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Component Description: IBM 2701 Data Adapter Unit

This reference manual describes the functions of the IBM 2701 and is designed to aid the 2701 user, operator, and programmer achieve efficient use of the 2701. The reader should have a knowledge of teleprocessing and be familiar with the principles of operation for the IBM System/360 or System/370.

PREFACE

The IBM 2701 Data Adapter Unit--Component Description is a reference manual describing the functions of the IBM 2701. The IBM 2701 permits an IBM System/360 or System/370 to communicate with a variety of remote terminals, devices, and stations.

This publication is designed to help the 2701 user, operator, and programmer achieve efficient use of the 2701. Detailed descriptions are presented for the following:

- The 2701 in the IBM System/360 and System/370 environment
- Characteristics of the 2701 (including features)
- Terminal adapter types: IBM Start/Stop Terminal Adapters, Telegraph Terminal Adapters, Parallel Data Adapter, Synchronous Transmit Receive (STR) Adapter, and Binary Synchronous Communications (BSC) Adapter
- Programming considerations for the 2701
- Line control sequences to and from the 2701 and attached terminals
- Ending status and sense bit descriptions

The reader should have a knowledge of teleprocessing and be familiar with the principles of operation for the IBM System/360 or System/370. For detailed information about Binary Synchronous Communication, refer to General Information--Binary Synchronous Communication, GA27-3004. For detailed information about a specific terminal, refer to the appropriate publication for that terminal.

Sixth Edition (August 1971)

This is a major revision of, and obsoletes, GA22-6864-4. New features are described for the Synchronous Data Adapter-Type II, and the entire section headed "IBM Telegraph Adapter" has been deleted. Other changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

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CONTENTS

ILLUSTRATIONS

ACF	Auto Call feature
ACK	Affirmative Acknowledge
ACR	Abandon Call and Retry
ACU	Automatic Calling Unit
BCC	block-check character
BCD	Binary Coded Decimal
bps	bits per second
BS	back space
BSAM	Basic Systems Access Method
BSC	Binary Synchronous Communications
BTAM	Basic Telecommunications Access Method
BYP	Bypass
CAN	Cancel
CAW	Channel-Address Word
CC	Command Chaining
CC	Cursor Control
CCITT	International Telephone and Telegraph Consultive Committee
CCW	Channel-Command Word
CDC	Call Directing Code
CE	Channel End
CHIF	channel interface
CL	control leader
cps	characters per second
CPU	Central Processing Unit
CR	carrier return
CRC	cyclic redundancy check
CRLF	carrier return-line feed
CSW	Channel-Status Word
DC	Device Control
DE	Device End
DEL	Delete
DLE	Data Link Escape
DLF	double line feed select
DS	Digit Select
EBCD	Extended Binary Coded Decimal
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECE	early channel end
EIA	Electronic Industries Association
EIB	Error Index Byte
EM	End of Medium
ENQ	Enquiry
EOA	End of Address-- (D)
EOB	End of Block-- (B)
EOF	End of File
EOM	End of Message
EOR	End of Record
EOT	End of Transmission-- (C)
EOTR	end-of-transmission-record
ERR	Error
ESC	Escape
ETB	End of Transmission Block
ETX	End of Text
FF	forms feed
FIGS	figures (upshift)
FS	Field Separator
GS	Group Separator
hex	hexadecimal
HIO	Halt Input/Output command
I/O	Input/Output
ID	identification
IFS	Interchange Field Separator
IGS	Interchange Group Separator
IL	idle
Inq	Inquiry
IOCS	Input/Output Control System
IRS	Interchange Record Separator
IS	Interface Stop
ITB	Intermediate Block Check
IUS	Interchange Unit Separator
lc	lower case
LF	line feed
LRC	longitudinal redundancy check
LTRS	letters (downshift)
NAK	Negative Acknowledgment
NL	new line
PDA	Parallel Data Adapter
PF	punch off
PN	punch on
PRE	Prefix
PS	printer start
PSW	Program-Status Word
PTTC	Perforated Paper Tape Transmission Code
QSAM	Queued Systems Access Method
QTAM	Queued Telecommunications Access Method
RES	Restore
RO	Rubout
RS	Record Separator
RSD	ribbon shift down (black)
RSU	ribbon shift up (red)
RVI	Reverse Interrupt
SDA	Synchronous Data Adapter
SI	Shipped In
SLF	single line feed select
SLI	Suppress Length Indication
SM	Set Mode
SMM	Start of Manual Message
SO	Shipped Out
SOA	Start of Address-- (S)
SOH	Start of Header

SOM	Start of Message
SOR	Start of Record
SOS	Start of Significance
SP	space
SSC	Station Selection Code
STR	Synchronous Transmit Receive
STX	Start of Text
SUB	substitute
SYN	Synchronous Idle
Sync	synchronization
TA	Terminal Adapter
TCAM	Telecommunications Access Method
TIC	Transfer in Channel
TIO	Test Input-Output
TL	transmit leader
TP	Teleprocessing
TRT	Translate and Test
TTD	Temporary Text Delay
TWX	Teletypewriter Exchange
uc	upper case
UC	Unit Check
UE	Unit Exception
US	Unit Separator
USASCII	United States of America Standard Code for Information Interchange
VRC	vertical redundancy check
VT	Vertical Tab
WACK	Wait-Before-Transmit Positive Acknowledgment
WC	word count
WRU	Who Are You
XA	Transmission Adapter
XIC	Transmission Interface Converter
XOFF	Transmitter Off
XON	Transmitter On
Ⓐ	Address Mode Control
Ⓑ	End of Block--EOB
Ⓒ	End of Transmission--EOT
Ⓓ	End of Address--EOA
Ⓝ	negative response
Ⓢ	Start of Address--SOA
Ⓣ	Text Mode Control
Ⓨ	positive response

The IBM 2701 Data Adapter Unit permits the IBM System/360 and System/370 to communicate with a wide variety of remotely located terminals, devices, and processors. It allows the combining of data processing operations with data communications, thus merging scheduled batch processing with unscheduled real-time processing.

The terminals, devices, and processors served by the 2701 offer a wide range of transmission speeds, transmission codes, transmission methods, line capacities, and application flexibility.

The 2701 provides the equipment for servicing four classes of terminal equipment via the use of various transmission (terminal) adapters. These are shown in Figure 1.

Class	2701 Transmission Adapter	Terminal Equipment Serviced
Start/Stop	IBM Terminal Adapter-Type I, Model II or IBM Terminal Adapter-Type I (Shipped prior to April 1, 1969)	IBM 1050 Data Communication System IBM 1060 Data Communication System IBM 1070 Process Control System IBM 2740 Model 1 Communications Terminals IBM 2741 Communications Terminals (w/o Interrupt Feature) IBM System/7 (Using the IBM 2740 Communications Terminal Model 1 line control sequence.)
	IBM Terminal Adapter-Type I, Model II	IBM 2740 Model 2 Communications Terminals
	IBM Terminal Adapter - Type II	IBM 1030 Data Collection System
	IBM World Trade Telegraph Adapters	Teleprinters
	Telegraph Adapter - Type I	A T & T 83B2 Type Selective Calling Terminals A T & T 83B3 Type Selective Calling Terminals Western Union Plan 115A Outstations
	Telegraph Adapter - Type II	TWX Terminals - Models 33 and 35
Data Acquisition and Control	Parallel Data Adapter	Parallel Data Devices
Display	IBM Terminal Adapter - Type III	IBM 2848 Display Control with IBM 2260 Display Stations IBM 2845 Display Control with IBM 2265 Display Stations
Synchronous	Synchronous Data Adapter - Type I (Synchronous Transmit - Receive)	IBM 1013 Card Transmission Terminal IBM 7702 Magnetic Tape Transmission Terminal IBM 7711 Data Communication Unit IBM 1130 Computing System IBM 2701 Data Adapter Unit with SDA-I
	Synchronous Data Adapter - Type II (Binary Synchronous Communication)	IBM S/360 or S/370 equipped with either an IBM 2701 (with SDA-II), an IBM 2703 (with Synchronous Line Set), or an IBM 3705 Communications Controller IBM 2701 equipped with SDA-II (with Wideband Interface) IBM System/3 equipped with Binary Synchronous Communication Adapter IBM S/360 Model 20 equipped with Binary Synchronous Communication Adapter IBM S/360 Model 25 equipped with Integrated Communication Attachment or Synchronous Data Adapter IBM S/370 Model 135 equipped with Integrated Communication Adapter or Synchronous Data Adapter Type II IBM 1130 Computing System equipped with Synchronous Communication Adapter IBM 2780 Data Transmission Terminal IBM 3735 Programmable Buffered Terminal IBM 2715 Transmission Control Unit Model 2 IBM 1800 Data Aquisition and Control System equipped with Binary Synchronous Communication Adapter IBM 3271 Control Unit IBM 3275 Display Station

Figure 1. Terminal Equipment Serviced by IBM 2701 Transmission Adapters--by Adapter Type

Programming Support

The installation of 2701 Tele-processing (TP) applications is made easier and more efficient by the use of the IBM-supplied programming-support packages. The primary support packages consist of a pair of data-management access methods, designed specifically for the TP environment. These access methods satisfy the programming requirements for a large portion of commonly used TP applications. They operate under either a full Operating System (OS) or the smaller Disk Operation System (DOS).

BTAM. Basic Telecommunication Access Method, provides the programmer with simple, efficient access to the communication environment so that he can program the terminal in a manner consistent with that used for conventional sequential-type input/output devices. BTAM controls data transmission; however, it does not provide for elaborate message-queuing capability or the actual processing of the message itself.

QTAM. Queued Telecommunication Access Method, provides all the above-mentioned capabilities of BTAM. In addition, it incorporates facilities for queuing messages on direct-access storage devices (e.g., disk, drum, etc.). QTAM also provides capabilities for data-collection and message-switching applications and may be used intact, both for these functions and for a large range of other TP uses.

Like BTAM, QTAM insulates the programmer against most of the details of the 2701 and the attached terminal equipment.

TCAM. The Telecommunications Access Method is a generalized input/output control system (IOCS) that extends the techniques of the logical IOCS to the telecommunications environment. TCAM is a queued access method; its data sets are queues of messages coming in from, or going out to, remote terminals over communications lines. Although the time and order of the arrival and departure of messages to and from the central processing unit are unpredictable, TCAM handles messages as if they were organized sequentially. TCAM transfers messages from one station to another, and between terminals and user-written application programs.

TCAM is also a high-level, flexible message control program. TCAM macro instructions are used to construct an installation-oriented, device-dependent message control program that controls the flow of message traffic through the teleprocessing system. Through data-set definition and control-information macro instructions, you specify your equipment configuration and the main-storage areas (buffers) required for your applications. These macros generate the tables and lists of control information that define the environment of the system.

TCAM also provides macro instructions and logic modules for many procedural functions, such as message routing, message editing, and error checking. By selecting the appropriate macro instructions and their operands, you specify the TCAM logic modules to be incorporated into your message control program and the action they are to take. In this way, the system is tailored to the exact requirements of your applications.

Typical TCAM applications are data collection, inquiry processing, message switching, and message processing when used with BSAM, QSAM, QTAM, or TCAM application programs.

Other Access Methods. In addition to BTAM, QTAM, and TCAM (operating under OS and DOS), Read/Write macro instructions for STR (Synchronous Transmit-Receive) networks are provided in the Basic Programming Support (BPS) Tape system. Other access methods and specialized TP control programs are also available for special requirements.

User-Developed Programs

In some cases, primarily because of special system configurations or requirements, TP programming can be more appropriately implemented directly by the user developing the channel-command programs for the 2701-TP operation.

This publication provides programming information about the channel commands used with each of the 2701 transmission adapters. Included in these descriptions are the status and sense information associated with each command. These commands can be implemented through the EXCP (Execute Channel Program) macro instruction offered in each of the System/360 programming systems. This publication provides sufficient information for user preparation of his channel program. The user of the various programming-support packages will also find this publication helpful.

Advantages of IBM 2701 in a System/360 and System/370 Environment

The characteristics that make System/360 and System/370 such an efficient all-purpose processing system are frequently the same characteristics that make it the ideal hub of a data communication system. Most important, its design and features permit it to be both at the same time, without significant degradation to either.

Among the major System/360 and System/370 characteristics applicable to Tele-processing are:

- The modular, program-compatible growth offered by System/360 and System/370, together with the expansion capability of both main storage and direct-access storage (particularly important in TP because of unscheduled inputs), permits 2701 users to readily expand their TP network with a minimum of reprogramming.

- The System/360 and System/370 multiplexer and selector channels are designed to make TP operations more efficient and easier to program. These channels are, in effect, "input/output processors." Using separate, stored-channel programs, the channel and the 2701 provide the following TP functions, independent of continuous central processor activity:

  Access to main storage, for the reading and writing of messages, is overlapped with continued program execution.

  The highly variable data structure (including the presence of control characters in the data stream) encountered in TP operations can be monitored and controlled to a great extent through the use of various channel-command sequences. These channel commands can be modified as necessary with flag-bit settings to achieve many of the functions that formerly required a large amount of additional programming overhead.

  Messages can be segmented under byte-count control in the channel-command word to facilitate main-storage buffering and to allow checking to be performed on smaller units of data.

  The multiplexer channel permits the simultaneous handling of many lower-speed messages from a number of terminals.

  The selector channel offers high-speed transmission rates, of major significance when communicating with the high-speed data transmissions encountered in STR (Synchronous Transmit-Receive) and BSC (Binary Synchronous Communication) operations.

- System/360 and System/370 storage protection, applicable to I/O-main storage store and fetch operations, is provided. This capability safeguards programs and data residing in main storage from alteration or destruction by the program or external sources (for example, due to terminal-operator errors, programmer errors, etc.).

- Swift, automatic interrupts minimize the time required to switch to an interruption subroutine, determine the cause of the interruption, and act upon it.

- Standardized channel-to-control-unit interface provides ease of programmer training and development over the wide range of I/O equipment available--including the multiple classes of TP equipment for the various programming methods available.

- Data Chaining. This is particularly useful in TP gather-read and scatter-write operations. For example, in a TP operation, the main-storage location of message-framing control characters may not be contiguous to the message text. Data chaining permits the issuance of a Write command that obtains these control characters from one storage location, data chains to another noncontiguous location for the message text, and then data chains to another noncontiguous location for any message-ending characters required. Thus the need for the three separate write operations is reduced to one logical operation.

  Data chaining is very useful in TP operations for the purpose of efficiently affixing standardized headings to message outputs when the headings and messages are located in noncontiguous locations of main storage.

- Command Chaining. Because of the extensive line-control and line-conditioning requirements of TP, channel programs in TP operations tend to require longer command sequences than other types of conventional device programming. The command-chaining capabilities of System/360 and System/370 ease this TP programming requirement.

  Command chaining also reduces much of the CPU interference that could otherwise exist if separate operations had to be started and serviced for each logical operation.

- System/360 and System/370 Interval Timer. This timer can be used as an interval timer and/or a real-time clock. It is program-selectable in all segments (hours, minutes, seconds, etc., down to approximately 13 microseconds). In TP operations, it is particularly useful in time-of-day recording of message arrival and message dispatch.

- Multicode translation (up to eight-level codes) is provided by the powerful Translate instruction that automatically translates to or from all transmission codes normally used in communications traffic. It permits translation to and from the trans-

mission code to the internal code structure used by the processor.

- Status and sense information recording provide constant TP network awareness.

- Variable-Record-Length Considerations. Variable-length records (as compared to fixed-length records) are the rule rather than the exception in TP operations.

  The Suppress Length Indication (SLI) in the channel-command-word structure of System/360 and System/370 enables the programmer to selectively control (inhibit or permit interruptions) program activity resulting from these variable-length messages.

- Program-Controlled Interruption Capability. The programmer, by use of a programmed-control-interrupt (PCI) bit, can effect a programmer-initiated interruption during the execution phase of a command. This is useful in presenting the programmer with information about the progress of the channel program (i.e., location of the command being executed in a command sequence).

  The PCI capability is particularly useful in dynamic buffer allocation in main storage. Because of such factors as the variable lengths of messages, the relatively low data-transfer rates, and the unpredictable input volumes experienced in TP operations, storage frequently must be assigned dynamically as needed rather than being preassigned.

  The PCI capability, used in a Read or Write command, initiates an interrupt that permits the dynamic allocation of the required new buffer.

- In a System/360 and System/370-based operation, the 2701 permits the combining of various TP application areas within a single processing/communication complex. Some of these application areas include data acquisition, message switching, process monitoring and analysis, transaction posting, data display, remotely located processor-to-processor information interchange, and so forth.

IBM 2701 Functions--Generalized

The 2701 serves as a vital link between the System/360 and System/370 and a wide variety of communications facilities and Tele-processing with the System/360, performs the following functions:

Establishes connection between the central complex and the terminals.
Implements data transfers between terminals (devices/stations) and main storage.
Indicates to the program the status of attached communications facilities and terminals.
Checks the accuracy of received data.
Implements line-control operations.
Provides multiple-transmission-code recognition.
Implements polling and selection of terminals.
Provides for attachment of both IBM and non-IBM communication and terminal equipment.
Implements automatic calling of distant terminals (only when Auto Call feature is provided).
Detects and inserts shift codes for upper/lower-case activity (adapter dependent).
Provides for insertion of certain time delays into the data stream.
Minimizes the central-computer involvement required to maintain line operations by providing autoanswering activities and detection of line-control characters.
Deletes, during receive operations (information coming from a terminal with a main-storage destination), certain bits and characters required to maintain the communications line--e.g., start and stop bits in start/stop operations, parity bits involved in a transfer operation, some line-control characters in start/stop and STR operations, validity-checking characters, etc. Conversely, the 2701 inserts many of these various characters in transmit operations (information going to a terminal). Normally, these characters are inserted via automatic generation by the 2701; however, some control and functional characters must be included via the program.
Generates several classes of timeouts to prevent system "hang-up."
Signals an interrupt to the channel when the current transmission comes to an ending point. This may result in an I/O interrupt. In the event the 2701 interrupt indicated a normal (planned-for) ending, and if command chaining to the next command was indicated, an I/O interrupt will not occur. However, if the 2701 detected some abnormal occurrence (for example, Unit Check) in the operation, the 2701 interrupt to the channel will be structured so that it will inhibit command chaining (if so indicated) and will cause an I/O interrupt. A Sense command may then be issued to obtain further information on the abnormal occurrence.

System/360 and System/370-2701 Attachment

The 2701 can be attached to the following System/360 models: Models 25 (only on the multiplexer channel), 30, 40, 44, 50, 65, 67, 75, and 85. The 2701 can be attached to the following System/370 models: Models

135, 145, 155, 165, and 195. It is designed for either multiplex or burst-mode operation on the multiplexer channel and for burst mode only on the selector channel. When operating on the multiplexer channel, either multiplex or forced-burst mode of 2701-main storage transfer can be employed.

Note

Figure 1 lists the terminals supported by the IBM 2701 Transmission Adapters.

Terminals which are equivalent to those explicitly supported may also function satisfactorily. The customer is responsible for establishing equivalency. IBM assumes no responsibility for the impact that any changes to the IBM-supplied products or programs may have on such terminals.

The three functional sections of the 2701 are:

-- Channel Interface (CHIF)
-- Transmission Interface Converter (XIC)
-- Transmission Adapter (XA)

(Note: While knowledge of the CHIF and XIC functional sections is not required for 2701 programming and operation, it is nevertheless helpful in understanding the 2701, particularly in system setup and configuration activities.)

The XIC and XA operate as a couple, which, in conjunction with the CHIF, provides a single complete path for the operation of the terminal devices with the I/O channel (Figure 2). In a 2701 having more than one XIC-XA couple, one CHIF is common to all couples. While each XIC is logically the same for each couple, the XA will vary according to the type of terminal devices attached. A minimum 2701 configuration contains one CHIF and one XIC-XA couple. Through various features, the 2701 can have up to three additional XIC-XA couples. See "2701 Configuration" section and Figure 3.

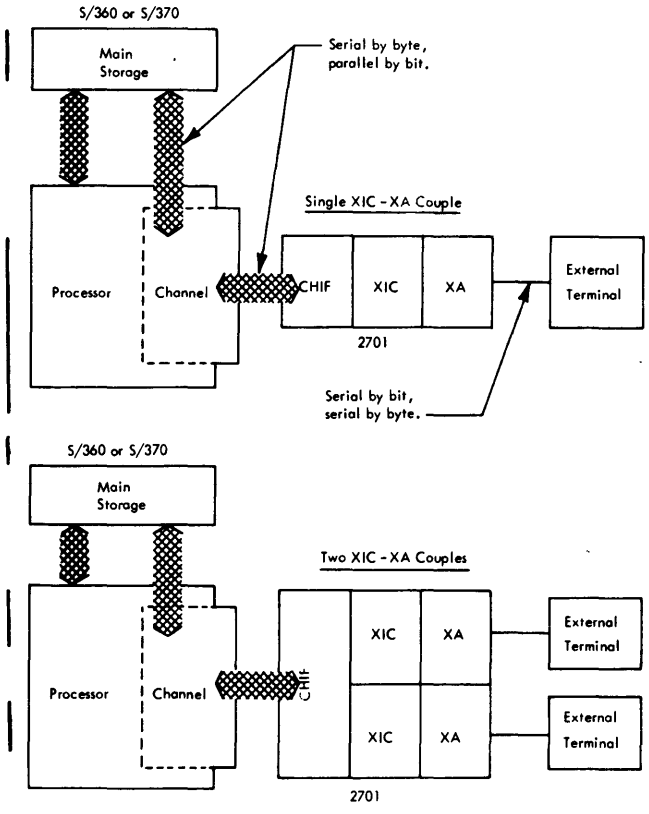


Figure 2. Functional Sections Illustrating Relationship of 2701 to System/360 or System/370, and External I/O Devices (Terminals)

Channel Interface (CHIF)

An I/O channel (either a multiplexer channel or a selector channel) is a facility that serves an a means of communication between the System/360 processor/main storage and one or more input/output (I/O) devices. It provides for and controls the interchange of data, control, and program information between the processor/main storage and the I/O devices.

The channel-interface section of the 2701 provides the circuits to attach the 2701 to a System/360 I/O channel. It supplies the path for transferring the various control signals, addresses, commands, and data between the I/O channel and an XIC and also controls the operation of the usage meter. The CHIF is capable of operating with up to four XIC's and will interface normally with one I/O channel, or two in the event the 2701 is equipped with the Second Channel Interface feature.

Transmission Interface Converter (XIC)

The transmission-interface-converter section of the 2701 controls information and/or controls signal transfers between the System/360 I/O channel (via the CHIF) and a transmission adapter. The XIC operates through the CHIF with either a selector or multiplexer channel. When the XIC is connected to a selector channel, information transfer is always in byte mode; when connected to a multiplexer channel, information transfer is normally in the data-interleave (multiplex) mode. However, in the latter case, an XA can force multiple-byte mode for any number of bytes. The 2701 will also operate in burst mode on a multiplexer channel, when selected by a manually operated CE switch (Normal/Record Lock). (Safety Note: The Normal/Record Lock switch must be set only by the CE.)

PROGRAM NOTE: In burst-mode operations, either by operating on the selector channel or on the multiplexer channel (via setting of the Normal/Record Lock switch to RECORD LOCK), the maximum time between bytes must not exceed 500 milliseconds.

The XIC stores channel commands for the transmission adapter and handles byte transfer to or from main storage when requested by the XA. The XIC also responds to specific commands received from the I/O channel and/or specific requests from the XA,

initiates operation-ending procedures when requested by the XA, relays an Interface Stop signal from the I/O channel to the XA, and stores the status byte and a sense byte for transfer to main storage.

Transmission Adapter (XA)

The transmission-adapter section of the 2701 contains circuits necessary for the connection of a remote terminal (station, remote processor, device) to the 2701 and the necessary controls to effect movement of data to or from the channel via the CHIF and XIC. The XA decodes the I/O channel commands presented by the XIC, initiates service requests for data-byte transfer, and provides buffering for each transmitted or received character. Terminal-control functions such as communication-interface control, character and character-sequence recognition, parity checking, sense and status byte generation, end-of-operation, control, and error detection are performed by the XA.

Transmission adapters used in the 2701 are classified as start/stop, synchronous (STR and BSC), data acquisition and control, and display adapters.

2701 FEATURES

The 2701 features fall into two major classifications. Some features are common to all the transmission adapters, while others are for use with a particular transmission adapter and affect only that adapter. The former are discussed in this section. Details of the features associated with a specific transmission adapter are found in the individual section in which the adapter is discussed.

Expansion Feature

The Expansion feature provides an additional transmission interface converter (XIC) for the operation of an additional transmission adapter. One Expansion feature is required for each transmission adapter after the first, to form a new XIC-XA couple. The only circuitry in common with the first XIC-XA couple is the power supplies and the channel-interface (CHIF) section. This sharing of the channel interface allows additional XIC-XA couples to be added without decreasing the total number of control units allowable on the I/O channel. With the Expanded Capability feature (see following), up to three Expansion features are available in the same 2701

Expanded Capability Feature

The Expanded Capability feature provides additional equipment to permit installation of additional XIC-XA couples on a second gate within the 2701. This feature, in conjunction with the Expansion features, allows a maximum combination of either two or four adapters in a single 2701 (depending on adapter types and feature combinations). For example, with the use of an Expansion feature, two start/stop transmission adapters (category I) may be housed within the 2701. The Expanded Capability feature further allows for two additional start/stop transmission adapters (category I) with their respective Expansion features to be housed within the same 2701 (see Figure 3).

