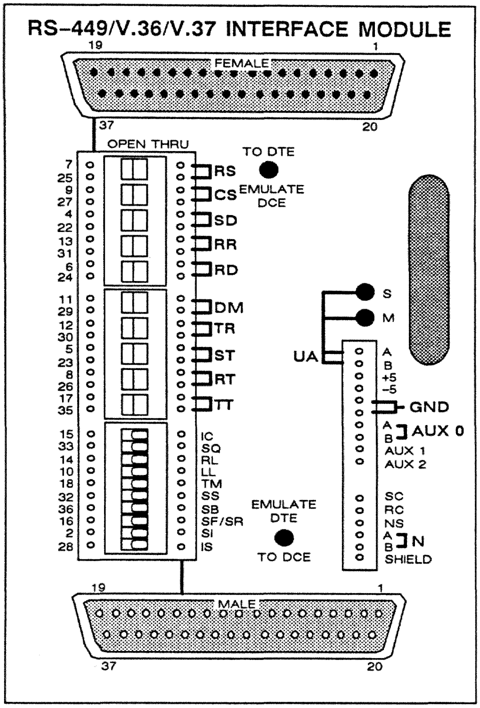


Figure 45-1 RS-449/V.36/V.37 Interface Module.

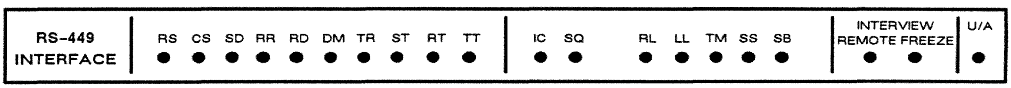


Figure 45-2 RS-449/V.36/V.37 LED Overlay.

45 RS-449

Figure 45-1 and Figure 45-2 show the TIM and the LED overlay for the RS-449/V.36/V.37 interface. Once the RS-449 module is installed, the following EIA functions are enabled:

- Ten balanced data, control, and clock circuits and seven single-wire, unbalanced control leads can be monitored on the front-panel green-red LEDs.
- Twenty RS-449 circuits can be switched, patched, and tested on the breakout box on the module.
- Up to five control circuits can be selected for real-time screen display.
- Seven control circuits can be monitored by menu and spreadsheet triggers.
- Five two-wire, balanced control circuits, one two-wire, balanced auxiliary circuit, and two single-wire, unbalanced auxiliary leads come under spreadsheet *control* in emulate modes.
- Also in emulate modes, five two-wire, balanced control circuits, one balanced, two-wire auxiliary circuit, two single-wire, unbalanced auxiliary leads, six RS-CS handshake timers, and two transmit delays can be regulated via an Interface Control menu screen.

45.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 45-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE LED on the TIM is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector.

When **Mode:** EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE connector. The EMULATE DTE LED is red, and the EMULATE DCE LED is off.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

45.2 Green-Red LEDs

The RS-449 LED overlay (Figure 45-2) identifies twenty LED indicators. Seventeen of these represent RS-449 circuits monitored at either of the line interfaces (TO DTE, TO DCE) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated and red when the lead is at or above the *on* threshold.

For two-wire, balanced circuits, LEDs are red (*on*) for relative voltages of A over B of over +0.3 V. For single-wire, unbalanced leads, the indicators go red at signals more positive than +3 V with respect to signal ground.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE or phone-jack interface. The remote-control feature is a future enhancement.

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any lead or twisted pair of leads patched to the UA-input jack(s) on the module. See Figure 45-3. Any of the RS-449 circuits that are not accounted for on the front overlay can be assigned to this LED by the user.

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data-plus-leads display; but playback data never drives the green-red LEDs.

45.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable-connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 45.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any RS-449 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

Figure 10-3 in a previous section illustrated the position of the INTERVIEW's receivers and high-impedance monitors relative to the breakout and patching area of any TIM (including RS-449) when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. *Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.*

The top ten DIP switches on the breakout box (Figure 45-1) correspond to the RS-449 balanced two-wire circuits. RS-449 balanced circuits currently defined are the following, with their pin designators in parentheses: RS (7, 25), CS (9, 27), SD (4, 22), RR (13, 31), RD (6, 24), DM (11, 29), TR (12, 30), ST (5, 23), RT (8, 26), and TT (17, 35).

The next ten DIP switches on the breakout box correspond to RS-449 unbalanced leads. They are IC (15), SQ (33), RL (14), LL (10), TM (18), SS (32), SB (36), SF/SR (16), SI (2), and IS (28).

The DIP switches conduct signals straight through, or they open the circuits so that you can reroute them using one of the twisted-pair patch cords provided with the RS-449 module. You may patch any of these pairs of leads to the leads on the opposite side of the DIP switches, or to the input or output jacks in the UA-input area on the TIM (Figure 45-3).

> **NOTE:** Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of RS-449 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

> **NOTE ALSO:** Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

Off to the right of the breakout area is a single column of patch pins without DIP switches. Included in this column are three additional RS-449 unbalanced leads: SC (37), RC (20), and NS (34).

Also included among the patch pins at the lower right is one balanced two-wire circuit, N (3, 21). *N* stands for national. This circuit is reserved permanently for national use.

45.4 Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs are a voltmeter for any unbalanced lead or balanced pair of leads patched to one or both top pins (A and B) on the pin column. These are the user-assigned inputs. The LEDs light when the input exceeds the input thresholds. For balanced signals patched to the A and B jacks, the red + LED will go on for relative voltages of A over B of over + 0.3 V (*S*pace). The green – LED will light for relative voltages of A over B of –0.3 V (*M*ark).

For unbalanced leads, use only the A jack for patching. When a signal is patched to the A jack only, B is assumed to be signal ground. The *on* threshold for the red + LED in that case is +3 V, and –3 V for the green – LED.

CAUTION: For unbalanced signals, patch only into pin A on the user-assigned input: never use pin B.

The INTERVIEW's triggers can monitor the unassigned input, and actions can be initiated when the signal crosses the appropriate threshold (+3 V for unbalanced RS-449 signals, or relative +0.3 V for balanced RS-449 signals).

The user-assigned input can also catch glitches on any interface lead. Whenever the voltage crosses the +3 V threshold on an unbalanced lead or the +0.3 threshold (A over B) on a balanced circuit for at least one microsecond, the input latches until the trigger logic (the UA field on interface conditions) can check it.

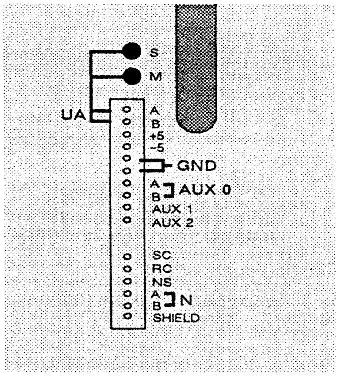


Figure 45-3 A separate column of patch jacks provides UA input and fourteen special jacks.

Below the UA input are fourteen more patch jacks. See Figure 45-3. The first eight are output jacks. Two of the outputs supply +5 V and -5 V, respectively, through 1-kohm resistors.

The 5 V output pins may be used to patch steady spaces or marks out to the interface-access leads. For A-lead patching, +5 V is a space, and -5 V is a mark. For balanced patching, orienting both ends of the patch the same way (yellow on top, for instance) will output a space or *on* signal; while turning either end of the patch over will output a mark or *off* signal.

The third and fourth output pins are at signal ground. These are provided for balanced or unbalanced use.

The next four jacks allow you to patch the output of three auxiliary RS-449 drivers that are controlled by trigger actions on the Protocol Spreadsheet and by selections on the Interface Control menu. Refer back to Sections 10.5 and 10.6 of the manual for a discussion of program control over AUX outputs.

Patch the AUX 0A and AUX 0B output jacks to *balanced* leads that you wish to control via the program. Then use the AUX 0 selection on the Protocol Spreadsheet and the Interface Control menu (refer to Figure 10-8 and Figure 10-14 in a previous section) to drive this circuit on and off. AUX 1 and AUX 2 on the spreadsheet and on the Interface Control menu controls the *unbalanced* output jacks AUX 1 and AUX 2 on the TIM.

> NOTE: The AUX pins on the test-interface module have nothing to do with the 25-pin TTL AUXILIARY connector on the rear of the unit.

Below the output area of the pin column are test points for five additional RS-449 unbalanced leads: SC (37), RC (20), NS (34), and N (3, 21). Frame ground is provided by the bottom pin in the column.

45.5 Screen Display of Lead Status

Five RS-449 control leads can be selected for a data-plus-leads display, in which the control leads are represented by two-state timing lines drawn beneath TX and RX data. See Section 5.3(B). The Display Setup menu and the data-plus-leads screen use the RS-232 names for leads. Consult Table 45-1 for the appropriate lead-name conversions.

Table 45-1
RS-449/RS-232 Conversion for Display and Triggering

To test or display this RS-449 lead . . .	. . . select this RS-232 lead on menu or spreadsheet
RS	RTS
CS	CTS
RR	CD
DM	DSR
TR	DTR
(SD	TD)
(RD	RD)

45.6 Monitoring RS-449 Control Leads

The status of seven RS-449 leads can be tested by triggers. The leads are RS, CS, RR, TR, DM, IC, and a lead of the user's choosing patched to the UA-input jack (see Section 45.4 above). The status of the lead may be made a trigger-menu condition or a Spreadsheet condition. The trigger menus and the spreadsheet "tokens" use RS-232 circuit names: refer to Table 45-1 for the circuit-name conversions.

45.7 Control of Lead Activity in Emulate Modes

Section 10 discussed the user's control over the standard (RS-232/V.24) interface in emulate modes. The mechanisms for this control were (1) actions on the Protocol Spreadsheet and (2) fields on the Interface Control menu. Refer to Sections 10.5 and 10.6. The same mechanisms apply in the same way to RS-449.

46 X.21

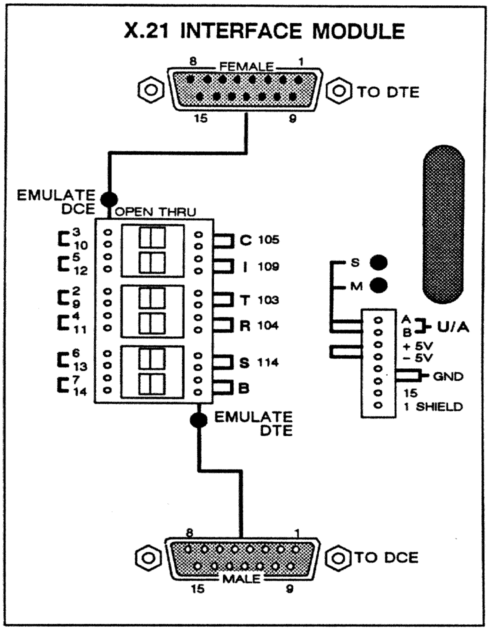


Figure 46-1 X.21 Interface Module.

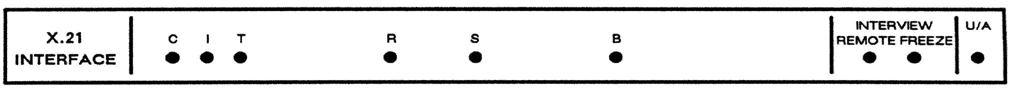


Figure 46-2 X.21 LED Overlay.

46 X.21

Figure 46-1 and Figure 46-2 show the TIM and LED overlay for the X.21 interface. Once the X.21 module is installed, the following functions are enabled:

- The six balanced data, control, and clock circuits can be monitored on the front-panel, green-red LEDs.
- Six X.21 circuits can be switched, patched, and tested on the breakout box on the module.
- C and I control leads can be selected for real-time screen display.
- When the X.21 layer-personality package has been loaded in from the Layer Setup screen or from a previously stored program, four data and control leads and a fifth, user-assigned lead can be monitored by spreadsheet trigger.
- When the X.21 layer package has been loaded, T and C (or R and I) come under spreadsheet control in emulate modes.
- The initial line-setup phase—Call Setup phase or Data Transfer phase—can be controlled via an Interface Control menu screen.

46.1 Connectors

When you break a data line for testing, you may connect one end of the line to the TO DTE connector on the TIM (see top of Figure 46-1). Connect the other end of the line to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the EMULATE DCE LED on the TIM is red. This indicates that the TO DTE connector is active. The INTERVIEW is transmitting and receiving data through the TO DTE connector.

When **Mode:** EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE connector. The EMULATE DTE LED is red, and the EMULATE DCE LED is off.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

46.2 Green–Red LEDs

The X.21 LED overlay (Figure 46-2) identifies nine LED indicators. Six of these represent X.21 circuits monitored at either of the line interfaces (TO DTE, TO DCE) on the test–interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off or unterminated and red when the lead is at or above the *on* threshold.

For two–wire, balanced X.21 circuits, LEDs are red (*on*) for relative voltages of A over B of over +0.3 V.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE or phone–jack interface. (The remote–control feature is not implemented.)

The final LED label on the right end of the overlay is UA (user assigned). This LED monitors any twisted pair of leads patched to the UA–input jacks on the module. See Figure 46-3. A circuit patched to the UA inputs can be tested by the program in Run mode via a LEADS UA ON/OFF condition on the Protocol Spreadsheet (see Section 32).

It is important to note that the front–panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk. Playback data may activate triggers that monitor interface leads, and it may generate a data–plus–leads display; but playback data never drives the green–red LEDs.

46.3 Breakout Box

The INTERVIEW is tied to the digital communications line by two cable–connections on the interface module, one cable going to the DTE and one to the DCE. Refer to Section 46.1. In between the two cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The breakout area has a column of switches that allows any X.21 circuit to be opened, and two columns of patch jacks that allow circuits to be rerouted by patch cords.

Figure 10-3 in a previous section illustrated the position of the INTERVIEW's receivers and high-impedance monitors relative to the breakout and patching area of any TIM (including X.21) when signals are moving across the interface module under two different emulate conditions (driving and receiving) and in Monitor mode. *Note that an opened switch will have a different effect on the screen display and LED display of signals depending on the test mode.*

The six DIP switches on the breakout box (Figure 46-1) correspond to the X.21 balanced two-wire (control, data, and clock) circuits. X.21 circuits are the following, with their pin designators in parentheses: C (3, 10), I (5, 12), T (2, 9), R (4, 11), S (6, 13), and B (7, 14). C and I are control circuits. T and R are data circuits. S and B are clock circuits.

The DIP switches conduct signals straight through, or they open the circuits so that you can reroute them using one of the twisted-pair patch cords provided with the X.21 module. You may patch any of these pairs of leads to the leads on the opposite side of the DIP switches, or to the input or output jacks in the UA-input area on the TIM (Figure 46-3).

NOTE: Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of X.21 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

NOTE ALSO: Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

46.4 Special Input and Output Pins

Off to the right of the breakout area are two LEDs and another column of patch pins. The LEDs are a voltmeter for any balanced pair of leads patched to both top pins (A and B) on the pin column. These are the user-assigned inputs. The LEDs light when the input exceeds the input thresholds. For balanced signals patched to the A and B jacks, the red + LED will go on for relative voltages of A over B of over + 0.3 V (*S*pace). The green – LED will light for relative voltages of A over B of –0.3 V (*M*ark).

The INTERVIEW's triggers can monitor the unassigned input, and actions can be initiated when the signal crosses the appropriate threshold (relative +0.3 V for balanced X.21 signals).

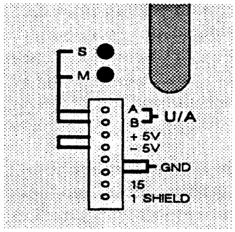


Figure 46-3 A special column of patch jacks provides UA input, positive and negative output jacks, two electrical grounds, a test point for pin 15, and case ground.

CAUTION: For unbalanced signals, patch only into pin A on the user-assigned input: never use pin B.

The user-assigned input can also catch glitches on any interface lead. Whenever the voltage crosses the +0.3 threshold (A over B) for at least one microsecond, the input latches until the trigger logic (the UA field on interface conditions) can check it.

Below the UA input are six more patch jacks. See Figure 46-3. The first two are output jacks that supply +5 V and -5 V, respectively, through 1-kohm resistors.

The 5 V output pins may be used to patch steady spaces or marks out to the interface-access leads. For balanced patching, orienting both ends of the patch the same way (yellow on top, for instance) will output a space or *on* signal; while turning either end of the patch over will output a mark or *off* signal.

The third and fourth pins are at signal ground.

The next to last pin on the special column is a test point for pin 15 on the X.21 connectors.

The bottom pin in the input-output area of the TIM is case ground.

46.5 Screen Display of Lead Status

C and I control leads can be selected for a data-plus-leads display, in which the control leads are represented by two-state timing lines drawn beneath T and R data.

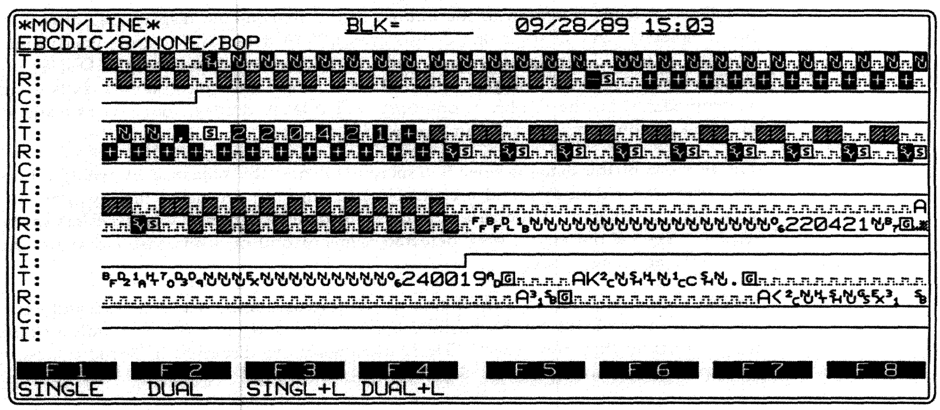


Figure 46-4 Control-lead transitions are displayable: in this example, C transitions high to indicate Call Request and I goes high to signal Ready for Data.

By pushing the Run-mode softkey labeled SINGL+L or DUAL+L (see Section 5), the user can monitor not only T and R display, but also a timing pattern for C and I control leads. A display of single-line data plus control leads is illustrated in Figure 46-4. The two states of the timing pattern can be defined in visual terms as low/high, in *CCITT Recommendation X.21* terms as off/on, and in electrical terms as minus/plus voltage.

Control leads are selected for display on the Display Setup menu. EIA leads available for screen monitoring are C and I (selectable as a pair). See Figure 46-5 for the single selection subfield under **Type:** DATA+LEADS .

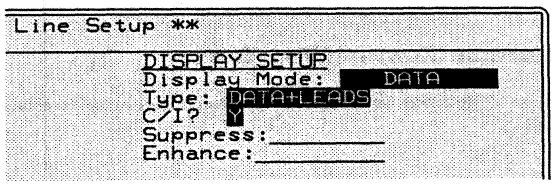


Figure 46-5 Two X.21 control leads are selectable under *Type: DATA+LEADS*.

If control leads are not set to be buffered on the Front-End Buffer Setup screen, control-lead status will not be available for data-plus-leads display and triggering. See Section 7.1(B) on buffering control leads.

A full set of leads is written to the bottom of the sixteen-line display area only if it fits completely. A full set is one or two lines of T/R data (with R underlined) and separate state-and-timing lines for C and I if specified previously on the Display Setup menu. For SINGL+L display, five full sets of data leads plus control leads will be accommodated on the display at one time. For DUAL+L display, four sets of leads will be displayed on one screen (as in Figure 46-4).

The purpose of the data-plus-leads display is to show the *sequence* of events. Two data bytes (or a data byte and a control-lead transition) are never displayed in the same vertical column. Otherwise, the order of their occurrence would be lost to the display. Even if the events were detected a millisecond or a microsecond apart, they are displayed in sequence.

Precise timing intervals, to a resolution of ten microseconds, between lead and data and between two leads can be attained both for live and recorded data with a simple trigger program that uses timers. Timer increments are discussed in Section 7, FEB Setup, and Section 17, Tabular Statistics.

46.6 Monitoring X.21 Control Leads

The status of both X.21 data leads and both control leads can be tested by conditions on the Protocol Spreadsheet. These conditions are described in detail in Section 32.4. The leads are T, C, R, and I, plus a lead of the user's choosing patched to the UA-input jack (see Section 46.4 above).

46.7 Control of Lead Activity in Emulate Modes

After loading in the layer-personality package for X.21, the user may control one side of the X.21 interface in emulate modes. The mechanisms for this control are actions on the Protocol Spreadsheet. See Section 32 for an explanation of the X.21 protocol package.

46.8 Interface Control Menu Screen

Figure 46-6 shows the programming selections on the Interface Control menu screen for X.21.

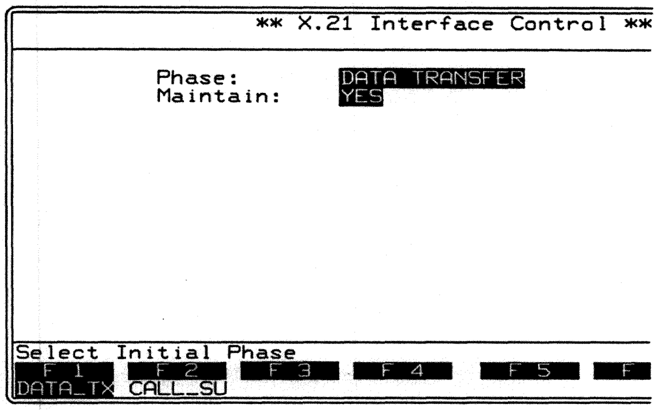


Figure 46-6 On the Interface Control menu, lead status can be maintained during Program mode and initial line-setup status can be specified.

(A) Initial Phase

In order to monitor and transmit X.21 data and higher-level data correctly without exiting Run mode and reconfiguring the line setup, the X.21 layer package provides two different "phases" of the transmitter and the receivers. These phases are called call setup and data transfer, and they may be programmed via softkey as spreadsheet actions. See Section 32.5(C).

The initial configuration phase that the program adopts upon entering Run mode is selectable on the X.21 Interface Control setup menu. See Figure 46-6. The default program-initiating phase is data transfer.

When the program is in call-setup phase, data is monitored and sent according to the following format and code: ASCII code, ␖␖ sync pattern, 7 data bits, odd parity, no BCC. In data-transfer phase, the format and code are as defined by the user on the Line Setup menu.

(B) Maintain Lead Status

Maintain: YES allows you to preserve the current lead status even after exiting Run mode. Use this selection when, for example, you want to remain in data-transfer phase while you go into the Protocol Spreadsheet and revise the upper-layer program.

If you select **Maintain:** NO, all interface leads will be reset to the *off* voltage each time the unit leaves Run mode.

47 RS–485

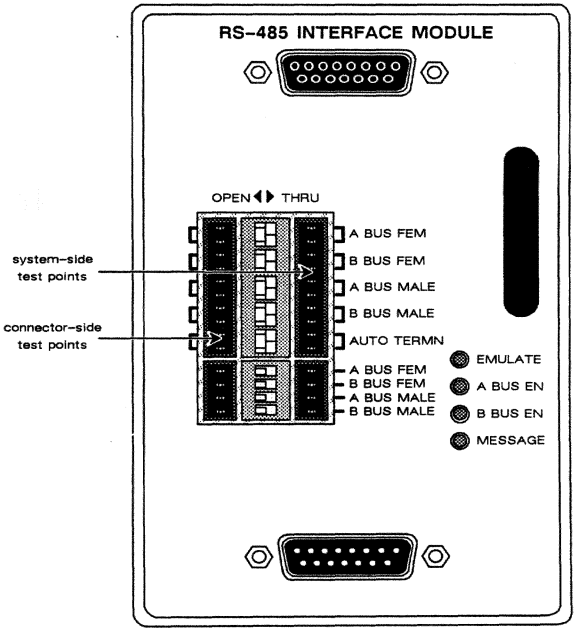


Figure 47-1 RS-485 Interface Module.

47 RS–485

RS–485 is a dual tri–state bus interface designed to operate to the British Telecom Specification RC–8245.

47.1 RS–485 Test Interface Module

Figure 47-1 shows the TIM for the RS–485 interface. **With the unit powered off,** insert the TIM into the module slot at the rear of the unit and press until it latches. After booting, the start–up screen will show RC–8245 as the installed TIM.