Second Channel Interface Feature

One channel interface is standard with the 2701. The Second Channel Interface feature provides a second channel interface for the 2701. This feature allows one (or both where applicable) of the XIC-XA couples housed on the second gate (Expanded Capability feature) to operate from a different I/O channel than the first XIC-XA couple. (See Figure 3.)

The second I/O channel may be another channel attached to the same processor (for example, the 2701 basic unit connected to the multiplexer channel and the Second Channel Interface feature connected to the selector channel); or the second I/O channel may be attached to another processor (CPU).

Once an XIC-XA couple is assigned to a channel, it will operate only on that channel. There is no capability to switch from one channel to the other channel.

Second Channel Enable/Disable Feature

This feature provides a second channel Enable/Disable switch that is optional with the Second Channel Interface feature.

The second channel Enable/Disable switch places the 2701 on-line to the second channel when set to Enable. When set to Disable, the second channel Enable/Disable switch places the 2701 off-line to the second channel.

NOTE: If the second channel Enable/Disable switch is not installed, the first switch will enable and disable both channel interfaces.

2701 CONFIGURATION AND TRANSMISSION ADAPTER CATEGORIES

2701 Configuration

The 2701 configuration may be made up of the following units and features:

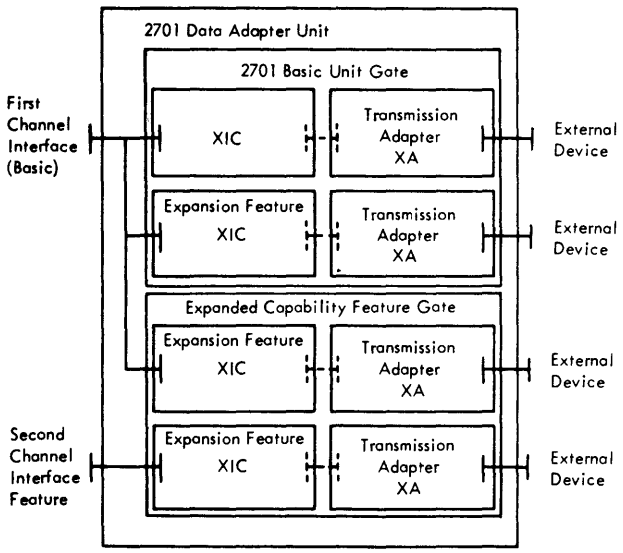


Figure 3. A Possible 2701 Configuration

2701 Basic Unit (including CHIF)
Transmission Interface Converter
Expansion Feature
Expanded Capability Feature
Second Channel Interface Feature

The 2701 basic unit supplies the frame, covers, power, logic gate, a channel interface, and a transmission interface converter. To complete the XIC-XA couple, a transmission adapter must be added.

Transmission Adapter Categories

Figure 3 shows a possible 2701 configuration. This configuration contains four transmission adapters, two per gate. However, this configuration is not possible with every transmission adapter, as some 2701 transmission adapters require more physical space than others in the 2701 frame. The use of these larger size adapters thus restricts the number of the other XIC-XA couples housed within the same 2701. As an aid in specifying the configuration capabilities of the 2701, the transmission adapters have been grouped into two physical-size categories (Figure 4). The 2701 basic-unit gate can accommodate up to two category I adapters or one category II adapter.

The use of the Expanded Capability feature gate increases the number of transmission adapters the

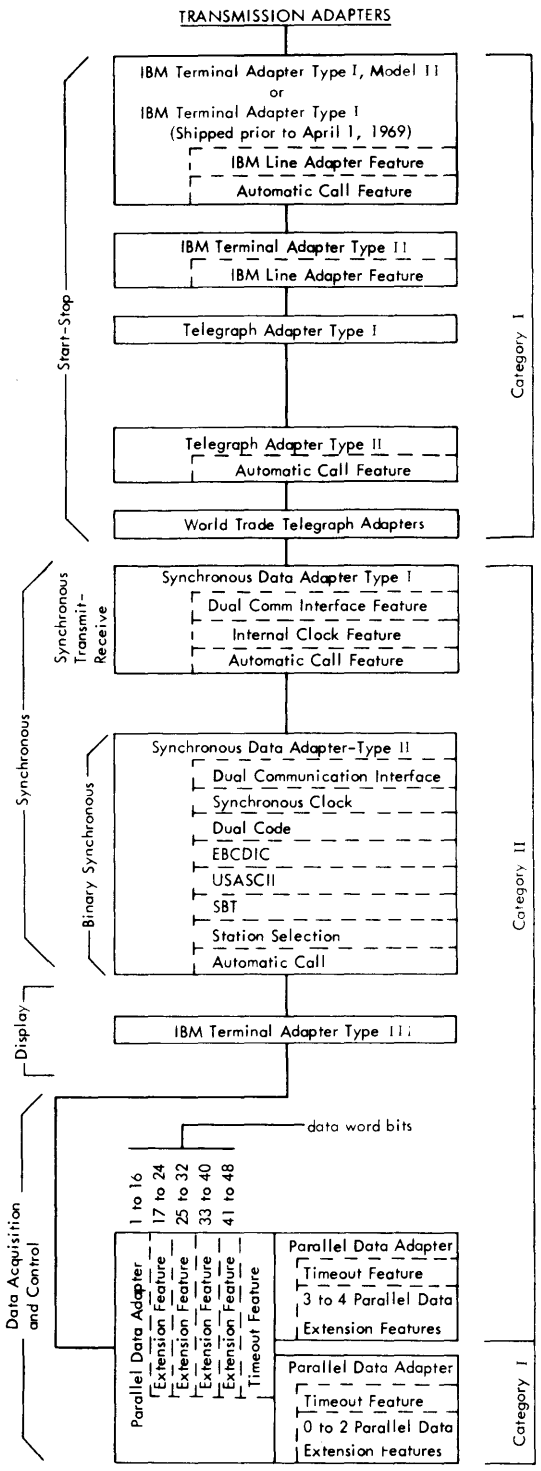


Figure 4. Physical Size Categories of 2701 Transmission Adapters and Adapter Features

individual 2701 can accommodate. Again, up to two category I adapters or one category II adapter can be installed on this gate. The transmission adapters on the Expanded Capability feature gate can be from the same or a different category as the adapters on the basic 2701 gate. One Expansion feature is required for each transmission adapter (after the first) in a 2701.

Figure 5 shows the maximum adapter configurations possible with the basic 2701, and the 2701 with the Expanded Capability feature. Each row in the table refers to a single 2701.

The Second Channel Interface feature connects an XIC-XA couple on the Expanded Capability feature gate to a second channel servicing the same processor, or to a channel servicing another processor. When more than one XIC-XA couple are ordered on this gate, one or both couples can be connected to the second channel. For example, in Figure 3, one XIC-XA couple on the Expanded Capability feature gate is shown connected to the second channel and the other is shown connected to the same channel as the XIC-XA couples on the 2701 basic unit gate. Alternatively, both XIC-XA couples on the Expanded Capability feature gate could have been connected to the channel. When the Second Channel Interface feature is not installed, all the XIC-XA couples housed within the 2701 are connected to the same channel.

	Category I	Category II
BASIC 2701	2	0
	0	1
BASIC 2701 with Expanded Capability Feature	4	0
	2	1
	0	2

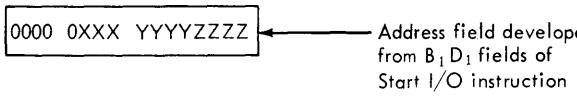
Figure 5. Maximum 2701 Configurations

LINE ADDRESSING

The 2701 is a control unit attached to an IBM System/360 channel but does not itself have a "control unit address." A 2701 may house up to four XIC-XA couples. Up to eight 2701's can be attached to each of the up to seven I/O channels available per System/360 complex (channels 0-6). Each XIC-XA couple within a 2701 is identified by a unique I/O address that is specified by an 11-bit binary number. This number appears in the address field of the Start I/O instruction: the three high-order bits of the field specify the channel (0-7); the other eight bits specify a specific XIC-XA couple within the 2701. See Figure 6. The four XA addresses for a four-line 2701 have no restriction as to the relation of one to the other. For additional information concerning I/O device addressing, see "Input/Output Operation" in IBM System/360 Principles of Operation, GA22-6821.

2701 I/O-CHANNEL OPERATION

The 2701 connects to and operates with the multiplexer or selector channel via the I/O interface. This interface consists of time- and function-shared lines consisting of byte buses for commands, addresses, data, or status; channel-interlock controls; and interface-scanning signals. The scanning signals and interlocks establish priorities among the different 2701's and other control units attached to a given I/O channel and among the XIC-XA couples within each 2701.



X-X= Channel 0-7

Within a given XIC-XA couple, the Y and Z fields are not separable i.e., YYYYZZZZ are recognized as a single XIC-XA address. The XIC-XA address is the line address.

Figure 6. Line Addressing--IBM 2701

On either the multiplexer or selector Channel, an I/O operation is initiated by a command fetched from main storage as part of the channel program and accepted by the 2701 (initial selection). The specific XIC-XA couple addressed cannot be re-addressed by the program under a Start I/O instruction until the 2701 presents the terminating status for the originally addressed XIC-XA couple; however, other XIC-XA couples may be addressed prior to the presentation of the terminating status from the originally addressed XIC-XA.

The 2701 operation on the multiplexer channel differs slightly from its operation on the selector channel. Each type of channel operation is discussed below.

Multiplexer-Channel Operation

When connected to a multiplexer channel, the 2701 operates in one of three modes: byte (single byte), multiple-byte (word), or burst. The choice of byte or multiple-byte mode depends on the buffering capability provided by each particular XA, while burst mode is selected by a manually operated (CE) switch.

Byte Mode. The 2701 releases the I/O channel following initial selection, after transferring each byte of data, and after presenting the terminating status.

Multiple-Byte Mode. The 2701 releases the I/O channel following initial selection and after each data word is transferred. (A data word is defined here as the number of bytes buffered in the transmission adapter). The data word length varies, for different transmission adapters, from two to six bytes. The channel is also released after the transfer of the last data word, and before the presentation of the terminating status.

Burst Mode. The 2701 retains control of the multiplexer channel for transmission of a complete record--i. e., from initial selection through data transfer and presentation of terminating status. Burst mode is obtained through a manually operated switch (Normal/Record Lock) associated with each transmission interface converter. Neither the transmission adapter, the program, nor the channel has any control over the selection of one or the other modes of operation once the XIC is switched to burst mode via this switch.

PROGRAM NOTE: In burst-mode operations, either by operating on the selector channel or on the multiplexer channel (via setting of the Normal/Record Lock switch to RECORD LOCK), the maximum time between bytes must not exceed 500 milliseconds.

The three indicated data-transfer modes have established priorities, since the 2701 and the I/O channel may not agree in the choice of mode. The order from low priority to high priority is byte mode, multiple-byte mode, and burst mode. The data-transfer mode is a collective function of the channel, the XIC Normal/Record Lock switch, and the adapter employed.

When attached to the multiplexer channel, the interface sequence presented by the channel indicates byte mode to the transmission-interface converter. The 2701 can indicate a choice of byte or multiple-byte mode. If the adapter requires burst-mode operation on the multiplexer channel, the Normal/Record Lock switch will be manually set by the CE to the RECORD LOCK position. The transmission interface converter then overrides the byte-mode operation inherent to the multiplexer channel and operates in burst mode only.

Selector-Channel Operation

The selector channel operates only in burst mode. This mode is forced by the selector channel and any setting of the Normal/Record Lock switch is ignored.

Normal/Record Lock Switch

CAUTION
The Normal/Record Lock switch must be set only by a Customer Engineer.

The Normal/Record Lock switch is used to modify the data mode of the transmission interface converter during operation with the multiplexer channel. Each transmission interface converter housed in the 2701 has its own Normal/Record Lock switch, located on the CE panel. With the switch in the NORMAL position, the associated adapter operates in either byte mode or multiple-byte mode as required by the specific transmission adapter. With the switch in the Record Lock position, the 2701 operates in burst mode independent of the mode indicated by the adapter. This switch has no effect when the 2701 is operating on a selector channel, since a selector channel always operates in burst mode. See Figure 7 for switch settings and attainable data modes of operation.

System Operation

From a programmer standpoint, the XIC-XA couple appears as a number of independent individual,

ADAPTER MODE	CHANNEL	SWITCH SETTING	OPERATIONAL MODE
Byte	Mpx	NORMAL	Byte
Multiple Byte	Mpx	NORMAL	Multiple Byte
Byte *	Mpx	RECORD LOCK	Burst
Multiple Byte *	Mpx	RECORD LOCK	Burst
Byte *	Sel	* *	Burst
Multiple Byte *	Sel	* *	Burst

* Time interval between data bytes provided by the adapter should be shorter than timeout of the channel.

* * Switch setting has no control over operational mode.

Figure 7. Normal/Record Lock Switch Settings and Attainable Modes of Operation

addressable devices (one to four). When an operation or a sequence of operations is to be performed, the programmer prepares a list of one or more channel-command words located in main storage. The channel-command word (CCW) signifies:

1. The command (operation) to be performed: Write, Dial, Read, etc.
2. The number of bytes to be used in the operation.
3. The initial byte address in main storage where the data should be placed when the movement of data is from the 2701 to main storage (e. g., reading), or the address of the first byte to be fetched from main storage when the data movement is from main storage to the 2701 (e.g., writing).
4. Command flags to control possible modification in command execution. The flags are: chain data, chain command, suppress length indication, skip, and program-control interrupt.

For a more detailed description of the channel-command word operation, see IBM System/360 Principles of Operation, GA22-6821.

When the CCW's have been formed, the programmer specifies the channel and address of the XIC-XA couple. The execution of a Start I/O instruction points to a channel-address word (CAW), which in turn causes the command, count, data-address, and control information to be stored in a specified sub-channel associated with the multiplexer channel or in the registers in the selector-channel circuitry. The channel circuitry then selects the 2701's XIC-XA couple, and presents the command to it. This presentation is called initial selection. If the command is valid, the 2701 accepts the command. The channel then indicates successful or unsuccessful execution of the Start I/O instruction to the CPU via the setting of the condition code in the PSW (Bit 34 and 35). Once

the command has been accepted by the channel and the 2701, the CPU program is unaware of the continuance of the operation until all the data has been received or transmitted, or until the channel needs program intervention to perform functions such as dynamic storage allocation--i.e., assigning buffers dynamically on an as-needed basis.

Because the channel contains all the information needed for the current operation, data transfer between main storage and the XIC-XA couple can be overlapped with CPU processing. The extent of the overlap varies depending on the type of channel (multiplexer or selector) and the processor model of the System/360 to which the 2701 is attached.

The 2701 will always respond to initial selection, except when (1) the 2701's power is off; (2) the 2701 has been switched off-line through either the Enable/Disable switch located on the operator's control panel, or via the Customer Engineer On Line/Off Line switch; or (3) the address presented by the I/O channel had invalid parity (Bus Out Parity error). In each of these cases, the interface-selection signal will be passed to the next control unit on the channel even though the address is valid for the 2701. When selection is initiated by command chaining, the I/O channel will initiate a program interruption and set the Interface Control Check bit in the stored channel-status word (CSW).

I/O INSTRUCTIONS

The System/360 processor operates with the 2701 through the Start I/O, Halt I/O, and Test I/O instructions.

An I/O instruction executed by the CPU causes initial selection and the transfer of a command byte or interface signal from the I/O channel to the addressed XIC-XA couple of the 2701. Command chaining within the I/O channel also causes selection and transfer of a command byte. The 2701 either accepts or rejects the command, informs the I/O channel of its state with a status response, and then terminates the initial-selection sequence.

Start I/O

As a result of the Start I/O instruction, a command is transferred from the channel program in main storage to the 2701, where it is stored in the addressed transmission-interface-converter command register (provided the register is not occupied by a previous command). Similiarly, command chaining within the I/O channel circuitry causes selection and transfer of a command to the 2701. Both the transmission interface converter and transmission adapter decode the contents of the command register.

Two groups of commands are defined for the 2701. The first group consists of commands decoded and executed by the transmission interface converter (XIC) alone, and without intervention by the transmission adapter. These commands are defined below. The second group consists of those commands decoded and executed by the specific transmission adapter. Each type of transmission adapter has its own repertoire of valid commands; however, a given command may be defined differently for each adapter type. These commands are defined in each of the appropriate adapter sections.

(Note: The definitions of the commands applicable to the Start/Stop class of adapters are included in a generalized Start/Stop section of this publication.)

During initial selection, when each command is presented to the 2701 (whether initiated via Start I/O or via command chaining), one of the following status responses is transferred back to the I/O channel.

1. An all-zeros status response is given if the command was accepted by the XIC-XA couple. This all-zero status is indicated to the program by a condition-code 0 in the PSW in the event the command was initiated by the Start I/O instruction.
2. Channel End and Device End status response is given when the command was accepted by the transmission interface converter; it is executed as a control-immediate command (see the definitions of "XIC Commands" following), and its execution is completed. This results in a CSW being stored, and is indicated to the program as condition-code 1 in the PSW--provided the command was initiated by the Start I/O instruction and command chaining is not specified (CCW bit 33 set to 0) in the command's CCW. When command chaining is specified, the CSW is not stored and chaining to the new command takes place in the I/O channel. Condition-code 0 is set in the PSW.
3. Channel End, Device End, and Unit Exception status response is returned when the command was accepted by the transmission interface converter and executed as a control-immediate command, and the command execution is completed. This results in a CSW being stored. Command chaining is inhibited by the I/O channel circuitry, and an I/O interruption takes place. When the command was initiated by Start I/O, condition-code 1 is set in the PSW.

4. Unit Check status response is given when a invalid command is presented at the time the XIC is both command- and status-free. This is the Command Reject status response. Any outstanding XIC sense information is cleared, Command Reject is set in the XIC's sense field, and the Unit Check status bit is set to one; this results in a CSW being stored. Command chaining is inhibited and an I/O interruption takes place. In the event the command was initiated by Start I/O, the Condition-code is set in the PSW.
5. Busy status response in combination with the current contents of the transmission interface converter's status field is given when either the 2701 or the transmission interface converter is found to be in one of the following conditions:
   a. An interface disconnect is in process.
   b. A system or selective reset is in process.
   c. The execution of a previous command is still in process (the execution of the previous command is not affected).
   d. The XIC's status field contains outstanding status information

   This results in the storing of a CSW. The new command is neither stored nor executed by the XIC-XA couple, and the I/O channel inhibits command chaining. If the command was initiated by the Start I/O instruction, condition-code 2 is signaled in the PSW. Note that if Unit Check is present in the CSW without either Device End or Attention, the program should defer issuing the Sense command until the Device End CSW is stored for this address.

The termination of command selection depends upon the command decoded, the status returned to the I/O channel, status acceptance or rejection by the I/O channel, and the mode of operation. The following actions occur when status is accepted by the I/O channel (see Figure 8).

a. All-zeros status response to commands other than defined-control immediates indicates that the command was accepted. If the I/O channel signals burst mode or if the Normal/Record Lock switch is in the RECORD LOCK position, the transmission interface converter does not release the I/O channel and data transfer takes place. Otherwise, the transmission interface converter releases the I/O channel.
b. A nonzero status response to a command indicates that the 2701 is releasing the I/O channel. When the command is not a defined-control immediate, it is not executed. Execution of all control-immediate commands is completed when status is accepted.

The following actions occur when status is rejected by the I/O channel:

a. In byte mode, the rejection of status terminates the command immediately. The status register is not reset and the status is retransmitted by the XIC together with the busy status when the channel is ready to accept the Status information.
b. In burst mode, the rejection of status by the I/O channel terminates the command immediately, provided the 2701 is deselected by the I/O channel when the command is rejected. The status is not reset and is sent again when the channel is ready to accept the interrupt. If the 2701 remains selected by the I/O channel when status is rejected, the transmission interface converter repeats the status response until the status byte is accepted by the I/O channel or the 2701 is deselected by the I/O channel.

Test I/O

The program can obtain the current status from an XIC-XA couple by use of the Test I/O instruction. (Note: Test I/O instruction is presented to the 2701 as a Test Input-Output command. This Test Input-Output command is generated via a Test I/O instruction.) This command is decoded and executed by the transmission interface converter (XIC) without disturbing or affecting the operation of the transmission adapter (XA). The XIC sense field is unaffected. The following status response can be made to Test I/O:

1. An all-zeros response when no command is present in the 2701 and no status is outstanding (the status register is empty). This is the "available" condition that is indicated to the program by condition-code 0 in the program status word (PSW). No CSW is stored.
2. A nonzero status response (with Busy status off) when the XIC is maintaining an outstanding status and no command is currently being executed by the XIC-XA couple. This will occur if the I/O channel has not yet accepted a status byte generated by either (a) the termination of execution of a previous command or (b) an interrupt condition that occurred when no command was being executed. The XIC status field is cleared. This is indicated to the PSW as condition-code 1, and a CSW is stored. If Unit Check status is indicated in the CSW, the program should issue a Sense command to obtain the XIC-XA couple's sense information, which defines the reason for Unit Check.
3. Busy status response, plus the current contents of the XIC's status field, when a previous com-

Instructions / Commands → / Status Response	Start I/O		Test I/O
	I/O No-Op	Other	Test I/O
	Legend Notes		
All Zeros	4	1	1 3 6
Busy	2 5 6 10 } or { 2 9	2 5 6 10 } or { 2 9	2 5 6 10 } or { 2 9
Busy and Status Register*	2	2	4
Status Register*	7 1 3	4	1 3
Unit Check	4	2 8	4

Legend

1. Command accepted.
2. Command rejected.
3. Command successfully terminated with status response.
4. Status response invalid for this command.
5. Previous command outstanding.
6. No outstanding status.
7. This status response is valid when the "Status Register" contains only the Device End and Channel End status.
8. Invalid command or valid command which cannot be executed, such as Dial sent to a line on which an Automatic Calling Unit is not installed.
9. A reset operation is being preformed.
10. This command should not have progressed past the channel.

* The "Status Register" is defined here as an outstanding status within a control unit excluding the busy bit (that is, up to 7 bits).

Figure 8. Status Response to Instructions and Commands

mand is being executed by the XIC-XA couple (Device End status has not yet been set). The XIC's status field is cleared. This busy condition is indicated to the program by condition-code 2, and a CSW is stored. Note that if Unit Check is present in the CSW, the program should defer issuing the Sense Command until the Device End status is stored for this address.

The 2701 execution of Test I/O is completed when the status byte has been sent back to the channel.

Halt I/O

The I/O channel signals halt to the 2701 as a result of the Halt I/O instruction. When Halt I/O is received, the addressed XIC-XA couple inhibits any further data transfers occurring under the command currently being executed and the XIC immediately releases the I/O channel. If no command is being executed when Halt I/O is received, the XIC simply releases the I/O channel without returning a status byte.

PROGRAM NOTE: If an Enable command is ended by issuing a Halt I/O, the line is disabled. This can affect the operation if waiting for an incoming call.

The effect of the Halt I/O instruction on a command depends upon the particular command being executed, the type of adapter, and the state of the XA when Halt I/O is received. Refer to the appropriate section concerning each type of transmission adapter for a description of the effect of Halt I/O on any of the adapter's valid commands. The effect of Halt I/O on the commands handled by the XIC is discussed under "XIC Commands."

STATUS BYTE

The purpose of the status byte is to provide an I/O device (and associated control unit) with a means of defining its status and signaling the conditions under which an I/O operation has been terminated. The status byte is signaled to the I/O channel, which in turn determines whether or not an I/O interruption will be initiated. This depends on many factors, such as the type of channel, the particular status bits that are set, whether or not command chaining is specified, the availability of the interrupt register,

and so forth. When an I/O interruption does occur, the status byte (among other indications) is stored in the channel status word (CSW).

There are four different instances in which the XIC can transfer a status byte to the I/O channel: (1) During initial selection for each command presented, including Test Input-Output; (2) During command execution (at a point when no further data transfers will occur between the 2701 and the I/O channel) in order to free the I/O subchannel for another operation (this is often signaled in combination with (3); (3) At the completion of a command execution (for control-immediate commands, which occurs at initial-selection time); and (4) when no command is being initiated or executed, and an interrupt condition is signaled.

The setting of the Attention, Channel End, or Device End bits alone or in combination with themselves or with other bits in the status field causes the 2701 to transfer the contents of this field to the I/O channel. The XIC status field is reset when the status byte is accepted by the I/O channel and under the following reset conditions: system reset, selective reset, or power-on reset.

The status responses that can occur during initial selection have already been discussed under the section on "I/O Instructions." All other status responses depend on the type of transmission adapter, the state of the adapter, the conditions that initiated the status transfer, and the particular command being executed, if any. They are defined in detail in the appropriate transmission-adapter section and in the following under "XIC Commands."

Listed below are the status bits that can be set by a XIC-XA couple, along with a brief description of each:

Attention (CSW Bit 32). An asynchronous interrupt condition, not necessarily associated with a command, has been detected by the XA.

PROGRAMMING NOTE: During command chaining, the 2701 responds to the chained commands with Busy and Attention status when the Attention bit is set by the adapter in the interval between the transmission of Device End to the channel (which initiated the chaining) and the receipt of the chained command. The status contained in the CSW is a function of the period when the CSW is stored. If the CSW is stored immediately upon the rejection of the chained command by the 2701 (channel accepts the status), the status byte will contain Busy and Attention. The channel will suppress the status response if the channel cannot effect storage of the CSW immediately dur to the channel being masked to interruptions. When this condition occurs, the status ultimately presented to the channel is a function of the stimulus causing the rejected status to be retransmitted. If the 2701 receives a new command other than Test I/O, Busy and Attention status will be indicated; if the command is Test I/O, only Attention status will be indicated. If the 2701 attempts to retransmit the status because the channel terminated its suppression of status, the status byte will contain only the Attention bit.

Unit Exception (CSW Bit 39). This status bit is individually defined for each command; it is set by the transmission adapter.

Busy (CSW Bit 35). This status set by the XIC to indicate that the XIC-XA couple cannot execute the command because it is executing a previously initiated operation or because it contains a pending interruption condition.

Channel End (CSW Bit 36). This is set by either the XIC or the XA to signal the completion of the channel portion of an I/O operation involving transfer of data or control information between the XIC-XA couple and the I/O channel. This status bit is generally signaled in combination with Device End.

Device End (CSW Bit 37). This is set by either the XIC or the XA when execution of a command is completed. The XIC-XA couple is then free to accept another command.

Unit Check (CSW Bit 38). This is set by either the XIC or the XA whenever an error or other conditions cause sense information to be set in the 2701. This status bit provides a summary indication of the conditions further identified by sense data. Whenever this bit appears in the CSW, the program should issue a Sense command to obtain the XIC-XA couple sense information.

Status Modifier (CSW Bit 33). This is set by the XA when it detects a condition that requires that the normal sequence of commands be modified.

SENSE BYTE

The purpose of the sense byte is to provide the program with information concerning both unusual conditions detected in the last operation and the status of the XIC-XA couple. This information is more detailed than that supplied in the status byte. The XIC contains a sense register that holds a single byte of sense data. A given XIC-XA may contain more than one sense byte (e.g., the SDA-I contains two in which case the XA maintains the additional sense data).

The program can access the sense bytes stored in the XIC-XA couple by the issuance of the Sense command. The first sense byte transferred to the channel is the byte stored in the XIC. If the XA has any additional sense information (e.g., SDA-I), the additional sense information is transferred before the Sense command is ended.

The sense field is reset when any new command other than Test Input/Output, I/O No Op, or Sense is addressed to the XIC-XA couple. The sense field is always cleared when an invalid command or a parity check in the command byte is received during initial selection. After clearing, the Control Reject or Bus Out Check bits are set. The sense field is not reset by the Halt I/O instruction.

XIC sense byte depends on the associated XA. These adapter-dependent sense-bit meanings are defined in the appropriate adapter section. Bit positions 0 and 2 of the XIC sense byte are reserved for the XIC. Whenever either of these bits are set by the XIC, Unit Check is also set in the status byte.

Position 0--Command Reject. This bit is set during an initial-selection or a command-chaining sequence when a command byte (CCW bits 0-7) is not successfully decoded by the XIC or XA.

Position 2--Bus Out Parity Check. This bit is set in the sense register whenever the XIC detects a parity error on the transfer of a data byte or command byte from the I/O channel to the 2701.

Interface Stop Signal

The Interface Stop signal is used by the channel circuitry to notify the 2701 that the channel is ending its current operation. Stop can be signaled only during data-service cycles--i.e., when the 2701 is transferring a data character to the I/O channel or, conversely, is requesting the next character from the I/O channel. Normally, Stop is signaled at this time if data chaining has not been specified in the CCW (bit 32 set to 0), if the byte count of the CCW has decremented to zero, and if additional data service is requested. It has no meaning for commands under which no data transfers occur. The ending procedure initiated by a Stop signal depends on the type of adapter and the particular command being executed. Refer to the appropriate section of each transmission adapter for a description of the effect of Stop on any of the adapter's valid commands. The effect of Stop on the commands handled by the XIC is discussed under "XIC Commands."

XIC COMMANDS

The group of commands that will be decoded and executed by the XIC alone, without intervention by the XA, are defined below.

Normal Command Operation

Each XIC command is defined below by its normal operation. Special effects due to Halt I/O and Interface Stop are described following the description of normal operation.

I/O No Op

This command is executed as a control-immediate command by the XIC. Channel End and Device End are simultaneously set in the status register both to accept and to end the command. This command does not reset the XIC's sense field. No operation is performed by the XA.

Test I/O

The Test I/O instruction is presented to the 2701 as the Test Input-Output command. See the description of the Test I/O instruction previously provided under "I/O Instructions."

Sense

This command causes the XIC and XA (where applicable) sense information to be transferred to the I/O channel. It does not reset the XIC sense field. After acceptance of the Sense command, the sense data is sent to the I/O channel. If only one sense byte is to be transferred, Channel End and Device End is then set in the status register. When an XA uses more than one sense byte (e.g., the SDA-I), the additional bytes are maintained in the XA and transferred via the XIC exactly as are data bytes. Under this command, once the last byte has been transmitted, the XA sets Channel End and Device End status. The sequence is terminated with a normal ending status transfer to the I/O channel.

Effect of Halt I/O Instruction on XIC Commands

Halt I/O has no effect on the execution of I/O No Op or Test Input-Output.

When Halt I/O is received while the XIC-XA couple is in the process of executing the Sense command, the command is ended immediately with Channel End and Device End status without any further transfer of sense bytes to the I/O channel.

Effect of Interface Stop on XIC Commands

Interface stop cannot be signaled during the execution of I/O No Op or Test Input-Output, as no data transfer takes place.

If Interface Stop is signaled during the execution of the Sense command, the command is ended immediately with Channel End and Device End status without any further transfer of sense bytes to the I/O channel.

METERING

The 2701 usage meter will record only when all the following conditions are met:

1. The 2701 has power on.
2. The 2701 is on-line.
3. The attached CPU cluster meter is running.

The on-line and off-line state of the 2701 is manually controlled by the Enable/Disable switch located on the Operator Control Panel (see Figure 9); however, the 2701 can transfer from on-line to off-line (disable) and from off-line to on-line (enable) only if the CPU is in the halt or wait state and the 2701 is not signaling the cluster meter to run. (Note: The references ENABLE/DISABLE for the switch positions have no relation to the Enable or Disable command used by some of the XA's.)

The 2701 signals the attached CPU cluster meter to record if one of the XIC's is executing the I/O No Op, Test Input-Output, or Sense command. It will also signal the attached CPU cluster meter to run whenever signaled to do so by one of the XA's.

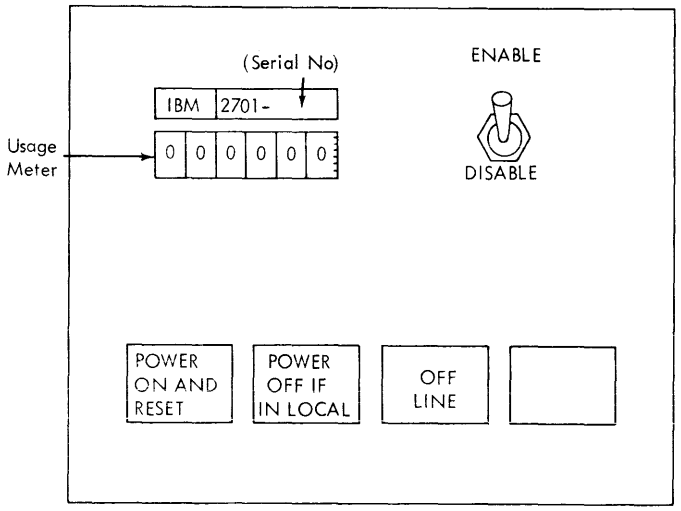


Figure 9. Operator's Control Panel--IBM 2701

RESET

The entire 2701 can be reset by one of the following reset conditions:

1. A system reset sequence given by the I/O channel.
2. A power-on reset.

A particular XIC-XA couple is reset by the Selective Reset, which is issued only as a result of a malfunction detected at the I/O channel or a time-out by the I/O channel.

When executing a read-type or write-type command, re-initialization procedures are required to restart the operation. When a read-type command is being executed, data may be lost and error-recovery procedures may be required.

OPERATOR CONTROL PANEL

Figure 9 shows the controls of the operator control panel, which is located at the upper right corner of the 2701. These controls are tabulated below:

Control	Type	Function
Power On and Reset	Pushbutton/ indicator light	Turns on power. Resets the entire 2701. Light is on when power is present.
Power Off, If in Local	Pushbutton	Turns off power providing Local/ Remote switch is set to Local.
Off-Line	Indicator Light	Lit whenever any Transmission Interface Converter (XIC) in 2701 is set off-line.
*Enable/ Disable	Toggle Switch	When set to Enable, places 2701 on-line. When set to Disable, places the 2701 off-line when CPU goes to Halt or Wait state.
Usage Meter	Meter	Registers on-line usage of 2701.

Notes

Power On and Reset Switch:

1. This switch is active for Power On Function in local mode only.
2. This switch is active for Reset function in both local and remote modes.

Enable/Disable Switch

The terms ENABLE/DISABLE for the switch positions have no relation to the Enable/Disable commands nor to the channel-interruption masking states of Enable/Disable.

*If the Second Channel Interface feature is installed, a second Enable/Disable switch can be installed. This switch performs the same function for the second channel interface as the first switch does for the first channel interface. If the Second Enable/Disable switch is not installed (with the Second Channel Interface feature), the first switch will enable and disable both channel interfaces.

The transmission adapter (XA) permits the attachment and operation of remote and local terminals with the System/360. Each IBM 2701 obtains its personality from the transmission adapters it houses. Each transmission adapter provides for the attachment and operation of a particular terminal or class of terminals with the 2701. The transmission adapter contains the circuitry for operation with the transmission code and line control requirements at the terminal's speed of operation, for the control of the data flow, for the decoding of the program commands, and for the connection to and operation with the transmission interface converter (XIC) and the communications line or data set.

Transmission adapters used in the 2701 are classified into four types: start/stop adapters, display adapters, synchronous adapters, and data acquisition and control adapters.

START/STOP ADAPTERS

The start/stop adapters are a class of transmission-adapter types for the 2701 that include the following: IBM Terminal Adapter Type I, Model II; IBM Terminal Adapter Type I; IBM Terminal Adapter Type II; World Trade Telegraph Adapter; Telegraph Adapter Type I; and Telegraph Adapter Type II. Because of their similarity, the common aspects of these adapters are described for the start/stop group in this section while their individual characteristics are described separately in each adapter section.

Operation of the 2701 start/stop adapters with the remote terminals requires various types of communications services (Figure 10).

The function of a 2701 line adapter is to interface the communications facility to the 2701. A 2701 line adapter, depending on the type, interfaces: (1) a data set, (2) a telegraph channel, and (3) a telephone channel (when using an IBM Line Adapter feature). One 2701 line adapter is provided for each communications channel (line). The 2701 line adapter, which is a functional part of the start/stop adapter, should not be confused with the IBM Line Adapter feature (the IBM equivalent of a common-carrier data set).

Data Set Line Adapter (2701)

The Data Set Line Adapter is used by the IBM Terminal Adapter Type I Model II, IBM Terminal Adapter Type I, IBM Terminal Adapter Type II, and Telegraph Adapter Type II for attachment of these adapters to external data sets.

Telegraph Line Adapter (2701)

The Telegraph Line Adapter provides for attachment to leased telegraph channels utilizing 62.5 milliampere neutral signaling or the IBM 3945 Line Terminator for WTC operations.

IBM Line Adapter Features (2701)

These IBM Line Adapters (Figure 11) provide for the attachment of IBM terminals equipped with IBM Limited-Distance Line Adapters to the 2701 Data Adapter Unit. For specifications and restrictions see Planning and Installation of a Data Communications System Using IBM Line Adapters GA24-3435 (second revision or later).

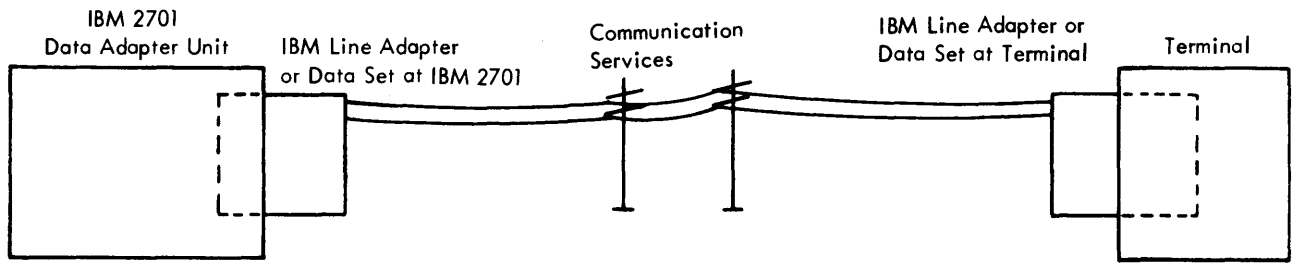


Figure 10. Terminal Connection via IBM Line Adapters or Data Sets and Communications Services

IBM Line Adapter (Modem)	Bit Rate	IBM 2701 Adapter Type
Limited-Distance Type 1	134.5 BPS	TA Type I
Limited-Distance Type 2	134.5 BPS	TA Type I
Limited-Distance Type 2	600 BPS	TA Type I or Type II

Figure 11. IBM Line Adapters (Modems) Used With the IBM 2701 Type I and Type II Terminal Adapters

IBM Terminal Adapter Type I Model II

Two versions of the IBM Terminal Adapter Type I are being used; they are the IBM Terminal Adapter Type I, and the IBM Terminal Adapter Type I Model II. The capabilities of the two versions are identical with two exceptions. The IBM Terminal Adapter Type I Model II has the capability of communicating with the IBM 2740 Model 2; it also is compatible with the Dynamic Buffering feature of the QTAM programs in that it has the capability of handling a single block of text under two successive Write operations. The IBM Terminal Adapter Type I Model II, #4640 with speed selection sub-features #9581 (134.5 bps), and #9582 (600 bps), replaces the IBM Terminal Adapter Type I, #4645 or #4646.

The IBM Terminal Adapter Type I Model II (#4640) with Speed Selection sub-feature #9581 permits the 2701 to operate with IBM 1050/1060/1070 Systems and 2740 Models 1 and 2, and 2741 Communications Terminals (2741 without Interrupt feature) at 134.5 bps via a data set over an appropriate communications facility. The IBM Terminal Adapter Type I Model II (#4640) with Speed Selection sub-feature #9582 permits the 2701 to operate with 1070 and 2740 Model 2 terminals at 600 bps over appropriate communications facilities (including data set).

This adapter may be used with an appropriate IBM Line Adapter in place of a common-carrier data set, if the communications facility is a privately owned or common-carrier leased private-line telephone channel (not exceeding eight wire-miles) conforming to the line requirements for the Limited-Distance Line Adapter Type 2 as specified in SRL Manual A24-3435-2 (or later revision). The IBM Line Adapter feature displaces the Data Set Line Adapter which is otherwise provided with this adapter.

IBM Terminal Adapter Type II

The IBM Terminal Adapter Type II controls data communications between the IBM System/360 and IBM 1030 terminals operating at 600 bps via a data set over either a common-carrier leased private-line telephone channel (four-wire) or equivalent privately owned facility. This feature may be used with an IBM Line Adapter in place of a common-carrier data set, if the communications facility is a line not exceeding eight wire-miles and the facility conforms to the Line Requirements for the Limited-Distance Line Adapter Type 2 as specified in SRL Manual A24-3435-2 (or later revision). The Data Set Line Adapter is normally provided with this adapter.

Telegraph Adapter Type I

The Telegraph Adapter Type I controls data communications between IBM System/360 and various telegraph terminals. Line control is identical to AT&T 83B2, 83B3 Type Selective Calling Terminals or Western Union Plan 115A Terminals at 45.5, 56.9, or 74.2 bps. The Telegraph Line Adapter is provided with this adapter.

Telegraph Adapter Type II

The Telegraph Adapter Type II controls data communications between System/360 and Common-Carrier (TWX) stations using eight-level code at 110 bps on common-carrier 150-baud Teletypewriter Exchange change (TWX) networks. The Data Set Line Adapter is included within this adapter.

World Trade Telegraph Adapter

The World Trade Telegraph Adapter, operating in conjunction with the IBM 3945 Telegraph Line Terminal, provides for single- or double-current lines and line-control capability for various telegraph terminals. Selective features provides 50 or 75 bps operation.

World Trade Telegraph Single Current Adapter

The World Trade Telegraph Single Current Adapter provides for direct attachment of single-current lines and line control capability for Telegraph terminals. Selective Speed features provide 50 or 75 bps operation.

Terminal Control

The terminal control refers to the control circuitry employed to provide for the line-control functions and requirements as used by a particular terminal. These functions and requirements accommodated by the terminal control (which is a functional part of each start/stop adapter) include control of character length, character format, and use of special characters.

Auto Call Feature

The Auto Call feature (ACF) is available with some adapters. The Auto Call capability is stated for adapters that employ this feature. Each applicable adapter section indicates the availability of this feature with a given transmission adapter. The ACF allows a remote terminal, connected to a common-carrier switched telephone network, to be called automatically under stored-program control. An external Automatic Calling Unit (ACU) with an interface conforming to EIA Standard RS-366 is required for use of this feature. (For further information see IBM 2701 Data Adapter Unit--Original Equipment Manufacturers' Information GA22-6844.)

The dialing operation is implemented by the Dial command. The Auto Call feature connects the Automatic Calling Unit (ACU) and the transmission interface converter section of its host XIC-XA couple. The transmission adapter handles the data path while the Auto Call feature handles only the origination of dial calls. The Auto Call feature is not required or used for handling the automatic answering of calls on a switched network. (See Dial command for further information.)

Auto Answering

This capability permits the "answering location" (i.e., the location called) to automatically recognize a signal from the calling location. The detection of this answer signal will normally result in directing the operation to a program-provided answer subroutine to handle the incoming call.

The answer routine generally incorporates a Read or Write command. This depends upon the type terminal involved, the line control utilized, and whether the called terminal is to:

- Accept the data from the calling terminal (Read command used);
- Transmit information directly to the calling terminal or go through a polling operation to the calling line (Write command used).

Automatic answering is provided for 1050, 2740 or 2741 (without Interrupt) operations via the IBM Terminal Adapter Type I Model II and for TWX Stations 33/35 via the Telegraph Adapter Type II (start/stop operations) and on the SDA-II operating on a switched network (for Binary Synchronous operations).

The Data Set Line Adapter capability plus the appropriate external data set must be used with the IBM Terminal Adapter Type I Model II and Telegraph Adapter Type II. It should be recognized that auto answering affects only dialed calls coming to the applicable XA; it does not provide for originating dial calls at the XA; accordingly, the Auto Call feature (used for programmed dialing) is not needed or used for handling the automatic answering of calls.

The automatic answering of calls requires the preconditioning (enabling) of the local (called) data set via use of the Enable command. Once enabled, the data set remains conditioned to automatically answer calls until either a Halt I/O (HIO) instruction or a Disable command is issued. After a HIO or Disable has been issued, the data set must be re-enabled via Enable to permit automatic answering of subsequent calls.

COMMANDS--START/STOP

The start/stop adapters decode and execute the commands in Figure 12. Some commands, such as Read and Write, are valid for all adapters; while other commands, such as Dial and Search, are valid only for certain adapters. The commands (Figure 13) that are valid for and used by each type of adapter are listed in the section for that adapter.

Command	Command Code	Command Classifications		
		Receive (Read-type)	Transmit (Write-type)	Control
Dial	29		x	
Enable	27			x
Disable	2F			x
Read	02	x		
Inhibit	0A	x		
Prepare	06	x		
Write	01		x	
Search	0E	x		
Break	0D		x	
Diagnostic Write	05		x	
Diagnostic Read	12	x		

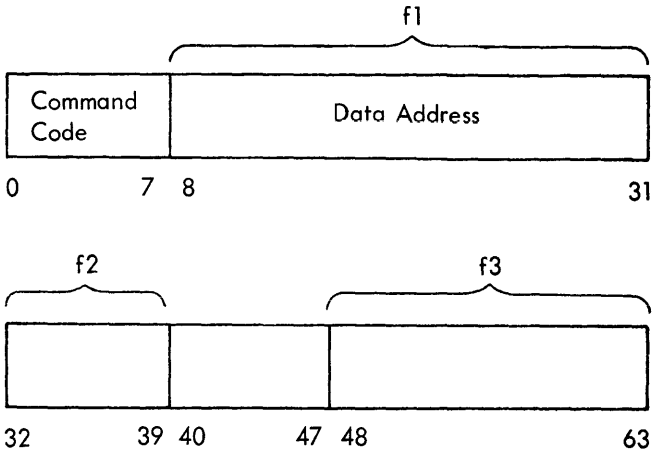


Figure 12. Commands for Start/Stop Adapters

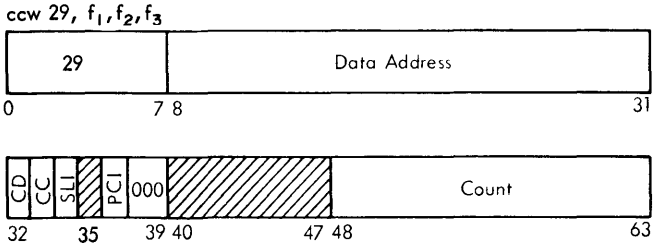
Command	Start/Stop Adapter Use			Teleg. Adapter I	Teleg. Adapter II
	IBM Terminal Adapter-I	IBM Terminal Adapter-II	IBM W.T. Teleg. Adapter		
Dial	*	---	---	---	*
Enable	x	x	x	x	x
Disable	x	x	x	x	x
Read	x	x	x	x	x
Inhibit	x	x	x	x	x
Prepare	x	x	x	x	x
Write	x	x	x	x	x
Search	---	---	#	x	---
Break	---	---	x	x	x
Diagnostic Write	x	x	x	x	x
Diagnostic Read	x	x	x	x	x

* Requires Auto Call feature
\# Decoded but not executed

Figure 13. Adapter Commands Used with Each Start/Stop

The Dial, Enable, and Disable commands are used to control operation of the communications channel. Read, Inhibit, Write, Prepare, Break, and Search provide for handling data and controlling communications on the communications channel. Diagnostic Read and Diagnostic Write are used for adapter testing.

Dial
ccw 29, f_1, f_2, f_3



Dial

The Dial command is used with the Auto Call feature. It is used when the program desires to originate a call over a switched network, and is accepted only when the Auto Call Feature (ACF) is installed. When executed, dial digits (bytes) are transferred from main storage through the ACF to the Automatic Calling Unit (ACU) at a rate controlled by the dialing equipment. Digits are presented until the I/O channel signals Interface Stop after the last dial digit has been transferred. At this time the transmission adapter and ACF wait for the ACU and the data set to signal that either (1) the connection has been established or (2) the call should be aborted and redialed. The ending status signals the results of the dialing operations to the stored program.

Description of Dial Operation

Before the Dial command is issued, the previously established connection must have been terminated via the Disable command. This is true whether or not the connection has been established by dialing or automatic answering, and is recommended to prevent an auto-answering conflict from a terminal.

To perform a dial operation, the program sets up the dial number, one digit per byte, in a main storage location (see Figure 14). The Dial command is then issued with a byte count equal to the number of digits to be dialed. The command is accepted provided the line to which it is issued is equipped with the Auto Call feature. (Note: The Enable command is not required to condition the line in a dial operation.) If the ACU is found to be inoperative (e.g., power off) at any point in the execution of Dial, the command is ended immediately with Channel End, Device End, and Unit Check status and the Intervention Required bit set in the sense field. Otherwise, dial digits are transferred to the ACU until Interface Stop is received from the channel (byte count is exhausted). When the

S 360 Byte

Bit Positions	0	1	2	3	4	5	6	7	Dial Digit
	X	X	X	X	0	0	0	0	0
	X	X	X	X	0	0	0	1	1
	X	X	X	X	0	0	1	0	2
	X	X	X	X	0	0	1	1	3
	X	X	X	X	0	1	0	0	4
	X	X	X	X	0	1	0	1	5
	X	X	X	X	0	1	1	0	6
	X	X	X	X	0	1	1	1	7
	X	X	X	X	1	0	0	0	8
	X	X	X	X	1	0	0	1	9

X four-high order bits which may be set to either zero or one; they are not used in the dial operation.

Figure 14. Dial Digits in System/360 Byte Structure

data set and ACU signal that the connection has been established, Dial is ended immediately with Channel End and Device End status. Command chaining can be employed to obtain the first data-handling command to be issued by the program once the connection is established.

The ACU performs a timeout operation following the transfer of the last dial digit. If a connection is not established before the timeout completes, the ACU signals the program to abandon the call and retry. When this signal is received, the Dial command is ended with Channel End, Device End, and Unit Check status, and with the Timeout sense bit set.

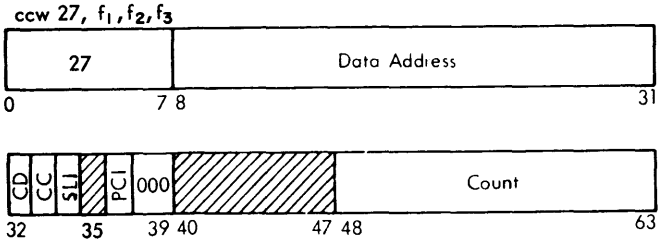
NOTE: When command chaining from a Dial command to a Write command in communicating with an IBM 2740 Communications Terminal, at least three pad 'DF' characters (1101 1111) must be inserted prior to the text transmission.