(A) Connectors

The connectors on the RS–485 TIM provide access to either (or both) bus(es). Use the connector(s) to monitor or emulate on either bus *without breaking the circuit*. If you do break a data line for testing, connect one end of the line to the female (top) connector on the TIM (Figure 47-1). Connect the other end of the line to the male (bottom) connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line. (For connector pin–designations, consult Table I–7A.)

CAUTION: If you must interrupt the flow of data on the line, be sure you have permission to break the line before doing so.

When **Mode:** MONITOR or AUTOMONITOR is the program selection, the INTERVIEW only monitors data passively through the connector(s) on the TIM.

When **Mode:** EMULATE DTE is the program selection, the INTERVIEW can also transmit data through the connector(s). EMULATE DCE is not a valid selection since RS–485 does not have one–to–one DCE to DTE connections.

(B) Breakout Box

The INTERVIEW is tied to the digital communications line by the two cable connections on the interface module. Refer to Section (A) above. In between the cables are the INTERVIEW's drivers and receivers and, on the face of the module, a breakout area. The TIM in Figure 47-1 shows the normal settings for all DIP switches.

The top four DIP switches on the breakout box control the two RS-485 balanced, dual-lead data circuits. In the THRU position, the DIP switches conduct signals straight through to the connectors. When OPEN, as in Figure 47-2, either bus may be disconnected at the female or male (or both) connector(s). To access two (logically) separate devices, for example, OPEN the A BUS FEM and B BUS MALE (or the A BUS MALE and B BUS FEM) switches.

> **NOTE:** The DIP switches do not control the A BUS EN and B BUS EN LEDs to the right of the breakout box. The buses are enabled/disabled via the RTS and DTR control leads.

When the INTERVIEW is in emulate mode and the AUTO TERMN switch is in the THRU position, 130-ohm resistors will automatically be placed across the buses when the INTERVIEW enters Run mode. The resistors remain in place until a monitor-mode program is run.

When the AUTO TERMN switch is THRU, the four single-pole switches at the bottom of the breakout box should be OPEN, as shown in Figure 47-2. To selectively terminate the bus(es) at a given connector, first OPEN the AUTO TERMN switch. Then set the appropriate connector-termination switch(es) to THRU.

Figure 47-2 also shows the logical location of the RS-485 TIM's test points. (Refer to Figure 47-1 for the physical location of the test points on the TIM.) Access these test points or reroute the circuits using one of the twisted-pair patch cords provided with the RS-485 module.

> **NOTE:** Always keep the colors of the twisted pair oriented in the same direction to maintain correct balance. For example, if you patch one pair of RS-485 leads with the yellow wire on top and the blue wire on the bottom, be sure to connect the other end with the yellow on top and the blue on the bottom.

> **NOTE ALSO:** Patching or switching the leads on the front panel can affect not only the received data but also the actual data on the line, *even when the INTERVIEW is in Monitor mode.*

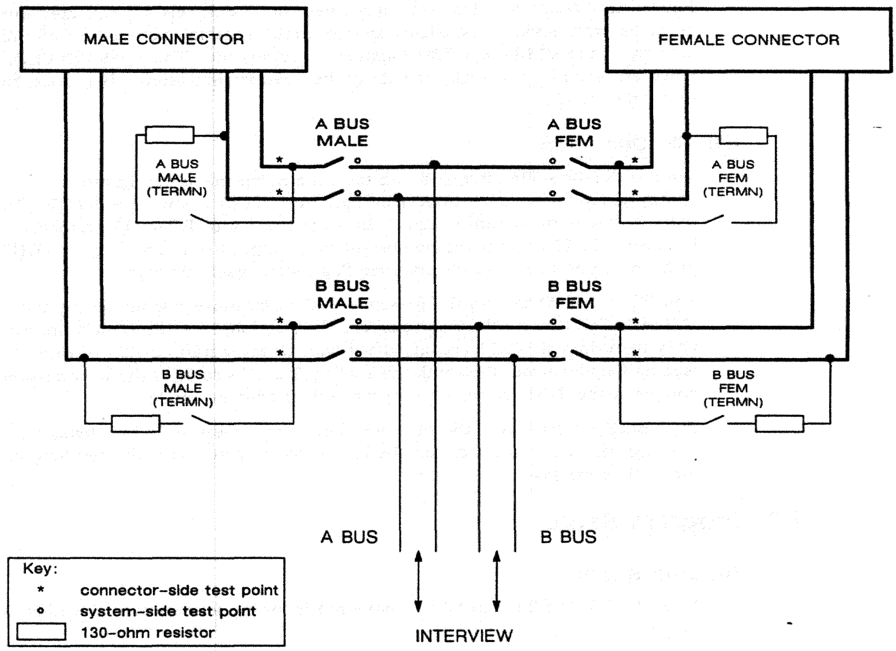


Figure 47-2 There is a pair of DIP switches for each bus. One switch controls the connection from the bus to the female connector; the other controls the connection to the male connector. When the *AUTO TERMN* switch is *OPEN*, use the four connector-termination switches (located below the *AUTO TERMN* switch on the TIM) to selectively place 130-ohm resistors across the balanced buses. To illustrate their positions, all switches in this figure are *OPEN*.

(C) LEDs

Off to the right of the breakout area are four LEDs. The top LED is on (red) when the Line Setup menu is configured to emulate DTE.

The next two LEDs, A BUS EN and B BUS EN, indicate which bus has been enabled/disabled via the Interface Control Screen, a spreadsheet EIA action, or the C *ctl_eia* routine. The default is both buses enabled. An "on" status for either of these LEDs means only that a bus is enabled, not that a driver has been activated. The status of the control leads, moreover, does not effect what is monitored.

Finally, the MESSAGE LED lights only when the line drivers are activated during an actual transmission. At higher speeds, rapid transition between on and off may cause the MESSAGE LED to appear constantly on. The MESSAGE LED, however, should not actually remain on between transmissions. If it does, return to monitor mode.

(D) TIM Operation

With an RS-485 TIM installed and the Line Setup menu configured appropriately for emulate mode (see Section 47.2(A) below), the INTERVIEW outputs a constant stream of flags. In accordance with RC-8245 protocol, however, the TIM limits the number of flags output to the line. In this HDLC protocol, three flags precede and one flag follows each message.

The RS-485 TIM detects the presence of data messages transmitted by the INTERVIEW (the result of spreadsheet SEND actions or C transmit routines). Only then does the TIM activate the drivers to allow transmission of three leading flags, the message, and one trailing flag. As soon as the transmission is complete, the TIM returns the drivers to their tri-state mode.

Excluding protocol flags, the minimum length of a message is four bytes. A message with fewer bytes causes the drivers to tri-state too early, resulting in an incomplete message.

47.2 Program Setup

(A) Line Setup

With the RS-485 TIM installed, make the following selections on the Line Setup menu:

Mode: MONITOR, AUTOMONITOR, or EMULATE DTE
Format: BOP
Clock Source: INTERNAL
Xmit Idle Char: $^{F}_{E}$ (in emulate mode)
Speed: 128000 (maximum speed)
NRZI: YES

(B) Screen Display

On any of the four data-screens, the A bus will be displayed as TD data and the B bus as (underlined) RD data. See Figure 47-3.

Notice in the dual-line display in Figure 47-3 that the INTERVIEW transmits first on both buses simultaneously. Subsequent transmissions alternate between the two buses. Also notice that the only flags in the display are those required for the RC-8245 protocol. All others are automatically suppressed by the TIM. Use the **Suppress** field on Display Setup menu to exclude protocol flags from Run-mode displays.

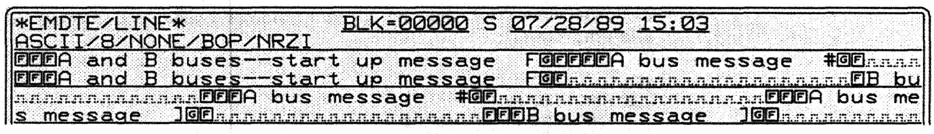


Figure 47-3 In emulate mode, INTERVIEW transmissions on the A bus are displayed as TD data and transmissions on the B bus as RD data. In this figure, the initial message is transmitted on both buses simultaneously. The remaining transmissions alternate between the A and B buses.

(C) Program Control of Buses

The RTS control lead enables/disables the A bus; DTR controls the B bus. The initial condition of RTS and DTR can be set via the Interface Control Screen. See Section 10.6. To programmatically enable/disable the buses, use the EIA action on the Protocol Spreadsheet (or Trigger menu). Consult Section 28.2(B) for more information on the EIA spreadsheet action.

You may transmit messages on an enabled bus via a SEND action (see Section 28.2) or one of the C transmit routines (Section 59.3).

The following program on the Protocol Spreadsheet uses the SEND action to generate the display in Figure 47-3:

```
LAYER: 1
    STATE: transmit
      CONDITIONS: KEYBOARD " "
      ACTIONS: EIA RTS ON DTR ON
        SEND "A and B buses--start up message  " GOOD_BCC
      CONDITIONS: DTE STRING "A and B" WAIT_EOF
      ACTIONS: EIA DTR OFF
        SEND "A bus message  " GOOD_BCC
      CONDITIONS: DTE STRING "A bus" WAIT_EOF
      ACTIONS: EIA RTS OFF DTR ON
        SEND "B bus message  " GOOD_BCC
      CONDITIONS: DCE STRING "B bus" WAIT_EOF
      ACTIONS: EIA RTS ON DTR OFF
        SEND "A bus message  " GOOD_BCC
```

NOTE: Remember that the minimum length of a message is four bytes. Also notice in the example above that the programmer's messages do not include protocol flags.

Accomplish the same result with the *ctl_eia* routine (see also Section 60.2), as in the following example:

```
LAYER: 1
    STATE: transmit
      CONDITIONS: KEYBOARD " "
      ACTIONS:
      {
       ctl_eia(0xfc, 0x00);
      }
        SEND "A and B buses--start up message  " GOOD_BCC
      CONDITIONS: DTE STRING "A and B" WAIT_EOF
      ACTIONS:
      {
       ctl_eia(0xfe, 0x02);
      }
        SEND "A bus message  " GOOD_BCC
      CONDITIONS: DTE STRING "A bus" WAIT_EOF
      ACTIONS:
      {
       ctl_eia(0xfd, 0x01);
      }
        SEND "B bus message  " GOOD_BCC
      CONDITIONS: DCE STRING "B bus" WAIT_EOF
      ACTIONS:
      {
       ctl_eia(0xfe, 0x02);
      }
        SEND "A bus message  " GOOD_BCC
```

48 ISDN

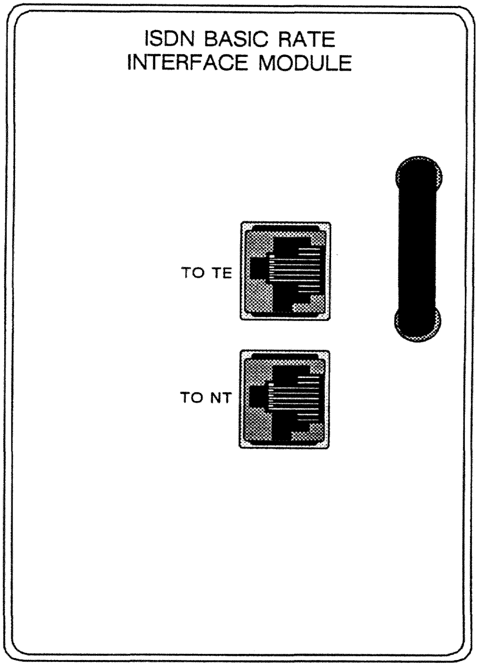


Figure 48-1 ISDN Interface Module.

Figure 48-2 ISDN LED overlay.

48 ISDN

ISDN is an optional interface in the INTERVIEW 7000 Series. The interface includes the ISDN Test Interface Module and the ISDN multiplexer board.

In order to capture ISDN data on the INTERVIEW, your unit must be equipped with the ISDN option (OPT-951-15-1 for North America or OPT-951-15-2 for Europe), which consists of an ISDN multiplexer board and the removable Test Interface Module (documented in the following paragraphs). The system software necessary to control the hardware and provide the user interface for the protocol is Software Version 5.02 or above. Once installed in your unit, the ISDN mux board will not interfere with the operation of other, non-multiplexed TIMs, such as RS-232 or X.21. Is is not compatible with T1 or G.703 TIMs.

The TIM is installed as other interface TIMs are as described in Section 10. See Appendix J4 for installation of the mux board.

The ISDN Layer 1 protocol package (ISDN_D) is presented in Section 38.

48.1 Overview of ISDN Testing Capabilities

ISDN relies on digital (vs. analog) telephone lines and switching for modemless data communication. Digitized data is sent over both B and D channels. Voice is transmitted on the B channels in digital form also.

The INTERVIEW 7000 Series supports both single-channel and dual-channel (one B channel plus the D channel) Basic Rate ISDN monitoring and emulation. Primary Rate ISDN is transmitted over T1 (Section 49) or G.703 (Section 50) lines.

(A) Physical Characteristics

The Basic Rate ISDN service provides an aggregate data rate of 192 Kbps, with 144 Kbps available to users: two 64 Kbps B-channels and one 16 Kbps D-channel per interface (2B+D). The additional 48 Kbps are used for framing and maintenance.

The INTERVIEW's physical interface conforms to CCITT I-Series Recommendations. The physical connectors and the ISDN Test Interface Module are discussed in Section 48.2.

The INTERVIEW normally transmits and expects to receive ISDN data encoded in Alternate Mark Inversion Format (AMI). In AMI, the polarity of each sequential one (mark) alternates with reference to the zero (space) voltage level. (See Figure 49-2.)

(B) B Channels

The two ISDN B-channels transport either data or voice at 64 Kbps. They are designated as "B1" and "B2" and are selectable on the ISDN Interface Setup screen for monitoring or emulating. All bit patterns are acceptable user data and none of the bits are to be stolen for signaling. Common channel signaling for calls on the B channel is out-of-band, carried on the D channel. This speeds the sending of data on the B channel.

(C) D Channel

The ISDN D-channel transports data (vs. voice) at 16 Kbps. It is selectable on the ISDN Interface Setup screen for monitoring or emulating. The D channel carries the common channel signaling for calls on the B channel, accessing a circuit switch network. These common channel signals are for establishing, maintaining, accounting for, and terminating connections.

The D channel uses LAPD protocol at Layer 2 and Q.931 at Layer 3 for signaling. The same D channel also accesses the X.25 packet-switching network. It uses X.25 at Layer 3 for packet-switching.

(D) Data Capture

The Front-End Buffer can capture one ISDN channel in real-time for immediate analysis or recording and playback. Capture speeds are 64 Kbps for a B channel and 16 Kbps for the D-channel.

Unlike T1 and G.703 protocols, aggregate record is not available for ISDN. If high-speed record is selected on the Line Setup screen, the only channel recorded will be the channel selected on the Interface Control screen (even if the INTERVIEW is monitoring both the D channel and one of the B channels via the ISDN trace application package, OPT-951-35).

(E) Dual-Channel Testing

Whenever you specify one of the B channels in the **Channel:** field on the ISDN Interface Setup menu, your configuration is "dual channel." This means that you have access to the specified B channel *plus* the D channel. You always have access to the D channel, whether your **Channel:** selection is the D channel or one of the B's. You never can access both B channels in a single test run.

The format and code selections you make on the Line Setup screen pertain to the single channel you have selected on the ISDN Interface Setup screen. These line-setup selections are indicated at the top of the run-time display and determine the appearance of the data stream on the screen. Protocols selected on the Layer Setup screen also pertain to single specified channel only. This means that protocol-package traces and spreadsheet softkeys will be geared to the specified channel only.

In a dual-channel configuration (that is, when the specified channel is one of the B channels), the D channel is accessible for monitoring and for data transmissions *via C-language on the Protocol Spreadsheet*. See Section 38, "ISDN D Channel," and Section 76, "ISDN D Channel Library," for a discussion of the C-language tools available for dual-channel operation.

(F) Single-Channel Testing

When you specify the D channel in the **Channel:** field on the ISDN Interface Setup menu, your configuration is "single channel." This means that your line setup, data display, and protocol packages (including traces and spreadsheet softkeys) all pertain to the D channel.

In single-channel operation, the C-language tools necessary for dual-channel operation are extraneous for monitoring or emulating on the D channel. The special ISDN D-Channel protocol package described in Section 38, "ISDN D Channel," is not necessary. The library of special C-language tools documented in Section 76, "ISDN D Channel Library," also is unnecessary.

(G) Monitor Mode

When **Mode** is set to MONITOR on the Line Setup menu, the INTERVIEW may monitor either one of the B channels plus the D channel (or the D channel alone) passively. Once the initial cabling is done (see Section 48.3(C)), the ISDN circuit through the INTERVIEW is bridged, not broken—even when the unit is turned off—and the INTERVIEW does not interfere with communications in progress.

(H) Emulate DTE or DCE

The INTERVIEW can also emulate a DTE or a DCE over ISDN lines, depending on the **Mode** selection made on the Line Setup menu. In an emulation mode, the INTERVIEW actively transmits and receives data as prescribed by ISDN protocol at 64 Kbps for one of the B channels and 16 Kbps for the D channel. See Section 48.3(C) for line cabling.

Either of the B channels plus the D channel may be selected for analysis. INTERVIEW test data can be transmitted on the outbound channels; incoming data on the corresponding channels is monitored. Higher layer protocols carried by the ISDN point-to-point protocol can be tested simultaneously as statistics on the performance of the ISDN circuit are taken and, at the user's need, displayed.

The INTERVIEW emulates by transmitting idle (FF) to the unselected B channel(s).

48.2 Test Interface Module

(A) Connectors

The ISDN Test Interface Module has just two ports on the face of the TIM (see Figure 48-1). One interface is for connection to the terminal (**TO TE**) and the other completes the connection on the network side (**TO NT**). Each is an RJ45 connector with eight wires in a standard ISDN setup. Four of the wires on each connector are for the ISDN bit stream. Two of them handle transmission in one direction and the other two handle transmission in the other direction. Two additional wires transfer power for the lines. The remaining two wires are unused.

(B) Green-Red LEDs

The ISDN LED overlay (Figure 48-2) identifies two LED indicators, Remote and Freeze. These switch from green to red when the unit is in a particular mode. Remote means that the unit is under remote control via the REMOTE RS-232 connector on the rear of the unit. (The Remote function is not implemented in early releases of the INTERVIEW 7000 Series.) Freeze means the FREEZE key has been pressed and the data is "frozen" on the screen for examination.

48.3 Testing Configurations

See Section 10 for instructions on installing the TIM.

(A) ISDN Physical Devices

Figure 48-3 illustrates a typical Basic Rate ISDN setup. The physical devices that constitute the common user interface are described in the following paragraphs.

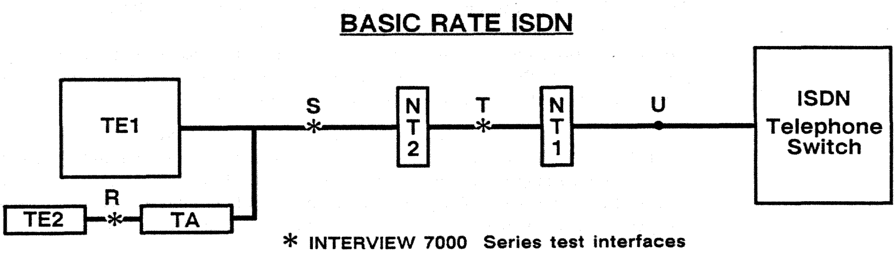


Figure 48-3 Typical Basic Rate ISDN configuration with INTERVIEW 7000 Series test interfaces.

1. *TE1.* (Terminal Equipment—Type 1) A terminal device equipped with a standard ISDN physical interface. May be ISDN–equivalent of TE2 device (a present–day telephone, data terminal, voice/data workstation, or similar communicating device), a terminal cluster controller, a multiplexer, or a very local branch of a local area network (LAN).

2. *TE2.* (Terminal Equipment—Type 2) A terminal device equipped with a non–ISDN physical interface such as V.24 (RS–232–C) or X.21. ISDN does not support this type, which would require a terminal adapter (TA). This is a non–ISDN terminal, usually a present–day telephone, data terminal, voice/data workstation, or similar communicating device.

3. *TA.* (Terminal Adapter) An interface adapter for connection of one or more TE2 devices to the network. Equivalent to a protocol or interface converter.

4. *NT2.* (Network Termination—Type 2) A possibly intelligent device responsible for the user's side of the connection to the network, performing such functions as multiplexing and switching. Could be a digital PBX or a local area network (LAN).

5. *NT1.* (Network Termination—Type 1) A device responsible for the carrier's side of the connection, performing such functions as signal conversion and maintenance of the loop's electrical characteristics. These functions are similar to those provided by DSU/CSUs.

(B) ISDN Interfaces

Figure 48-3 also identifies four interfaces between the various physical devices. It is at these points the INTERVIEW is used to test the lines. They are defined in the following paragraphs.

1. *R.* The interface between a non–ISDN terminal (TE2) and an ISDN terminal adapter (TA).

2. *S.* The interface between an ISDN terminal and the network; the interface between TE1 or TA and NT2.

3. *T.* The interface between the subscriber's portion of the network and the carrier's portion; the interface between NT2 and NT1.

4. *U.* The carrier's local loop; the interface between NT1 and the telephone switch.

(C) ISDN TIM Test Configurations

1. *Monitor.* Figure 48-4 shows the test configuration when the INTERVIEW is monitoring at the S or T interface. Connect both interfaces, **TO TE** and **TO NT**, to the line.

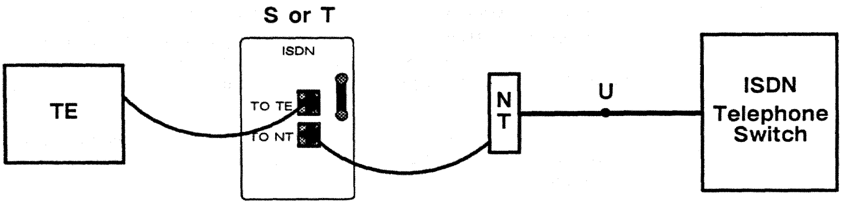


Figure 48-4 To monitor the line, connect both interfaces, *TO TE* and *TO NT*, to the line at the S or T interface.

2. *Emulate DCE in normal transmit mode.* Figure 48-5 shows the ISDN TIM test configuration when emulating DCE in normal transmit mode. Connect the **TO TE** interface to the ISDN terminal.

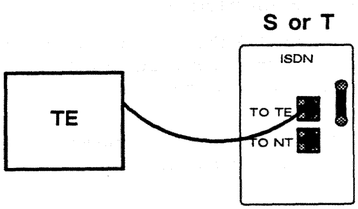


Figure 48-5 When emulating DCE in normal transmit mode, break the S or T interface toward the ISDN terminal (TE).

3. *Emulate DTE in normal transmit mode.* Figure 48-6 shows the ISDN TIM test configuration when emulating DTE in normal transmit mode. Connect the **TO NT** interface to the network side of the line.

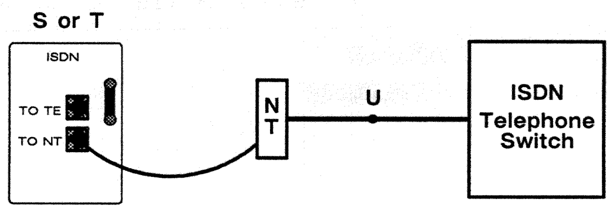


Figure 48-6 When emulating DTE in normal transmit mode, break the S or T interface toward the ISDN switch.

48.4 Setting Up Menus for ISDN Testing

The Line Setup menu (Section 4) and Layer Setup screen (Section 6) selections for ISDN testing are selected according to the data on the channel selected on the ISDN Interface Setup screen. See Section 48.5 below. When the D channel is the selected channel, the ISDN_D protocol package should *not* be loaded at Layer 1.

For both single– and dual–channel monitoring or emulation, all the testing capabilities of the INTERVIEW are directed to the channel selected on the ISDN Interface Setup screen. For dual–channel operation, the user can enter an application program (such as the ISDN trace, OPT–951–35) to display the common channel signaling information in the User Trace screen.