Effect of Dial Command on Metering

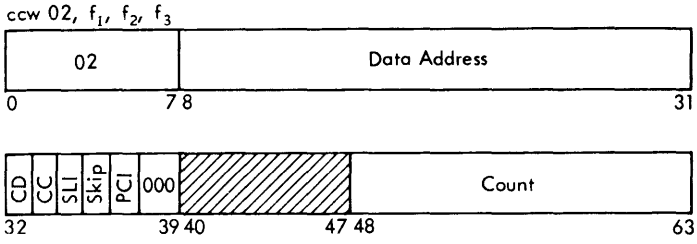
The ACF causes the 2701 to signal the CPU cluster meter to record while the Dial command is being executed.

PROGRAM NOTES: The time required to establish a dialed connection is determined by the common-carrier dial equipment and will vary depending on the dial equipment used. For example, for a 10-digit number--area code (3 digits), office code (3 digits), and line number (4 digits) --rotary (dial pulse) equipment requires as much as 30 seconds, while pushbutton (tone) dialing would under similar circumstances require about 10 seconds.

Enable
ccw 27, f_1, f_2, f_3



Read
ccw 02, f_1, f_2, f_3



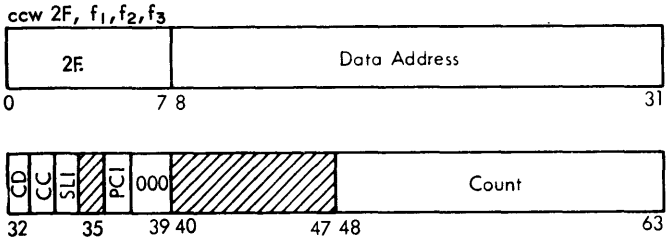
Enable

This command is used to condition the line adapter and attached data set (if any). Execution and use of the Enable command depends on the line type used in the operation. Operation on the various types of communications facilities is as follows:

1. Private line--the line adapter is conditioned (enabled) so that the 2701 can send to a remote terminal.
2. Switched network--the attached data set is conditioned to automatically answer a call from a terminal. When connection with the terminal is established, execution of the Enable command ends. The 2701 can then transmit to and receive from a remote terminal.
3. Telegraph lines--the 2701 is conditioned to transmit to and receive data from a remote terminal over telegraph facilities.

No data is transferred during execution of the Enable command. The Dial command provides its own enabling function.

Disable
ccw 2F, f_1, f_2, f_3



Disable

This command deconditions the enabling effect of the Enable and Dial commands. In private-line operation, the line adapter is made inoperative and data transfer with the communications channel is suppressed in either direction. On a switched-network operation, the Disable command causes the adapter to signal the data set to disconnect the connection to the terminal (if a call is in operation). No incoming calls will be answered until an Enable command is issued.

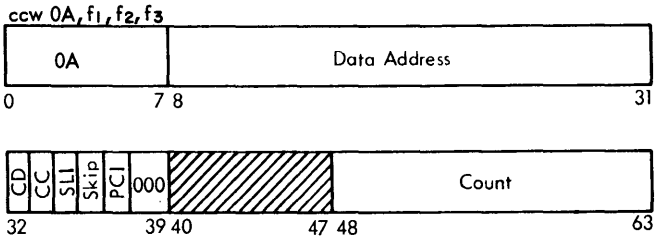
Read

This command is used to transfer incoming data to main storage. It causes bytes to be transferred from the addressed communications channel to the I/O channel at a rate equal to the rate that data is being received from the communications channel. The terminal control may provide for deletion of shift, idle, and delete control characters from the incoming data, and also controls character assembly in the transmission adapter. It may also perform VRC and LRC error checking.

The first character must be received by the adapter within a certain time period, called a line timeout, after the Read command is issued. A similar timeout also occurs between each received character. The length of these line timeouts is governed by the specific transmission adapter. (See "Timeout Summary" in each adapter section.) When no character is received before a timeout period ends, the Read command is terminated.

PROGRAMMING NOTE: To prevent the loss of data, the Read command should be terminated only by the reception of an ending control character from the terminal. Data may be lost if the Read command is terminated by a Halt I/O instruction and is always lost if terminated by an Interface Stop signal from the I/O channel.

Inhibit
ccw 0A, f_1, f_2, f_3

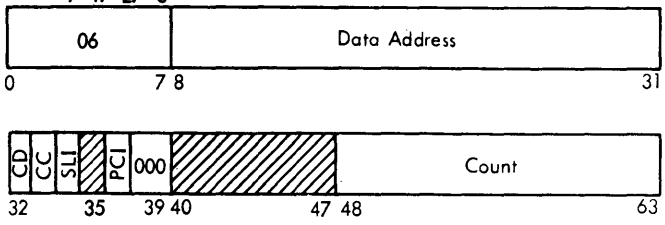


Inhibit

This command is used in place of a Read command when a read operation is required without the protection of the line timeout, such as when receiving from a manual keyboard. Inhibit is executed similarly to the Read command except that the normal line timeouts are inhibited.

PROGRAMMING NOTE: The Inhibit command should be used with caution because a terminal can cause excessive unused time on the communications channel due to the suppression of line timeouts. The Inhibit command should not be used with a manual keyboard that provides a timeout function of its own.

Prepare
ccw 06, f_1, f_2, f_3



Prepare

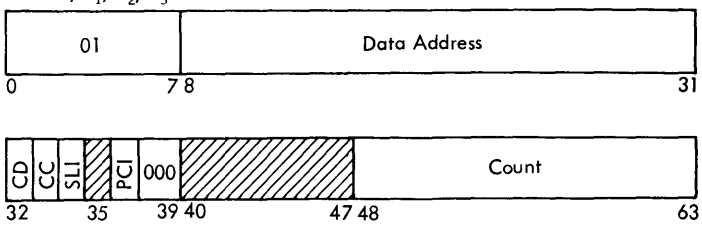
This read-type command is used to permit the 2701 to monitor the communications channel in order to signal the program in the event some activity is detected on the addressed communications line. In a contention-type communications system, it may also be used to indicate to the program when the first character begins to arrive. It can also be used to check for the Line Break signal and to thus detect a permanently open line (line failure). No data transfer to main storage occurs when executing the Prepare command. Normal line timeout is not active as long as the communications line remains at the Mark level (the idle state of the line). With timeout prevented, the transmission adapter monitors the communications channel for a legitimate start bit preceding same data bits of a character or the beginning of a broken line condition.

The Prepare command is normally ended by receipt of a "wake-up" type character or Line Break signal. (A wake-up character is any character sent by a remote terminal to notify the 2701 that a message is about to follow.) The transmission adapter initiates the termination of the Prepare command upon detection of a legitimate start bit. When the adapter detects the stop bit (Mark) of the wake-up character, the Prepare command ends with Channel End and Device End. When a Space signal is detected instead of Mark at the normal stop-bit time, the adapter begins a timeout. If the communications channel returns to Mark before the timeout elapses (23 seconds), a Line Break signal is indicated. The Prepare command is ended with Channel End and Device End. If a message is to immediately follow the wake-up character, command chaining to a Read or Inhibit command should be programmed to receive an incoming message.

If the communications channel does not return to Mark before the 23-second timeout expires, a probable open line is indicated. Under this condition, the Prepare command ends with Channel End, Device End, and Unit Check status together with the Timeout Sense bit set.

The received wake-up character, which terminates the Prepare command, is deleted from the received message and is not transferred to main storage.

Write
ccw 01, f_1, f_2, f_3

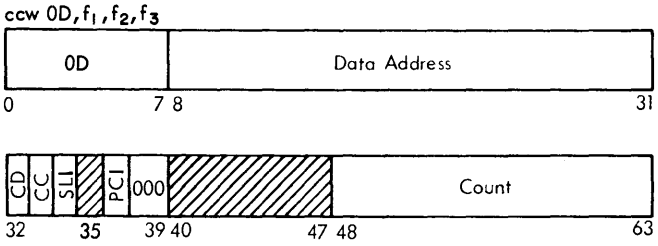


Write

The Write Command causes the 2701 to transfer data and control characters, as residing in main storage, to the communications channel for transmission to a terminal. Data-transfer rate is determined by the rated speed of the transmitting adapter, the line adapters involved, and the receiving terminal.

The Write command is normally ended by an Interface Stop from the channel, or, for certain adapters, by the recognition of an ending control character.

Break
ccw 0D, f_1, f_2, f_3

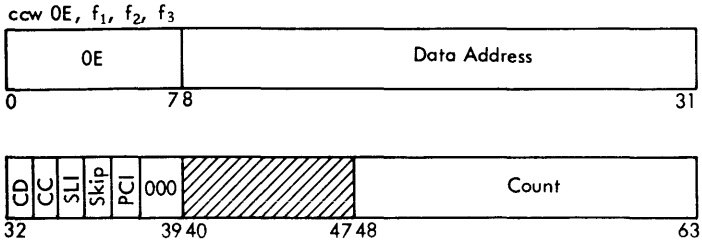


Break

The Break command is used by Telegraph Adapters Type I and II, and by the World Trade Telegraph Adapter. This command causes a continuous Space (Line Break) signal to be transmitted on the addressed communications channel. It is used to interrupt the transmission of a current message from a terminal so that the 2701 may transmit a message of higher priority. The byte count in the CCW specifies the length of the Space signal in character times. Bytes are transferred from the I/O channel to the addressed terminal to provide control over the duration of the Space signal. These bytes may have any bit configuration except that of a pad character 'DF'. The

command ends normally with Channel End and Device End status when the Interface Stop signal is received from the I/O channel. The program can send the message to the terminal by command chaining to the Write command.

Search
ccw 0E, f_1, f_2, f_3



Search

This read-type command is valid (in start/stop operations) only for lines controlled by Telegraph Adapter Type I. It is provided to allow the adapter to ignore terminal-to-terminal messages transmitted on multipoint lines to which the adapter is attached. For example, a teletypewriter terminal, having been polled by the Telegraph Adapter Type I (TA-I) may in turn address another teletypewriter attached to the same multipoint line. The message between the two teletypewriter terminals can be exchanged without going through the adapter and on to main storage, and thus without causing channel interference due to data servicing during the body of the exchanged message.

Channel End and Device End status is indicated to the I/O channel when either (1) the first non-shift character received is a V (or M) or (2) the two-character sequence, AZ, is received. This sequence is the established address for the Telegraph Adapter Type I (See "Telegraph Adapter Type I" section for further information about addressing in TA-I operations.)

The detection of the AZ indicates that the message is from the terminal to the adapter. The AZ sequence is sent to main storage and the command is terminated with CE, and DE immediately following the receipt of the Z character. A Write command can be chained to the Search to send a positive response back to the terminal.

If any other non-shift character (other than V or M) is received at the beginning of the message, the adapter is placed in a state that it only monitors the terminal-to-terminal message exchange for an EOT control character (consists of upper-case H-LTRS sequence). No data is transferred to main storage.

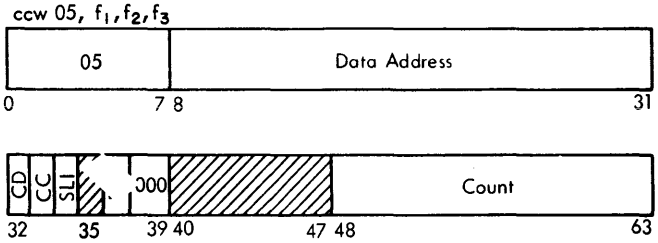
Upon detection of the EOT at the adapter, the upper-case H character is transferred to main storage. The command ends with Channel End, Device End, and Unit Exception status.

Note that if the first non-shift character happens to be an A, but Z does not immediately follow (because another terminal other than the TA-I is being addressed), the A alone will be transferred to main storage.

As a read-type command, Search provides the same line timeouts as the Read command.

NOTE: The Diagnostic Write and Diagnostic Read commands are intended primarily for 2701 equipment operating considerations.

Diagnostic Write
ccw 05, f_1, f_2, f_3

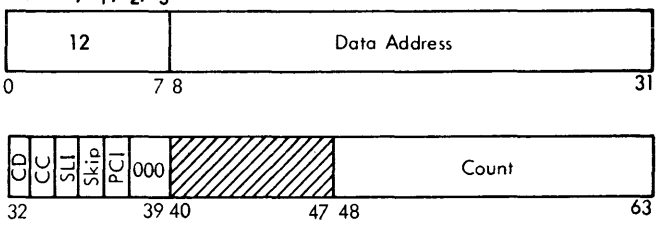


Diagnostic Write

This command causes the 2701 to perform essentially all normal write functions. However, data is blocked from going to the communications channel, but is still stored in the adapter's diagnostic register. If more than one byte is transferred, only the last byte remains stored in the diagnostic register. This command is not executed and is ended immediately if a character is being received or if one character has already been received. It is ended as a normal Write either by the adapter recognizing an ending control sequence or by an Interface Stop signal issued by the I/O channel.

NOTE: Data characters transferred serially to the communications channel under a normal Write command are also placed in the diagnostic register.

Diagnostic Read
ccw 12, f_1, f_2, f_3



Diagnostic Read

This command causes the 2701 to read data from the diagnostic register instead of from the communications channel. Essentially all other normal read functions are performed.

The first character read is always the character stored in the diagnostic register. The second character is automatically generated after the character originally stored in the diagnostic register has been transferred to the I/O channel. The second character varies with the transmission adapter.

PROGRAMMING NOTE: To suppress the effect of any extraneous signals from the communications channel during execution of the diagnostic commands, the line should be disabled (by issuance of a Disable command) before issuing diagnostic commands.

Effect of Halt I/O Instruction--by Command for Start/Stop Adapters

When the Halt I/O (HIO) is issued to an XIC-XA couple executing a command, the ending status depends on the command being executed and the condition of the line when the HIO occurs. The effects of HIO on the execution of each command follow:

Read, Search, Inhibit, and Diagnostic Read

a. If the XA has not received data when HIO is issued, the command ends normally with Channel End and Device End status.
b. If there is a character in the data register, the command ends with Channel End, Device End, and Unit Check status and the Lost Data sense bit is set.

PROGRAMMING NOTE: When the Lost Data sense bit is set, the setting of Unit Exception status and Data Check, Overrun, and Timeout sense bits is unpredictable. If data is being received, HIO will generally cause the adapter to lose synchronism with the terminal. HIO should be used with discretion in terminating the execution of the Read and Inhibit commands.

Write and Diagnostic Write

When HIO is issued, the command ends immediately if no data is stored in the data register. Otherwise, the command ends as soon as the stored character and the accumulated LRC character are transmitted to the remote terminal. In either case, the command ends with Channel End and Device End.

Prepare

a. The command ends immediately with Channel End, Device End, and Unit Exception when HIO is issued before a legitimate start bit has been received--that is, before a character begins to arrive.
b. The command ends normally when HIO is signaled after a legitimate start bit is received (a character has started to arrive). The HIO is disregarded and the command is executed and ended as it would have ended had the HIO not been issued. (See the previous description and use of the Prepare command.)

NOTE: To detect the difference between a received Break signal and an open line, a Prepare command should be issued followed by a Halt I/O. If the command ends with Channel End and Device End or with Channel End, Device End, and Unit Exception status, it may be assumed that the Break signal was received. If the command ends with Channel End, Device End, and Unit Exception status and the Timeout sense bit set to one, then the line has been open for approximately 23 seconds and an open-line condition can be suspected.

Dial

If HIO is issued after the Interface Stop signal has been received (i.e., the entire number has been dialed), the execution of Dial is not affected; however the issuance of HIO does prevent any specified command chaining even though the command ended normally with Channel End and Device End.

If HIO is issued before Interface Stop is received (i.e., the entire number has not been dialed), the dialing operation is aborted and the command ends with Channel End, Device End, and Unit Exception status. In the event the data set fails to go "on-hook," the Unit Check status bit, as well as the Equipment Check sense bit, is also set.

Break

The Break command is ended by a HIO, and the ending status returned is Channel End and Device End.

Effect of Interface Stop Signal--by Command for Start/Stop Adapters (Byte Count = 0)

Stop is a signal developed in the channel to indicate that the I/O channel is ending the current operation. Interface Stop can be signaled by the channel only during a data-service cycle when the CCW count has decremented to zero. The following are the effects of the receipt of an Interface Stop signal on each command:

Read, Inhibit, and Diagnostic Read

The command ends immediately with Channel End, Device End, and Unit Check status and the Lost Data sense bit is set.

Write and Diagnostic Write

The command ends with Channel End and Device End status following the transmission of the last character received from the channel and the LRC character if applicable.

Prepare, Enable, and Disable

Since no data transfer takes place during execution of these commands, Interface Stop cannot be signaled.

Dial

Stop indicates the last dial digit has been transferred.

a. The command ends normally with Channel End and Device End status if the call is answered correctly.
b. If the ACU does not receive a correct response in time (as determined by an adjustable setting on the ACU), the command ends immediately with Channel End, Device End, and Unit Check status. The Timeout sense bit is also set.

Search

The command ends on receipt of an Interface Stop. The ending status returned is Channel End and Device End.

Break

The command ends normally on receipt of an Interface Stop with Channel End and Device End status set.

START/STOP ADAPTER OPERATION

The following descriptions of the receive and transmit operations assume that the reader has a knowledge of the serial start/stop mode of transmission. Refer to SRL manual, Data Communications Concepts and Communications Facilities, Form No. E20-8158, for a general description of communications facilities and modes of operation.

Receive Operation

The normal receive operation is initiated when a start bit is received provided the data set (line adapter/modem) is operational and the XIC-XA couple is not operating on a diagnostic or write-type command. Upon detection of the start bit, the terminal adapter prepares to receive a character. The character, which is received one bit at a time, is assembled in a data register. When a full character has been assembled, it is transferred to the I/O channel provided a read-type command has been issued. If a read-type command has not been issued, the incoming data is lost. The XIC-XA couple continues to receive and assemble ensuing characters until an interrupt condition or a normal ending condition occurs.

The adapter monitors the communications channel for line-control characters and deletes the start and stop bits. Where applicable, it also deletes shift, idle, and delete characters; receives, checks, and deletes the LRC character; checks for correct parity; and adds a shift-control bit before transferring data to main storage.

Timeouts

Five types of line timeouts must be considered in start/stop operations when executing read-type commands other than Inhibit:

1. A timeout of 23 seconds is started when the Read or Search command is decoded in the adapter, and is terminated when the start bit of the first character is received. Some adapters utilize a shorter timeout period of 2.5 seconds prior to receiving the start bit of the first character. This short timeout reduces wait time for those terminals having no message to send;
2. A timeout of 23 seconds is started when the stop bit of a character is detected, and is terminated when the start bit of the next character is detected;
3. A timeout of 23 seconds is performed during Prepare command execution while the line remains at space level;
4. A 23-second timeout is used with a switched-network data set when executing the Disable command to limit the time that the data set can signal that the disconnect has been complete; and
5. A timeout is performed in the Automatic Calling Unit (ACU) while the Dial command is being executed to signal if the call should be aborted and retried. The length of this last timeout is adjustable within the Automatic Calling Unit.

Transmit Operation

The transmit operation is initiated by the acceptance of a write-type command by an XIC-XA couple. The transmission adapter requests the first character

from main storage via the I/O channel. Before transmitting the first character to the remote terminal, the 2701 sends a series of Mark bits for one full character time. (This includes the start bit which is normally a Space.) The first character is then transmitted to the remote terminal. The transmission adapter inserts the required start and stop bits, checks for special characters, accumulates and transmits the LRC character (where applicable), and inserts applicable shift characters. Unless some terminating condition occurs, the XIC-XA couple requests data service from the I/O channel as the last of the previous character is transmitted. Data service by the I/O channel results in another character being transferred to the XIC-XA couple for transmission to the terminal. This operation continues until an interrrupt condition or a normal ending of the command occurs.

SPECIAL START/STOP CONSIDERATIONS

Echo Check

During a write-type operation on a line equipped with a Telegraph Line Adapter feature, each data bit placed on the communications channel is tested automatically to ensure that it is correct. Upon detecting an error, called an echo check, the write-type command is terminated immediately with Channel End, Device End, and Unit Check together with the Data Check sense bit set. Echo checking is performed only in the Telegraph Adapter Type I, and the World Trade Telegraph Adapter.

Line Break

When operating with the Telegraph Adapter Type I or II, the 2701 may transmit a Line Break signal to interrupt transmission from a remote terminal. The Line Break (which is a continuous Space signal) is generated when the Break command is issued. Characters are transferred from main storage to the 2701, but the 2701 sends only Space signals to the attached line adapter regardless of the character bit configuration. The CCW must specify the number of characters to be transferred to the 2701. This governs the length of the Line Break Signal. The command sends when the CCW byte count decrements to zero. As with other write-type operations, an all-Marks character is automatically transmitted before the start of the Line Break signal.

PROGRAMMING NOTE: If a pad character is the first character transferred to the 2701 following the issuance of the Break command, the line break commences only when the first character other than the pad character is decoded.

Write Marks

The Write command has a built-in feature to allow transmission of a continuous Mark signal for a number of character times. A Mark signal is transmitted for one character time (including the start bit) when the pad character is received from the I/O channel. The pad character has the bit configuration 11011111 (DF in hexadecimal). All start/stop terminal adapters permit this operation.

Terminal	Speed (bps)	Communication Services (Notes 1&2)	2701 Adapter Required*
IBM 1050 System	134.5 134.5 134.5	B1, B2 C1, C2 Note (3) D1	4640 with 9581 4640 with 9581 4640 with 9581
IBM 1060 System	134.5 134.5	B1, B2 D1	4640 with 9581 4640 with 9581
IBM 1070 System	134.5 134.5 600.0	B1, B2 D1 D2	4640 with 9581 4640 with 9581 4640 with 9582
IBM 2740 Model 1	134.5 134.5 134.5	B1, B2 C1, C2 Note (3) D1	4640 with 9581 4640 with 9581 4640 with 9581
IBM 2740 Model 2	134.5 134.5 600.0	B1, B2 D1 D2	4640 with 9581 4640 with 9581 4640 with 9582
IBM 2741	134.5 134.5 134.5	B1, B2 C1, C2 Note (3) D1	4640 with 9581 4640 with 9581 4640 with 9581
IBM System/7 (Using 2740 Model 1 line control sequences)	134.5 134.5 134.5 600.0	B1, B2 C1, C2 Note (3) D1 D2	4640 with 9581 4640 with 9581 4640 with 9581 4640 with 9582

*** Feature Codes**

Notes

(1) Communication service designations are as follows:

B1 and B2--Common carrier leased type 1006 sub-voice grade channel or equivalent privately owned services.

C1 and C2--Common carrier public switched telephone network or equivalent privately owned services.

D1 and D2--Common carrier leased type 3002 voice grade channel or equivalent privately owned services.

(2) On appropriate communication services, IBM Line Adapters (4636* or 4637*) may be used instead of external data sets. For detailed information see Planning and Installation of a Data Communications System Using IBM Line Adapters, GA24-3435.

(3) On communication services C1 and C2, Autocall is available. For detailed information, consult your local IBM representative.

Figure 15. Asynchronous Start/Stop Terminals that Communicate with the IBM Terminal Adapter Type I Mode II

The IBM Terminal Adapter Type 1 Model II replaces the IBM Terminal Adapter Type 1. All following references to the IBM Terminal Adapter Type 1 apply to both, as the operation of both is identical except where noted.

For further information, see IBM Terminal Adapter Type 1 Model II under "Start/Stop Transmission Adapters Generalized" in this publication.

- Class of Adapter:

  Asynchronous Start/Stop

- Terminal Equipment Serviced:

  Figure 15 shows the terminals that communicate with the 2701 IBM Terminal Adapter Type 1 Model II.

  At 600 bps (66.6 char. per sec)--
  IBM 1070 Process Control System
  IBM 2740 Communication Terminals Model 2

- Associated Publications:

  IBM 1050 Data Communication System--A24-3020
  IBM 1060 Data Communication System--A24-3034
  IBM 1070 Process Communication System--A26-5989
  IBM 2740 Communications Terminal--A24-3403
  IBM 2741 Communications Terminal--A24-3415
  IBM System/7--GA34-0003

- Adapter Physical-Size Classification:

  Category I

- Special Adapter Capabilities:

  Auto Answer--only with IBM 1050, 2740, 2741 (without Interrupt)

- Type of Operation (Transmission):

  1050--Point-to-Point, Multipoint, Switched
  1060--Point-to-Point, Multipoint
  1070--Point-to-Point, Multipoint
  2740--Point-to-Point, Multipoint, Switched (Multipoint only with Station Control feature)
  2741--Point-to-Point, Switched

- IBM Terminal Adapter Type I Features:

  Communications-Line Interface Types

  EIA RS-232-A

  CCITT V24

  For further information see IBM 2701 Data Adapter Unit-Original Equipment Manufacturers' Information (GA22-6844).

  Auto Call

  For IBM 1050, 2740, and 2741.

  IBM Line Adapter

  When operating with IBM 1050, 1070, 2740, 2741, and in accordance with A24-3435-2 or subsequent revision.

- Communication Service Required:

  For communication services required, consult your local IBM representative.