48.5 ISDN Interface Setup Menu

Figure 48-7 shows the programming selections on the ISDN Interface Setup menu screen for ISDN.

```
                    ** ISDN Interface Setup **
ISDN Parameter Setup
Channel:         B1

Speaker:         OFF










Enter Channel to Monitor,Emulate (B1, B2, D)
  F 1     F 2     F 3     F 4     F 5     F 6     F 7     F 8
  B1      B2      D
```

Figure 48-7 The channel selected on the ISDN Interface Setup screen is the channel tested by the INTERVIEW; the INTERVIEW setup parameters are for this selected channel.

(A) Channel

The user may select the channel to be monitored or emulated: D, B1, or B2.

Channel: D means that operation will be single channel. The line setup, data display, and protocol packages—including traces and spreadsheet softkeys—all will be directed at the 16 Kbps D channel. No B-channel operation of any kind will be possible.

Channel: B1 or **Channel:** B2 means that operation will be dual channel. The line setup, data display, and protocol packages—including traces and special softkeys—will be directed at the 64 Kbps B1 or B2 channel. The D channel, meanwhile, will be accessible via special C-language tools embedded in the ISDN_D layer package at Layer 1. A sophisticated D-channel application program (the ISDN trace available as OPT-951-35) has been constructed with these tools and is available for dual-channel monitoring.

(B) Speaker

The user may elect to turn the speaker off (OFF) or to monitor voice on either B-channel (Monitor B1 or Monitor B2). The **Speaker:** selection to monitor voice on one of the B channels is independent of the **Channel:** selection. That is, if **Channel:** B1 and **Speaker:** Monitor B2 are selected, the data tested, displayed, and traced will be on the B1 channel, but the speaker will pick-up voice or data-static of the B2 channel.

1. *Off*. This selection turns the speaker off.
2. *Monitor B1*. This selection allows the user to monitor the speaker on channel B1.
3. *Monitor B2*. This selection allows the user to monitor the speaker on channel B2.

48.6 ISDN Runtime Statistics Screen

The ISDN Runtime Statistics screen shown in Figure 48-8 displays information on the state of both the terminal equipment (**TE Information**) and network termination (**NT Information**), as well as the line status of both RD and TD. The version of the ISDN mux board installed in the unit is also displayed. Tabular and graphical statistics are also available via the indicated softkeys.

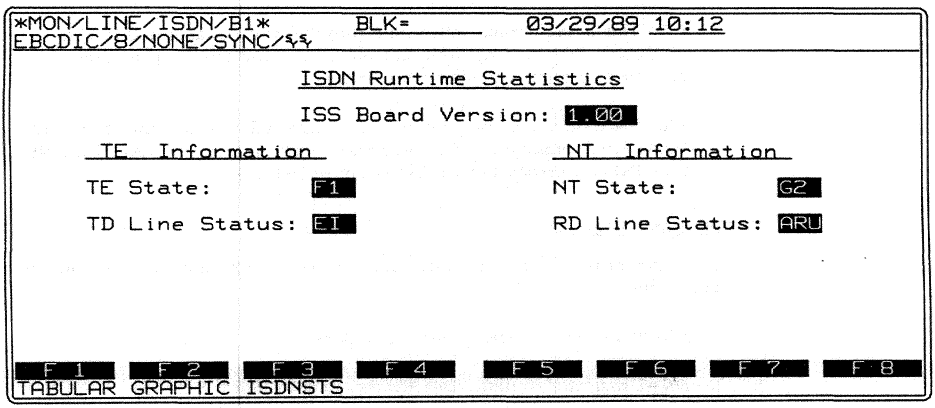


Figure 48-8 ISDN Runtime Statistics screen.

(A) TE State

The state of the terminal equipment is coded and displayed using alphanumeric characters F1 through F8.

1. *F1*. State F1 indicates the condition that the terminal-side equipment is not powered on.
2. *F2*. The terminal-side equipment has been powered on, but it has not determined the type of signal (if any) that the terminal-side equipment is receiving.

3. *F3*. This is the deactivated state of the physical protocol. Neither network-side equipment nor terminal-side equipment is transmitting.

4. *F4*. In this state, the terminal-side equipment is requested to initiate activation. It then transmits a signal (INFO 1) and waits for a response from the network-side equipment.

5. *F5*. At the first receipt of any signal from the network-side equipment, the terminal-side equipment ceases to transmit INFO 1 and awaits identification of signal INFO 2 or INFO 4 in State F5.

6. *F6*. In State F6, the terminal-side equipment receives an activation signal from the network-side equipment (INFO 2). It then responds with a signal (INFO 3) and waits for normal frames from the network-side equipment (INFO 4).

7. *F7*. This is the normal active state with the protocol activated in both directions. Both the network-side equipment and the terminal-side equipment are transmitting normal frames.

8. *F8*. State F8 is the condition when the terminal-side equipment has lost frame synchronization and is awaiting resynchronization by receipt of INFO 2 or INFO 4 or deactivation by receipt of INFO 0.

(B) TD Line Status

The status of the TD line is coded and displayed as explained in the following paragraphs.

1. *PU—Power up*. Module interface is clocked.

2. *DR—Deactivate request*. Deactivation Request Form S.

3. *SD—Slip detected*. Wander is greater than 18 µs Peak-Peak.

4. *DIS—Disconnected*. PIN CON is at ground.

5. *EI—Error indication*. RST or Reset.

6. *RSY—Resynchronizing*. Level received, not synchronous.

7. *ARD—Activate request*. INFO 2 received.

8. *TI—Test indication*. Test loop or test mode.

9. *ATI—Awake test indication.* Level received during test loop.

10. *AI8—Activate indication P10.* INFO 4 received, D channel priority is 8 or 9.

11. *AI0—Activate indication P10.* INFO 4 received D channel priority is 10 or 11.

12. *DID—Deactivate indication.* Clocks are switched off, a quiescent state.

(C) NT State

The state of the network (NT) is coded and displayed using alphanumeric characters G1 through G4.

1. *G1.* This is the deactivated state; the network-side equipment is not transmitting.

2. *G2.* State G2 is a partially active state; the network-side equipment sends INFO 2.

3. *G3.* This is the normal active state where the network-side equipment to terminal-side equipment direction is active. The terminal-side to network-side direction may or may not be active. The network side may deactivate or maintain the active state when the terminal side stops transmitting. The choice to eventually deactivate is up to higher-layer protocols within the network side.

4. *G4.* When the network-side equipment wishes to deactivate, it may wait for a timer to expire before returning to the deactivated state in State G4.

(D) RD Line Status

The status of the RD line is coded and displayed as explained in the following paragraphs.

1. *LSL—Lost signal level.* No received level.

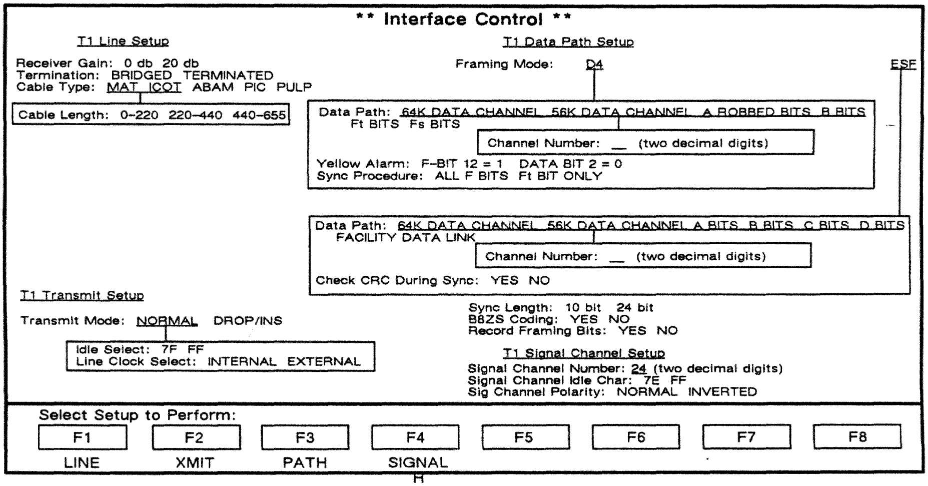
2. *RSY—Resynchronizing.* Receiver not synchronous.

3. *ARU—Active request.* INFO 1 received.

4. *AIU—Active indication.* Receiver synchronous.

5. *DIU—Deactivate indication.* Time TS 6 or TS 7 after deactivation instruction is finished.

49 T1



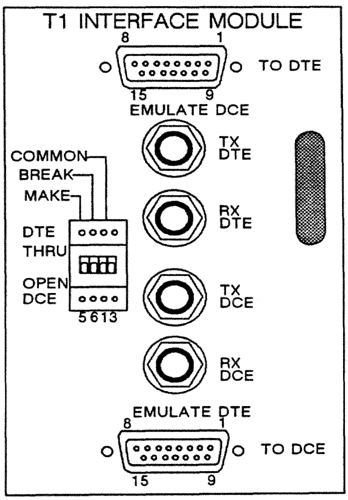


Figure 49-1 Interface Control screen (above) presents T1 options when a T1 TIM (below) is installed.

49 T1

T1 is a point–to–point protocol at the physical layer (Layer 1) used to transmit high–speed voice or data over telephone lines. The INTERVIEW 7000 Series, with T1 software and the T1 Test Interface Module installed, is capable of testing T1 circuits that comply with North American standards. In particular, the INTERVIEW tests circuits with a total bandwidth of 1.544 MHz (as opposed to 2.048 MHz circuits typically used in Europe). The bandwidth is divided into 24 channels with an absolute speed of 64 Kbps each.

In order to capture T1 on the INTERVIEW, your unit must be equipped with a T1 option (OPT–951–11–1 or OPT–951–11–2), which consists of a Multiplexer board and a removable Test Interface Module (documented in the following paragraphs).

The INTERVIEW supports T1 Primary Rate ISDN with 23 B–channels and one D–channel (23B+D).

49.1 Overview of T1 Testing Capabilities

(A) Physical Characteristics

The INTERVIEW's physical interface conforms to CCITT Recommendation G.703 for 1.544 MHz (DS1) circuits. The physical connectors and the T1 Test Interface Module are discussed in Section 49.2.

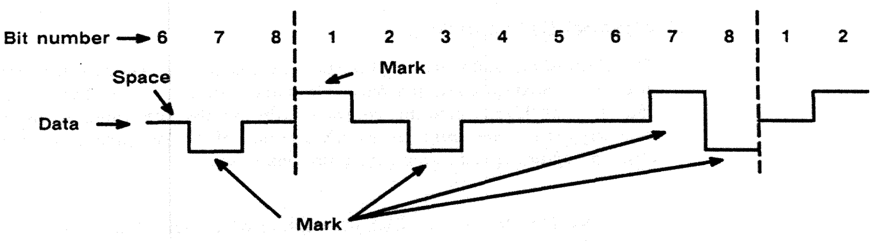


Figure 49-2 Alternate Mark Inversion.

The INTERVIEW normally transmits and expects to receive T1 data encoded in Alternate Mark Inversion Format (AMI). In AMI, the polarity of each sequential 1 (mark) alternates with reference to the zero (space) voltage level.

As an alternative, the user may select B8ZS (Binary 8 Zero Suppression), a transmission technique which is sometimes used to overcome the occurrence of long strings of zeroes and the associated timing problems. The B8ZS option is explained later in this section.

(B) Framing Characteristics

Any T1 circuit that operates at 1.544 MHz and conforms to the basic physical characteristics laid out in Recommendation G.703 may be BERT–tested with the INTERVIEW; however, the full set of statistical analyses and protocol testing capabilities apply only to T1 circuits which employ D4 or Extended Superframe (ESF) framing structures. These framing structures are discussed in detail in CCITT Recommendation G.704; the major characteristics of the two schemes are outlined in Section 49.7. The INTERVIEW 7000 Series supports both in–band signalling (bit robbing) and clear channel (common channel or out–of–band) signalling.

> **NOTE:** Hereafter, the word "circuit" will be used to indicate a DS1 circuit unless otherwise specified.

(C) T1 BERT

The INTERVIEW can perform both framed and unframed BERT tests on T1 transmissions. An individual channel may also be BERT tested. Tests may be performed in a simple loopback configuration or in conjunction with another INTERVIEW or BERT tester. In Run mode, a separate T1 BERT display tracks test results. The contents of the display and BERT options and setup are described in Section 9.

(D) Channel Data Capture

The Front–End Buffer can capture one T1 channel in real–time for immediate analysis or recording and playback. Maximum speed for T1 channel data capture is 64 Kbps, since this coincides with the absolute speed of the individual data channels. The user may specify any one of 24 data channels; or he may elect to capture specific framing or signalling bits.

> **NOTE:** When recording the capture of a single channel to RAM, select **Record Speed:** NORMAL on the Record Setup menu. See Section 11.4.

When you enter Run mode configured to capture a single channel, 24 for example, the following message appears on the status line: *"Ch24."*

(E) Aggregate T1 Record

To record the aggregate T1 data stream (1.544 Mbps), with or without framing bits, your unit must be equipped with an FEB board capable of high-speed recording (see Section 11.4.) and software revision 5.02, or higher. Select **Mode:** MONITOR on the Line Setup menu. Configure the Record Setup menu for **Capture Memory:** RAM and **Record Speed:** HIGH SPEED .

A **Record Framing Bits** field is present on the T1 Interface Control screen. See Section 49.5(P). Your selection for this field screen determines whether or not framing bits will be included in the aggregate data stream.

When you enter Run mode configured for aggregate T1 record, the status line will contain the following message: *"HS AGG REC."*

(F) Monitor Mode

When **Mode** is set to MONITOR on the Line Setup menu, the INTERVIEW as T1 protocol analyzer may be used to monitor any one of the data channels or framing or signalling patterns passively. Once the initial cabling is done, the T1 circuit through the INTERVIEW is bridged, not broken — even when the unit is turned off — and the INTERVIEW does not interfere with communications in progress.

A special DSX monitor jack that is found at telco central offices may be used to monitor nonintrusively even when the INTERVIEW is not already cabled to the line. See Figure 49-9 for an illustration of this configuration.

(G) Emulate DTE or DCE

The INTERVIEW can also emulate a DTE or a DCE over T1 lines, depending on the **Mode** selection made on the Line Setup menu. In an emulation mode, the INTERVIEW actively transmits and receives data as prescribed by T1 protocol at a maximum speed of 64 Kbps. A selection on the Interface Control screen allows the user to specify whether clocking is supplied externally or provided by the INTERVIEW.

Any of the 24 data channels on the circuit can be selected for analysis. INTERVIEW test data can be transmitted on the outbound channel; incoming data on the corresponding channel is available for display and test. Higher layer protocols carried by the T1 point-to-point protocol can be tested simultaneously as statistics on the performance of the T1 circuit are taken and, at the user's need, displayed.

The INTERVIEW emulates in two fashions: it can transmit idle to all but one channel to which it transmits data and which it monitors; or it can perform drop-and-insert emulation. When the drop-and-insert option is employed, transmissions on 23 channels are terminated and regenerated by the INTERVIEW, while the channel selected for analysis is terminated and INTERVIEW data is transmitted on the out-going channel.

(H) Protocol Spreadsheet

T1 protocol cannot be controlled from the Protocol Spreadsheet. Other protocols operating above the physical interface may, however, be tested. Spreadsheet options for testing in this case will depend on the protocols you have loaded from the Layer Setup screen.

(I) Data Displays

The format and code selections you make on the Line Setup screen, indicated at the top of the run-time display, determine the appearance of the data stream on the screen. Protocols selected on the Layer Setup screen will be available as trace displays. An alternate real-time display (see Figure 49-18) selection allows you to view T1 statistics and track performance on the T1 circuit only when the T1 TIM is in place. The T1 Statistics Display is described in Section 49.6.

(J) Primary Rate ISDN

The INTERVIEW 7000 Series supports T1 Primary Rate ISDN at 1.544 Mbps (23B+D) with either version of the mux board and TIM option package (OPT-951-11-1 or OPT-951-11-2) and software revision 6.00, or higher. The ISDN_D protocol package is used in T1 at Layer 1 to access the ISDN variables. See also Sections 38, 48, and 76 on Basic Rate ISDN.

The D channel selection (**Signal Channel Number** field) defaults to channel 24. For dual-channel monitoring and emulation, OPT-951-11-2 (T1 TIM and mux board option) is required; an ISDN trace application package (available as OPT-951-35) is also available for monitoring and emulating both single and dual channels. For dual-channel emulation, LAPD should be loaded at Layer 2 on the B channel.

Three fields (**Signal Channel Number, Signal Channel Idle Char,** and **Sig Channel Polarity**), present on the T1 Interface Control screen in the **T1 Signal Channel Setup** section, are applicable *only* when monitoring or emulating dual channels. Otherwise these fields are not used by the INTERVIEW.

49.2 The Test Interface Module

The T1 Test Interface Module (TIM), shown in Figure 49-1, is a removable module which may be replaced by different interfaces when other types of lines must be tested. The T1 TIM provides two 15-pin female connectors (top and bottom of module) labeled TO DTE and TO DCE. In addition, there are two pairs of WECO-310 connectors. All connectors are two-wire and attach to a standard DS1 line. The signal direction for each connector is indicated in Figure 49-5. An overlay which identifies active LEDs on the front panel accompanies the T1 TIM. In addition, there are three access points for testing a remote CSU.

Install the T1 Test Interface Module and insert the correct LED overlay as described in Section 1.10. Once the T1 module and the overlay are installed, TX and RX leads can be monitored on the front-panel green-red LEDs.

(A) Connectors

When you break a data line for testing, you may connect the end of the line coming from the DTE (multiplexer, channel bank, PBX, or switch) to the TO DTE connector on the TIM (see top of Figure 49-3). Connect the other end of the line coming from the DCE (CSU or telco office repeater) to the TO DCE connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.

If you are using the WECO 310 phone jacks, you may create a pass-through connection by connecting the top two jacks toward the DTE and the bottom two jacks toward the DCE.

When **Mode:** MONITOR or AUTOMONITOR is the program selection and the INTERVIEW is connected as a pass-through as described in the preceding paragraph, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the INTERVIEW is transmitting and receiving data through the DA-15 connector labeled TO DTE, or through the top set of WECO 310 connectors, labeled TX DTE (for Transmit; that is, Input from the DTE) and RX DTE (for Receive; Output to the DTE).

When **Mode:** EMULATE DTE is the program selection, the INTERVIEW transmits and receives data through the TO DCE connector if the DA-15 connectors are in use, or through the bottom set of WECO 310 connectors, if these are connected. The WECO 310 connectors which are active in this case are labeled TX DCE (for Transmit; Output to the DCE) and RX DCE (for Receive; Input from the DCE).

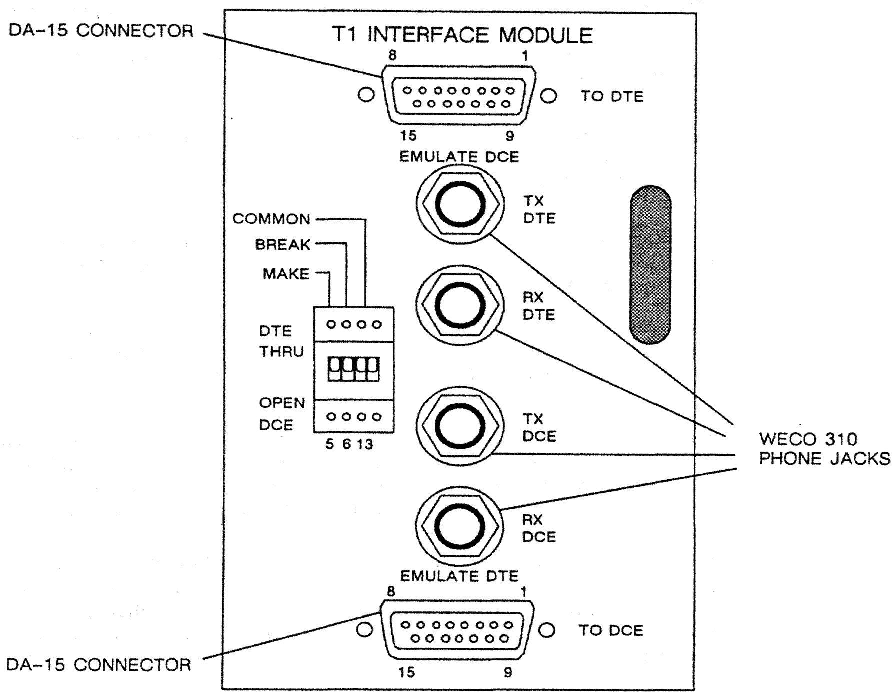


Figure 49-3 The T1 Test Interface Module provides both WECO 310 and DA-15 connectors for reception and transmission of data.

(B) Green-Red LEDs

Two of the front-panel LEDs are active when the unit is testing T1 protocol. These represent leads monitored at either of the line interfaces (TO DTE, TO DCE) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off (at mark voltage, representing 1) or unterminated, and red when the lead is on (representing space voltage or 0).

Data leads transition quite rapidly. As a result, their LEDs typically show a shade of orange that is intermediate between red and green when data is being transmitted. Data-lead LEDs will vary in color with the type of data. ${}^{F}{}_{F}$-idle, for example, has no *on* transitions, while ${}^{7}{}_{F}$-idle has only one, so both cause an LED to glow bright green.

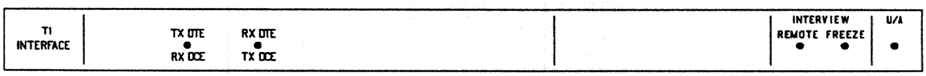


Figure 49-4 T1 Green-Red LED Overlay.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE or phone-jack interface. (The remote-control feature is not implemented in the early releases of the INTERVIEW 7000 Series.)

The user-assigned lead (UA) to the far right of the panel is not employed in T1 testing.

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk.

(C) Test Access Points

There are three test access points on the Test Interface Module. These points are labeled MAKE, BREAK, and COMMON and correspond to Pins number 5, 6, and 13, which are wired through to both connectors.

These three test points allow the user to place a CSU in test mode and to tear down test mode manually once it has been established.

To place a CSU in test mode, connect the test point labeled MAKE (pin 5) to the test point labeled COMMON (pin 13). Once this connection is made, the local CSU generates a Loop-up command to the remote CSU. This command allows any pattern of data to be transmitted to the remote CSU for any length of time desired. Assuming that the remote CSU is functioning properly, all data will be looped back on the corresponding return lead.

> **NOTE:** The INTERVIEW can generate a loop-up or loop-down command in response to softkey selections when you are performing a preliminary BERT test with the CSU. It is not necessary to send the Loop-up command, however, when the INTERVIEW is troubleshooting the line while remotely connected to another BERT tester. Refer to Section 9 for more information on BERT testing.

Once you have completed testing the CSU, the loop must be torn down. This can be done by patching the COMMON test point to the test point labeled BREAK (pin 6). Once this connection is made, the CSU responds by transmitting a Loop-down command to the remote CSU, removing it from loopback mode.

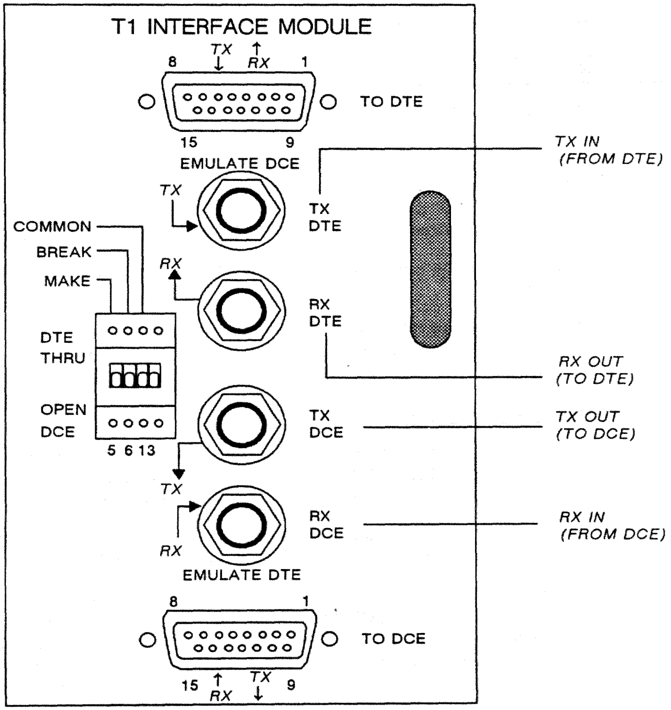


Figure 49-5 Signal direction for T1 connectors.