- Commands Decoded in IBM Terminal Adapter Type I:

Command	Command Code in Hexadecimal	Flag Bits Bit Positions CD	CC	SLI	SKIP	PCI
Read	02	O	O	O	O	O
Write	01	O	O	O	X	O
Inhibit	0A	O	O	O	O	O
Enable	27	NA	O	NA	X	NR
Disable	2F	NA	O	NA	X	NR
Prepare	06	NA	O	NA	NA	NR
Dial*	29	O	O	O	X	NR
Diagnostic Read	12	O	O	O	O	O
Diagnostic Write	05	O	O	O	X	O

*Requires Auto Call feature.

Legend:

O	Optional usage
NA	Not applicable to command
NR	Not recommended
X	Not used

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with an incorrect length indication will occur.

The following commands can also be used in IBM Terminal Adapter Type I operation. They are decoded in the coupled XIC.

Command	Code
Sense	04
I/O No Op	03
Test I/O	00

NOTE: The Test Input-Output operation may only be issued via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of "00" will result in a program check.

See previous Start/Stop section for command operations.

- Transmission Codes Employed:

System	Generic Name of Character Sets
IBM 1050	BCD
IBM 1060	BCD
IBM 1070	BCD
IBM 2740	PTTC/BCD, PTTC/EBCD, or Correspondence
IBM 2741	PTTC/BCD, PTTC/EBCD, or Correspondence

Character Sets. The transmission code used between the 2701 equipped with the IBM Terminal Adapter Type I and the 1050, 1060, and 1070 systems and the 2740 and 2741 (without Interrupt feature) terminals is BCD plus parity. The relationship between the 2701 and the System/360 byte structure in servicing these terminals is illustrated in Figures 16 through 19. One start bit and one stop bit are added to a character by the terminal adapter when the adapter is transmitting; these bits are deleted from the character by the adapter before transfer to main storage when the adapter is receiving.

In the six-bit BCD transmission code, S position represents the shift bit. A logical 1 identifies upper case; a logical 0 identifies lower case. The B bit is the first bit transmitted and received following the start bit. An odd-parity (check) bit follows the 1 bit.

Each received and transmitted character is checked for odd vertical parity. VRC errors cause Data Check to be set in the Sense register, but do not cause termination of the command currently being executed. LRC accumulation and checking is done by this adapter; detected errors also set Data Check within the Sense register and Unit Check within the Status register. Idle, delete, and shift characters are included in the LRC character accumulation.

The C (check) bit in the character indicates the odd-parity count: a logical 1 if the bit count of the data bits in the character is even, or a logical 0 if the bit count is odd. The whole character, including the parity bit, is transferred to to main storage.

If the line is in text-in mode (for incoming data), the shifted-character-set-conversion operation (a standard feature) automatically deletes the upshift and downshift characters from the received data stream, notes the last shift character received, and modifies the shift bit to indicate the case (upper or lower) to the program. While downshift and upshift characters are included in the LRC character accumulation, their transfer to main storage is inhibited. The shift bit is set to zero for all characters transferred to main storage under a read-type command when the line is in either text-out mode or control mode. (Downshift mode is associated with lower-case characters, and upshift mode with upper-case characters.)

On outgoing data, with the line in text-out mode, the shift bit is noted and removed from each data character. A change in the shift bit automatically causes insertion of the appropriate shift character (upshift or downshift) into the outgoing data stream before sending the data character. The shift bit has no effect if the line is in text-in mode or control mode.

PROGRAMMING NOTE: The programmer is cautioned on writing shift characters from the processor to the 2701. The 2701 does not recognize the upshift or downshift character coming from main storage, so it will not update the shift mode unless the shift bit accompanying the shift character indicates the same case as the shift character. If the shift bit changes the current case, the result will be that two identical shift characters will be transmitted where one is generated by the 2701 and the other is received from main storage.

- Transmission-Code Error Detection Employed:

Longitudinal Redundancy Checking (LRC)--effective only if the terminal is equipped for checking.
Vertical Redundancy Checking (VRC)

		Lower Case								Upper Case							
		S/360 Main Storage Byte Positions 0, 1, 2, 3 (S, B, A, 8)															
Byte Positions 4,5,6,7 (4,2,1,C)	HEX	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0		8	@		(N) —			h		*	¢		(N) —			H
0001	1	Space			y		q	&		Space			Y		Q	+	
0010	2	1			z		r	a		=			Z		R	A	
0011	3		9	/		j			i		(	?		J			I
0100	4	2					Minus Zero (MZ)	b		<						B	
0101	5		0	s		k			Plus Zero (PZ)		)	S		K			
0110	6		# (D) EOA	t		l			(Y) .		(D) "EOA	T		L			(Y) ¬
0111	7	3			,		$	c		;				!		C	
1000	8	4			By-pass		Re-store	d		:			By-pass		Re-store	D	
1001	9		Punch On (PN)	u		m			Punch Off (PF)		Punch On (PN)	U		M			Punch Off (PF)
1010	A		Rdr (RS) Stop	v		n			Horiz Tab		Rdr (RS) Stop	V		N			Horiz Tab
1011	B	5			LF		CR/LF	e		%			LF		CR/LF	E	
1100	C		Up-Shift	w		O			Down-shift		Up-Shift	W		O			Down-shift
1101	D	6			(B) EOB		Back-space	f		'					Back-space	F	
1110	E	7			Pre-fix		Idle	g		>			Pre-fix		Idle	G	
1111	F		(C) EOT	x		P			De-lete		(C) EOT	X		P			De-lete

Notes - Equivalent functions
CR/LF = NL
LF = Index

0	1	2	3	4	5	6	7

System/360 Byte

S	B	A	8	4	2	1	C

Terminal Code Structure

S bit position 0 (lower case) or 1 (upper case) inserted on receive operations or deleted on transmit operations. Insertion/deletion preformed by equipment.

Start	B	A	8	4	2	1	C	Stop

Transmitted and Received Character

These codes perform no function in the IBM 1050 System, but are valid data codes. They are not printable.

On receive operations, the start-stop bits are deleted at the 2701.
On transmit operations, the start-stop bits are added at the 2701.

Figure 16. Code Structure for IBM 1050 in IBM Terminal Adapter Type I Operation, System/360 Oriented

Certain models of the IBM 2740 and 2741 terminals do not have VRC/LRC checking. They do, however, send correct VRC parity bits to the 2701. These models can be handled by IBM Terminal Adapter Type I; however Ⓑ is not used in their line controls.

- Line-Control and Functional Characters Recognized by IBM Terminal Adapter Type I:

Line-Control Characters

The following line-control characters are recognized by the IBM Terminal Adapter Type I during transmit operations.

Ⓑ--End of Block (EOB). Indicates the end of a block of text. The LRC character, developed by the adapter (in concert with the terminal), is transmitted immediately after the Ⓑ. After transmitting the LRC character, Channel End and Device End status is set, provided no error conditions have been detected. (If the two LRC's differ, the Data Check bit is also set.) Command chaining to a Read command should be used so the adapter will be ready to receive the response character from the terminal as quickly as possible.

Ⓒ--End of Transmission (EOT). Indicates the end of transmission. This control character places the IBM Terminal Adapter Type I in control mode. While the adapter is in control mode, the character case (upper or lower) is effectively lower-case or downshift mode. The EOT Ⓒ does not end a write-type command. To end the command after transmission of the Ⓒ, the byte count in the CCW should be set to go to zero after the Ⓒ is transferred to the 2701. The Ⓒ resets the LRC counters at both the transmitting and receiving locations.

Ⓓ--End of Address (EOA). Indicates the end of address and is normally followed by text transmission. Ⓓ sets text-out mode and initiates LRC accumulation beginning with the following character. Ⓓ is recognized as a line-control character only when the adapter is in control mode or text-in mode. In text-out mode, Ⓓ is treated as a normal data (text) character.

When the line is in control mode, and Ⓓ is transmitted, the line is placed in lower case. When the line is in text-in mode, the shift bit of the Ⓓ is ignored and the case is not changed.

In text-out mode, when any text character has its S bit set to one and the immediately preceding character had its S bit set to zero, the line will generate and transmit the upshift character and will set upper case before the text character is transmitted.

The following line-control characters are recognized by the IBM Terminal Adapter Type I during receiving operations:

Ⓑ--End of Block (EOB). Indicates the end of a block of text. The next received character will be the LRC character, which will be matched against the LRC character accumulated in the adapter. With no LRC error (i.e., both LRC characters match), the command is ended with Channel End and Device End status. The response (answerback) character, Ⓨ or Ⓝ, should then be transmitted by means of the Write command.

PROGRAMMING NOTE: When using the Ⓑ, the Write CCW does not have to contain a specific count as long as it is equal to or greater than the actual number of bytes to be transmitted. The Write command is ended after transmitting a Ⓑ and the LRC characters; therefore, an Interface Stop is not required.

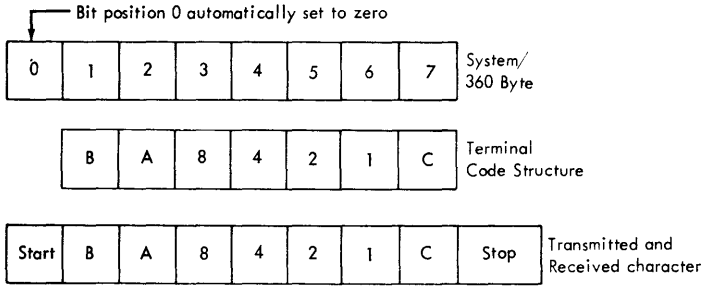
For write-type operations under the control of the IBM TA Type 1, the Ⓑ line control character used for End of Block control must be the lower case B (Hex 3D).

Ⓒ--End of Transmission (EOT). Indicates the end of transmission and sets the line in control mode. The command is terminated with Channel End, Device End, and Unit Exception status.

Ⓓ--End of Address (EOA). Indicates that the characters following will be text. Ⓓ sets text-in and downshift mode within the adapter and initiates LRC accumulation. Ⓓ is recognized as a control character only if the line is in control mode; otherwise, it is a normal data character and has no control effect.

Ⓝ Received as a Negative Response to Polling. When the adapter is in control mode, indicates that the terminal is not ready to receive data. The command ends with Channel End, Device End, and Unit Exception status. Ⓝ received following text, (when adapter is in text-out mode,) indicates an error was detected and the command is ended with Channel End, Device End, and Unit Check status and the Data Check bit set in the

Byte Positions 4,5,6,7 (4,2,1,C)		S/360 Main Storage Byte Positions 0, 1, 2, 3, (Ø, 8, A, 8)							
		0000	0001	0010	0011	0100	0101	0110	0111
	HEX	0	1	2	3	4	5	6	7
0000	0		8	Add		(N)			H
0001	1	Space			Y		Q	+	
0010	2	1			Z		R	A	
0011	3		9	/		J			I
0100	4	2					Mess-age	B	
0101	5		0	S		K			Re-store
0110	6		(D) EOA #	T		L			(Y)
0111	7	3					$	C	
1000	8	4					*	D	
1001	9			U		M			Subtr
1010	A			V		N			Tab
1011	B	5			LF		CR	E	
1100	C			W		O			
1101	D	6			(B) EOB			F	
1110	E	7					Idle	G	
1111	F		(C) EOT	X		P			Delete



On receive operations, the start-stop bits are deleted at the 2701.
On transmit operations, the start-stop bits are added at the 2701.

Figure 17. Code Structure for IBM 1060 in IBM Terminal Adapter Type I Operation, System/360 Oriented

sense field. If (N) is received while the adapter is in text-in mode, this character is treated as a normal data character and has no control effect.

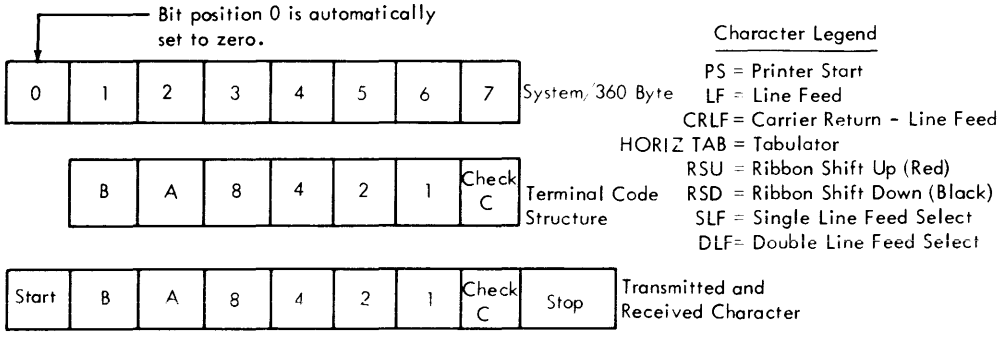
(Y) Received as a Positive Response to Polling. Indicates that the polled terminal is ready to receive data. (Y) received in reply to text, (adapter in text-out mode,) indicates the text was received without error. In either case, the command ends with Channel End and Device End status. If (Y) is received while the adapter is in text-in mode, it is treated as a normal data character and has no control effect.

Functional Characters

The upshift character sets text-in upshift mode if the line is in text-in downshift mode. If the line is already in either text-in upshift mode, text-out mode, or control mode, this character has no effect. In any case, the adapter inhibits transfer of the upshift character to the I/O channel, removing it from the incoming data stream if the line is in text-in mode. The upshift character is included in the accumulated LRC character.

The downshift character sets text-in to the downshift mode if the line is in text-in upshift

Byte Positions 4,5,6,7 (4,2,1,C)	S/360 Main Storage Byte Positions 0, 1, 2, 3, (Ø, B, A, 8)							
	0000	0001	0010	0011	0100	0101	0110	0111
HEX	0	1	2	3	4	5	6	7
0000	0		8			(N) -			H
0001	1	Space			Y		Q	&	
0010	2	1			Z		R	$\overline{\text{RSU}}$ A	
0011	3		9	/		J			I
0100	4	2					! •	$\overline{\text{RSD}}$ B	
0101	5		0	S		K			
0110	6		(D) EOA #	T		L			(Y)
0111	7	3			(S) ,		$	$\overline{\text{SLF}}$ C	
1000	8	4			%		(T) *	$\overline{\text{DLF}}$ D	
1001	9		@	U		M			PS
1010	A		:	V		N			Horiz Tab
1011	B	5			LF		CRLF	E	
1100	C		>	W		O			
1101	D	6			(B) EOB		;	F	
1110	E	7			PRE		(A)	G	
1111	F		(C) EOT	X		P			



Character Legend

PS = Printer Start
LF = Line Feed
CRLF = Carrier Return - Line Feed
HORIZ TAB = Tabulator
RSU = Ribbon Shift Up (Red)
RSD = Ribbon Shift Down (Black)
SLF = Single Line Feed Select
DLF = Double Line Feed Select

On receive operations, the start-stop bits are deleted at the 2701.
On transmit operations, the start-stop bits are added at the 2701.

Note: Underlined characters (LF, TAB, etc.) are 1053 control. Overlined characters ($\overline{\text{RSU}}$, $\overline{\text{RSD}}$, etc.) are 1050 control that must be preceded by a prefix (PRE) character.

Figure 18. Code Structure for IBM 1070 in IBM Terminal Adapter Type I Operation, System/360 Oriented

		Lower Case								Upper Case							
		S/360 Main Storage Byte Positions 0, 1, 2, 3, (S, B, A, 8.)															
Byte Positions 4,5,6,7 (4,2,1,C)	Hex	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	0		8	@		¬ (N)			h		*	¢		¬ (N)			H
0001	1	Space			y		q	&		Space			Y		Q	+	
0010	2	1			z		r	a		=			Z		R	A	
0011	3		9	/		j			i		(	?		J			I
0100	4	2						b		< ¤						B	
0101	5		0	s		k					)	S		K			
0110	6		# (D) EOA	t		l			(Y) •		" ± (D)	T		L			¬ • (Y)
0111	7	3			' (S)		$	c		;			| ,		!	C	
1000	8	4						d		:						D	
1001	9			u		m						U		M			
1010	A			v		n			Horiz Tab			V		N			Horiz Tab
1011	B	5			LF See Notes 1 & 4		NL	e		%			LF See Notes 1 & 4		NL	E	
1100	C		Up-Shift	w		o			Down-Shift		Up-Shift	W		O			Down-Shift
1101	D	6			(B) EOB		Back Space	f		'					Back Space	F	
1110	E	7					IDLE	g		> "					IDLE	G	
1111	F		(C) EOT	x		p						X		P			

0	1	2	3	4	5	6	7	System/360 Byte

S	B	A	8	4	2	1	C	Terminal Code Structure

Start	B	A	8	4	2	1	C	Stop	Transmitted and Received Character

PTTC/EBCD characters are shown above dashed line
PTTC/BCD characters are shown below dashed line
Characters in undashed boxes are common to PTTC/BCD and PTTC/EBCD

Note:
On receiving operations, the Start and Stop bits are deleted at the 2701.
On transmitting operations, the Start and Stop bits are added at the 2701.

S bit position 0 (lower case) or 1 (upper case) inserted on receive operations or deleted on transmit operations. Insertion/deletion is performed by equipment.

Notes:
1. LF (Line Feed) performs the indexing function.
2. NL (New Line) performs the carrier return and Line Feed function.
3. In the 2741, the Attention function is performed instead of the indexing functions while the terminal is in transmit state. The terminal will receive the index character and perform this function.
4. Similar terms:
   Downshift = Lower case
   Upshift = Upper case

Figure 19. Code Structure for IBM 2740/2741 in IBM Terminal Adapter Type I Operation, System/360 Oriented

mode. If the line is already in text-in downshift mode, text-out mode, or control mode, this downshift character has no effect. In any case, the terminal adapter inhibits transfer of the downshift character to the I/O channel, removing it from the incoming data stream. If the line is in text-in mode, the downshift character is included in the LRC character accumulation.

Delete characters are removed from the incoming data stream and their transfer to main storage is inhibited by the terminal adapter. However, the delete character is included in the accumulated LRC character if the line is in text-in mode.

Idle characters are removed from the incoming data stream and their transfer to main storage is inhibited by this adapter. However, the delete character is included in the accumulated LRC character if the line is in text-in mode.

- Polling and Addressing with IBM Terminal Adapter Type I:

The IBM 1050, 1060, and 1070 systems and the IBM 2740 Communications Terminal (with the Station Control feature) can operate on a multipoint communications network. All transmission over the network is controlled by the IBM TA-1 as a master station. This controlling function is under program control from main storage located at the CPU and connected to the network via an IBM Terminal Adapter Type I. This permits messages to be transmitted to or received from each terminal in an order of priority established by the program. This control requires the use of two techniques: polling and addressing.

Polling

Any or all of the terminals on the multipoint network may be ready to send a message simultaneously. To eliminate having each terminal contend for the use of the communications channel, and also to maintain program control of the network, the program has a method of selecting each terminal. This method, called polling, permits the program to specify when a terminal may send its message.

Addressing

Addressing is the method that permits the program to select a specific terminal for which the CPU has a message. One or more terminals may be selected to receive a single message. Also, individual components within a terminal sub-system, such as a printer or punch, may be selected to receive the message.

Polling and addressing permit program control of communications over the multipoint communications channel to be maintained.

Terminal Selection

To permit terminal selection during polling or addressing, each remote terminal is assigned a unique station address. For the 1050, this address is composed of an alphabetic character for each station plus a numeric character for each input and output component of that station. These numeric codes and their associated 1050 components are:

0	Common polling character for any input component
1	Printer 1
2	Printer 2
3	Punch 1
4	Punch 2
5	Keyboard
6	Reader 1
7	Reader 2
8	Unassigned
9	Common addressing character for any output component

The station alphabetic plus the component numeric are collectively called the polling (or addressing character), and are used to designate the specific station and component to be involved in the ensuing data-transfer operations. All other stations on the same multipoint network are prevented from using the communications line until the operation with the polled (or addressed) station has been completed.

A more detailed description of these operations may be found in the SRL manual concerned with the specific system or terminal. These manuals should be consulted for message formats and line-control procedures and repertoires, since these vary between systems and terminals.

Polling and Addressing Operation

Polling and addressing in IBM Terminal Adapter Type I are each performed by alternate Write and Read commands. When polling a terminal, both the adapter and the line must be in control mode. The Write command causes the polling

characters to be transmitted over the communications channel. The byte count in the CCW must be set to the exact number of characters to be transmitted. Command chaining to a Read command is utilized so that the adapter and allocated main storage are ready to receive incoming data as quickly as possible, thus minimizing the possibility of data being lost. Data chaining can be utilized after the initial Read command to assign sections of the received data block to various main-storage areas.

Polling

The Ⓒ (if required to set control mode) and the polling characters are sent by a Write command, command chained to a Read command. At this point, the adapter initiates a 2.5-second timeout. The Read command is ended and the program is interrupted when (1) the timeout period is exceeded or (2) a Ⓝ is received. Exceeding the timeout period sets Channel End, Device End, and Unit Check status together with the Timeout sense bit. Receiving a Ⓝ sets Channel End, Device End, and Unit Exception status only. The Ⓝ indicates that the polled terminal has no message to send. At this time, the line remains in control mode, and, if polling is reinitiated, the Ⓒ need not be retransmitted.

A Ⓓ received as the first character indicates that the polling was successful and that the following character is the first character of text. The Ⓓ sets the adapter to text-in mode and initiates LRC accumulation. (The Ⓓ itself is not included in the LRC.) The first character received following the Ⓓ must be in downshift mode. The Read command ends when Ⓑ and the LRC character are received.

When the first character received is not a Ⓓ, the message that follows is received in control mode and without LRC accumulation. Since the adapter is in control mode, any control character received in the body of the message performs its control function. For examples, a Ⓨ or Ⓝ ends the Read command prematurely; a Ⓓ sets the line to text-in mode and starts LRC accumulation at this point. If the command is not ended prematurely by Ⓨ or Ⓝ , it is ended when the Ⓑ and LRC character are received at the end of the message. This happens whether the line is in control or text-in mode. However, if the line is in control mode, no LRC error check is performed.

Addressing

When addressing a remote terminal, the IBM Terminal Adapter Type I must be in control mode. A Ⓒ (if required to set control mode) and the address characters are transmitted over the communications channel. Command chaining to the Read command is utilized to receive the addressed terminal's response. Receipt of Ⓝ indicates that the terminal is not ready to receive data. This ends the Read command with Channel End, Device End, and Unit Exception. A Ⓨ response indicates the terminal is ready to receive. This ends the command with Channel End and Device End. Command chaining to the Write command may then be utilized to transmit the message to the terminal. With either response, the line remains in control mode. When no response is received within 2.5 seconds, the Read command ends with Channel End, Device End, and Unit Check status together with the Timeout sense bit set.

2741 and 2740 (Without Station Control Feature)

Note that the IBM 2741 Communications Terminal and the IBM 2740 Communications Terminal (without the Station Control feature) never operate on multipoint lines. Therefore, they do not respond to polling and addressing as described above. These terminals are used primarily on contention-type communications channels. With no polling or addressing, each message starts with Ⓓ and ends with Ⓒ . The Ⓓ indicates that the following characters are text while Ⓒ signals the end of text and terminates the Read command in the 2701.

Messages sent by the 2701 should also be in this format. No formal line control is established; that is, the terminal communicates with main storage in a conversational mode. It is the program's responsibility to determine when and how the incoming message from the terminal is processed. For example, the program may monitor for a "wake-up" type character or line-break signal by means of the Prepare command (the Prepare command is ended by either signal). How the program proceeds depends on the operating procedure for the particular system. The Prepare command must be command chained to a read command to receive the incoming message if the terminal operator has been instructed to send the message

immediately after he sends the wakeup signal. Should the operator be instructed to wait for a reply from the program before sending the message, ending of the Prepare command can be used to interrupt the program. The program may then issue the Write command and send a message to inform the terminal operator that he is to wait or proceed. In any case, the Read command must then be issued to receive the message from the terminal.

See Figures 20 through 24 for line-control sequence examples.

PROGRAMMING NOTES: The IBM 2741 does not perform parity or LRC checking of received data. The 2741 sends all characters with correct parity, but does not send either Ⓑ or an LRC character. It uses Ⓒ to end each block (or message).

Refer to SRL Manuals, Form No. A24-3403, IBM 2740 Communications Terminal, and Form No. A24-3415, IBM 2741 Communication Terminal, for the description of operation of these terminals.

- Modes of Operation--Terminal Adapter Type I:

The IBM Terminal Adapter Type I can be set in one of the following mutually exclusive modes:

1. Control Mode. The IBM Terminal Adapter Type I is set in control mode: when it receives or transmits the Ⓒ character or if the 2701 is reset. The adapter is in control mode when polling or addressing .
2. Text-Out Mode. The IBM Terminal Adapter Type I is set in text-out mode when a Ⓓ character is transmitted by the adapter while the line is in control mode or text-in mode. The adapter remains in text-out mode until one of the conditions occurs which sets control mode. (See preceding item 1.)
3. Text-In Mode. The IBM Terminal Adapter Type I is set in text-in mode when a Ⓓ character is received from the communications channel while the line is in control mode. The adapter remains in text-in mode until one of the conditions which sets control mode occurs, or until a Ⓓ is transmitted. This sets text-out mode. (See preceding items 1 and 2.)

- Timeouts in IBM Terminal Adapter Type I Operations:

Immediately following the issuance of the Read command when the IBM Terminal Adapter Type I is in control mode, the normal 23-second line timeout is pre-empted by a 2.5-second short timeout. Once the first character is received, the timeout period between characters is 23 seconds while executing the Read command.

- Status Byte--IBM Terminal Adapter Type I:

An ending status byte is sent from the 2701 to the I/O channel at the termination of command execution. The following status conditions may be signaled by use of IBM Terminal Adapter Type I:

Channel End and Device End

This CE, DE status indicates that the current command has been ended normally. No conditions have occurred that would require a program interrupt and the 2701 couple is free to accept another command. This CE, DE status has one of the indicated meanings for the following commands:

Write and Diagnostic Write

a. A Ⓑ character and the LRC character have been transmitted, indicating a complete block of data has been transmitted to the terminal.
b. Interface Stop has been signaled by the I/O channel and all characters received from main storage have been transmitted. No error or unusual condition has been detected.
c. A Halt I/O instruction has been issued; the command ends normally as soon as the stored character (if any) and the LRC character are sent after Ⓑ.

PROGRAMMING NOTE: For write-type operations under the control of the IBM TA-1 the Ⓑ line control characters used for End of Block control must be the lower case Ⓑ (Hex 3D).

Read, Inhibit, and Diagnostic Read

a. The LRC character following a Ⓑ character has been received by the IBM Terminal Adapter Type I (TA-I) and no errors were detected.
b. A Ⓨ character is received while the IBM TA-I is in control mode, indicating the terminal is ready to receive data.
c. A Ⓨ character is received while the IBM TA-I is in text-out mode, indicating the terminal has detected no error in the last block of data received and is ready to receive the next block.

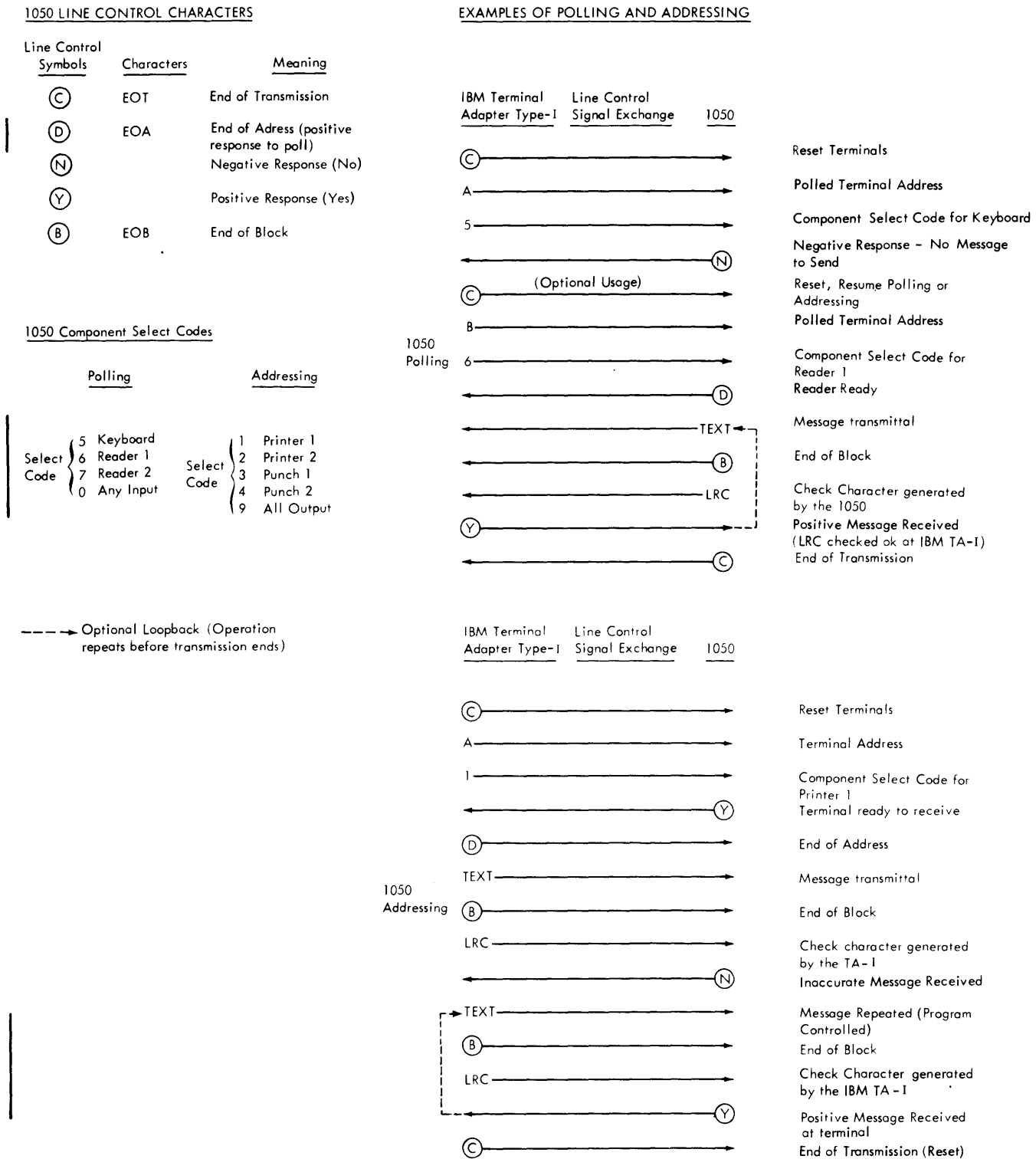


Figure 20. Line Control Sequences--IBM Terminal Adapter Type I with IBM 1050

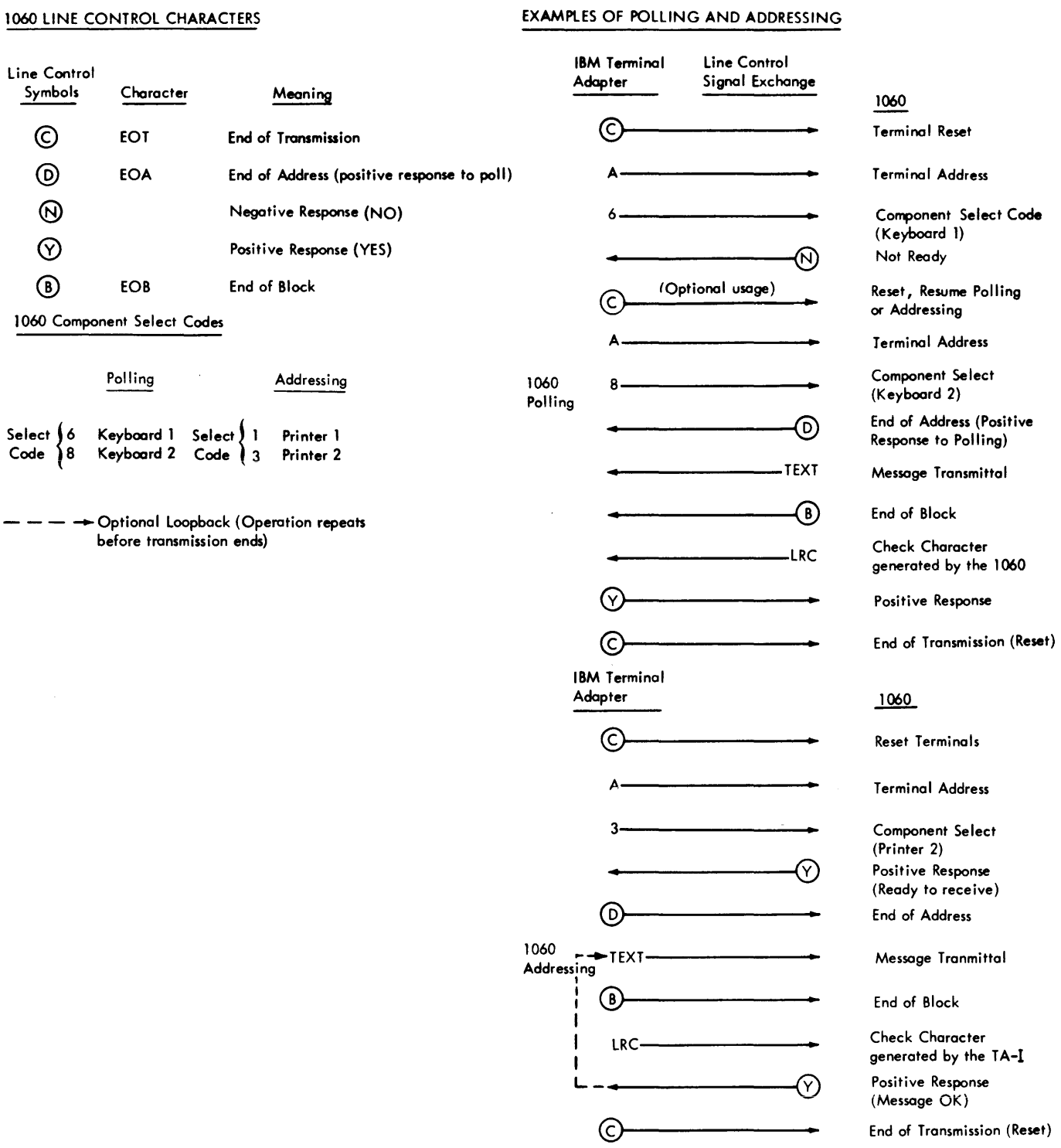


Figure 21. Line Control Sequences--IBM Terminal Adapter Type I with IBM 1060

1070 LINE CONTROL CHARACTERS

Line Control Symbol	Character	Meaning
(C)	EOT	End of Transmission
(D)	EOA	End of Address
(B)	EOB	End of Block
(Y)		Positive Response (Yes)
(N)		Negative Response (No)
(T)		Text Mode Control
(A)		Address Mode Control

1070 Operation Code

0 Conditional Polling--start input scanning at address 000 if Process Alert Indicator is on.
5 Unconditional Polling--start input scanning at address 000.
6 Conditional Polling--start input scanning at the current address if the Process Alert Indicator is on.
7 Unconditional Polling--start input scanning at the current address.
9 Prepare to receive.

EXAMPLES OF POLLING AND ADDRESSING

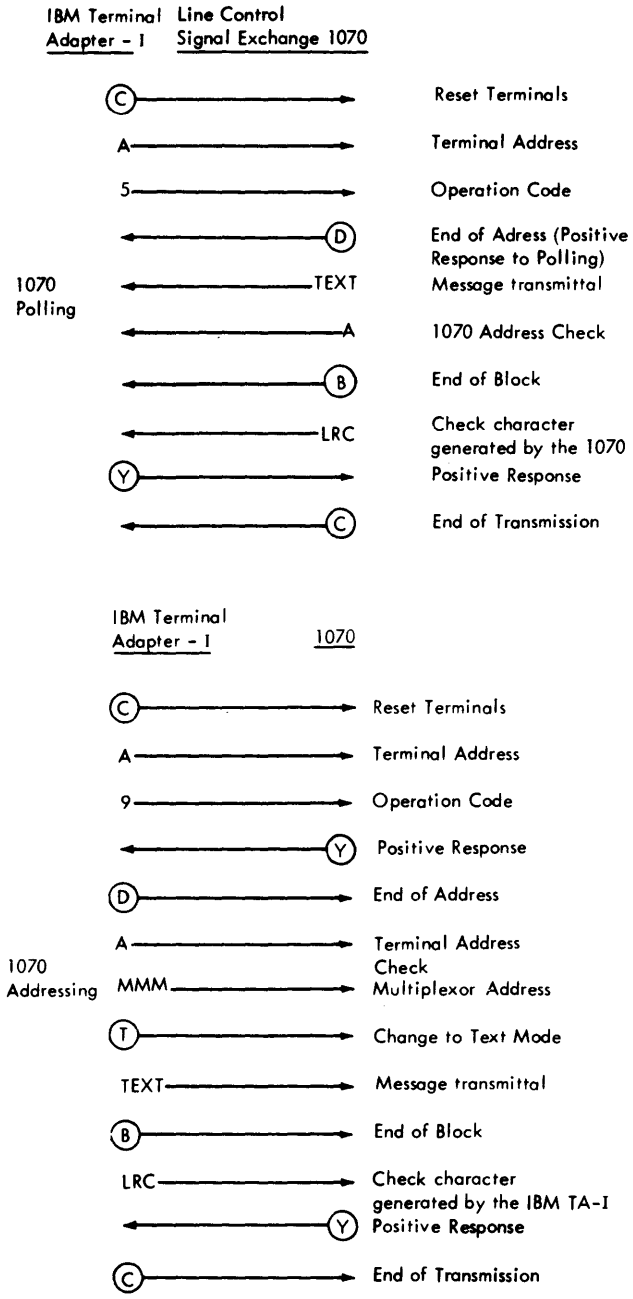
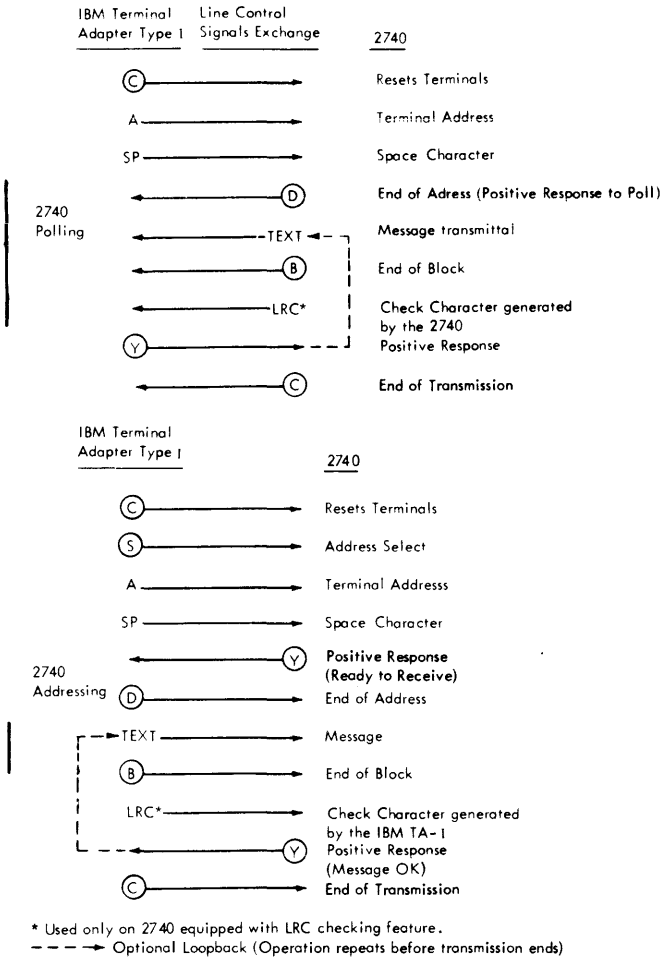


Figure 22. Line Control Sequences--IBM Terminal Adapter Type I with IBM 1070

2740 LINE CONTROL CHARACTERS

Line Control Symbols	Characters	Meaning
C	EOT	End of Transmission
D	EOA	End of Address (Positive response to poll)
S	SOA	Start of Address (used only in addressing).
Y		Positive Response to address (Yes)
N		Negative Response - poll or address (No)
B	EOB	End of Block

EXAMPLES OF POLLING AND ADDRESSING



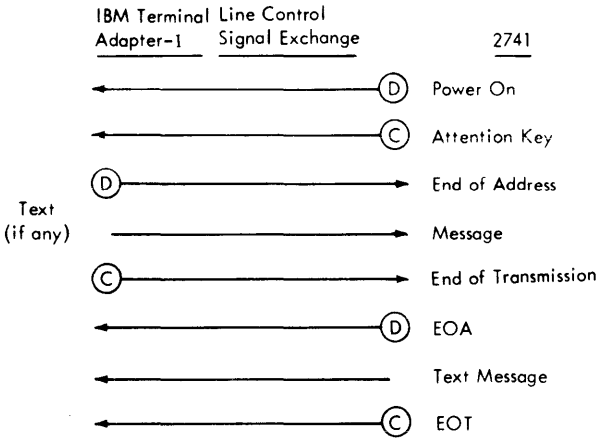
* Used only on 2740 equipped with LRC checking feature.
- - - → Optional Loopback (Operation repeats before transmission ends)

Figure 23. Line Control Sequences--IBM Terminal Adapter Type I with IBM 2740 (with Station Control Feature)

2741 Line Control Characters

Line Control Symbol	Character	Meaning
C	EOT	End of Transmission
D	EOA	End of Address

Examples of Operating Sequence, Transmit or Receive



This sequence must be followed for transmit or receive

Figure 24. Line Control Sequences--IBM Terminal Adapter Type I with IBM 2741, and IBM 2740 Model I (without Station Control Feature)

d. Halt I/O has been issued and the line has not started to receive.

Enable

a. On a private line, this CE, DE status indicates that the line has been successfully "enabled" (conditioned).
b. On a switched network, the line has been enabled and the connection to the terminal has been established--i.e., the incoming call from the terminal has been answered.

Disable

a. On a leased private line, the line has been successfully "disabled" (deconditioned).
b. On a switched network, the line has been disabled and disconnected from the terminal.

Prepare

a. The addressed line has received one character and the communications channel returned to Mark at stop-bit time of the character.
b. The addressed line has received one character but the communications channel did not return to Mark at stop-bit time of the character; however, the communications channel did return to Mark within 23 seconds after stop-bit time.

Dial

The call has been answered and the switched connection is established with the remote terminal.

Channel End, Device End, and Unit Exception

The conditions that cause this status to be signaled depend on the type of communications channel and the command that was issued. This CE, DE, UE status is signaled for the following reasons:

Read, Inhibit, and Diagnostic Read

a. A (C) has been received.
b. A (N) has been received while the communications channel is in control mode, indicating that the terminal was not ready to transmit.

Write

This CE, DE, UE status indiactes that the command was immediately ended because it was issued to a communications channel that was receiving data or had received data since ending the previous read-type, write-type, or Disable command and before the Write command was issued.

Enable

On a switched network, this CE, DE, UE status indicates that a command was successfully aborted by a Halt I/O because the data set was on-hook when the Halt I/O was issued. The line is left in the same state as though the Disable command had been issued.

This CE, DE, UE status is not signaled for leased Private-line operation.

Prepare

This CE, DE, UE status indicates that the command was successfully aborted by a Halt I/O and the line has not started to receive.

Dial

This CE, DE, UE status indicates that the command was successfully aborted by a Halt I/O before the entire number was dialed. The line remains in the same condition as though the Disable command had been issued.

Diagnostic Write

This CE, DE, UE status can occur only when the line is enabled. It indicates that the command was ended because it was issued to a line that was receiving data or had received data since ending the previous read-type, write-type, or Disable command and before the Diagnostic Write command was issued.

This CE, DE, UE status is never signaled for the Disable command.

PROGRAMMING NOTE: The Unit Exception status bit is never set without accompanying Channel End and Device End.

Channel End, Device End, and Unit Check

The command has been ended with an error or other unusual condition being encountered. The Sense command must be issued to the addressed line to further define these conditions.

Note that Unit Check status can be set alone (without Channel End and Device End) when the Data Check sense bit is set during command execution. Channel End and Device End are always set at the termination of the command.

Channel End, Device End, Unit Check and Unit Exception

The conditions that cause the CE, DE, UC, UE status to be signaled to the channel are a combination of the conditions that would cause the command to end with Channel End, Device End, and Unit Exception status, plus one or more error conditions that cause sense bits to be set. A Sense command must be issued in order to determine the error conditions. This CE, DE, UC, UE status is never signaled when ending the Disable command.

- Sense Byte--IBM Terminal Adapter Type I

The sense bits that are set by the associated transmission interface converter have previously been covered. Those set by the IBM Terminal Adapter Type I, and transferred to main storage in the sense byte, are defined below:

Intervention Required (Bit 1)

The command is ended when the Intervention Required bit is set. Intervention Required is set during execution of the following commands:

Read, Inhibit, and Prepare

These commands set Intervention Required when:

a. Data carrier detected is not up before timeout completes.
b. The connection with the remote data set is broken after the IBM TA Type 1 has started to receive.

Read, Inhibit, Prepare, and Write

These commands set Intervention Required when:

a. The line has not been enabled (only if E.C. 309072 is installed).
b. The line has been enabled, and the data set is not ready.

Dial

The Dial command sets sense bit 1 when this command is issued but the Automatic Calling Unit (ACU) interface is not operational (Power Indicator is off).

Read, Inhibit, and Diagnostic Read

These commands set sense bit 1 when a continuous Space signal is received for the period of at least one character time.

Note that during execution of the Diagnostic Read command, a continuous Space signal is generated after the diagnostic register has been read and the line is enabled.

Intervention Required is never set under the Diagnostic Write, Enable, or Disable commands.

Equipment Check (Bit 3)

This bit is set if (1) the IBM Terminal Adapter Type I fails to become enabled when the Enable Command is issued, or (2) the adapter fails to become disabled when the Disable command is issued.

Data Check (Bit 4)

This bit is set during the execution of the Read, Diagnostic Read, and Inhibit commands if:

a. The line is in text-out mode and a Ⓝ is received. In this case, Data Check indicates that the remote terminal detected a VRC, LRC, or other error in the last block of data received by the terminal.
b. The line is at space level at stop bit time for a received character (stop-bit error).
c. A received character (not including the LRC character) contains a VRC error.
d. An LRC error is detected while the line is in text-in mode.

Data Check is set when the line is executing Write or Diagnostic Write and a VRC error is detected in one of the characters being transmitted.

The Data Check sense bit is not set during the execution of the Dial, Prepare, Enable, or Disable command.

Overrun (Bit 5)

This bit is set under the Read, Inhibit, and Diagnostic Read commands during a receive operation when a byte of data is lost. Overrun occurs if the channel has not taken a byte of data from a 2701 communications line by the time that line receives the last bit of the next byte.

Overrun can be set only while executing a Read, Inhibit, or Diagnostic Read command.

Lost Data (Bit 6)

This bit is set when at least one received character is lost for reasons other than overrun. Lost Data is set during the execution of Read, Inhibit, or Diagnostic Read when:

a. At least one complete character has already been received at the time the command is issued (unless that character had been the first character received under the Prepare command).
b. Interface Stop is signaled by the I/O channel.
c. Halt I/O is received after at least one character has been received and before an ending status is set.
d. A line that is equipped with the Auto Call feature is commanded to Dial, but the line is already off-hook.

The Lost Data sense bit is not set while executing any command other than Dial, Read, Inhibit, or Diagnostic Read.

Timeout (Bit 7)

This sense bit is set for the following commands:

Read and Diagnostic Read

1. When the line is in other than control mode and no character is received for a period of 23 seconds after the command is accepted or after a character is received during command execution.
2. When the line is in control mode and the first character is not received within 2.5 seconds after the command is accepted.

Prepare

When a continuous Space signal is received for a period exceeding 23 seconds.

Disable

If a switched-network data set does not go on-hook within 23 seconds after being signaled to do so.

Enable

When on a switch network, Data Carrier Detected signal is not received within 23 seconds of the reset of the Data Set Ready signal.

Dial

When the ACU signals Abandon Call and Retry (ACR) because it has not received an indication that the call has been properly answered within a reasonable time (as determined by an adjustable setting on the ACU).

Timeout is not set during the execution of the Write, Inhibit, Diagnostic Write, or Enable command on a private line.

- Special Requirements:

The following message restrictions must be considered when programming the IBM Terminal Adapter Type I.

1. 1070 Printer Operation at 600 bps

The IBM 1070 Process Communications System uses the IBM 1053 Printer when operating via the 600 bps IBM Model 2 Terminal Control Unit. The 1053 Printer can operate at a speed no greater than 15 characters per second, while the rate of the transmission line is 600 bps or a comparable character rate of 66.6 cps. Because of this rate differential, a four-character time delay must be provided by the program between each character to be printed. This results in a printing speed of 13.3 characters per second. The four-character delay is effected under the Write command by utilizing four pad characters (DF in hexadecimal representation) inserted between each character to be printed. Delays must also be effected in this manner to allow for carriage return, line feed, tabs, etc. It is the program's responsibility to insert these special pad characters.

All data characters (excluding the pad character) sent to the 1070 under the Write com-

mand must be in lower case to prevent generation of shift characters. The 1053 Printer does not use a shifted character set.

2. Operation with 1050 System Line-Correction Feature

Care must be exerised in programming the 1050 Terminal when the Line Correction feature has been installed. Timeouts may occur at the IBM TA-I while rereading or repunching operations are being performed, as controlled by this special feature.

When transmission of text is being made to the IBM 1055, the block length should be no more than 156 characters; otherwise, an LRC check will cause the tape to backspace to the beginning of the block and then punch delete characters for the entire block in error. The (N) response (answerback) from the 1050, in this case, is given to the IBM TA-I when this delete operation has occurred. For a block of more than 156 characters, the 1050 may take more than 23 seconds to respond to the Read command given by the processor to accept the answerback from the IBM 1055. Thus, the 2701 will end the Read command prematurely with Channel End, Device End, and Unit Check and with Timeout set in the sense byte.

In IBM 1054 Paper Tape Reader operation, the same problem exists in waiting for the 1054 to return to the beginning of a block for a reread operation. In this case, the maximum block length is 312 characters. Over this length a timeout is possible before the reread begins.

- Timing Considerations for IBM Terminal Adapter Type I Operation:

The timings summarized in Figure 25 must be taken into consideration by the program to operate the 2701 with IBM Terminal Adapter Type I in the most efficient manner. The following are definitions for the operations listed in Figure 25.

Begin Write. Time that accrues between Write command acceptance and transmission of the first character.

Begin Read. Time that accures between Read command acceptance and IBM TA-I's readiness to receive.