CAUTION: Do not activate the Make lead when a T1 BERT test is in progress. Since the Loop-up signal has already been sent, generating a second Loop-up signal risks locking up all equipment under test and the INTERVIEW in a continuous data loop. Activating the Break lead will interrupt the test in progress. The Loop-down signal can be generated from the T1 BERT screen.

49.3 Testing Configurations

(A) Test at Line Levels (No Pad)

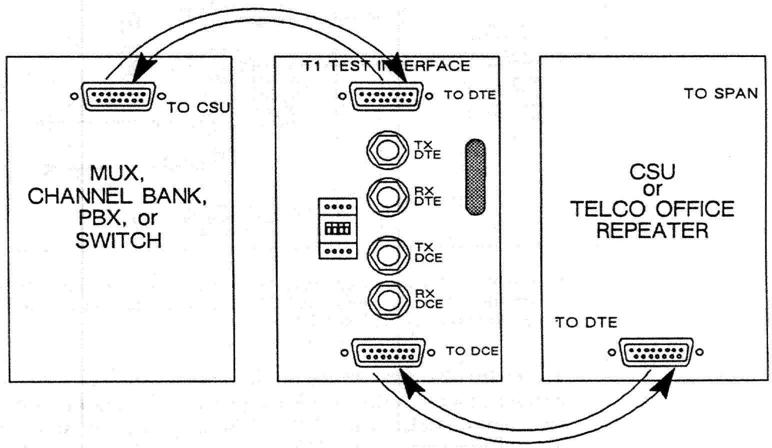


Figure 49-6 Place the INTERVIEW between the multiplexer and the Channel Service Unit (for example) to monitor or emulate over the T1 circuit. The illustration indicates how cables equipped with DA-15 connectors would be connected.

Connect the INTERVIEW into the DS1 circuit between the DTE (multiplexer, channel bank, PBX, or switch) and the DCE (Channel Service Unit or telco office repeater) for T1 testing. In this position, the INTERVIEW may monitor a selected channel, emulate a T1 customer transmission, emulate the network on an individual channel towards a user terminal, or perform a BERT test. See Figure 49-6 and Figure 49-7.

To emulate one channel on the customer side of the conversation (for example), select EMULATE DTE as the operating **Mode** on the Line Setup screen. This breaks the line between the mux and the CSU as illustrated in Figure 49-6. The INTERVIEW communicates through the CSU in this configuration, transmitting and receiving over the DA-15 connector labeled TO DCE, or transmitting over the 310 connector labeled TX DCE and receiving over the connector labeled RX DCE when the WECO jacks are used (Figure 49-7).

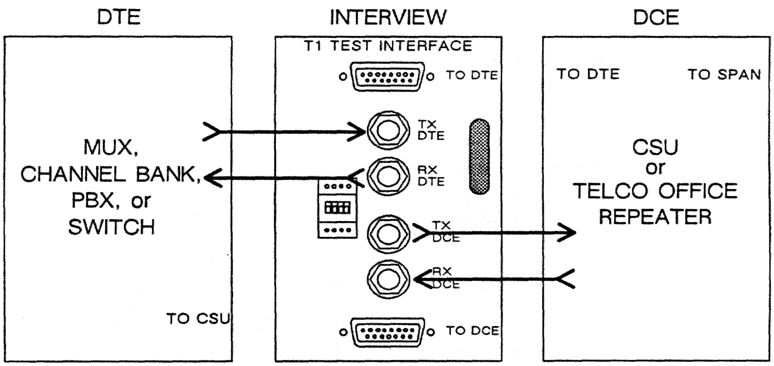


Figure 49-7 The same configuration may be achieved with WECO 310 connectors. Once the cables are in place, the INTERVIEW may monitor nonintrusively or break the line toward the DTE or DCE.

To emulate the network side of the conversation, select EMULATE DCE as the operating **Mode** on the Line Setup screen. This breaks the line between the mux and the CSU. The INTERVIEW then communicates through the attached mux, transmitting and receiving over the DA–15 connector labeled TO DTE (Figure 49-6), or transmitting over the 310 connector labeled RX DTE and receiving over the connector labeled TX DTE (Figure 49-7). Since no clocking is available from the network in this case, choose **Line Clock Select:** INTERNAL on the Interface Control screen.

(B) Simplex Repeater Power

The T1 Test Interface Module will pass simplexed repeater power down the transmit pair and the receive pair when it is patched in series into the powered portion of a T1 span. Figure 49-8 is the standard "looped-through" configuration shown in the previous figure, except that here the INTERVIEW has been placed on a powered span and is providing a DC path between input and output for both receive and transmit pairs. Both in monitor and emulate modes, a permanent DC path is maintained from TX DTE (in) to TX DCE (out) and from RX DCE (in) to RX DTE (out).

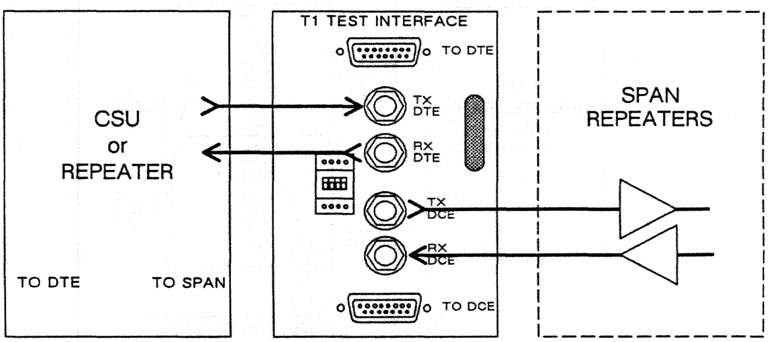


Figure 49-8 The INTERVIEW can be patched in series into the powered portion of a T1 span.

One of the functions of a CSU is to complete the simplex current path between the transmit pair and the receive pair. When the INTERVIEW is used to break the line toward the span and emulate the CSU, a simple patch connection (via one of the WECO 310 patch cords provided with the T1 option) between TX DTE and RX DTE will complete the DC current path.

(C) Test at DSX (20db Pad at Monitor Jack)

Many T1 sites have a special patch panel called a DSX that allows nonintrusive monitoring of lines. (Actual monitoring with the INTERVIEW always is passive and nonintrusive, but unless a DSX panel is installed at the test site, the line normally must be broken simply to cable the test equipment to the line.)

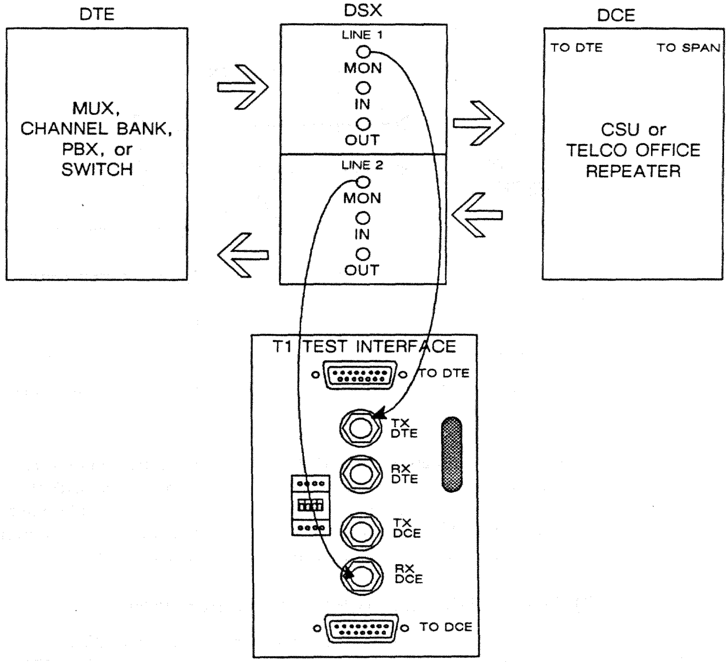


Figure 49-9 If a DSX panel is available for patching at the telco office, the line can be monitored without even momentary intrusion.

Figure 49-9 shows a T1 test-interface module (TIM) cabled to the MONITOR jacks of two separate DSX panels. These panels handle Tx and Rx traffic separately. Because the DSX monitor jacks are isolated from the line by a 20 db "pad," these jacks may be patched into without disrupting traffic on the line. When the INTERVIEW monitors at this interface, 20 db of gain should be added to the signal via the **Receiver Gain:** 20 db selection on the Interface Control menu. See Section 49.5(A).

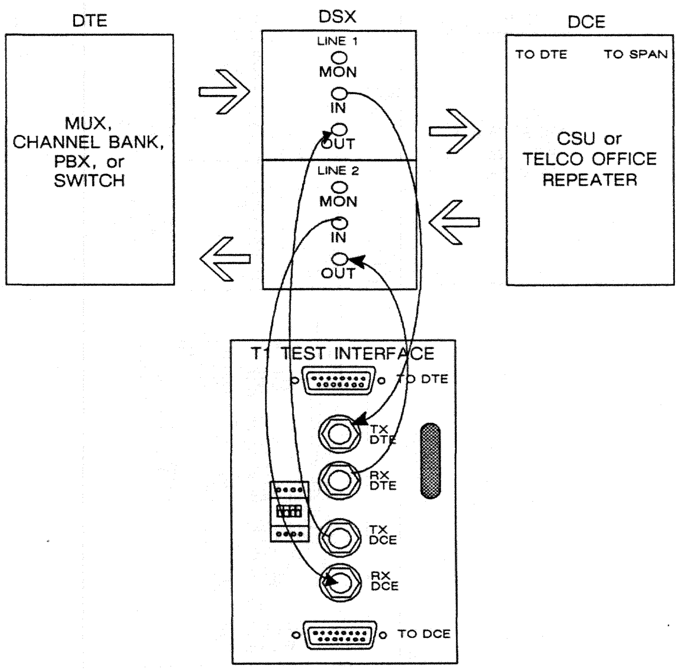


Figure 49-10 This is a "permanent" INTERVIEW-to-DSX configuration. The line is broken once during installation. With the cables in place, the INTERVIEW may monitor nonintrusively or break the line toward the DTE or DCE.

Figure 49-10 shows a "permanent" installation of the INTERVIEW at a DSX location. Inserting connectors into the IN and OUT jacks on the DSX panel will break the line. Once the cables are in place, however, the INTERVIEW can be used to monitor the line nonintrusively or break the line toward the DTE or DCE.

There is no special "padding" at the IN and OUT interfaces on the DSX. Select **Receiver Gain:** 0 db on the Interface Control menu when you monitor or emulate at these interfaces.

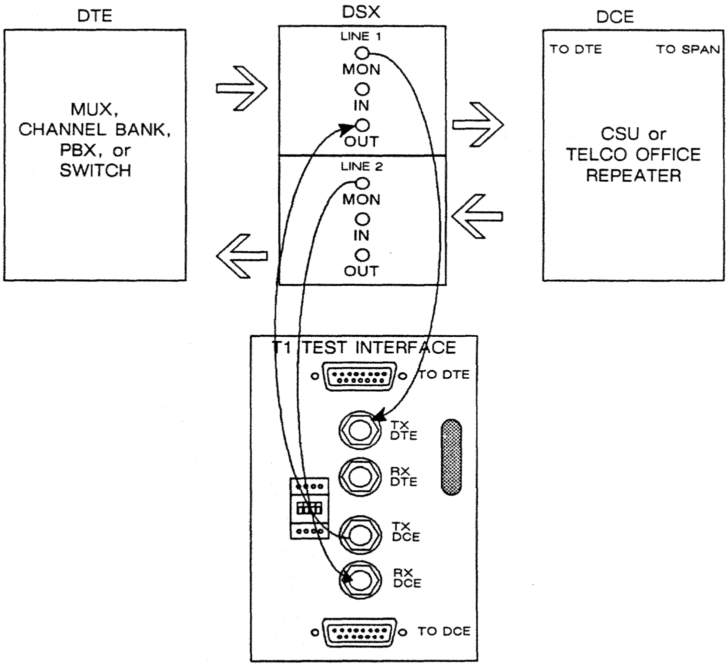


Figure 49-11 This is a "fast-emulate" configuration that minimizes disruption when the line must be broken toward the DCE.

Figure 49-11 is a configuration that minimizes the disruption caused by breaking the line at the DSX to emulate a DTE (toward the CSU or repeater). The sequence is as follows:

1) Select **Receiver Gain:** 20 db on the Interface Control menu.
2) Set up the unit to emulate DTE.
3) Enter the desired emulate program.
4) Cable the DSX MONITOR jacks to the INTERVIEW TIM as shown.
5) Plug a cable connector into the TX DCE jack on the INTERVIEW but *do not patch the cable to the OUT jack on the DSX at this point.*
6) Press [RUN].
7) With the test running and the INTERVIEW in sync with the T1 frames, complete the final cable connection that breaks the Tx line toward the DCE.

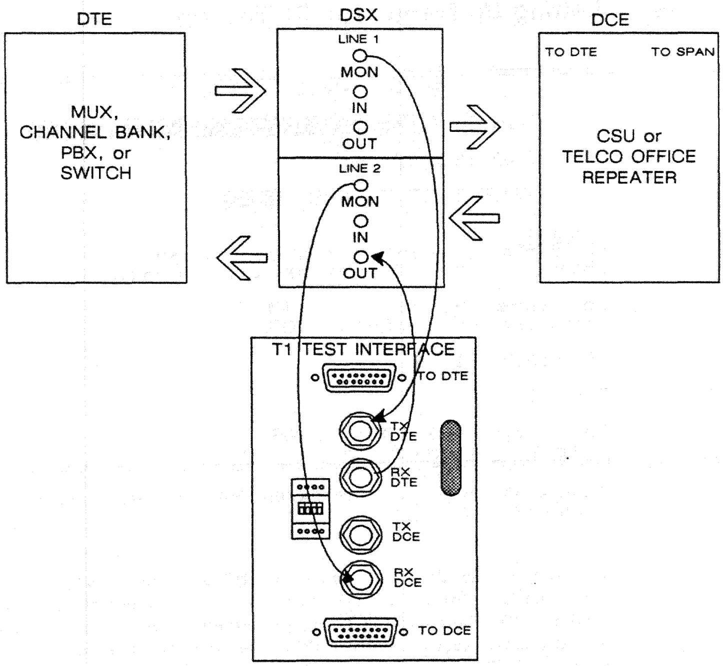


Figure 49-12 This DSX configuration minimizes disruption when the line must be broken toward the DTE.

Figure 49-12 illustrates the same configuration as Figure 49-11, except that here we are breaking the line toward the DTE.

49.4 Setting Up Menus for T1 Testing

```
                   ** INTERVIEW  7500 **

        DISKS: FLOPPY 1  FLOPPY 2  HARD DISK

        PROCESSORS: 4

        SELF TEST ERRORS: NONE

    Press:
    [PROGRAM] to enter the menu page
    [RUN]     to run the default program

    Software  Version:  7.00
    Firmware  Version:  5.00

    OPTIONS:  11-1

    TIM: T1

    Copyright (c) 1987, 1989
    Telenex Corporation
```

Figure 49-13 Power-up screen, INTERVIEW 7500. *OPTIONS:* field could also display *OPTIONS: 11-2*.

T1 testing can be done only when the TIM described in Section 49.2 is in place. Install the T1 TIM and connect to a data source before power up as described in Section 1.10. Compare the Power Up screen to the one shown in Figure 49-13. It should indicate that the correct TIM is in place and that the unit is equipped with a mux board (OPT-951-11-1 or OPT-951-11-2).

> **NOTE**: If you plan to perform a T1 BERT test, refer to Section 9.

Before you run a T1 test, you must configure the Line Setup screen for the type of testing you wish to do. Select **Mode:** MONITOR if you plan to monitor a T1 exchange. If the INTERVIEW is to perform an interactive test (that is, will be required to transmit), select **Mode:** EMULATE DCE or **Mode:** EMULATE DTE .

> *CAUTION: When the INTERVIEW operates in an emulate mode, it interrupts the regular exchange of data on the circuit. Be certain you have permission to test the circuit before you proceed.*

Select the **Code and Format** required for accurate interpretation of the data stream.

Clocking of T1 data is not provided by the standard data clock. As a result, the **Clock Source** selection on the Line Setup screen is overridden. An applicable clock selection is provided on the Interface Control screen, described in Section 49.5.

If you plan to test higher-layer protocols (such as Common Channel Signalling System #7, LAPD, ISDN, or any others carried on the T1 circuit), you must first load them from the Layer Setup screen. The Layer Setup screen is documented in Section 6.

49.5 Interface Control Screen

Certain T1 characteristics are selectable. All options specific to T1 are selected on the Interface Control screen, which is accessed from the main Program menu. With the Program menu displayed, press F1 (for Setup), then F2 (for T1) to obtain the screen shown in Figure 49-14. The full set of options available on the Interface Control screen is illustrated in Figure 49-1.

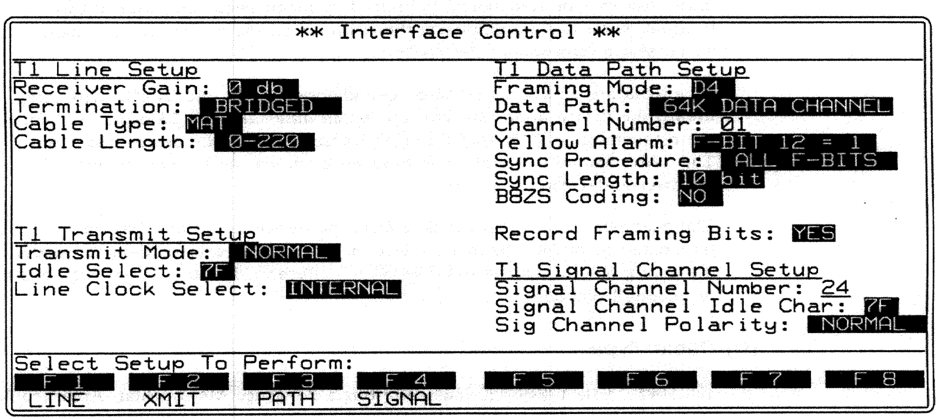


Figure 49-14 Interface Control screen for T1 Protocol. Transmit Setup selections apply when an Emulate mode is selected on the Line Setup screen. Line Clock is available for master T1 transmit clocking. T1 Signal Channel Setup selections apply only for dual-channel monitoring or emulating in Primary Rate ISDN.

(A) Receiver Gain

A DSX monitor jack at the telco office is isolated from the line by 430 ohm resistors in series with both the tip and ring. The resistors combine with a 100 ohm termination at the monitoring device to form a 20 db pad.

In order for the INTERVIEW to compensate for the padding at this monitor jack, select **Receiver Gain:** 20 db to add 20 db of gain to the line signal. (Also select **Termination:** TERMINATED ; see below.)

(B) Termination

Line termination is selectable by the user for data in both directions in monitor mode and for Receive data (that is, data coming *from* the device under test) in emulate mode.

In a normal "looped-through" monitor configuration (see Figure 49-6 or Figure 49-8), the appropriate termination is BRIDGED . When you are monitoring at a DSX jack, select **Termination:** TERMINATED .

When you are in emulate mode and have selected **Transmit Mode:** NORMAL , all channels on the line that is transmitting data toward the device under test (toward DTE or DCE, depending on the emulate setup on the Line Setup menu) are terminated automatically. The channels that are coming *from* the device under test may be terminated or bridged by menu selection. Since in this transmit mode you are emulating the end user on the circuit, you normally would select **Termination:** TERMINATED .

When you are emulating in the drop-and-insert mode, the 24 channels going toward the device under test are *terminated automatically*. 23 of these channels are regenerated and "passed through" transparently to the device under test. The 24th channel is the one you have selected, via the **Channel Number** field, for drop-and-insert.

The channels that are moving data *from* the device under test may be terminated or bridged by menu selection. Normally in drop-and-insert mode, the appropriate termination is BRIDGED . Receive data that is terminated is *not* regenerated outbound.

(C) Cable Type

1. *MAT*. Select MAT if you are testing a 25-gauge Metropolitan Area Trunk.

2. *ICOT*. Select ICOT if you are testing a 24-gauge Inter-city trunk.

3. *ABAM*. Select ABAM if you are testing a PBX with an internal 22-gauge PIC cable.

4. *PIC*. Select PIC if you are testing a jelly-filled cable.

5. *PULP*. Select PULP if you are testing a paper-filled cable.

(D) Cable Length

For MAT and ICOT cable, you must specify the length of the cable between the INTERVIEW and the device under test to achieve proper test results. The three lengths available are 0-220, 220-440, and 440-655. Lengths are calculated in feet. No length selection is available for ABAM, PIC, or PULP cables. These cables must be 0 to 137 feet in length for T1 testing.

(E) Transmit Mode

The **Transmit Mode** options control the INTERVIEW's transmissions on the 24 channels of the circuit under test. The field is applicable when **Mode:** EMULATE DCE or **Mode:** EMULATE DTE is selected on the Line Setup screen. (The **Transmit Mode** options have a special meaning in BERT DTE and BERT DCE operating modes. See Section 9.11.)

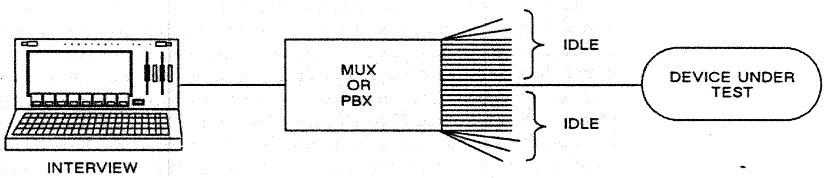


Figure 49-15 The INTERVIEW 7000 Series in normal T1 emulation mode.

1. *Normal mode.* When emulating in normal mode (that is, as the only end user on an otherwise inactive T1 circuit), the INTERVIEW should be set up to terminate all 24 receive channels. See the discussion of the **Termination** option in Section 49.5(B). The INTERVIEW will isolate one incoming channel for capture and transmit on the corresponding outbound channel. On all other channels, the INTERVIEW transmits the idle line character selected in the **Idle Select** field. If ESF framing is used, the circuit's Frame Data Link (FDL; see Table 49-2 and description in Section 49.7) is filled in with the standard milliwatt pattern of all one's. Statistics are maintained on the selected incoming channel.

   – When the transmit mode is NORMAL, the sub-field **Idle Select** appears. Available selections are 7F and FF (hex).

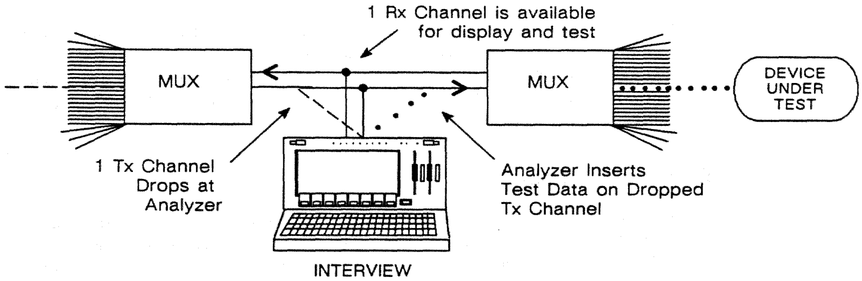


Figure 49-16 The INTERVIEW 7000 Series in drop-and-insert mode.

2. *Drop-and-insert mode.* This type of transmission (illustrated in Figure 49-16) is useful for testing a single channel over an active T1 circuit. If the user selects drop-and-insert mode, the INTERVIEW receives all 24 channels in both directions (left to right *and* right to left in Figure 49-16). The transmissions on 23 of the left-to-right channels are terminated and passed through (regenerated) outbound. The remaining channel is terminated, and higher-layer test data is inserted into the corresponding outbound channel. All the while, T1 protocol is maintained at the physical level. The INTERVIEW recalculates the correct CRC for the superframe. Data on the Frame Data Link is relayed without change. Drop-and-insert mode may be used in either direction, towards DTE or DCE. Statistics are maintained on the selected channel.

   The INTERVIEW should be set up to *bridge* the data moving right-to-left in Figure 49-16. See the discussion of BRIDGED as a **Termination** option in Section 49.5(B).