Overrun Read. This timing indicates the average time for the I/O channel to accept one byte of data from the 2701 after data service has been requested by the 2701 to avoid an overrun condition.

Service Write. This timing indicates the maximum permissible time for the I/O channel to transfer one byte to the 2701 after data service has been requested by the 2701, without reducing the speed on the communications channel during a write operation.

Stop Write. This timing indicates the maximum delay within the 2701 that may accrue from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the IBM Terminal Adapter Type I during a write operation.

Stop Read. This timing indicates the maximum delay within the adapter that will accrue from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the adapter during a read operation.

Halt I/O Write. The maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status can be presented by the adapter during a write operation.

Halt I/O Read. The maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status can be presented by the adapter during a read operation.

- Diagnostic Provisions

A character generator is included in the IBM Terminal Adapter Type I which simulates the reception of the (B) character while executing Diagnostic Read. Reception of this character is simulated once the diagnostic register has been read and the line is not enabled. Otherwise an all-Space character is generated. See Figure 26.

Operation	Timing (ms)	
	134.5 bps	600 bps
Begin Write Begin Read	68 immediate	15 immediate
Overrun Read Service Write Stop Write	10 9 5	2 2 1
Stop Read	As soon as line returns to Mark for a character time. 68 minimum	15 minimum
Halt I/O Write Halt I/O Read	139 immediate	32 immediate

Figure 25. Timing of Operations for IBM Terminal Adapter Type I

Adapter Mode	Diagnostic Register	Diag Read Command Ended?	Sense	Status	EOB Character Generated Prior to Ending?
Control	Ⓒ or Ⓝ	Yes	———	CE, DE, UE	No
Control	Ⓨ	Yes	———	CE, DE	No
Control	Valid Character other than Ⓝ or Ⓨ	Yes	———	CE, DE	Yes
Text	LRC	Yes	Data Check	CE, DE, UC	Yes
Text	Ⓓ	Yes	———	CE, DE	Yes
Text	Ⓑ	Yes	———	CE, DE	No
Text	Ⓒ	Yes	———	CE, DE, UE	No
Text	Ⓨ	Yes	———	CE, DE	No
Text	Ⓝ	Yes	Data Check	CE, DE, UC	No

Figure 26. Diagnostic Operations for IBM Terminal Adapter Type I

- Class of Adapter:

  Asynchronous Start/Stop

- Terminal Equipment Serviced:

  IBM 1030 Data Collection System

- Associated Publications:

  IBM 1030 Data Collection System--Form A24-3018

- Adapter Physical-Size Classification:

  Category I

- Type of Operation (Transmission):

  Point-to-Point and Multipoint

- IBM Terminal Adapter Type II Features:

  Communications-Line Interface Types

  EIA RS-232-A

  For further information see IBM 2701 Data Adapter Unit--Original Equipment Manufacturers' Information (GA22-6844).

  IBM Line Adapter

  An IBM Line Adapter may be used in place of an external data set in accordance with Planning and Installation of a Data Communications System Using IBM Line Adapters, GA24-3435-2 (or subsequent revision).

- Communication Services Required:

  For communication services required, consult your local IBM representative.

- Commands Used with IBM Terminal Adapter Type II:

Command	Command Code in Hexa-decimal	Flag Bits Bit Positions 32 CD	33 CC	34 SLI	35 SKIP	36 PCI
Read	02	O	O	O	O	O
Write	01	O	O	O	X	O
Inhibit	0A	O	O	O	O	O
Prepare	06	NA	O	NA	NA	NR
Enable	27	NA	O	NA	X	NR
Disable	2F	NA	O	NA	X	NR
Diagnostic Read	12	O	O	O	O	O
Diagnostic Write	05	O	O	O	X	O

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with an incorrect length indication will occur.

Legend

O = Optional Usage
NA = Not applicable to command
NR = Not recommended
X = Not used.

The following XIC commands can be used in IBM Terminal Adapter Type-II operation. They are decoded and operated upon in the coupled XIC.

Sense	04
I/O NO OP	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

See generalized Start/Stop section for command description.

- Transmission Codes Employed: BCD

Character Set. The BCD transmission code is used between the 2701 equipped with the IBM Terminal

Adapter Type II and the attached IBM 1030 System. The relationship between the 2701 and main storage is illustrated in Figure 27. One start bit and two stop bits are automatically added to a character when the IBM TA-II is transmitting to the terminal. One start and one stop bit are detected with each received character and these are deleted by the IBM TA-II before the character is transferred to main storage.

The B bit is the first transmitted and received on the communications line following the start bit. The C bit in the character is added to maintain odd parity.

Each received and transmitted character is checked for odd vertical parity. VRC errors cause Data Check to be set in the sense register but do not cause termination of the current command. Unit Check is also set in the status register.

- Transmission-Code Error Detection Employed:

  Vertical Redundancy Checking—VRC

- Line-Control and Functional Characters Recognized by IBM TA-II:

  Line-Control Character-Recognition Summary:

  Transmit Operations

  The following characters are recognized in the IBM Terminal Adapter Type II during transmit operations:

  Ⓒ--End of Transmission (EOT). Indicates the end of transmission and places the IBM TA-II in control mode. It is normally followed by a polling character or addressing character.

  Ⓓ--End of Address (EOA). Indicates the end of address (start of text) and sets text-out mode.

  Receive Operations

  The following characters are recognized by the IBM TA-II during receive operations:

  Ⓑ --End of Block (EOB). Indicates the end of a block of text. If a VRC error is detected in the block of data, the Channel End, Device End, and Unit Check status is set and the Data Check bit is set in the sense byte. Normally only the Channel End and Device End status is set.

  Ⓓ--End of Address (EOA). Indicates that the following characters will be text and sets text-in mode. Ⓓ is recognized only if the line is in control mode. Otherwise it has no control effect and is treated as a normal data character.

  Ⓝ Received as a Negative Response to Polling. Indicates that the addressed terminal is not ready to receive data. Channel End, Device End, and Unit Exception status is set. A Ⓝ in reply to text (IBM TA-II is in text-out mode) indicates a text error and sets Channel End, Device End, and Unit Check status together with Data Check in the sense byte. If Ⓝ is received in text (IBM TA-II in text-in mode), it is treated as normal data character and has no control effect.

  Ⓨ Received as a Positive Response to Addressing. Indicates that the addressed terminal is ready to receive data. Ⓨ received following text (IBM TA-II in text-out mode) indicates the text was received without error. In either case, the command ends with Channel End and Device End status. If Ⓨ is received while the IBM TA-II is in text-in mode, it is treated as a normal data character and has no control effect.

  Functional-Character Recognition

  Delete Characters (BA8421C) are removed from the incoming data stream and their transfer to the I/O channel is inhibited by the IBM TA-II. Idle characters (B8421) are removed from the incoming data stream and their transfer to the I/O channel is inhibited by the IBM TA-II.

- IBM Terminal Adapter Type II Modes of Operation:

  The IBM Terminal Adapter Type II can be set in one of the following modes.

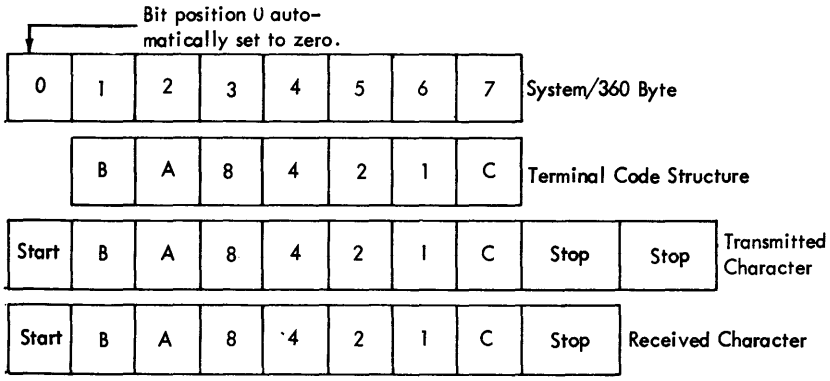
  Control Mode

  The IBM TA-II is set in control mode when it transmits the Ⓒ character. Also, the adapter is in control mode when polling or addressing.

  Text-Out Mode

  The IBM TA-II is set in text-out mode when a Ⓓ character is transmitted. The IBM TA-II remains in text-out mode during ensuing read-type operations. Text-out mode is reset only when a Ⓒ is transmitted or received or an I/O reset is given.

Byte Positions 4,5,6,7 (4,2,1,C)		S/360 Main Storage Byte Positions 0, 1, 2, 3 (Ø,B, A,8)							
		0000	0001	0010	0011	0100	0101	0110	0111
	HEX	0	1	2	3	4	5	6	7
0000	0		8	@ 0 See Note		(N) -			H
0001	1	Space			Y		Q		
0010	2	1			Z		R	A	
0011	3		9	/		J			I
0100	4	2						B	
0101	5		0 See Note	S		K			
0110	6		(D) EOA	T		L			(Y) E of C
0111	7	3			, (S)		$	C	
1000	8	4						D	
1001	9			U		M			
1010	A			V		N			H. Tab
1011	B	5			LF		LF/CR	E	
1100	C			W		O			
1101	D	6			(B) EOB			F	
1110	E	7						G	
1111	F		(C) EOT	X		P			EOC Delete



On receive operations, start-stop bits are deleted by 2701.
On transmit operations, start-stop bits are added by 2701.

Notes: The 1031 transmits the numeric zeros as an A-bit only.
The 1033 receives the numeric zero as a C-8-2 code and @ as an A-bit only code.
Pad Characters = Hex DF = 11011111_2

	Options	
Hex	S	H
61	&	+
16	#	=
20	@	/

Figure 27. Code Structure for IBM 1030 Data Collection System--System/360 Oriented

Text-In Mode

The IBM TA-II is set in text-in mode when a Ⓓ character is received from the communications line. The adapter remains in text-in mode during read-type operations. Text-in mode is reset when a Ⓒ is transferred from the channel or an I/O reset is given.

Polling and Addressing

Polling of 1031 Input Stations is performed by the Write and Read commands issued by the Start I/O instruction. When polling, a Write command causes the polling character to be transmitted. Command chaining to a Read command is used so that the 2701 and allocated storage are ready to receive incoming data as quickly as possible; otherwise data may be lost.

On sending out the polling characters (provided via the stored program), command chaining to the Read command initiates a timeout. At this point, the IBM TA-II pre-empts the 23-second timeout with a 2.5-second timeout. Interruption of the program occurs if the timeout period ends or if a Ⓝ is received. Command execution is ended with Channel End, Device End, and Unit Check status, and the Timeout bit is set in the sense byte. Channel End, Device End, and Unit Exception status is set if a Ⓝ is received. Ⓝ is used as the negative response to polling. The Read command proceeds normally when the first received character is not a Ⓝ. Normally the Ⓓ character followed by text will be received, as stated above. Ⓓ sets text-in mode.

Addressing is performed by the Write command issued via the Start I/O instruction. The addressing characters, Ⓒ and Ⓢ, plus the terminal address, are provided via the stored program. Command chaining to the Read command should be utilized to receive the response character, Ⓝ or Ⓨ. Ⓝ sets Channel End, Device End, and Unit Exception as in polling. Ⓨ sets Channel End and Device End to terminate the Read command and thus permits command chaining to the Write command to transmit the outgoing message.

See Figure 28 for examples of polling and a addressing of 1030 system components from the IBM Terminal Adapter Type II.

- Timeouts in IBM Terminal Adapter Type II Operations:

  Immediately following the issuance of the Read command, when the IBM TA-II is in control mode, the normal 23-second line timeout is pre-empted by a 2.5-second short timeout. Once the first character is received, the timeout period between characters is 23 seconds during execution of the Read command.

- Status Byte--IBM Terminal Adapter Type II:

  An ending status byte is sent from the 2701 to the I/O channel at the termination of command execution. The status conditions that may be signaled by the IBM TA-II, by command, together with meaning are:

  Channel End and Device End

  This status indicates that the current command has been ended normally. No conditions have occurred which would require a program interrupt and the 2701 is free to accept another command. This CE, DE status has the following meaning for each command:

  Write and Diagnostic Write

  a. A Halt I/O instruction has been issued; the command ends normally after the stored character (if any) is transmitted.
  b. An Interface Stop signal has been issued by the I/O channel and no error or unusual condition has been detected.
  c. The Ⓑ character has been transmitted, indicating a complete block of data has been sent.

  Read, Inhibit, and Diagnostic Read

  a. Halt I/O has been issued, there is no character in the data register, and no error or unusual condition has been detected.
  b. A Ⓑ character has been received, and the Ⓑ has been transferred to the channel and no error or unusual condition has been detected.
  c. A Ⓨ was received while the IBM TA-II was in control or text-out mode.

  Enable

  This CE, DE status indicates that the line has been successfully enabled.

  Disable

  The line has been successfully disabled.

1030 LINE CONTROL CHARACTERS

Line Control Symbol	Character	Meaning
C	EOT	End of Transmission
S	SOA	Start of Address (Address Select)
D	EOA	End of Address (positive response to poll)
N		Negative Response (No)
Y		Positive Response (Yes)
B	EOB	End of Block

EXAMPLES OF POLLING AND ADDRESSING

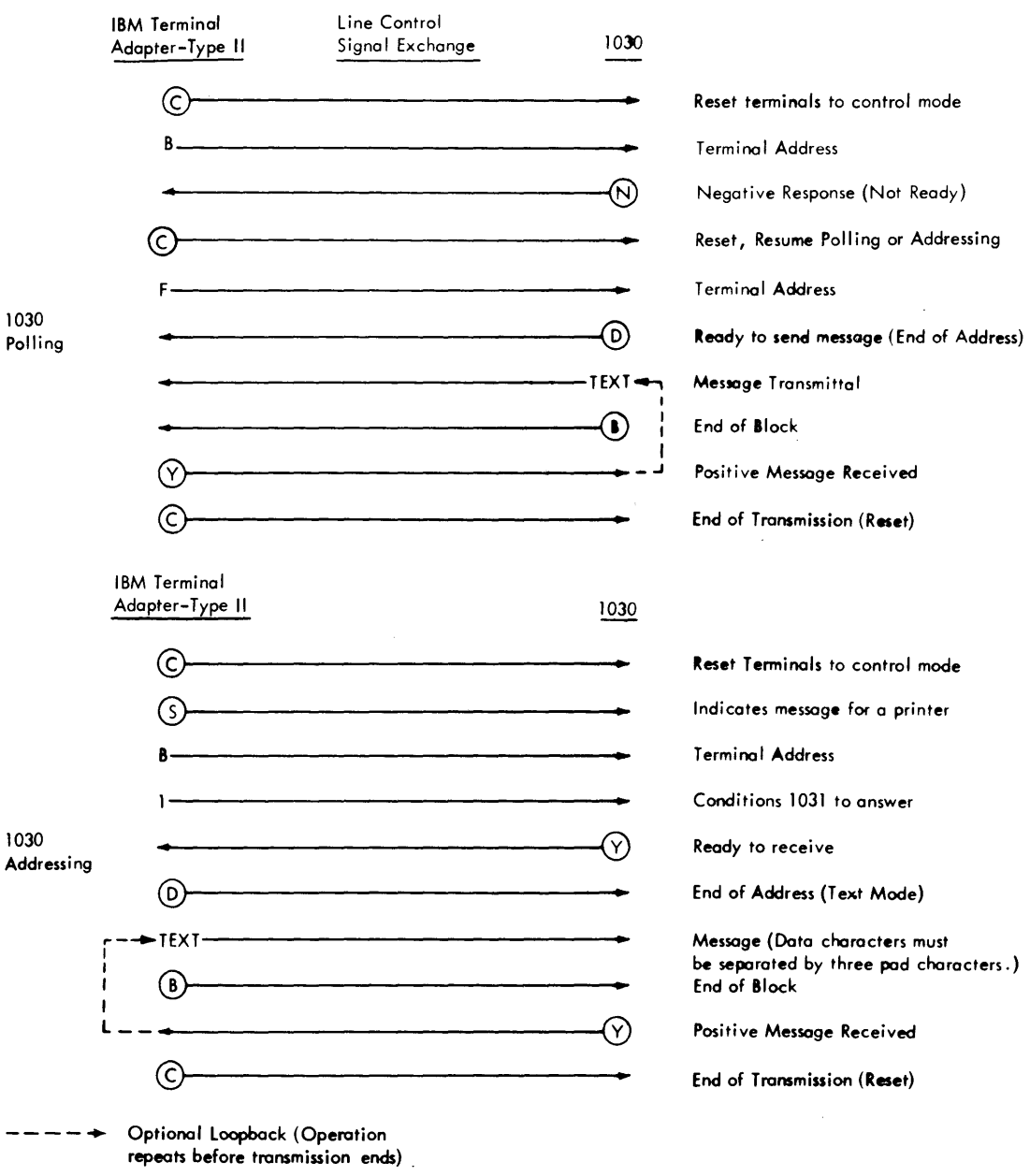


Figure 28. IBM Terminal Adapter Type II and IBM 1030 Line Control Sequences

Prepare

The addressed line has received one character and the communications channel returned to Mark within 23 seconds of Stop-bit time.

Channel End, Device End, and Unit Exception

The conditions that cause this CE, DE, UE status to be signaled depend on the type of communications line and the command that was issued. This status is signaled for the following reasons:

Read, Inhibit, and Diagnostic Read

A (N) was received while the communications channel was in control mode and no error or unusual conditions have been detected.

Write

This CE, DE, UE status indicates that the Write command was ended immediately because it was issued to a line that was receiving data.

PROGRAMMING NOTE: The foregoing statement does not imply that a read-type command was issued. Once the line is enabled, data can be received by the IBM TA-II even though a read-type command has not been issued to the line. Obviously any data received this way will be lost. Under this condition, Disable followed by Enable should be issued to reset the data register.

Enable and Disable

The CE, DE, UE status is not signaled for the Enable or Disable command.

Prepare

This CE, DE, UE status indicates that the command was successfully aborted by a Halt I/O and the line never went to Space long enough to be considered a true start bit.

Diagnostic Write

This CE, DE, UE status will be signaled if the line has been enabled and a true start bit was detected or at least one character was already stored in the data register at the time the command was issued. This indicates that the line was receiving data when the command was issued. See previous "Programming Note" under "Write."

PROGRAMMING NOTE: The Unit Exception status bit is never set without accompanying Channel End and Device End status.

Channel End, Device End, and Unit Check

The command has been ended by error or unusual conditions. The Sense command must be issued to the addressed line to further define these conditions. The command ends immediately with this CE, DE, UC status if any of the following sense bits are set: Intervention Required, Equipment Check, Lost Data, Timeout, Data Check, or Overrun. Note that Unit Check status can be set alone (without Channel End and Device End) when the Data Check Sense bit is set during command execution.

Channel End, Device End, Unit Check and Unit Exception

The conditions that cause the CE, DE, UC, UE status to be signaled to the channel are a combination of the conditions that would cause the command to end with Channel End, Device End, and Unit Exception status, plus one or more error conditions that cause sense bits to be set. A Sense command must be issued in order to determine the error conditions. The CE, DE, UC, UE status is never signaled when ending the Enable or Disable command.

- Sense Byte--IBM Terminal Adapter Type II:

The sense bits that are set by the IBM TA-II operations are defined in the following.

Intervention Required (Bit 1)

This bit is set during execution of the following commands:

Read, Inhibit, Prepare, and Write

Set on a line using a data-set line adapter when one of the following conditions occurs:

1. The data set has power off or is not attached to the IBM TA-II.
2. The data set is not in data mode.

Read and Prepare

Set when connection with the remote data set is not established before a timeout (either 2.5 or 23 seconds as applicable) occurs.

Read, Inhibit, and Prepare

Bit 1 is set if connection with the remote data set is broken after the IBM TA-II has started to receive.

Read, Inhibit, and Diagnostic Read

Bit 1 is set if a continuous Space signal is received for more than the period of one character time. Note that during execution of the Diagnostic Read command, a continuous Space signal is generated after the diagnostic register has been read, provided the line is enabled. Intervention Required is never set under the Diagnostic Write, Enable, or Disable commands.

Equipment Check (Bit 3)

This sense bit is set when:

a. The line fails to become enabled when the Enable command is issued; or
b. The line fails to become disabled when the Disable command is issued.

Data Check (Bit 4)

This sense bit is set during the execution of the Read, Diagnostic Read, and Inhibit commands when:

a. The line is in text-out mode and a (N) is received. Data Check indicates that the remote terminal detected a VRC error in the last block of data received by the terminal.
b. The line is at Space at stop-bit time of a received character.
c. A VRC error is detected in a received character.

Data Check is set when the line is executing Write or Diagnostic Write and a VRC error is detected in one of the characters being transmitted. Data Check is also set if an Echo Check occurs.

The Data Check sense bit is not set during the execution of the Prepare, Enable, or Disable command.

Overrun (Bit 5)

This sense bit is set under the Read, Inhibit, and Diagnostic Read commands when a byte of data is lost because data service by the communications channel could not be obtained before sampling of the first data bit of the following character.

Overrun should not be set while executing any command other than the Read, Inhibit, or Diagnostic Read.

Lost Data (Bit 6)

This bit is set when at least one received character is lost for reasons other than overrun. It is set during the execution of Read, Inhibit, or Diagnostic Read if:

a. At least one character has already been received at the time the command is issued (unless that character had been the first received under the Prepare command).
b. Interface Stop is signaled by the I/O channel.
c. Halt I/O is received when the IBM TA-II has a character to transfer to the I/O channel.

The Lost Data sense bit is never set while executing any command other than Read, Inhibit, or Diagnostic Read.

Timeout (Bit 7)

This sense bit is set for the following commands:

Read, Search, and Diagnostic Read

1. If no character is received within 23 seconds after the stop bit of the previous character and the line is not in control mode.
2. If the first character is not received within 2.5 seconds following the initial-selection sequence and the line is in control mode.

Prepare

A continuous Space signal is received for a period exceeding 23 seconds. Timeout should not be set during Write, Diagnostic Write, Inhibit, Enable, or Disable commands.

- Special Requirements in IBM Terminal Adapter Type II Operations:

Message Restrictions

The following message restrictions must be considered when programming the IBM Terminal Adapter Type II.

1. IBM 1033 Printer Operation:
   The IBM 1033 Printer operates at 15 cps (characters per second), and the transmission line operates at 600 bps (or comparable rate of 60 cps). A three-character delay time is therefore required between output characters. This is effected by using the Write command with three pad (DF in hexadecimal) characters inserted after every character to be printed. Delays must also be effected in this manner for carriage returns, tabs, line feeds, and so on. It is the program's responsibility to insert these pad characters.
2. Data Set Line Adapter Operation:
   When using a data-set line adapter with the IBM TA-II, the program must provide for a delay of at least 500 milliseconds after the Enable command ends to allow the leased-line data set enough time to turn itself on. This delay prevents issuing any read- or write-type command (other than Diagnostic Read and Diagnostic Write), which would otherwise be ended with Unit Check status and with Intervention Required set in the sense byte, indicating a data-set malfunction.

- Timing Considerations for IBM Terminal Adapter Type II Operation:

Operation	Timing (ms)
Overrun Read	15
Service Write	3.7
Stop Write	2.7
Stop Read	As soon as line returns to mark
Halt I/O Write	16
Halt I/O Read	immediate

Figure 29. Timing of Operations for IBM Terminal Adapter Type II Operating at 600 bps

The timings summarized in Figure 29 must be taken into consideration by the channel (program) to operate the IBM TA-II most efficiently. The terms used in Figure 29 are defined in the following:

Overrun Read

This timing indicates the maximum time for the I/O channel to accept one byte of data from the IBM TA-II after data service has been requested by the IBM TA-II, if an overrun condition is to be avoided.

Service Write

This timing indicates the maximum time for the channel to transfer one byte to the adapter after data service has been requested by the IBM TA-II, if the speed on the communications line during a write operation is not to be reduced.

Stop Write

This timing indicates the maximum delay that may accrue from the time the Interface Stop signal is issued by the channel until the ending status is presented by the IBM TA-II during a write operation.

Stop Read

This timing indicates the maximum delay that may accrue from the time the Interface Stop signal is issued by the channel until the ending status is presented by the IBM TA-II during a read operation.

Halt I/O Write

This timing indicates the maximum delay permissible from the time a Halt I/O is issued by the channel until the ending status is presented by the IBM TA-II during a write operation.

- Diagnostic Provisions

A character generator is included in the terminal adapter in order to simulate the reception of a Ⓑ character. This character is generated once the diagnostic register has been read and the line is not enabled. Otherwise an all-space character is generated.

- Class of Adapter:
  Asynchronous Start/Stop

- Terminal Equipment Serviced:
  World Trade Teleprinters

- Associated Publications:
  IBM 3945 Telegraph Line Terminations--A19-0013
  See Teleprinter Manufacturer for equipment publications.

- Adapter Physical-Size Classification:
  Category I

- Type of Operation (Transmission):
  Point-to-Point only.

- World Trade Telegraph Adapter Features:
  Selective Speeds at 50 bps and at 75 bps.

- World Trade Telegraph Single Current Adapter allows direct attachment to single-current telegraph lines. W.T. Telegraph Adapter allows attachment of single or double current telegraph lines via IBM 3945 Mod 12 (s.c.) or Mod 11 (d.c.) Both World Trade adapters operate the same except for line termination.

- Communications Services Required:

  For communication services required, consult your local IBM representative.