(F) Idle Select

In Normal transmit mode, the INTERVIEW will isolate one incoming channel for capture and transmit on the corresponding outbound channel. On all other channels, the INTERVIEW transmits the idle line character selected in the **Idle Select** field. This field defaults to 7F (hex) but FF (hex) may be alternately selected.

(G) Line Clock Select

Two selections are available to the user in the **Line Clock Select** field, internal and external. Select **Line Clock Select:** EXTERNAL when performing normal emulation or normal channel BERT and an external clock source is used. Otherwise, the field defaults to internal.

(H) Framing Mode

The INTERVIEW can recognize either standard D4 or ESF Superframes. Statistics automatically performed on the T1 circuit are based on the **Framing Mode** you have selected. This selection also dictates the frame format anticipated or transmitted by the INTERVIEW.

D4 or ESF framing can be accurately interpreted whether or not robbed-bit signalling is employed. For a circuit which uses robbed-bit (in-band) signalling, select **Data Path:** 56K DATA CHANNEL when you wish to view data. For a circuit which uses clear channel signalling, select 64K DATA CHANNEL as the data path.

> NOTE: Make any **Code** and **Format** selections you wish on the Line Setup screen, as these can be accurately transmitted and interpreted, even when 56 Kbps is the usable data speed per channel (seven valid bits per channel) due to robbed-bit signalling.

> NOTE: The data rate of originating terminals is likely to vary from the rate of the data channel. The Interface Control selection pertains only to the maximum usable data rate for a single multiplexed time-slot (channel).

Robbed-bit paths are an accurate reflection of signalling only when in-band signalling is employed in T1; otherwise, these data paths will show a random pattern for data bits which coincide with the robbed-bit positions. For the location of robbed bits within a D4 frame, see Table 49-1; see Table 49-2 for their positions in an ESF frame.

Other **Data Path** selections which appear are valid for frames which employ either in-band or clear channel signalling.

1. *D4 framing.* With D4 selected, the INTERVIEW expects 12-frame superframes with a prescribed format, described in Section 49.7. When D4 framing is selected, **Data Path** options change and two new fields, **Yellow Alarm** and **Sync Procedure**, appear. These fields are described in subsequent paragraphs.

2. *ESF framing.* The INTERVIEW expects a 24-frame superframe when ESF framing is selected. The ESF frame structure is described in Section 49.7. When you select ESF, **Data Path** selections are modified. The field **Check CRC During Sync**, described in following paragraphs, appears.

(I) Data Path

Choose the data path for which you wish to display data. A data channel must be selected if you plan to test or view a higher layer protocol.

1. *64K data channel.* This option applies to both D4 and ESF framing. It should not be selected if in-band signalling is employed on the T1 circuit. Recommended selection for Primary Rate ISDN.

2. *56K data channel.* This option applies to both D4 and ESF framing. Select it when in-band signalling is employed on the T1 circuit.

3. *A or B robbed bits.* These selections are available for both D4 and ESF; however, they provide accurate signalling data only when in-band signalling is used on the circuit. A and B paths are distinct to the channel (time slot) designated in the **Channel Number** field.

4. *C or D robbed bits.* These selections are available only for ESF framing. The signalling pattern shown with either selection is valid only when in-band signalling is used on the circuit. C and D paths are distinct to the channel (time slot) designated in the **Channel Number** field.

5. *Ft bits.* This selection applies only to D4 framing. Ft bits are the transmission framing bits used for frame alignment. There are 6 Ft bits per frame. See Table 49-1 for their location.

6. *Fs bits.* This selection applies only to D4 framing. Fs bits are the frame signalling bits used for superframe alignment and indication of yellow alarms in some instances. There are 6 Fs bits per frame. See Table 49-1 for their location.

7. *FDL.* This selection, representing the Frame Data Link, applies only to ESF framing. The 12 FDL bits per frame provide measurements on line performance. See Table 49-2 for its location.

(J) Channel Number

This field appears when a 56K data channel, a 64K data channel, or a robbed bit path has been selected. Valid entries are 1 through 24 (decimal). For Primary Rate ISDN, this entry is the B channel selection (recommended B channels are 1 through 23, with channel 24 for use as the D channel).

(K) Yellow Alarm

When D4 is selected as the **Framing Mode**, this field appears. Since yellow alarms are tracked as part of the T1 statistics package and since D4 framing has two alternatives for conveying these alarms, you must indicate the type of alarm used.

1. *F-bit 12 = 1.* Select this option if yellow alarms are indicated in the last F-bit (the sixth Fs bit) in the frame. When this selection is made, synchronization is not influenced by the value of Bit 12 (see the description of the syncing procedure in the following section).

2. *Data bit = 0.* Select this option if the second data bit in every channel is set to zero to indicate a yellow alarm.

(L) Sync Procedure

When D4 is selected as the **Framing Mode**, this field appears. There are two means of synchronizing the frame for statistical analysis and display of its contents.

1. *All F bits.* Make this selection to allow synchronization only when all 12 framing bits have been received. Aligns on Ft bits for individual frames and cross-checks Fs to provide additional protection against false framing errors. (Bit 12 is not checked if F-Bit 12 = 1 has been indicated as the **Yellow Alarm** mode.) The delay for synchronization will be greater in this case.

2. *Ft bits only.* This selection allows the frame to sync more rapidly, on only the Frame Transmission (Ft) bits. Use this selection when non-standard Fs patterns are in use.

(M) Check CRC During Sync

This field appears only when ESF framing has been selected. An ESF frame carries a six-bit CRC among its framing bits (see Table 49-2) to indicate the accuracy of the transmission. If you select YES in this field, the INTERVIEW will not synchronize on a frame which produces a bad CRC. This provides an added safeguard to the framing pattern, for transmissions which must be precise. Select NO to allow the INTERVIEW to synchronize more quickly, on a correct framing pattern, regardless of the block check results.

> NOTE: The T1 CRC is entirely distinct from the block checking which may be performed for a protocol operating at a higher layer. The T1 CRC is included in statistical measurements only on the T1 statistics screens (where it is included in both CRC and ESF errors).

(N) Sync Length

Indicate in this field the number of bits validated before sync is declared. Selections are 10 bit and 24 bit. The 10-bit test minimizes reframe time; 24-bit testing provides more protection against false framing.

(O) B8ZS Coding

By default, the INTERVIEW sends and expects to receive T1 transmissions encoded in Alternate Mark Inversion format. The user has the option, however, of switching to Binary 8 Zero Suppression (B8ZS).

When you select **B8ZS: YES**, the INTERVIEW transmits any occurrence of eight consecutive zero bits as a special bit pattern containing two intentional bipolar violations in defined positions. These anticipated bipolar violations (BPV) are removed and the eight zero bits are restored at the receiving end. The INTERVIEW also performs the restoration function when it is the receiver.

The BPV's associated with B8ZS occur in the fourth and seventh bit positions of the inserted code. The code inserted is 000+–0–+ if the preceding one bit was positive; and 000–+0+– if the preceding one bit was negative.

The intentional bipolar violations which occur with **B8ZS** are not included in BPV calculations on the T1 statistics screen when **B8ZS: YES** is selected.

```
                          ** Interface Control **

T1 Line Setup                          T1 Data Path Setup
Receiver Gain: 0 db                    Framing Mode: D4
Termination: BRIDGED                   Data Path: 64K DATA CHANNEL
Cable Type: MAT                        Channel Number: 01
Cable Length: 0-220                    Yellow Alarm: F-BIT 12 = 1
                                       Sync Procedure: ALL F-BITS
                                       Sync Length: 10 bit
                                       B8ZS Coding: NO

                                       Record Framing Bits: YES

                                       T1 Signal Channel Setup
                                       Signal Channel Number: 24
                                       Signal Channel Idle Char: 7E
                                       Sig Channel Polarity: NORMAL

Select Setup To Perform:
 F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
 LINE              PATH     SIGNAL
```

Figure 49-17 The T1 Interface Control screen in monitor (or automonitor) mode, configured to include framing bits in recorded aggregate data.

(P) Record Framing Bits

This field relates to aggregate T1 record and appears only when 1) your unit is equipped with a T1 mux board, Revision E or higher; 2) **Mode: MONITOR** is selected on the Line Setup menu; and 3) **Capture Memory: RAM** and **Record Speed: HIGH SPEED** are selected on the Record Setup menu. See also Sections 11.4(A) and 49.1(E).

Select **Record Framing Bits:** YES, the default selection, to include all framing bits in the aggregate T1 data stream. See Figure 49-17. Choose NO if you want to exclude framing bits from the recorded data-stream.

Use the recorded data for later playback and analysis. Note, however, that a specific channel cannot be isolated from the aggregate data stream for monitoring and analysis.

During high-speed recording, data display and program conditions (or triggers) based on incoming data are disabled. The T1 Statistics display, however, remains active. Use the **T1 LINE CONDITIONS** field on this display to check for TD and RD in sync as a condition for recording. See Section 49.6.

(Q) Signal Channel Number

This field is applicable only for T1 Primary Rate ISDN dual-channel monitoring or emulation, with *only* BOP format on the D channel; it defaults to 24, the recommended signalling channel for Primary Rate ISDN. When monitoring dual channels, the number in the **Channel Number** field is the selected B channel and the number in the **Signal Channel Number** field is the D channel.

(R) Signal Channel Idle Char

This field is applicable only for T1 Primary Rate ISDN dual-channel emulation, with *only* BOP format on the D channel; it defaults to 7E, with an alternate selection of FF. The **Signal Channel Idle Char** field allows the user to enter the idle character to be sent on the signalling channel selected in the **Signal Channel Number** field.

(S) Sig Channel Polarity

This field is applicable only for T1 Primary Rate ISDN dual-channel monitoring or emulation, with *only* BOP format on the D channel; it defaults to NORMAL, with an alternate selection of INVERTED. Normal polarity means the bits on the signalling channel selected in the **Signal Channel Number** field will be sent normally; inverted polarity means those bits will have their polarity reversed—1's become 0's and 0's become 1's.

49.6 Interpreting the T1 Statistics Display

The T1 Statistics Display can be viewed in Run Mode when the T1 TIM is installed. To access the statistics screen, press F5 (for STATS), then F3 (for T1STATS) while the INTERVIEW is actively monitoring or testing the line. You may alternate between the statistics screen and any other displays listed at the bottom of the screen by pressing the function key indicated. A sample T1 Statistics screen is shown in Figure 49-18. For more information on alternate run-time displays, refer to Section 5.

```
*MON/LINE/T1/Ch01*          BLK=            06/10/89 18:06
ASCII/8/NONE/BOP
T1 STATISTICS               DTE         RATE         DCE          RATE
TEST SECONDS:               1.2540E03
FRAMES RCVD:                1.0020E07                0.0000E00
BPV'S RCVD:                 9.2708E04   4.791E-05    0.0000E00    0.000E-00
BPV-FREE SECS:              1.2480E03   9.952E-01    0.0000E00    0.000E-00
OOF EVENTS:                 0.0000E00   0.000E-00    0.0000E00    0.000E-00
FT/FS ERRORS:               2.0000E00   1.994E-07    0.0000E00    0.000E-00
ESF ERRORS:                 0.0000E00   0.000E-00    0.0000E00    0.000E-00
CARRIER LOSSES:             1.1000E01   1.097E-06    0.0000E00    0.000E-00
SYNC LOSSES:                1.1000E01   1.097E-06    0.0000E00    0.000E-00
SYNC LOSS TIME:             1.4980E00   1.194E-03    0.0000E00    0.000E-00
ERROR-FREE SECONDS:         1.2440E03   9.920E-01    0.0000E00    0.000E-00

T1 LINE CONDITIONS
CURRENT [PREVIOUS]          NORMAL   [YSgSy]         NOT MONITORED

  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
TABULAR  GRAPHIC  T1STATS
```

Figure 49-18 T1 Statistics Display reports on T1 transmissions in real time and is an alternate screen to data or trace displays in Run mode when the T1 TIM is installed.

(A) Layout of the Screen

The statistics display is divided into two general regions. T1 statistics appear at the top of the screen; information pertaining to line conditions appears at the bottom of the screen.

All values displayed in the statistics region are cumulative. That is, calculations begin when you press [RUN] and continue until you press [RUN] again. Freezing the trace or character displays has no effect on the statistics gathered, although the statistics will not be updated until the screen is unfrozen.

> **NOTE:** Pressing [RUN] resets all timer and counters and clears all values from the T1 Statistics screen. It also clears buffer memory and RAM.

Values are given in scientific notation, shown to a maximum of four decimal places. The right-most positions of each highlighted field are reserved for display of the exponent. The capital letter E sets off the exponent from the base number. The E is followed by a minus sign to indicate a negative exponent for a value less than one.

There are four columns for each T1 measurement. The left-most column displays the current measurement calculated on the DTE side of the line. The next column displays a cumulative rate when applicable. The two columns on the right display the same type of measurement calculated for the DCE and the rate, if any, on the DCE side. The various statistics measurements are explained in the following paragraphs.

T1 line conditions are listed in two columns, one for DTE and one for DCE. Both current and previous conditions are shown. Line conditions which may be displayed are described in Section 49.6(O).

(B) Test Seconds

TEST SECONDS indicate elapsed time. The count begins from zero when you press [RUN].

(C) Frames Received

The value listed in the **FRAMES RCVD** row is equal to the number of bits received divided by 193. Thus, the value represents the number of individual frames rather than the number of superframes received. The frame count is not incremented unless a valid frame is received. The definition of a valid frame may vary depending on the Interface Control selections you have made pertinent to the syncing procedure (see Section 49.5, **Sync Procedure, Check CRC During Sync**, and **Sync Length**).

(D) BPV's Received

The row labeled **BPV'S RECVD** displays the number of bipolar violations received in valid frames during the test. Anticipated bipolar violations used to maintain one's density are not included in these values if B8ZS encoding is selected on the Interface Control screen (see Section 49.5).

The **RATE** column equals **BPV'S RECVD** divided by total number of bits received in valid frames.

(E) BPV-Free Seconds

This reading gives elapsed test time free of BPV errors. If B8ZS is selected, BPV's anticipated as part of the pattern are not subtracted from the total time.

NOTE: Time out of sync is included in the time displayed.

The **RATE** column equals **BPV-FREE SECS** divided by total test seconds.

(F) Sync Losses

SYNC LOSSES records the number of sync loss incidents. A sync loss occurs when two or more consecutive framing bits are in error.

The **RATE** column shows total sync losses divided by total valid frames received.

(G) Sync Loss Time

SYNC LOSS TIME displays time out of sync. Time out of sync may vary slightly, depending on selections made pertaining to resync on the Interface Control screen (see Section 49.5, **Sync Procedure**, **Check CRC During Sync**, and **Sync Length**).

The **RATE** column shows sync loss time divided by total test seconds.

(H) OOF Events

OOF EVENTS is the number of out-of-frame (OOF) errors since [RUN] was pressed. An out-of-frame error occurs when two out of four framing bits are in error.

The value in the **RATE** column equals framing errors divided by the number of valid frames received.

(I) CRC-6 Errors

CRC-6 ERRORS indicates total CRC errors since [RUN] was pressed. This field is present when the T1 Interface Control screen shows **Framing Mode:** ESF .

The **RATE** is equal to total CRC errors divided by the total number of superframes received.

(J) FT/FS Errors

This field is present when the T1 Interface Control screen shows **Framing Mode:** D4 and **Sync Procedure:** ALL F-BITS . **FT/FS ERRORS** indicates total Ft and Fs errors since [RUN] was pressed.

The **RATE** is equal to total Ft and Fs errors divided by the total number of frame-alignment words.

(K) FT Errors

This field is present when the T1 Interface Control screen shows **Framing Mode:** D4 and **Sync Procedure:** Ft BITS ONLY . **FT ERRORS** indicates total Ft errors since [RUN] was pressed.

The **RATE** is equal to total Ft errors divided by the total number of frame-alignment words.

(L) ESF Errors

ESF ERRORS indicates the combined total for OOF errors and CRC errors.

(M) Error-Free Seconds

This row lists total seconds free of CRC-6 errors (or Ft/Fs or Ft errors), OOF errors, and bipolar violations.

The **RATE** column lists error-free seconds divided by test seconds.

NOTE: This measurement differs from error–free seconds measured in T1 BERT statistics. The BERT measurement includes bit errors as well.

(N) Carrier Losses

This value is the number of times signal was lost on the monitored circuit long enough for 32 consecutive zeroes to be received. Refer to Section 49.6(O), below, for a description of how Carrier Loss is posted as a line condition.

(O) T1 Line Conditions

When an error condition occurs, the status of the line under test appears in the T1 LINE CONDITIONS area at the bottom of the T1 Statistics Screen. DTE line conditions appear in the highlighted box to the left; DCE conditions in the highlighted box to the right. Once the current condition changes, an abbreviation for the error is posted in the brackets which follow the current condition. This bracketed area contains an abbreviation for up to four previous conditions which have occurred in the present testing session.

NOTE: The order of the abbreviations in the previous conditions field is not necessarily a chronological representation of events.

When there is no longer an error condition on the line, NORMAL is displayed in the left–hand box. The types of errors that may appear as line conditions are explained in the following paragraphs.

1. *Yellow alarm.* A yellow alarm (YEL. ALARM; Y to indicate a previous condition) is sent to alert the remote site that the sender is experiencing an out–of–frame condition. The yellow alarm signal can be transmitted in two manners as explained in Section 49.5(K). The user must indicate the type of signal in use in order for yellow alarm conditions to be accurately detected, included in statistics, and displayed as a line condition.

2. *Blue alarm.* A blue alarm (B in the previous conditions area) indicates that the sender is experiencing a loss–of–signal condition.

3. *Loss of Signal.* Signal loss is indicated in one of two ways. If after [RUN] is pressed no signal is received from the line under test, the condition NO SIGNAL is posted. Any time a received signal is lost for a minimum of 150 ms, the message SIGNAL LOST is posted. Either type of signal loss is recorded as Sg in the line conditions box to indicate a previous condition.

4. *Loss–of–Sync.* This condition is displayed anytime two or more consecutive framing bits are found to be in error. The abbreviation Sy within brackets is used to indicate a previous loss of sync.

When an emulate mode has been selected on the Line Setup screen *and* **Transmit Mode:** NORMAL has been selected on the Interface Control screen, the words NOT MONITORED appear on the side of the line that the INTERVIEW is emulating. If **Transmit Mode:** DROP/INS is selected on the Interface Control screen, both sides of the line are monitored. (On the side of the line which the INTERVIEW is monitoring, the incoming channel — rather than the inserted INTERVIEW data — is analyzed.)

(P) T1 Statistics as an Alternate Display to T1 BERT

The function keys shown in Figure 49-19 appear at the bottom of the T1 Statistics display when the INTERVIEW is running a T1 BERT test. Press F8 to display T1 BERT Statistics; other display options are not available during a BERT test. Although they can be executed with regular T1 statistics displayed, the commands in this bank of softkeys apply for the most part to the BERT test. Consult Section 9 for a description of these commands, BERT testing, and statistics.

One command in this group which does affect the T1 Statistics display is RESET, F3. RESET sets the value of all timers and counters, including T1 counters, to zero. The BERT test continues, however, even though the elapsed time (TEST SECONDS) at the top of the screen is reset.

F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8
INJ1ERR	ERR INJ	RESET	RESTART	LOOPUP	LOOPDN	T1STATS	BERT

Figure 49-19 Run-time function keys available with T1 Statistics Display when performing a T1 BERT test

49.7 D4 and Extended SuperFrame Structures

A D4 superframe contains twelve frames of 193 bits each; that is, 12 (24 x 8 + 1), where 24 is the number of time slots, 8 the number of bits per time slot, and 1 the framing bit which precedes each component frame (see Figure 49-20 and Figure 49-21). In extended superframing (ESF), 24 of these 193-bit frames are contained within one superframe. Framing (F) bit patterns and in-band signalling (if employed) differ in the two schemes as illustrated in Table 49-1 through Table 49-2.

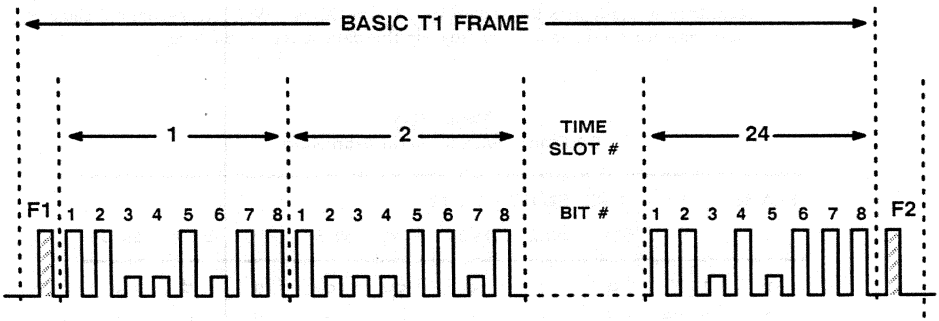


Figure 49-20 193-bit frame which serves as the component in both D4 and ESF extended framing formats.

F_T	1		0		1		0		1		0	
D4 F BITS	1	0	0	0	1	1	0	1	1	1	0	0
FRAME #	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F_S		0		0		1		1		1		0 +

Figure 49-21 D4 framing bits are always set to 100011011100. A yellow alarm is an exception: In this case, Bit 12 may be set to 1.

In the table which follows, A and B indicate robbed bits. When the bit-robbing technique is used, maximum data speed = 56 Kbps. With clear-channel signalling, these bits are used for data, increasing the data speed to 64 Kbps.

Table 49-1
D4 Frame with In-Band Signalling

FRAME #	F		TIME SLOTS 1...12							
			bit1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7	bit 8
1	1	FT	d	d	d	d	d	d	d	d
2	0	FS	d	d	d	d	d	d	d	d
3	0	FT	d	d	d	d	d	d	d	d
4	0	FS	d	d	d	d	d	d	d	d
5	1	FT	d	d	d	d	d	d	d	d
6	1	FS	d	d	d	d	d	d	d	A
7	0	FT	d	d	d	d	d	d	d	d
8	1	FS	d	d	d	d	d	d	d	d
9	1	FT	d	d	d	d	d	d	d	d
10	1	FS	d	d	d	d	d	d	d	d
11	0	FT	d	d	d	d	d	d	d	d
12	0	FS	d	d	d	d	d	d	d	B

The ESF Framing Pattern Sequence (referred to as FPS or FAS) is always equal to 001011. Extended Super-Frame format uses a 6-bit Block Check (CRC-6) and a 12-bit Frame Data Link (FDL) to measure line performance and transmit statistical information. There are four in-band signalling bits per frame (A, B, C, and D) if robbed-bit signalling is used. In-band signalling reduces the maximum data rate to 56 Kbps. With clear-channel signalling, these four bits become data bits, and the data rate is 64 Kbps.

Table 49-2
ESF Frame with In-Band Signalling

FRAME #	F	TIME SLOTS 1 ... 24							
		bit1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7	bit 8
1	FDL1	d	d	d	d	d	d	d	d
2	CRC1	d	d	d	d	d	d	d	d
3	FDL2	d	d	d	d	d	d	d	d
4	0	d	d	d	d	d	d	d	d
5	FDL3	d	d	d	d	d	d	d	d
6	CRC2	d	d	d	d	d	d	d	A
7	FDL4	d	d	d	d	d	d	d	d
8	0	d	d	d	d	d	d	d	d
9	FDL5	d	d	d	d	d	d	d	d
10	CRC3	d	d	d	d	d	d	d	d
11	FDL6	d	d	d	d	d	d	d	d
12	1	d	d	d	d	d	d	d	B
13	FDL7	d	d	d	d	d	d	d	d
14	CRC4	d	d	d	d	d	d	d	d
15	FDL8	d	d	d	d	d	d	d	d
16	0	d	d	d	d	d	d	d	d
17	FDL9	d	d	d	d	d	d	d	d
18	CRC5	d	d	d	d	d	d	d	C
19	FDL10	d	d	d	d	d	d	d	d
20	1	d	d	d	d	d	d	d	d
21	FDL11	d	d	d	d	d	d	d	d
22	CRC6	d	d	d	d	d	d	d	d
23	FDL12	d	d	d	d	d	d	d	d
24	1	d	d	d	d	d	d	d	D

50 G.703

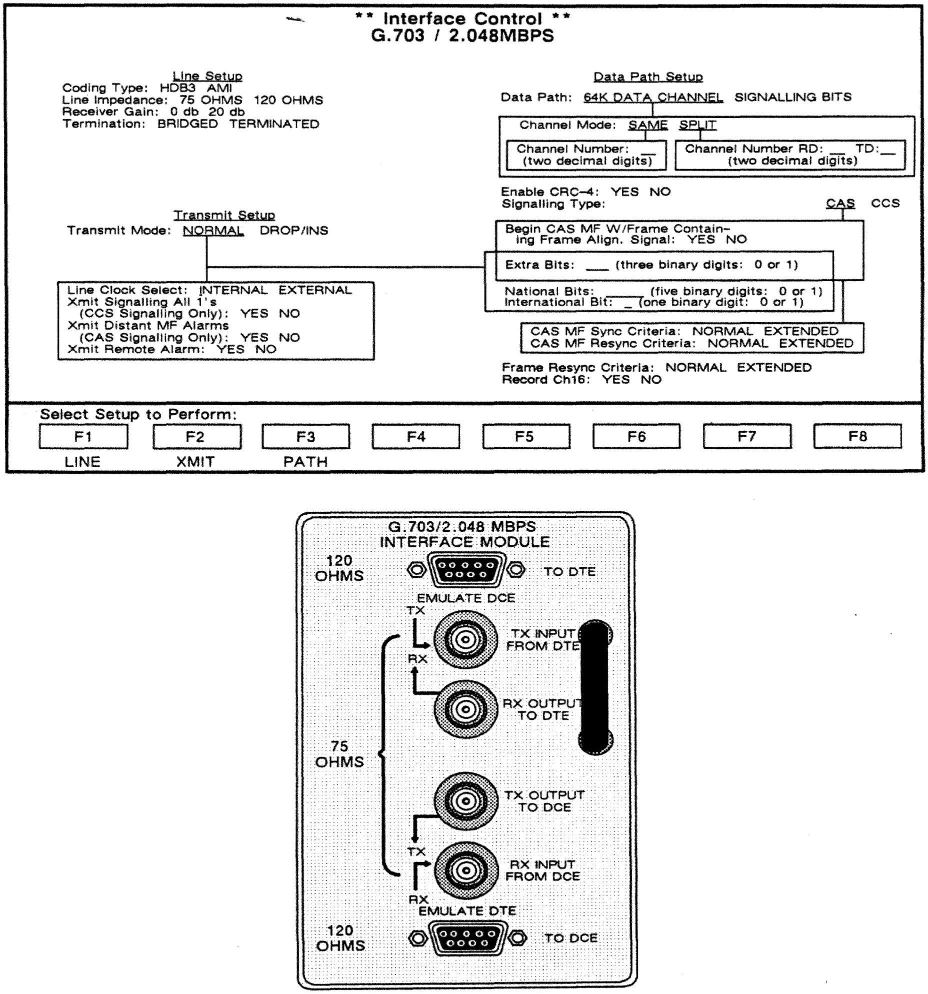


Figure 50-1 Interface Control screen (above) presents G.703 options when a G.703 TIM (below) is installed.

50 G.703

G.703 is a point-to-point protocol at the physical layer (Layer 1) used to transmit high-speed voice or data over telephone lines. The INTERVIEW 7000 Series, with G.703 software and the G.703 Test Interface Module installed, is capable of testing G.703 circuits that comply with European standards. In particular, the INTERVIEW tests circuits with a total bandwidth of 2.048 MHz (as opposed to 1.544 MHz circuits typically used in North America). The bandwidth is divided into 32 channels with an absolute speed of 64 Kbps each.

Only channels 1 through 31 are available for testing—channel 0 contains framing bits and is transparent to the user. Additionally, channel 16 is set aside for signalling and framing in CAS (Channel Associated Signalling) mode. The user should keep this in mind when this manual refers to the "32 channels" in G.703.

The INTERVIEW monitors the equivalent of both sides of a line, RD (DCE) and TD (DTE), or emulates RD or TD. The INTERVIEW allows the user to select a single channel on which to monitor (or emulate RD or TD) or to "split" the line and select RD and TD on different channels. Hereafter, references to monitoring or emulating a channel will inherently refer to the selection of split channels.

In order to capture G.703 on the INTERVIEW 7000 Series, your unit must be equipped with the G.703 option (OPT-951-24-1), which consists of a Multiplexer board and a removable Test Interface Module (documented in the following paragraphs).

The INTERVIEW supports G.703 Primary Rate ISDN with 30 B-channels and one D-channel (30B+D) in CCS (Common Channel Signalling) mode.

50.1 Overview of G.703 Testing Capabilities

(A) Physical Characteristics

The INTERVIEW's physical interface conforms to CCITT Recommendation G.703 for 2.048 MHz circuits. The physical connectors and the G.703 Test Interface Module are discussed in Section 50.2.

The INTERVIEW can transmit and receive G.703 data encoded in Alternate Mark Inversion Format (AMI) or High Density Bipolar 3 (HDB3). In AMI, the polarity of each sequential 1 (mark) alternates with reference to the zero (space) voltage level. HDB3, the default selection, is a transmission technique which is used to overcome the occurrence of long strings of zeroes and the associated timing problems. HDB3 is explained later in this section.

(B) Framing and Signalling Characteristics

Any G.703 circuit that operates at 2.048 MHz and conforms to the basic physical characteristics laid out in Recommendation G.703 may be BERT tested with the INTERVIEW; however, the full set of statistical analyses and protocol testing capabilities apply to G.703 circuits which employ CAS or CCS framing structures. These framing structures are discussed in detail in CCITT Recommendation G.704; the major characteristics of the scheme are outlined in Section 50.7.

1. *Channel 0.* Channel 0 is the channel reserved in G.703 for frame alignment information and remote alarms, including the optional CRC for detecting transmission errors and for syncing. The international and national bits are also carried *transparently* on channel 0, even though they are selectable on the Interface Control screen. Channel 0 cannot be emulated or monitored; it cannot be recorded for playback, even when aggregate recording is selected. Regardless of which Transmit mode is used, the INTERVIEW sends the framing information on channel 0 along with the selected channel(s).

2. *Channel 16.* Signalling bits are carried on Channel 16 when CAS mode is selected for the signalling type on the Interface Control screen. These ABCD bits can also be displayed when in Run mode by selecting first [F1], DATA, and then [F5], CAS SIG (Figure 50-18). For specific bit information, see Figure 50-22.

   In CCS mode, channel 16 can be used either as a data channel or for special signalling.

   When recording the aggregate G.703 data stream, selecting **Record Ch16: YES** on the Interface Control screen will include the information from channel 16 in the aggregate data stream.

(C) G.703 BERT

The INTERVIEW can perform both framed and unframed BERT tests on G.703 transmissions. An individual channel may also be BERT tested. Tests may be performed in a simple loopback configuration or in conjunction with another INTERVIEW or BERT tester. In Run mode, a separate G.703 BERT display tracks test results. The contents of the display and BERT options and setup are described in Section 9.

(D) Channel Data Capture

The Front-End Buffer can capture both sides of one G.703 channel in real-time for immediate analysis or recording and playback. Or, the user may elect to "split" the channel mode and to use *two* channels: one for RD and one for

TD. These selections are explained in Sections 50.5(K) and (L). The user may specify any one of channels 1 through 31; or split TD and RD on two of those channels.

> NOTE: When recording the capture of a single channel to RAM, select **Record Speed:** NORMAL on the Record Setup menu. See Section 11.4(A).

When you enter Run mode configured to capture a single channel, channel 30 for example, the following message appears on the status line: *"Ch30."* When capturing split channels (channel 4 for RD and channel 7 for TD, for example), the following message appears on the status line: *"R04T07."*

(E) Aggregate G.703 Record

To record the aggregate G.703 data stream (2.048 Mbps), with or without channel 16, your unit must be equipped with an FEB board capable of high-speed recording (see Section 11.4). Select **Mode:** MONITOR on the Line Setup menu. Configure the Record Setup menu for **Capture Memory:** RAM and **Record Speed:** HIGH SPEED.

Your selection for the **Record Ch16** field on the G.703 Interface Control screen determines whether or not information on channel 16 will be included in the aggregate data stream. See Section 50.5(V). Note that while channel 0 is always transmitted, it is never recorded for playback, even when aggregate recording has been selected.

Use the recorded data for later playback and analysis. Note, however, that a specific channel cannot be isolated from the aggregate data stream for monitoring and analysis.

During high-speed recording, data display and program conditions (or triggers) based on incoming data are disabled. The G.703 Statistics display, however, remains active. To optimize recording, however, do the following:

1. select **Initial Cond:** NOT RECORD on the Line Setup screen along with the high-speed recording selections and press [RUN];
2. access the G.703 Statistics display by pressing [F5] (for STATS), then [F3] (for G703STA); use the **G703 LINE CONDITIONS** field on the G.703 Statistics display to check for TD and RD in sync as a condition for recording (see Section 50.6);
3. press [DONE] to return to the data screen;
4. press [F7], NO DISP; and
5. then press [RECORD] to begin high-speed recording.

See also Section 11.4(A).

When you enter Run mode configured for aggregate G.703 record, the status line will contain the following message: *"HS RCRD"* and *"Monitoring is disabled for high speed ram recording."*

(F) Monitor Mode

When **Mode** is set to **MONITOR** on the Line Setup menu, the INTERVIEW as G.703 protocol analyzer may be used to monitor any one (or the split RD and TD of two) of the data channels or signalling patterns passively. Once the initial cabling is done, the G.703 circuit through the INTERVIEW is bridged, not broken — even when the unit is turned off — and the INTERVIEW does not interfere with communications in progress.

A BNC connector may be used to monitor nonintrusively even when the INTERVIEW is not already cabled to the line. See Figure 50-9 for an illustration of this configuration.

(G) Emulate DTE or DCE

The INTERVIEW can also emulate a DTE (multiplexer) or a DCE (network) over G.703 lines, depending on the **Mode** selection made on the Line Setup menu. In an emulation mode, the INTERVIEW actively transmits and receives data as prescribed by G.703 interface at a maximum channel speed of 64 Kbps. A selection on the Interface Control screen allows the user to specify whether clocking is provided by the INTERVIEW or recovered from the incoming data.

Any of the 30 data channels on the circuit (or channel 16) can be selected for analysis. INTERVIEW test data can be transmitted on the outbound channel; incoming data on the corresponding channel is available for display and test. Higher layer protocols carried by the G.703 point-to-point protocol can be tested simultaneously as statistics on the performance of the G.703 circuit are taken and, at the user's need, displayed.

The INTERVIEW emulates in two fashions: it can transmit idle to all but one channel to which it transmits data and which it monitors; or it can perform drop-and-insert emulation. When the drop-and-insert option is employed, transmissions on 31 channels are passed through the INTERVIEW, while the channel selected for analysis is terminated and INTERVIEW data is transmitted on the outgoing channel.

(H) Protocol Spreadsheet

G.703 protocol cannot be controlled from the Protocol Spreadsheet. Other protocols operating above the physical interface may, however, be tested. Spreadsheet options for testing in this case will depend on the protocols you have loaded from the Layer Setup screen.

(I) Data Displays

The format and code selections you make on the Line Setup screen, indicated at the top of the run-time display, determine the appearance of the data stream on the screen. Protocols selected on the Layer Setup screen will be available as trace displays. One alternate real-time display (see Figure 50-2) selection allows you to view G.703 statistics and track performance on the G.703 circuit. The G.703 Statistics Display is described in Section 50.6.

Additionally, another alternate real-time display (see Figure 50-18) is reached by selecting first F1, **DATA**, and then F5, **CAS SIG**. This screen displays a matrix of the ABCD bits in each channel transmitted on timeslot 16 of every frame, as shown in Figure 50-22.

```
*BERTDCE/QRSS*
G703/FRAMED/WITHOUT CH16

 G.703 STATISTICS        DTE          RATE          DCE          RATE
TEST SECONDS:         2.7000E01
FRAMES RCVD:          1.9276E05                 0.0000E00
BPV'S RCVD:           0.0000E00   0.000E-00     0.0000E00   0.000E-00
BPV-FREE SECS:        2.3000E01   8.571E-01     0.0000E00   0.000E-00
FRAMING ERRORS:       3.0000E00   1.503E-05     0.0000E00   0.000E-00

SYNC LOSSES:          1.0000E00   5.010E-06     0.0000E00   0.000E-00
SYNC LOSS TIME:       3.5150E00   1.255E-01     0.0000E00   0.000E-00
ERROR-FREE SECS:      2.2000E01   8.214E-01     0.0000E00   0.000E-00

G703 LINE CONDITIONS
 CURRENT [PREVIOUS]   REMOTE ALRM [RSgSy]       NOT MONITORED

  F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
INJ1ERR  ERR INJ   RESET   RESTART                    G703STA   BERT
```

Figure 50-2 G.703 alternate statistics screen display.

(J) Primary Rate ISDN

The INTERVIEW supports G.703 Primary Rate ISDN at 2.048 MHz (30B+D) with the mux board and TIM option package (OPT-951-24-1) and software revision 6.00, or higher. The ISDN_D protocol package is used in G.703 at Layer 1 to access the ISDN variables. See also Sections 38, 47, and 74 on Basic Rate ISDN.

The D channel is channel 16, the signalling channel. For dual-channel monitoring and emulation, load the LAPD personality package at Layer 2 for the B channel under test. A ISDN trace package (OPT-951-35) is also available for monitoring either the D channel alone or the D channel and one of the B channels.

50.2 The Test Interface Module

The G.703 Test Interface Module (TIM), shown in Figure 50-3, is a removable module which may be replaced by different interfaces when other types of lines must be tested. The G.703 TIM provides two 9-pin female connectors (top and bottom of module) labeled TO DTE and TO DCE, which attach to a twisted pair cable. (See Table I-10 for pin specifications.) In addition, there are two pairs of BNC connectors. All connectors are two-wire and attach to a standard line. The signal direction for each connector is indicated by the arrows to the left of the BNC connectors on the TIM as shown in Figure 50-4. An overlay (Figure 50-5) which identifies active LEDs on the front panel accompanies the G.703 TIM.

Install the G.703 Test Interface Module and insert the correct LED overlay as described in Section 1.10. Once the G.703 module and the overlay are installed, TX and RX leads can be monitored on the front-panel green-red LEDs.

(A) Connectors

When you break a data line for testing, you may connect the end of the line coming from the DTE (multiplexer, channel bank, PBX, network, or switch) to the TO DTE (or to terminal equipment or "to TE") connector on the TIM (see top of Figure 50-3). Connect the other end of the line coming from the DCE (terminal equipment or telephone company office repeater) to the TO DCE (or to network termination or "to NT") connector on the TIM. Even when the INTERVIEW is powered off, this provides a through connection for the data line.

> *CAUTION: To connect the data line, you must interrupt the flow of data on the line. Be sure you have permission to break the line before doing so.*

If you are using the BNC connectors, you may create a pass-through connection by connecting the top two jacks toward the DTE (to TE) and the bottom two jacks toward the DCE (to NT).

When **Mode:** MONITOR or AUTOMONITOR is the program selection and the INTERVIEW is connected as a pass-through as described in the preceding paragraph, the INTERVIEW monitors data passively through either (or both) TO connectors on the TIM.

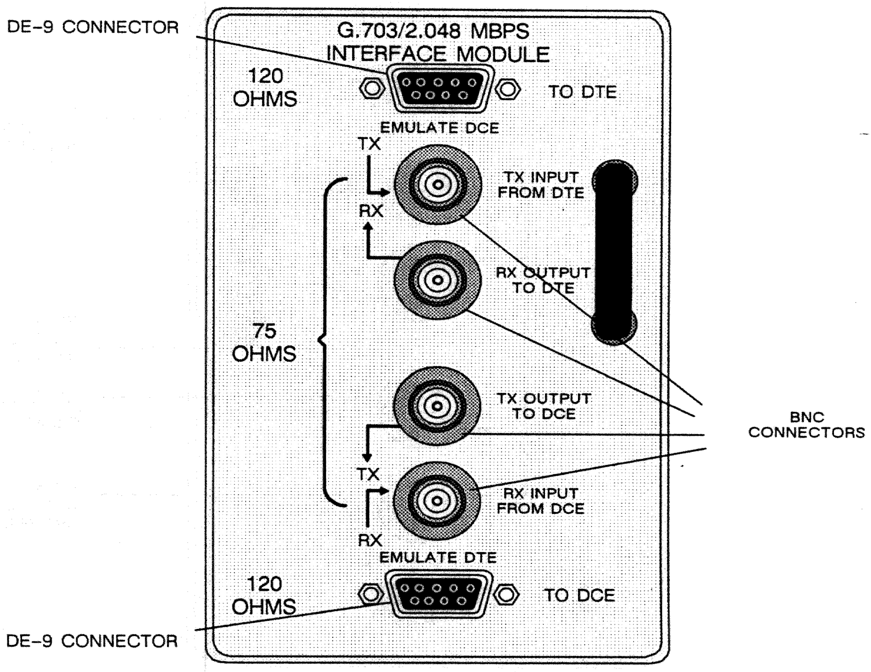


Figure 50-3 The G.703 Test Interface Module provides both BNC and DE–9 connectors for reception and transmission of data.

When the INTERVIEW is operating in EMULATE DCE mode (selected on the Line Setup menu), the INTERVIEW is transmitting and receiving data through the DE–9 connector labeled TO DTE (to TE), or through the top set of BNC connectors, labeled TX INPUT FROM DTE (for Transmit; that is, Input from the DTE or TE) and RX OUTPUT TO DTE (for Receive; Output to the DTE or TE).

When **Mode:** EMULATE DTE is the program selection, the unit transmits and receives data through the TO DCE (to NT) connector if the DE–9 connectors are in use, or through the bottom set of BNC connectors, if these are connected. The BNC connectors which are active in this case are labeled TX OUTPUT TO DCE (for Transmit; Output to the DCE or to NT) and RX INPUT FROM DCE (for Receive; Input from the DCE or from NT).

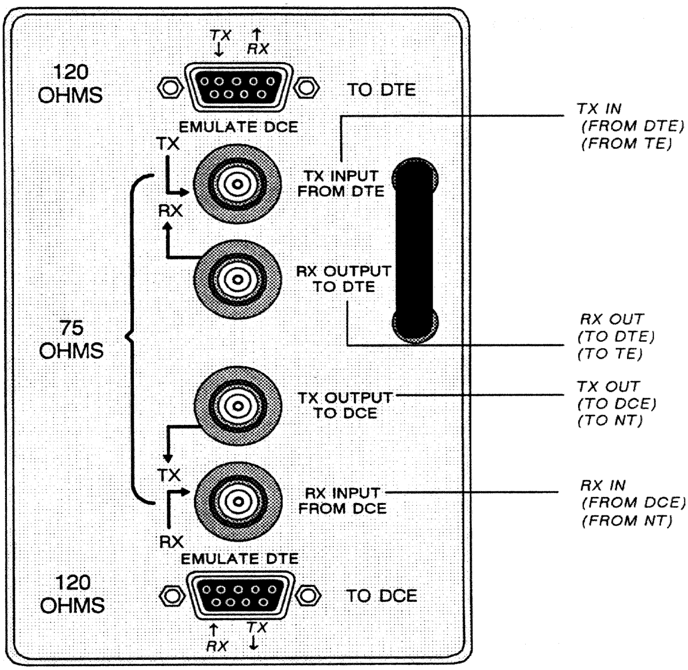


Figure 50-4 Signal direction for G.703 connectors.

(B) Green-Red LEDs

Two of the front-panel LEDs are active when the unit is testing G.703 interface. These represent leads monitored at either of the line interfaces (TO DTE or TE, TO DCE or NT) on the test-interface module. An LED is dark when the unit is off, green when the unit is powered on but the lead is off (at mark voltage, representing 1) or unterminated, and red when the lead is on (representing space voltage or 0).

Data leads transition quite rapidly. As a result, their LEDs typically show a shade of orange that is intermediate between red and green when data is being transmitted. Data-lead LEDs will vary in color with the type of data. FF–idle, for example, has no *on* transitions, while 7F–idle has only one, so both cause an LED to glow bright green.

Figure 50-5 G.703 Green-Red LED Overlay.

Two of the LEDs switch to red when the unit is in a special mode, Remote mode or Freeze mode. Remote means that the unit is *under* remote control via the REMOTE or phone-jack interface. (The remote-control feature is not implemented in the early releases of the INTERVIEW 7000 Series.)

It is important to note that the front-panel LED indicators always reflect TIM activity. If the LEDs are active while data is being played back from disk, the activity is on the line, not in the data stored on the disk.

50.3 Testing Configurations

(A) Test at Line Levels (No Pad)

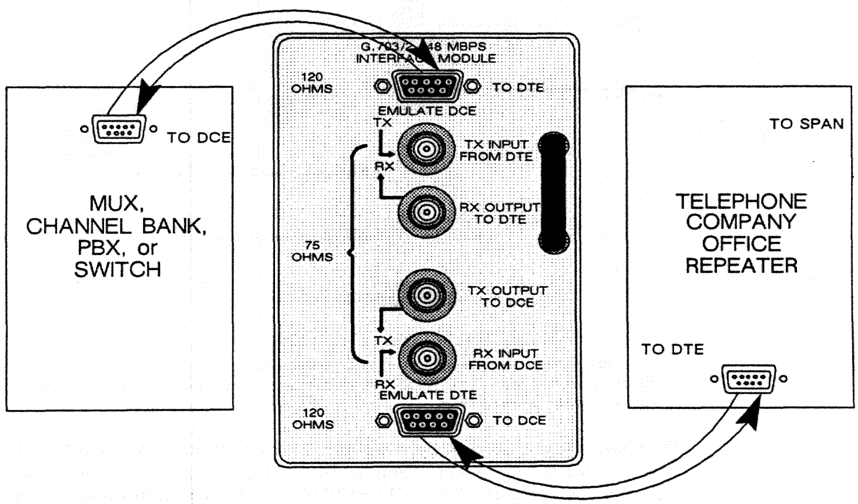


Figure 50-6 Place the INTERVIEW 7000 Series between the multiplexer and the telephone company office repeater (for example) to monitor or emulate over the G.703 circuit. The illustration indicates how cables equipped with DE-9 connectors would be connected.

Connect the INTERVIEW into the circuit between the DTE (multiplexer, channel bank, PBX, TE, or switch) and the DCE (telephone company office repeater) for G.703 testing. In this position, the INTERVIEW may monitor a selected channel, emulate a G.703 customer transmission, emulate the network on an individual channel towards a user terminal, or perform a BERT test. See Figure 50-6 and Figure 50-7.

To emulate one channel on the customer side of the conversation (for example), select EMULATE DTE as the operating **Mode** on the Line Setup screen. This breaks the line between the mux and the repeater as illustrated in Figure 50-6. The INTERVIEW communicates through the repeater in this configuration, transmitting and receiving over the DE-9 connector labeled TO DCE (to NT), or transmitting over the BNC connector labeled TX OUTPUT TO DCE and receiving over the connector labeled RX INPUT FROM DCE when the BNC jacks are used (Figure 50-7).

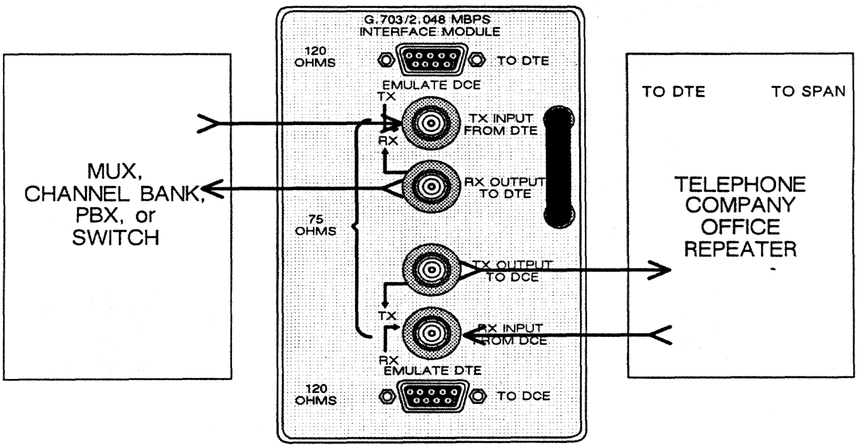


Figure 50-7 The same configuration may be achieved with BNC connectors. Once the cables are in place, the INTERVIEW may monitor nonintrusively or break the line toward the DTE or DCE.

To emulate the network side of the conversation, select EMULATE DCE as the operating **Mode** on the Line Setup screen. This breaks the line between the mux and the repeater. The INTERVIEW then communicates through the attached mux, transmitting and receiving over the DE-9 connector labeled TO DTE (to TE) (Figure 50-6), or transmitting over the BNC connector labeled RX OUTPUT TO DTE and receiving over the connector labeled TX INPUT FROM DTE (Figure 50-7).

(B) Simplex Repeater Power

The G.703 Test Interface Module will pass simplexed repeater power down the transmit pair and the receive pair when it is patched in series into the powered portion of a G.703 span. Figure 50-8 is the standard "looped-through" configuration shown in the previous figure, except that here the INTERVIEW has been placed on a powered span and is providing a DC path between input and output for both receive and transmit pairs. Both in monitor and emulate modes, a permanent DC path is maintained from TX INPUT FROM DTE (in) to TX OUTPUT TO DCE (out) and from RX INPUT FROM DCE (in) to RX OUTPUT TO DTE (out).

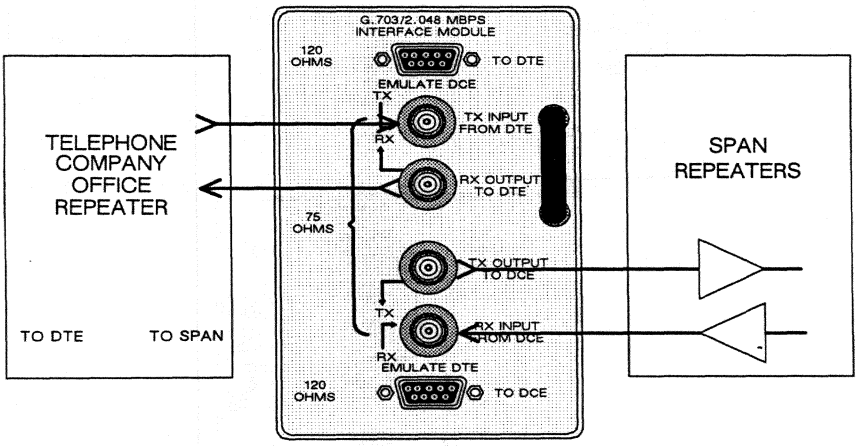


Figure 50-8 The INTERVIEW can be patched in series into the powered portion of a G.703 span.

One of the functions of a repeater is to complete the simplex current path between the transmit pair and the receive pair. When the INTERVIEW is used to break the line toward the span and emulate the repeater, a simple patch connection (via one of the BNC patch cords provided with the G.703 option) between TX INPUT FROM DTE and RX OUTPUT TO DTE will complete the DC current path.

(C) Test at Patch Panel (20db Pad at Monitor Jack)

Many G.703 sites have a special patch panel that allows nonintrusive monitoring of lines. (Actual monitoring with the INTERVIEW 7000 Series always is passive and nonintrusive, but unless a patch panel is installed at the test site, the line normally must be broken simply to cable the test equipment to the line.)

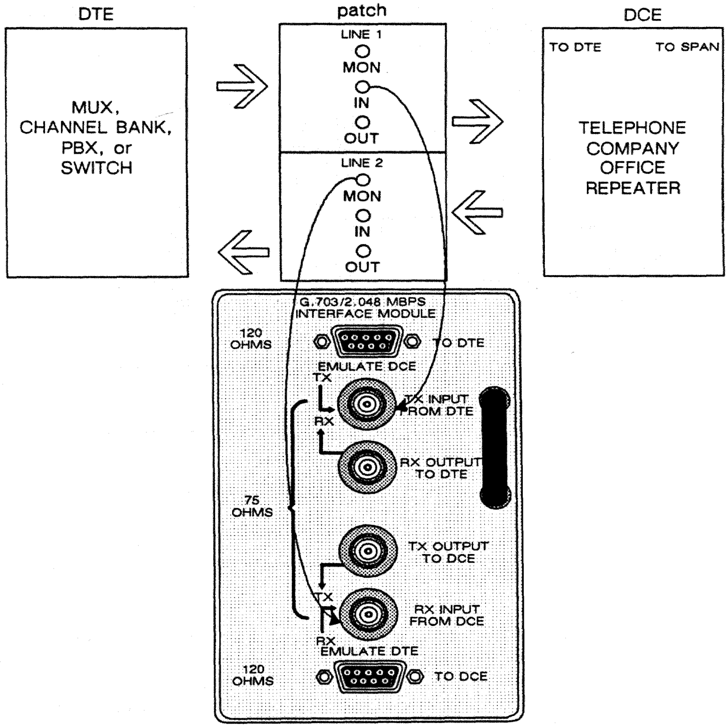


Figure 50-9 If a patch panel is available for patching at the telephone company office, the line can be monitored without even momentary intrusion.

Figure 50-9 shows a G.703 test-interface module (TIM) cabled to the MONITOR jacks of two separate patch panels. These panels handle Tx and Rx traffic separately. Because the monitor jacks are isolated from the line by a 20 db "pad," these jacks may be patched into without disrupting traffic on the line. When the INTERVIEW monitors at this interface, 20 db of gain should be added to the signal via the **Receiver Gain:** 20 db selection on the Interface Control menu—see Section 50.5(C). Terminate the line as well—select **Termination:** TERMINATED on the Interface Control screen.

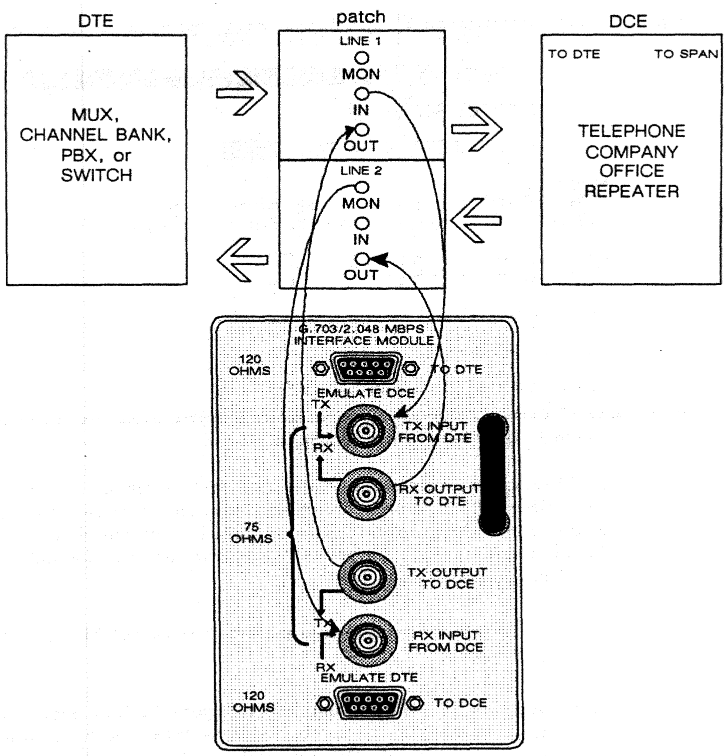


Figure 50-10 This is a "permanent" INTERVIEW-to-patch panel configuration. With the cables in place, the INTERVIEW may monitor nonintrusively.

Figure 50-10 shows a "permanent" installation of the INTERVIEW 7000 Series at a patch panel location. Once the cables are in place, the INTERVIEW can be used to monitor the line nonintrusively.

There is no special "padding" at the IN and OUT interfaces on the patch panel. Select **Receiver Gain:** 0 db on the Interface Control menu when you monitor or emulate at these interfaces. In this case, do not terminate the line—select **Termination:** BRIDGED on the Interface Control screen.

50.4 Setting Up Menus for G.703 Testing

```
                    ** INTERVIEW  7500 **

        DISKS: FLOPPY 1   FLOPPY 2   HARD DISK

        PROCESSORS: 4

        SELF TEST ERRORS: NONE

     Press:
     [PROGRAM]  to enter the menu page
     [RUN]      to run the default program

     Software   Version:  7.00
     Firmware   Version:  5.00

     OPTIONS:  24-1

     TIM: G.703

     Copyright (c) 1987, 1989
     Telenex Corporation
```

Figure 50-11 Power–up screen, INTERVIEW 7500.

G.703 testing can be done only when the TIM described in Section 50.2 is in place. Install the G.703 TIM and connect to a data source before power up as described in Section 1.10. Compare the Power Up screen to the one shown in Figure 50-11. It should indicate that the correct TIM is in place and that the unit is equipped with a G.703 mux board (Option 24–1).

> **NOTE:** If you plan to perform a G.703 BERT test, refer to Section 9.

Before you run a G.703 test, you must configure the Line Setup screen for the type of testing you wish to do. Select **Mode:** MONITOR if you plan to monitor a G.703 exchange. If the INTERVIEW is to perform an interactive test (that is, will be required to transmit), select **Mode:** EMULATE DCE or **Mode:** EMULATE DTE.

> *CAUTION: When the INTERVIEW operates in an emulate mode, it interrupts the regular exchange of data on the circuit. Be certain you have permission to test the circuit before you proceed.*

Select the **Code** and **Format** required for accurate interpretation of the data stream.

Clocking of G.703 data is not provided by the standard data clock. As a result, the **Clock Source** selection on the Line Setup screen is overridden. An applicable clock selection is provided on the Interface Control screen, described in Section 50.5.

If you plan to test higher–layer protocols (such as Common Channel Signalling System #7, LAPD, ISDN, or any others carried on the G.703 circuit), you must first load them from the Layer Setup screen. The Layer Setup screen is documented in Section 6.

50.5 Interface Control Screen

Certain G.703 characteristics are selectable. All options specific to G.703 are selected on the Interface Control screen, which is accessed from the main Program menu. With the Program menu displayed, press F1 (for Setup), then F2 (for G.703) to obtain a screen similar to those shown in Figure 50-12. The full set of options available on the Interface Control screen is illustrated in Figure 50-1.

```
                           ** Interface Control **
                              G.703 / 2.048MBPS
Line Setup                              Data Path Setup
Coding Type: HDB3                       Data Path: 64K DATA CHANNEL
Line Impedance: 75 OHMS                 Channel Mode: SAME
Receiver Gain: 0 db                     Channel Number: 01
Termination: BRIDGED                    Enable CRC-4: NO
                                        Signalling Type: CAS
                                        Begin CAS MF W/Frame Contain-
Transmit Setup                           ing Frame Align. Signal: YES
Transmit Mode: NORMAL                   Extra Bits: 111
Line Clock Select: INTERNAL             National Bits: 11111
Xmit Signalling All 1's                 International Bit: 1
   (CCS Signalling Only): NO            CAS MF Sync Criteria: NORMAL
Xmit Distant MF Alarm                   CAS MF Resync Criteria: NORMAL
   (CAS Signalling Only): NO            Frame Resync Criteria: NORMAL
Xmit Remote Alarm: NO
Begin CAS Multiframe with Frame Containing FAS?
 F 1     F 2     F 3     F 4     F 5     F 6     F 7     F 8
 YES     NO
```

Figure 50-12 Interface Control screen for G.703 Protocol with *Transmit Mode: NORMAL* and *Signalling Type: CAS* selected. Transmit Setup selections apply when an Emulate mode is selected on the Line Setup screen. Line Clock is available for master G.703 transmit clocking.

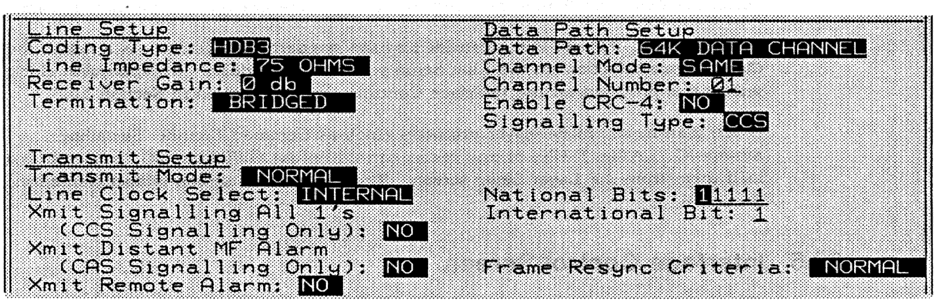


Figure 50-13 Interface Control screen for G.703 Protocol in Emulate mode with *Transmit Mode: NORMAL* and *Signalling Type: CCS* selected.

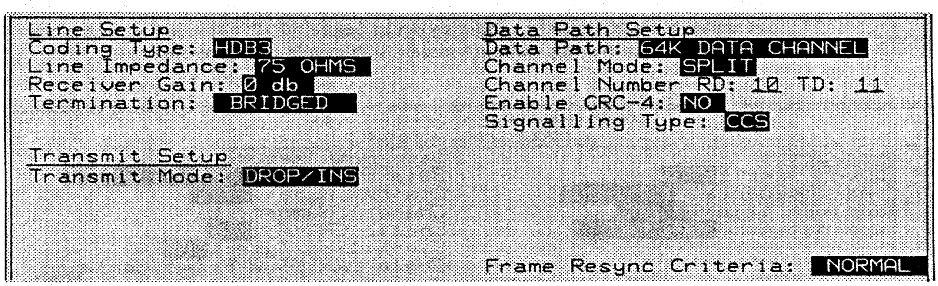


Figure 50-14 Interface Control screen for G.703 Protocol in Emulate mode with *Transmit Mode: DROP/INS*, *Signalling Type: CCS*, and *Channel Mode: SPLIT* selected.

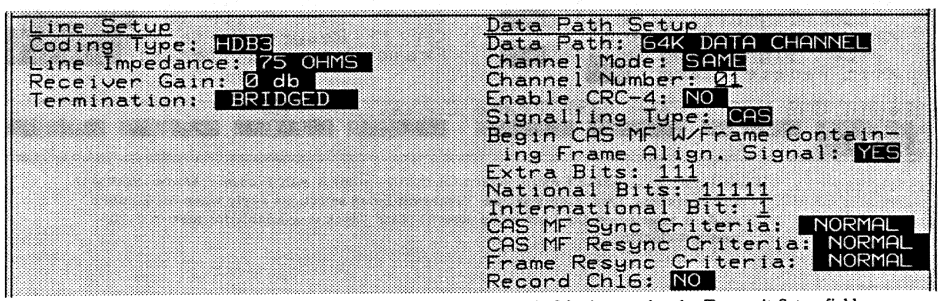


Figure 50-15 Interface Control screen for G.703 Protocol in Monitor mode; the Transmit Setup fields disappear, but the Line Setup and these Data Path Setup fields are available. The *Record Ch16* field only appears when high-speed record has been selected on the Line Setup screen.

The Interface Control screen for G.703 is divided into three sections: Line Setup, Transmit Setup, and Data Path Setup. The fields and selections for these setups are described in the following paragraphs. The appearance of some of the fields relies on selections made for preceding fields on this screen, such as those shown in Figure 50-12 through Figure 50-15.

(A) Coding Type

The first field in the Line Setup section of the Interface Control screen is the **Coding Type** field. The two options in the **Coding Type** field are AMI (Alternate Mark Inversion) and HDB3 (High–Density Bipolar 3); the default in this field is HDB3. AMI is described in Section 50.1(A).

When you select **Coding Type:** HDB3, the INTERVIEW transmits any occurrence of four consecutive zero bits as a special bit pattern containing an intentional bipolar violation in the fourth zero bit. These anticipated bipolar violations (BPV) are removed and the four zero bits are restored at the receiving end. The INTERVIEW also performs the restoration function when it is the receiver.

(B) Line Impedance

The user may select 75 ohms or 120 ohms line impedance, depending on the type of connection made to the TIM (Figure 50-3). If the coaxial connector is used, select 75 ohms (which is also the default for this field). If the DE–9 connector is used, 120 ohms is the proper selection.

(C) Receiver Gain

The **Receiver Gain** field defaults to 0 db, but if circumstances of the line setup require input gain for the INTERVIEW to recognize the data, the alternate selection of 20 db should be chosen.

A padded monitor jack at the telephone company office is isolated by resistors in series with both the tip and ring. The resistors combine with a 75 or 120 ohm termination at the monitoring device to form a 30 db (or less) pad.

In order for the INTERVIEW to compensate for the padding at this monitor jack, select **Receiver Gain:** 20 db to add 20 db of gain to the line signal. (Also select **Termination:** TERMINATED ; see below.) With 20 db gain selected, the unit will work with up to a –40 db signal received.

(D) Termination

Line termination is selectable by the user for data in both directions in monitor mode and for Receive data (that is, data coming *from* the device under test) in emulate mode.

In a normal "looped–through" monitor configuration (see Figure 50-6 or Figure 50-8), the appropriate termination is BRIDGED , the default selection. When you are monitoring at a padded jack, select **Termination:** TERMINATED .

When you are in emulate mode and have selected **Transmit Mode:** NORMAL , the channels that are coming *from* the device under test may be terminated or bridged by menu selection. Since in this transmit mode you are emulating the end user on the circuit, you normally would select **Termination:** TERMINATED .

When you are emulating in the drop-and-insert mode, 31 of the 32 channels going toward the device under test are "passed through" transparently to the device under test. The 32nd channel is the one you have selected, via the **Channel Number** field, for drop-and-insert.

The channels that are moving data *from* the device under test may be terminated or bridged by menu selection. Normally in drop-and-insert mode, the appropriate termination is BRIDGED . Receive data that is terminated is *not* regenerated outbound.

(E) Transmit Mode

The first field in the Transmit Setup section of the Interface Control screen is the **Transmit Mode** field. The **Transmit Mode** options control the INTERVIEW's transmissions on the 32 channels of the circuit under test. The field is applicable when **Mode:** EMULATE DCE or **Mode:** EMULATE DTE is selected on the Line Setup screen. (The **Transmit Mode** options have a special meaning in BERT DTE and BERT DCE operating modes. See Section 9.12.)

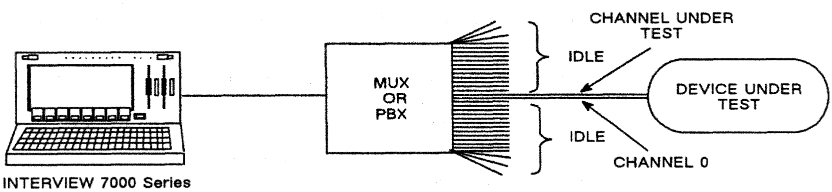


Figure 50-16 The INTERVIEW 7000 Series in normal G.703 emulation mode in CCS mode. Note that framing and signalling information is also transmitted (channel 0 and optional channel 16 in CAS mode).

1. *Normal mode.* When emulating in normal mode (that is, as the only end user on an otherwise inactive G.703 circuit), the INTERVIEW should be set up to terminate the line. See the discussion of the **Termination** option in Section 50.5(D). The INTERVIEW will isolate one incoming channel for capture and transmit on the outbound channel along with channel 0, as well

as providing multiframe synchronization in frame 0 of channel 16 when in CAS mode—see Section 50.5(N). On all other channels, the INTERVIEW transmits the idle line character $^{D}_{5}$ (hex D5). Statistics are maintained on the selected incoming circuit or line.

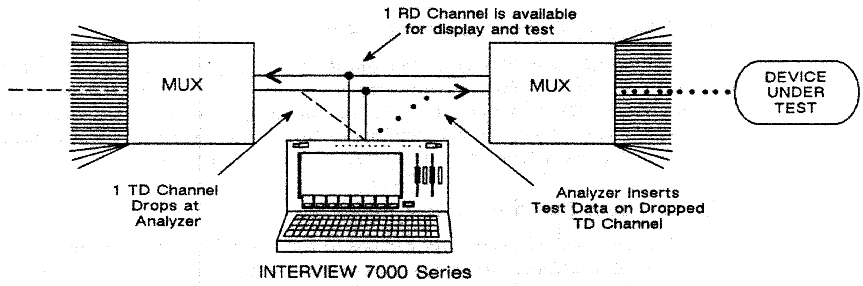


Figure 50-17 The INTERVIEW 7000 Series in drop-and-insert mode.

2. *Drop-and-insert mode.* This type of transmission (illustrated in Figure 50-17) is useful for testing a single channel over an active G.703 circuit. If the user selects drop-and-insert mode, the INTERVIEW receives all 32 channels in both directions (left to right *and* right to left in Figure 50-17). The transmissions on 32 of the left-to-right channels are passed through outbound. The remaining channel is terminated, and higher-layer test data is inserted into the corresponding outbound channel. All the while, G.703 protocol is maintained at the physical level. The INTERVIEW recalculates the correct CRC for the multiframe. Drop-and-insert mode may be used in either direction, towards DTE or DCE. Statistics are maintained on the selected line. Extra bits, national bits, international bits, and alarms are passed through without change.

   The INTERVIEW should be set up to *bridge* the data moving right-to-left in Figure 50-17. See the discussion of BRIDGED as a **Termination** option in Section 50.5(D).

(F) Line Clock Select

Two selections are available to the user in the **Line Clock Select** field, internal and external. Select **Line Clock Select:** EXTERNAL when performing normal emulation or normal channel BERT and an external clock is used (clock recovered from the incoming signal). Otherwise, the field defaults to internal.

(G) Transmit Signalling All 1's

The **Xmit Signalling All 1's (CCS Signalling Only)** field defaults to NO ; if YES is selected, the INTERVIEW fills the signalling channel (channel 16) with logic 1's continuously. This field only appears in Normal Transmit mode and is applicable when **Signalling Type:** CCS is selected—see Section 50.5(N).

(H) Transmit Distant Multiframe Alarm

The **Xmit Distant MF Alarm (CAS Signalling Only)** field defaults to NO ; if YES is selected, bit 2 of channel 16 of frame 0 (in the CAS multiframe—see Figure 50-22) is continuously set to indicate a signalling alarm condition to the remote end. This field only appears in Normal Transmit mode and is applicable when **Signalling Type:** CAS is selected—see Section 50.5(N).

(I) Transmit Remote Alarm

The **Xmit Remote Alarm** field defaults to NO ; if YES is selected, bit 5 of channel 0 of frames which do not contain the frame alignment signal (see Figure 50-22) is continuously set to indicate a G.703 line alarm condition to the remote end. This field only appears in Normal Transmit mode.

(J) Data Path

The first field in the Data Path Setup section of the Interface Control screen is the **Data Path** field. Choose the data path for which you wish to monitor or emulate data. A data channel must be selected if you plan to test or view a higher layer protocol.

1. *64K data channel*. This option selects a 64K data channel from 1 to 31.

2. *Signalling bits*. This option gives signalling bits on channel 16, except in frame 0, for both TD and RD. (Frame 0 of channel 16 contains the multiframe alignment code.)

(K) Channel Mode

This field appears when a 64K data channel path has been selected. The **Channel Mode** field offers the user the choice of selecting RD and TD from the same or from two different channels.

1. *Same*. Selecting **Channel Mode:** SAME enables the user to select RD and TD on the same channel in the **Channel Number** field.

2. *Split*. Selecting **Channel Mode:** SPLIT enables the user to select RD and TD on two *different* channels in the **Channel Number RD: __ TD: __** field.

(L) Channel Number

This field appears when a 64K data channel path has been selected. Valid entries in the **Channel Number** field are 1 through 31 (decimal). Channel 0 exists but cannot be selected; it contains frame alignment words, CRC checksums and international/national bits, but no data.

When **Channel Mode:** SAME is selected, only one channel number field appears for an entry in the **Channel Number** field, as the data is both received and sent on the channel number entered. When **Channel Mode:** SPLIT is selected, however, the field becomes **Channel Number RD: __ TD: __** and the user enters one channel number for RD and one for TD.

(M) Enable CRC-4

The **Enable CRC-4** field defaults to NO. Selecting YES enables the CRC checksum generation and error checking, as well as implementing the CRC multiframe structure. This structure makes use of channel 0 for checksums and the CRC multiframe alignment word for synchronization. Error count is displayed on the G.703 Run-Time statistics screen (Figure 50-19).

> NOTE: The G.703 CRC is entirely distinct from the block checking which may be performed for a protocol operating at a higher layer. The G.703 CRC is included in the **CRC-4 ERRORS** and **ERROR-FREE SECS** statistical measurements on the G.703 statistics screens.

(N) Signalling Type

The **Signalling Type** field has two selections for the type of signalling sent on the line. Each signalling type generates its own set of selection fields on the Interface Control screen. See Figure 50-1 for a complete view of these selections.

1. *CAS.* CAS (Channel Associated Signalling), the default selection, is a bit-oriented signalling technique which uses a 16-frame multiframe to provide four bits for each data channel, transmitted on channel 16 (see Figure 50-22). Channel 16 may be observed "as is" in Run mode, but a better view of the channel activity is obtained by pressing the softkey **CAS SIG** after selecting **DATA**—see Figure 50-18. This figure shows the ABCD bits from all channels presented in the form of a matrix. Figure 50-12 illustrates the Interface Control screen selections when **Signalling Type:** CAS is selected.

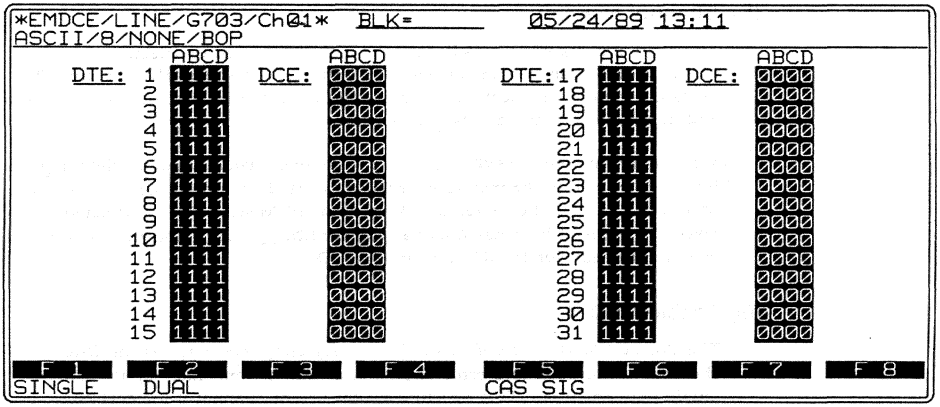


Figure 50-18 Selecting *CAS SIG* displays the ABCD bits for each data channel.

2. *CCS.* CCS (Common Channel Signalling), the optional selection, has no multiframe architecture. In this mode of signalling, a channel (channel 16) is set aside for receiving and sending signal information, such as implementing SS#7.

   Figure 50-13 and Figure 50-14 illustrate Interface Control screen selections when **Signalling Type:** CCS is selected.

(O) Begin CAS Multiframe With Frame Containing Frame Alignment Signal

This field only appears when in CAS mode. The **Begin CAS MF W/Frame Containing Frame Align. Signal** field defaults to YES, providing even frames of the CAS multiframe in which to place the Frame Alignment Signal (in channel 0); selecting NO provides odd frames of the CAS multiframe for the FAS. The frames which do not contain the FAS provide international and national bits and remote alarm indication in channel 0. This option does not exist in CCS signalling and is ignored when CRC-4 is selected because the CRC multiframe must begin with a frame containing the FAS.

(P) Extra Bits

This field only appears when in Normal Transmit and CAS Signalling modes. Three bits may be set by the user (to 0 or 1) to be transmitted in channel 16 of frame 0 of the CAS multiframe in bits 3, 1, and 0. This field defaults to 111.

(Q) National Bits

This field only appears when in Normal Transmit mode. Five bits may be set by the user (to 0 or 1) to be transmitted in channel 0 (bits 4 – 0) of frames not containing the FAS (Frame Alignment Signal) in that channel. This field defaults to 11111.

(R) International Bit

This field only appears when in Normal Transmit mode. One bit may be set by the user (to 0 or 1) to be transmitted in channel 0 (bit 7) of frames not containing the FAS in that channel. If CRC is selected, the international bit will only be transmitted in frames 13 and 15 of the multiframe. This field defaults to 1.

(S) CAS Multiframe Sync Criteria

The **CAS MF Sync Criteria** field allows selection of extended sync criteria for determining sync status of the CAS multiframe; the field only appears when in CAS mode.

1. *Normal.* The default selection in this field is NORMAL. This is declared when the multiframe alignment pattern is properly detected and timeslot 16 of the previous frame contains code other than zeros. If no valid pattern can be found in 12 to 14 milliseconds, the frame search is restarted.

2. *Extended.* The optional selection in this field is EXTENDED. This selection declares sync when fixed criteria are met and two additional consecutive valid multiframe alignment signals are detected.

(T) CAS Multiframe Resync Criteria

The **CAS MF Resync Criteria** field allows selection of extended sync criteria for determining sync status of the CAS multiframe; the field only appears when in CAS mode.

1. *Normal.* The default selection in this field is NORMAL. This selection automatically initiates frame search whenever two consecutive CAS multiframe alignment words are received in error.

2. *Extended.* The optional selection in this field is EXTENDED. This selection resynchronizes if fixed criteria are met and/or if two consecutive timeslot 16 words have values of zero in the first four MSB positions: 0000XXXX. (See Figure 50-22.)

(U) Frame Resync Criteria

The **Frame Resync Criteria** field allows selection of extended sync criteria for determining sync status of the frames.

1. *Normal.* The default selection in this field is NORMAL. This selection automatically initiates frame search whenever the frame alignment word is received in error three consecutive times.

2. *Extended.* The optional selection in this field is EXTENDED. This selection resynchronizes if fixed criteria is met and/or if bit 2 in timeslot 0 of non-align frames is received in error on three consecutive occasions.

(V) Record Ch16

This field relates to aggregate G.703 record and appears only when 1) your unit is equipped with a high-speed FEB board (Rev H or higher); 2) **Mode:** MONITOR is selected on the Line Setup menu; and 3) **Capture Memory:** RAM and **Record Speed:** HIGH SPEED are selected on the Record Setup menu. See also Sections 11.4(A) and 50.1(E).

To include channel 16 information in the aggregate G.703 data stream, select **Record Ch16:** YES. See Figure 50-22. Choose NO if you want to exclude channel 16 from the recorded data-stream.

50.6 Interpreting the G.703 Statistics Display

The G.703 Statistics Display can be viewed in Run Mode when the G.703 TIM is installed. To access the statistics screen, press F5 (for STATS), then F3 (for G703STA) while the INTERVIEW is actively monitoring or testing the line. You may alternate between the statistics screen and any other displays listed at the bottom of the screen by pressing the function key indicated. A sample G.703 Statistics screen is shown in Figure 50-19; the statistics displayed are those tallied when the line is in sync. For more information on alternate run-time displays, refer to Section 5.

(A) Layout of the Screen

The statistics display is divided into two general regions. G.703 statistics appear at the top of the screen; information pertaining to line conditions appears at the bottom of the screen.

All values displayed in the statistics region are cumulative. That is, calculations begin when you press RUN and continue until you press RUN again. Freezing the trace or character displays has no effect on the statistics gathered, although the statistics will not be updated until the screen is unfrozen.

Values are given in scientific notation, shown to a maximum of four decimal places. The right-most positions of each highlighted field are reserved for display of the exponent. The capital letter **E** sets off the exponent from the base number. The **E** is followed by a minus sign to indicate a negative exponent for a value less than one.

```
*EMDCE/LINE/G703/R01T01 BLK=          05/24/89 13:02
EBCDIC/8/NONE/SYNC/
```

G.703 STATISTICS	DTE	RATE	DCE	RATE
TEST SECONDS:	8.3000E01			
FRAMES RCVD:	6.6513E05		0.000E-00	
BPV'S RCVD:	0.0000E00	0.000E-00	0.000E-00	0.000E-00
BPV-FREE SECS:	8.3000E01	1.000E-00	0.000E-00	0.000E-00
FRAMING ERRORS:	0.0000E00	0.000E-00	0.000E-00	0.000E-00
CRC-4 ERRORS:	0.0000E00	0.000E-00	0.000E-00	0.000E-00
SYNC LOSSES:	0.0000E00	0.000E-00	0.000E-00	0.000E-00
SYNC LOSS TIME:	0.0000E00	0.000E-00	0.000E-00	0.000E-00
ERROR-FREE SECS:	8.3000E01	1.000E-00	0.000E-00	0.000E-00

```
G703 LINE CONDITIONS
 CURRENT [PREVIOUS]     NORMAL  [ ]          NOT MONITORED

 F 1      F 2      F 3      F 4      F 5      F 6      F 7      F 8
TABULAR GRAPHIC G703STA
```

Figure 50-19 G.703 Statistics Display reports on G.703 transmissions in real time and is an alternate screen to data or trace displays in Run mode when the G.703 TIM is installed.

There are four columns for each G.703 measurement. The left-most column displays the current measurement calculated on the DTE side of the line. The next column displays a cumulative rate when applicable. The two columns on the right display the same type of measurement calculated for the DCE and the rate, if any, on the DCE side. The various statistics measurements are explained in the following paragraphs.

G.703 line conditions are listed in two columns, one for DTE and one for DCE. Both current and previous conditions are shown. Line conditions which may be displayed are described in Section 50.6(K).

(B) Test Seconds

TEST SECONDS indicate elapsed time. The count begins from zero when you press [RUN].

(C) Frames Received

The value listed in the **FRAMES RCVD** row is equal to the number of bits received divided by 256. Thus, the value represents the number of individual frames rather than the number of multiframes received. The frame count is not incremented unless a valid frame is received. The definition of a valid frame may vary depending on the Interface Control selections you have made pertinent to the syncing procedure (see Section 50.5, **Resync Procedure**).

(D) BPV's Received

The row labeled **BPV'S RECVD** displays the number of bipolar violations received in valid frames during the test. Anticipated bipolar violations used to maintain one's density are not included in these values if HDB3 encoding is selected on the Interface Control screen (see Section 50.5).

The **RATE** column equals **BPV'S RECVD** divided by the total number of bits received in valid frames.

(E) BPV-Free Seconds

This reading gives elapsed test time free of BPV errors. If HDB3 is selected, BPV's anticipated as part of the pattern are not subtracted from the total time.

NOTE: Time out of sync is included in the time displayed.

The **RATE** column equals **BPV-FREE SECS** divided by total test seconds.

(F) Framing Errors

The **FRAMING ERRORS** row displays the count of the individual errors in received Frame Alignment Signals.

The **RATE** column equals **FRAMING ERRORS** divided by **FRAMES RCVD**.

(G) CRC-4 Errors

CRC-4 ERRORS indicates total CRC-4 code word errors since [RUN] was pressed. This field is present when the G.703 Interface Control screen shows **Enable CRC-4:** YES .

The **RATE** is equal to total CRC-4 code word errors divided by the total number of CRC-4 code words received.

(H) Sync Losses

SYNC LOSSES records the number of sync loss incidents. A sync loss occurs when the resync criteria, specified on the Interface Control screen, are met.

The **RATE** column shows total sync losses divided by total valid frames received.

(I) Sync Loss Time

SYNC LOSS TIME displays time out of sync. Time out of sync may vary slightly, depending on selections made pertaining to resync on the Interface Control screen (see Section 50.5, **Resync Procedure**).

The **RATE** column shows sync loss time divided by total test seconds.

(J) Error-Free Seconds

ERROR-FREE SECS displays the number of seconds free of CRC-4 errors, framing errors, and BPV's. To count a second as an error-free second, the line must be in sync during the *entire* second; if during any part of that second the line is out-of-sync, that second is not considered error-free.

The **RATE** column lists error-free seconds divided by total test seconds.

> **NOTE:** This measurement differs from error-free seconds measured in G.703 BERT statistics. The BERT measurement includes bit errors as well.

(K) G703 Line Conditions

When an error condition occurs, the status of the line under test appears in the **G703 LINE CONDITIONS** area at the bottom of the G.703 Statistics Screen. DTE line conditions appear in the highlighted box to the left; DCE conditions in the highlighted box to the right. Once the current condition changes, an abbreviation for the error is posted in the brackets which follow the current condition. This bracketed area contains an abbreviation for up to four previous conditions which have occurred in the present testing session.

> **NOTE:** The order of the abbreviations in the previous conditions field is not necessarily a chronological representation of events.

When there is no longer an error condition on the line, NORMAL is displayed in the left-hand box. The types of errors that may appear as line conditions are explained in the following paragraphs.

1. *Remote alarms*. A remote alarm is sent to alert the remote site that the sender is experiencing an out-of-frame condition. The remote alarm signal can be transmitted as explained in Section 50.5(I) and displayed as REMOTE ALRM. The abbreviation R within brackets is used to indicate a remote alarm as a previous condition.

2. *Distant multiframe alarms*. A distant multiframe alarm indicates that the sender is experiencing some type of problem, such as losing sync or power loss. See Section 50.5(H). When a distant multiframe alarm occurs, the condition MULTIFR ALM is posted. The abbreviation M within brackets is used to indicate a previous distant multiframe alarm.

3. *Out-of-Sync*. This condition, OUT OF SYNC, is displayed anytime the frame resync criteria are met. The abbreviation Sy within brackets is used to indicate a previous loss of sync.

4. *Loss-of-signal.* Signal loss is indicated in one of two ways. If after [RUN] is pressed no signal is received from the line under test, the condition NO SIGNAL is posted. Any time a received signal is lost for a minimum of 150 ms, the message SIGNAL LOST is posted. Either type of signal loss is recorded as Sg within brackets in the line conditions box to indicate a previous condition.

When an emulate mode has been selected on the Line Setup screen *and* **Transmit Mode:** NORMAL has been selected on the Interface Control screen, the words NOT MONITORED appear on the side of the line that the INTERVIEW is emulating. If **Transmit Mode:** DROP/INS is selected on the Interface Control screen, both sides of the line are monitored. (On the side of the line which the INTERVIEW is monitoring, the incoming channel — rather than the inserted INTERVIEW data — is analyzed.) This also holds true for the specific channels chosen for RD and TD when **Channel Mode:** SPLIT has been selected.

(L) G.703 Statistics as an Alternate Display to G.703 BERT

The function keys shown in Figure 50-20 appear at the bottom of the G.703 Statistics display when the INTERVIEW is running a G.703 BERT test. Press [F8] to display G.703 BERT Statistics; other display options are not available during a BERT test. Although they can be executed with regular G.703 statistics displayed, the commands in this bank of softkeys apply for the most part to the BERT test. Consult Section 9 for a description of these commands, BERT testing, and statistics.

One command in this group which does affect the G.703 Statistics display is RESET, [F3]. RESET sets the value of all timers and counters, including G.703 counters, to zero. The BERT test continues, however, even though the elapsed time (TEST SECONDS) at the top of the screen is reset.

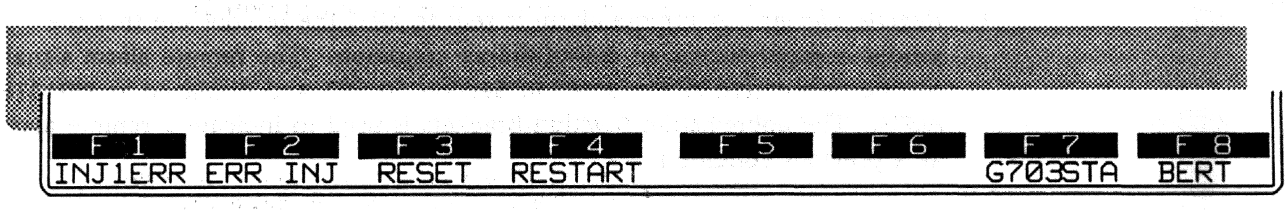
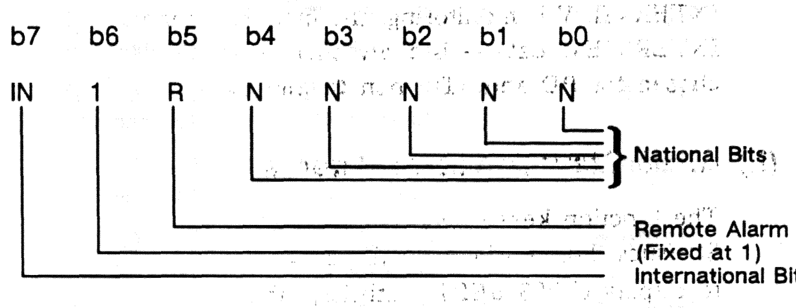


Figure 50-20 Run-time function keys available with G.703 Statistics Display when performing a G.703 BERT test

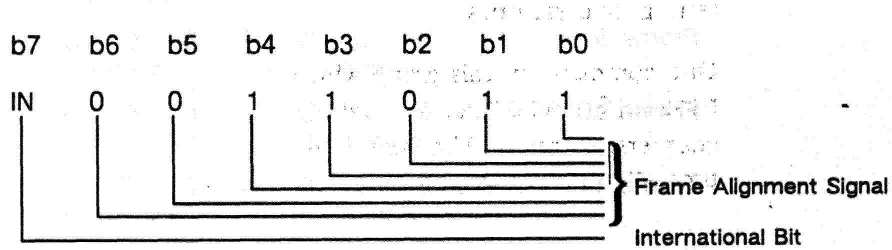
50.7 Multiframe Structures

(A) Signalling with No CRC-4

When CRC-4 is not enabled with CCS (Common Channel Signalling) or CAS (Channel Associated Signalling), frames with and without the FAS in channel 0 simply alternate. In CCS, there is no preferred order. In CAS, the order of which frame starts the multiframe is determined by the option selection **Begin CAS MF W/Frame Containing Frame Align. Signal:**, which is found on the Data Path portion of the G.703 Interface Control screen.



Channel 0 Frame: CCS/CAS signalling, but no CRC-4 nor FAS



Channel 0 Frame: CCS/CAS signalling and FAS, but no CRC-4

Figure 50-21 When CRC-4 is not enabled with CCS signalling, frames with and without the FAS in channel 0 simply alternate; there is no preferred order. Note the international bit is bit 7.

Channel 16 is reserved for signalling, but no standard or multiframe structure is specified in CCS. The CAS multiframe structure (Table 50-1), shown for channel 16 only, allows four bits of signalling data for each data channel in each multiframe. Signal bits for the data channels occupy channel 16 of frames 1-15. Channel 16 of frame 0 contains the signalling multiframe alignment word (0000), extra bits that may be set by the user, and the distant multiframe alarm.

Table 50-1
CAS Multiframe Structure — Signalling with Channel 16

CAS Frame	b7	b6	b5	b4	b3	b2	b1	b0
Frame 0	0	0	0	0	EX	DM	EX	EX
		(CAS MFAS)						
Frame 1	A	B	C	D	A	B	C	D
		(channel 1)				(channel 17)		
Frame 2	A	B	C	D	A	B	C	D
		(channel 2)				(channel 18)		
Frame 3	A	B	C	D	A	B	C	D
		(channel 3)				(channel 19)		
Frame 4	A	B	C	D	A	B	C	D
		(channel 4)				(channel 20)		
Frame 5	A	B	C	D	A	B	C	D
		(channel 5)				(channel 21)		
Frame 6	A	B	C	D	A	B	C	D
		(channel 6)				(channel 22)		
Frame 7	A	B	C	D	A	B	C	D
		(channel 7)				(channel 23)		
Frame 8	A	B	C	D	A	B	C	D
		(channel 8)				(channel 24)		
Frame 9	A	B	C	D	A	B	C	D
		(channel 9)				(channel 25)		
Frame 10	A	B	C	D	A	B	C	D
		(channel 10)				(channel 26		
Frame 11	A	B	C	D	A	B	C	D
		(channel 11)				(channel 27)		
Frame 12	A	B	C	D	A	B	C	D
		(channel 12)				(channel 28)		
Frame 13	A	B	C	D	A	B	C	D
		(channel 13)				(channel 29)		
Frame 14	A	B	C	D	A	B	C	D
		(channel 14)				(channel 30)		
Frame 15	A	B	C	D	A	B	C	D
		(channel 15)				(channel 31)		

A, B, C, D, = Channel Associated Signalling Digits
CAS MFAS = CAS Multiframe Alignment Signal
DM = Distant Multiframe Alarm
EX = Extra Bits

(B) Signalling with CRC-4

Selecting **Enable CRC-4: YES** forces a multiframe structure in which channel 0 is the only variant. There are 16 frames in the multiframe. In Table 50-2, channel 0 is similar to the second illustration in Figure 50-21, except the international bit is replaced by CRC-4 checksums and the CRC multiframe alignment signal. Bit 7, therefore, is the only bit that changes when CRC-4 is enabled. Its identity is dependent on the frame (of the CRC multiframe) in which it resides. Note that the multiframe begins with a frame containing the FAS (the relevant interface screen setting is ignored when CRC-4 is selected).

In CCS, Channel 16 remains available for signalling, with no multiframe structure. However, the CAS multiframe structure (Table 50-1), shown for channel 16 only, allows four bits of signalling data for each data channel in each multiframe. Signal bits for the data channels occupy channel 16 of frames 1-15. Channel 16 of frame 0 contains the signalling multiframe alignment word (0000), extra bits that may be set by the user, and the distant multiframe alarm.

Table 50-2
CCS/CAS Signalling with CRC-4

CRC-4 Frame	b7	b6	b5	b4	b3	b2	b1	b0
Frame 0	C1	0	0	1	1	0	1	1
Frame 1	0	1	R	N	N	N	N	N
Frame 2	C2	0	0	1	1	0	1	1
Frame 3	0	1	R	N	N	N	N	N
Frame 4	C3	0	0	1	1	0	1	1
Frame 5	0	1	R	N	N	N	N	N
Frame 6	C4	0	0	1	1	0	1	1
Frame 7	0	1	R	N	N	N	N	N
Frame 8	C1	0	0	1	1	0	1	1
Frame 9	0	1	R	N	N	N	N	N
Frame 10	C2	0	0	1	1	0	1	1
Frame 11	0	1	R	N	N	N	N	N
Frame 12	C3	0	0	1	1	0	1	1
Frame 13	IN	1	R	N	N	N	N	N
Frame 14	C4	0	0	1	1	0	1	1
Frame 15	IN	1	R	N	N	N	N	N

C1 = CRC-4
C2 = Checksum
C3 = Bits
C4 = C1-C4
IN = International Bit
N = National Bits
R = Remote Alarm

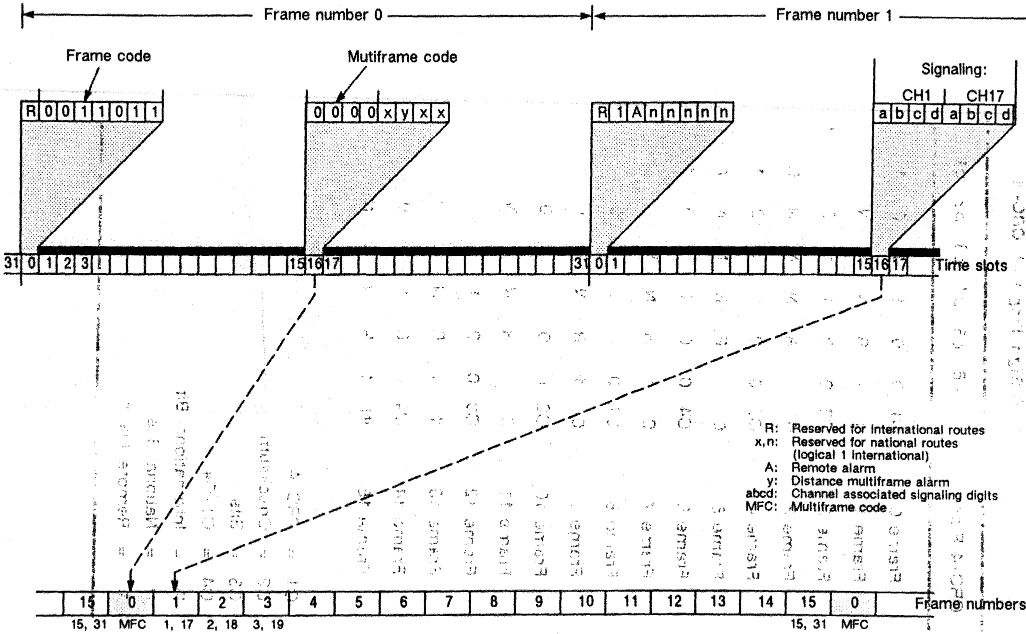


Figure 50-22 CEPT Frame Format