- Commands decoded in World Trade Telegraph Adapter:

Command	Command Code in Hexadecimal	Flag Bits 32 CD	33 CC	34 SLI	35 SKIP	36 PCI
Read	02	O	O	O	O	O
Write	01	O	O	O	X	O
Break	OD	O	O	O	X	O
Search #	OE	O	O	NR	NR	NR
Inhibit	OA	O	O	O	O	O
Prepare	06	NA	O	NA	NA	NR
Enable	27	NA	O	NA	X	NR
Disable	2F	NA	O	NA	X	NR
Diagnostic Read	12	O	O	O	O	O
Diagnostic Write	05	O	O	O	X	O

#--Decoded but not executed by WT Telegraph Adapter

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with incorrect length indication will occur.

Legend
O = Optional use
NA = Not applicable to command.
NR = Not recommended
X = Not used

The following commands can be used in WT Telegraph Adapter operation.

They are decoded in the coupled XIC.

Sense	04
I/O NO OP	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

See general Start/Stop section for command execution and operation.

- Transmission Code Employed:
  International Telegraph Alphabetic 2 (ITA2)

  Character Set: The transmission code used between the 2701 equipped with the World Trade Telegraph Adapter and the W. T. Teleprinters is the shifted ITA2 code. The relationship of the code in System/360 main storage is illustrated in Figure 30. One start bit and 1.5 stop bits are transmitted and received by this adapter.

S represents the character case (shift bit). A 1 identifies upper case; a 0 identifies lower case. The 1 bit is the first bit following the start bit. Shifted-character-set conversion, a standard feature, automatically deletes the LTRS (letters/downshift) and the FIGS (figures/upshift) characters from the received data stream, notes the last shift character (FIGS or LTRS) received, and accordingly inserts the appropriate shift bit in the received code to indicate the character case to the program. On outgoing data, the shift bit is removed and recorded. A change in the shift bit from character to character causes the automatic generation by the adapter of the appropriate shift character (FIGS or LTRS) in the outgoing data stream before sending of the data character that indicated the change.

In addition, "downshift on space" is provided as a selective feature of this adapter. "Downshift on space" means that the Space character causes the line to go to LTRS shift when it is transmitted or received. The WT Telegraph Adapter must be wired for "downshift on space" if, and only if, the attached World Trade Teleprinter has this capability and is so wired.

Space characters are not deleted from the received data stream regardless of whether the "downshift on space" feature is present. However, when a Space character is received and the "downshift on space" is present, the adapter records the LTRS (downshift) case. When the "downshift on space" feature is wired in, no shift character is inserted into the outgoing data stream as the Space character is transferred from main storage. The shift bit of the Space character is ignored.

Programming Notes:

The adapter is automatically set to lower case (LTRS) whenever the 2701 is reset.

The programmer is cautioned when writing shift characters (other than Space) from the stored program to this type of adapter. The adapter does not recognize the FIGS and LTRS characters coming from main storage, so it will not update the shift mode unless the shift bit accompanying the shift character indicates a change in case.

When a change in case is indicated, two identical shift characters will be transmitted, where one is generated by the adapter and the other is from the I/O channel (i.e., main storage).

With this adapter, read-type commands always perform an idle-line timeout for one character time before ending, following recognition of the EOT sequence. This is done to allow the line time to clear any superfluous character sent by the terminal following the EOT. It also prevents initiations of a write-type command, thus preventing sending onto a busy line. This idle-line timeout is not performed if a read-type command is ended by Halt I/O or Interface Stop from the I/O channel. These signals cause the command to end immediately.

The program must make certain that the upper-case characters selected by the customer and used in the EOT and EOB sequences are not inadvertently transmitted from the processor as printing text characters. This would result in an EOT sequence being erroneously transmitted. For example, assume FIGS B, LTRS is selected by the customer for his EOT sequence. If an upper-case B is sent that is followed immediately by a lower-case character, the result will be that FIGS B, LTRS, X (where X is the character following the upper-case B) will be transmitted by the 2701. The LTRS character is automatically generated by the 2701 due to the change in case from upper-case B to lower-case X.

Byte Positions 4,5,6,7 (2,3,4,5)	Hex	S/360 Main Storage Byte Positions 0, 1, 2, 3, (0, 0, S, 1) 0000	0001	0010	0011	0100	0101	0110	0111
		0	1	2	3	4	5	6	7
0000	0		E / E		3 / -				
0001	1	T / T	Z / Z	5	+				
0010	2	CR / CR	D / D	CR / CR	WRU / WRU				
0011	3	O / O	B / B	9 / :	? / 6				
0100	4	SPACE / SPACE	S / S	SPACE / SPACE	' / '				
0101	5	H / H	Y / Y		6 / 5				
0110	6	N / N	F / F	, / ,					
0111	7	M / M	X / X	. / 7	/				
1000	8	LF / LF	A / A	LF / LF	- / +				
1001	9	L / L	W / W	) /)	2 / 3				
1010	A	R / R	J / J	4 / /	BELL / 2				
1011	B	G / G	FIGS / FIGS		FIGS / FIGS				
1100	C	I / I	U / U	8 / BELL	7 / 1				
1101	D	P / P	Q / Q	0 / 9	1				
1110	E	C / C	K / K	: / 8	(/ (				
1111	F	V / V	LTRS / LTRS	= / =	LTRS / LTRS				

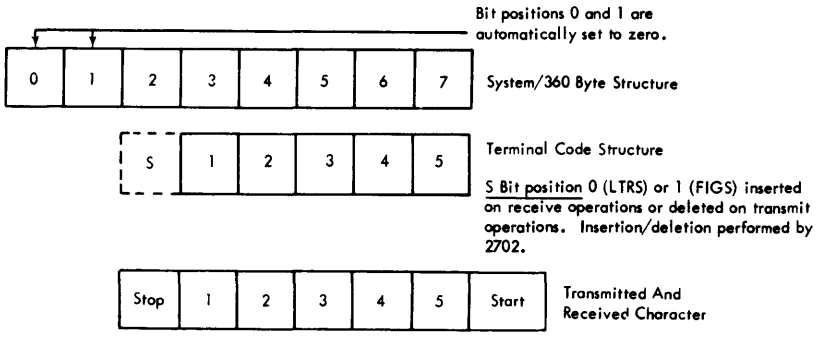
Lettershift Figureshift

Legend

ITA2 / ZSC3 — International Telegraph Alphabetic 2 / Figure Protected Code ZSC3

Not assigned

FIGS=↑-upshift
LTRS=↓-downshift



Note:
This chart is intended primarily for terminal to S/360 code translation considerations. See manufacturers terminal publication for applicable character options.

Figure 30. Code Structures for World Trade Teleprinters--System/360 Oriented

To avoid this situation, the program must scan each character that is to be sent for the presence of printing (or data) upper-case B's that are not part of the EOT sequence. When an upper-case B is found, the program must make certain that the next character is in upper case. If it is a lower-case character, the program must cause another upper-case character or the FIGS character to be sent before sending the lower case character. For example: FIGS B, FIGS, LTRS. The same restrictions apply to the EOB sequence.

There is another possibility if the 2701 is wired for "downshift on space." The program need simply insert the Space character (regardless of the state of the shift bit) after the customer-selected upper-case character. Of course, if the upper-case character is part of the EOT sequence, the program must ensure that a LTRS character is sent immediately following the upper-case character.

- Transmission Code Error Detection Employed: None

- Line Control and Functional Characters used:

Line Control:

Attachment to the World Trade Telegraph Adapter is point-to-point (one terminal per line); thus, the line-control method used in the contention-type rather than the polling-type.

Processor to Terminal. When the processor begins transmission, the program must insert from 4 to 20 LTRS characters before the Start of Message character (Line Feed) to ensure that the terminal is able to receive properly. Should the terminal bid for the line at the same time as the WT Telegraph Adapter, an Echo Check occurs. The Write operation is ended with Channel End, Device End, and Unit Check status. A Read command must be issued to receive the message from the terminal.

Terminal to Processor. The processor normally monitors the inactive communications line by issuing the Prepare command. Timeout is inhibited under this command until the line receives a Space signal. The Prepare command is normally terminated in one of three ways:

1. When a Space signal is detected. Usually, this signal is the start bit of the first of a series of LTRS characters that is sent ahead of a message or as a result of a motor-on operation at the sending terminal. If the line returns to Mark at stop-bit time of the first character, the Prepare command ends with Channel End and Device End. Command chaining to a Read command must be utilized to receive the incoming message.
2. The line does not return to Mark within 23 seconds after the first start bit is received. The Prepare command ends with Channel End, Device End, and Unit Check status and the Timeout bit is set in the sense byte.
3. A Halt I/O instruction is issued by the program. If no true start bit has been detected before the Halt I/O is issued, the command is terminated with Channel End, Device End, and Unit Exception status. If a true start bit has been detected (data has started to arrive) and Halt I/O is issued, the command is ended with Channel End and Device End.

Line-Control Character Recognition:

EOT (End of Transmission)

The format for EOT is FIGS X, LTRS, where X is a character assigned by the customer. This character is assigned on a per-system bases and must be different than the character chosen for the EOB sequence. EOT sets Channel End, Device End, and Unit Exception status when received during a read-type operation. (Its recognition is similar to the EOT sequence of Telegraph Adapter Type I, except the EOT sequence for Type I is fixed at FIGS H, LTRS.)

EOB (End of Block)

The format for EOB is FIGS Y, LTRS, where Y is a character chosen by the customer and assigned on a per-system basis. It must be different than the character chosen for the EOT sequence. Recognition of the EOB sequence during a read-type operation terminates the command with Channel End and Device End.

Functional Character Recognition:

The following characters are recognized during write-type operations.

In LTRS mode, any character with the shift bit set to one causes the adapter to send FIGS character and sets FIGS mode before it is transmitted.

In FIGS mode, any character with the shift bit set to zero causes the adapter to send the LTRS character and sets LTRS mode before it is transmitted.

If wired for the "downshift on space" operation, the Space character sets LTRS mode. In this case, the shift bit accompanying the Space character is ignored.

The following characters are recognized during read-type operations:

The FIGS Y, LTRS sequence, received as EOT, sets Channel End, Device End, and Unit Exception status.

The FIGS-Y, LTRS sequence, received as EOB sets Channel End and Device End status.

LTRS character sets LTRS mode if the adapter is in FIGS mode. If the adapter is already in LTRS mode, this character has no effect. In any case, the adapter inhibits transfer of this character to main storage, removing it from the incoming data stream.

FIGS character sets FIGS mode if the adapter is in LTRS mode; if the adapter is already in FIGS mode, this character has no effect. In any case, the adapter inhibits transfer of this character to the I/O channel, removing it from the incoming data stream.

If the "downshift on space" feature is present, the Space character sets LTRS mode when it is received. The Space character is then transferred to the I/O channel with its shift bit a zero (lower case).

- Timeouts in WT Telegraph Adapter Operation:

Timeout Summary

Both the line timeout immediately following initial selection and before arrival of the start bit of the first character and the line timeout between received characters is 23 seconds in duration. The World Trade Telegraph Adapter does not pre-empt the 23-second timeout with one of shorter duration.

- Status Byte--World Trade Telegraph Adapter:

An ending status byte is sent from the 2701 to the channel at the termination of command execution. The status conditions that may be signaled by the World Trade Telegraph Adapter follow.

Channel End and Device End

This status indicates that the current command has been ended normally. No conditions have occurred that require a program interrupt and the adapter is free to accept another command. This status is signaled for the following reasons:

Write and Diagnostic Write

A Halt I/O instruction has been issued.

An Interface Stop signal is received from the channel.

A Break (Space signal) is detected at stop-bit time of two successive characters.

Read, Inhibit, and Diagnostic Read

Halt I/O has been issued and there is no character in the data register. If an error or unusual condition that does not give an interrupt has been detected, the status byte may also contain Unit Check.

The EOB sequence is received.

Search (if used)

Halt I/O has been issued.

The EOB sequence is received.

Prepare

The addressed line has received one character and the line returned to Mark within 23 seconds of stop-bit time.

Enable

This status indicates that the line was successfully enabled. By using the proper command, data may either be sent or received.

Disable

This status indicates that the line was successfully disabled, and no further data may either be received or sent over the associated telegraph line.

Break

Halt I/O or Interface Stop was received from the I/O channel.

Channel End, Device End, and Unit Exception

The conditions that cause this status to be signaled depend on the type of communications line and the command that was issued. This status is signaled for the following reasons:

Write and Diagnostic Write

The Write command was ended immediately because it was issued to a line that was receiv-

ing data and a legitimate start bit had been detected or at least one character was already stored in the data register at the time the command was issued.

Programming Note: The foregoing statement does not imply that a read-type command was being executed when the Write command was issued. Once the line is enabled, data can be received by the 2701 even though a read-type command has not been issued to the line. Obviously any data received in this way will be lost.

Read, Inhibit, Search, and Diagnostic Read

The EOT sequence is received.

Halt I/O was issued before a character started to arrive.

Prepare

Halt I/O was issued to the line before a legitimate start line was received, that is, before the line started to receive.

Break, Enable, and Disable

The CE, DE, UE status has no meaning for these commands and should not occur.

Programming Note: The Unit Exception status will never be signaled without accompanying Channel End and Device End status.

Channel End, Device End and Unit Check

This status indicates that the command was ended by error or unusual conditions. The Sense command must be issued to further define these conditions. Command ending occurs immediately with this status if any of the following sense bits are set: Data Check, Intervention Required, Equipment Check, Lost Data, or Timeout. Note that Unit Check status can be set alone (without Channel End and Device End) when the Data Check bit is set during command execution; however, the Channel End and Device End will be set at the termination of the command.

The CE, DE, UC status is also set if an Echo Check occurs while executing Write or Break.

Channel End, Device End, Unit Check and Unit Exception

The conditions that cause this status to be signaled to the channel are a combination of the conditions that cause the command to end with Channel End, Device End, and Unit Exception status, plus one or more error conditions that cause sense bits to be set. A Sense command should be issued to the World Trade Telegraph Adapter to determine the error conditions. The CE, DE, UC, UE status is not signaled when using the Disable command.

- Sense Byte--World Trade Telegraph Adapter:

The sense bits that are set by the World Trade Telegraph Adapter follow.

Intervention Required (Bit 1)

This bit is set during execution of the following commands:

Read, Inhibit, Prepare, Break, Search, and Write

Bit is set if the line has not been enabled.

Read, Inhibit, Search, and Diagnostic Read

Bit is set if a continuous Space signal is received for more than one character time.

Intervention Required should not be set during execution of Enable, Disable, or Diagnostic Write.

Equipment Check (Bit 3) is set when:

The line fails to become enabled when commanded to do so; or The line fails to become disabled when commanded to do so.

Data Check (Bit 4) is set for the following commands:

Read, Inhibit, Search, and Diagnostic Read

Bit is set if the line is at Space at stop-bit time of a character (stop-bit error).

Write and Break

Bit is set if an Echo Check occurs. Data Check should not be set during Prepare, Enable, Disable, or Diagnostic Write command execution.

Overrun (Bit 5)

This sense bit is set during Read, Inhibit, and Diagnostic Read commands when a byte of data was lost because data service by the channel

could not be obtained before the first data bit of the following character is sampled. Overrun should not occur when executing any other command than Read, Inhibit, or Diagnostic Read.

Lost Data (Bit 6)

This bit is set when at least one received character is lost for reasons other than overrun. This sense bit is set during the execution of Read, Inhibit, or Diagnostic Read if:

At least one character has already been received at the time the command is issued (unless the character had been the first received under the Prepare command).
Interface Stop is signaled by the I/O channel.
Halt I/O is received when WT Telegraph Adapter has a character to transfer to the I/O channel.

The Lost Data sense bit should not be set when executing any command other than Read, Inhibit, or Diagnostic Read.

Timeout (Bit 7)

This bit is set for the following commands:

Read, Search, and Diagnostic Read

If no character is received within 23 seconds after receipt of the stop bit of the previous character.

If the first character is not received within 23 seconds following the initial-selection sequence.

Prepare

If a continuous Space signal is received for a period exceeding 23 seconds

Disable

If a switched-network data set does not go on-hook within 23 seconds after being signaled to do so.

Timeout should not be set during Write, Diagnostic Write, Inhibit, Enable or Disable command execution.

- Special Requirements--World Trade Telegraph Adapter Operation:

Message Restrictions

Terminal to Processor

1. The characters used for EOB and EOT must not be the same.
2. A Space character received by the adapter will not downshift (FIGS to LTRS) unless the "downshift on space" capability is wired in at installation time.
3. Text that immediately follows the EOT sequence will be lost. This EOT sequence must not be sent between blocks of data.
4. The recognition of V (or M) and AZ as first character(s) will be inhibited during read-type operations. Hence, Search will never end due to receiving V or AZ, nor will Read, Inhibit, or Diagnostic Read end due to receiving V. The Search command suppresses transfer of received data to the I/O channel; the command ends upon recognition of the EOT or EOB sequence. Search is not intended for use in World Trade Telegraph Adapter operation.

Processor to Terminal

1. When transmitted, the characters (CR, LF, Space, and Blank) must be in the same character case as the preceding character.
2. The adapter automatically inserts the proper shift character in outgoing data when a change of character case is encountered.
3. Four to twenty LTRS characters must be transmitted before the Start of Message character (Line Feed).

- Timing Considerations for World Trade Telegraph Adapter:

The timings of various operations must be taken into consideration by the channel (program) to operate the WT Telegraph Adapter in the most efficient manner. The following are definitions of the operations listed in Figure 31.

Overrun Read: This timing indicates the maximum time for the I/O channel to accept one byte of data from the 2701 after data service has been requested by the 2701, if an overrun condition is to be avoided.

Service Write: This timing indicates the maximum time for the I/O channel to transfer one

Operation	Timing (ms)	
	50 bps	75 bps
Overrun Read	139	93
Service Write	45	30
Stop Write	32	22
Stop Read	As soon as the line returns to mark.	
Halt I/O Write	172	115
Halt I/O Read	Immediate	

Figure 31. Timing of Operations for IBM World Trade Telegraph Adapter Operations

byte to the 2701 after data service has been requested by the 2701, if the speed on the communications line during a write operation is not to be reduced.

Stop Write: This timing indicates the maximum delay within the 2701 which may accrue from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the WT Telegraph Adapter during a write operation.

Stop Read: This timing indicates the maximum delay within the 2701 which may accrue from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by WT Telegraph Adapter during a read operation.

Halt I/O Write: This timing indicates the maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status is presented by the WT Telegraph Adapter during a write operation.

Halt I/O Read: This timing indicates the maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status is presented by the WT Telegraph adapter during a read operation.

- Diagnostic Provisions--World Trade Telegraph Adapter:

  Two character generators are provided to simulate reception of Z or LTRS characters. These characters are generated during execution of Diagnostic Read when the diagnostic register is read, provided the line is not enabled. Otherwise a Space character is generated.

  The LTRS character is generated under the Diagnostic Read command if the diagnostic register contains the H character. In all other cases the Z character is generated.

- Class of Adapter

  Asynchronous Start/Stop

- Terminal Equipment Serviced:

  AT&T 83B2 Type Selective Calling Terminals
  AT&T 83B3 Type Selective Calling Terminals
  Western Union Plan 115A Terminals

  All the above at 45.5, 56.9, and 74.2 bits per second.

- Associated Publications:

  See common-carrier representative.

- Adapter Physical-Size Classification:

  Category I

- Type of Operation (Transmission):

  AT&T 83B2: Point-to-point, multipoint
  AT&T 83B3: Point-to-point, multipoint
  WU115A: Point-to-point, multipoint

- Telegraph Adapter Type I Features:

  None

- Communications Services Required:

  For communication services required, consult your local IBM representative.

- Commands decoded in Telegraph Adapter Type I:

Command	Command Code in Hexa-decimal	Flag Bits Bit Positions 31 CD	33 CC	34 SLI	35 SKIP	36 PCI
Read	02	O	O	O	O	O
Write	01	O	O	O	X	O
Break	0D	O	O	O	X	O
Search	0E	O	O	NR	NR	NR
Inhibit	0A	O	O	O	O	O
Prepare	06	NA	O	NA	NA	NR
Enable	27	NA	O	NA	X	NR
Disable Diagnostic	2F	NA	O	NA	X	NR
Read Diagnostic	12	O	O	O	O	O
Write	05	O	O	O	X	O

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI is not set, an I/O interrupt with an incorrect length indication will occur.

Legend

O = Optional Use
NA = Not applicable to command
NR = Not recommended
X = Not used

The following commands can be used in Telegraph Adapter Type I operation. They are decoded in the coupled XIC.

Sense
I/O No Op
Test Input-Output

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

See general Start/Stop section for command execution and operation.

- Transmission Code Employed:

  Baudot

Character Set

The transmission code used between the Telegraph Adapter Type I and the remote terminal is the shifted Baudot code. The relationship of the code in System/360 main storage is illustrated in Figure 32.

This adapter transmits one start bit and two stop bits and checks received characters for one stop bit. S represents the character case--i.e., logical 1 identifies upper case; a logical 0 identifies lower case. The 1 bit is the first bit transmitted following the start bit.

Shifted-character-set conversion (a standard feature) automatically deletes the LTRS (letters/downshift) and the FIGS (figures/upshift characters) from the received data stream, notes the last shift character (FIGS or LTRS) received, and accordingly inserts the appropriate shift bit in the received code to indicate the character case to the program. On outgoing data, the shift bit is removed and recorded. A change in the shift bit from character to character causes the automatic generation by the adapter of the appropriate shift character (FIGS or LTRS) in the outgoing data stream before the sending of the data character that indicated the change.

In addition, "downshift on space" is provided as a selective feature of Telegraph Adapter Type I. "Downshift on space" means that the Space character causes the terminal to go to LTRS shift when it is transmitted or received. The Telegraph Adapter must be wired for "downshift on space" if, and only if, the attached AT&T Selective Calling Terminals Type 83B2/83B3 or Western Union Plan 115A Terminals have this capability. (The "downshift on space" option is not available on terminals using the A Keyboard.) A mixture of telegraph terminals with and without this wiring on the same line is not permitted.

Space characters are not deleted from the received data stream regardless of whether the "downshift on space" feature is present. However, when a Space character is received and the "downshift on space" feature is present, the adapter records the LTRS (downshift) case. Also, when the "downshift on space" feature is wired in, no shift character is inserted into the outgoing data stream as the Space character is transferred from main storage. The shift bit of the Space character is ignored.

PROGRAM NOTES: The Adapter is automatically set to lower case (LTRS) whenever the 2701 is reset.

The programmer is cautioned when writing shift characters (other than Space) from main storage to this adapter. The adapter does not recognize the FIGS and LTRS characters coming from main storage, so it will not update the shift mode unless the shift bit accompanying the shift character indicates a change in case. When a change in case is indicated, two identical shift characters will be transmitted, where one is generated by the adapter and the other is from the I/O channel (i.e., main storage).

- Transmission Code Error Detection Employed:

None

- Line Control and Functional Characters Used:

The following characters are recognized during write-type operations:

1. In LTRS mode, any character with the shift bit set to one (upper case) causes the adapter to send the FIGS character and sets FIGS mode before it is transmitted.
2. In FIGS mode, any character with the shift bit set to zero (lower case) causes the adapter to send the LTRS character and sets LTRS mode, before it is transmitted.
3. If the "downshift on space" feature is present, the space character sets LTRS mode. In this case, the shift bit accompanying the space character is ignored and no LTRS character is inserted into the outgoing data stream.

The following characters are recognized during read-type operations:

1. A V (or M) received as the first non-shift character sets Channel End and Device End status.
2. The FIGS H, LTRS sequence, received as EOT, sets Channel End, Device End, and Unit Exception status.
3. The two-character processor address AZ, if received as the first two non-shift characters of a message under the Search command only, sets Channel End and Device End status.
4. LTRS character (letters or downshift) sets LTRS mode if the adapter is in FIGS mode. If the adapter is currently in LTRS mode, this character has no effect. In any case, the adapter inhibits transfer of this character to the I/O channel, removing it from the incoming data stream.
5. FIGS character (figures or upshift) sets FIGS mode if the adapter is in LTRS mode; if the adapter is already in FIGS mode, this character has no effect. In any case, the adapter inhibits transfer of this character to the I/O channel, removing it from the incoming data stream.
6. If wired for the "downshift on space" operation, the Space character sets LTRS mode when it is received. The Space character is then transferred to the I/O channel with its shift bit a zero (lower case).

Line-control sequences for the Telegraph Adapter Type I with AT&T 83B2 and 83B3 and with Western Union Plan 115A terminals are illustrated in Figure 33.

Byte Positions 4,5,6,7 (2,3,4,5)		S/360 Main Storage Byte Positions 0, 1, 2, 3 (Ø, Ø, S, 1)			
		0000	0001	0010	0011
	HEX	0	1	2	3
0000	0	Blank	E	Blank	3
0001	1	T	Z	5	"
0010	2	CR	D	CR	$
0011	3	O	B	9	5/8
0100	4	Space	S	Space	Bell
0101	5	H	Y	◆	6
0110	6	N	F	7/8	1/4
0111	7	M	X	•	/
1000	8	LF	A	LF	-
1001	9	L	W	3/4	2
1010	A	R	J	4	,
1011	B	G	FIGS↑	&	FIGS↑
1100	C	I	U	8	7
1101	D	P	Q	0	1
1110	E	C	K	1/8	1/2
1111	F	V	LTRS↓	3/8	LTRS↓

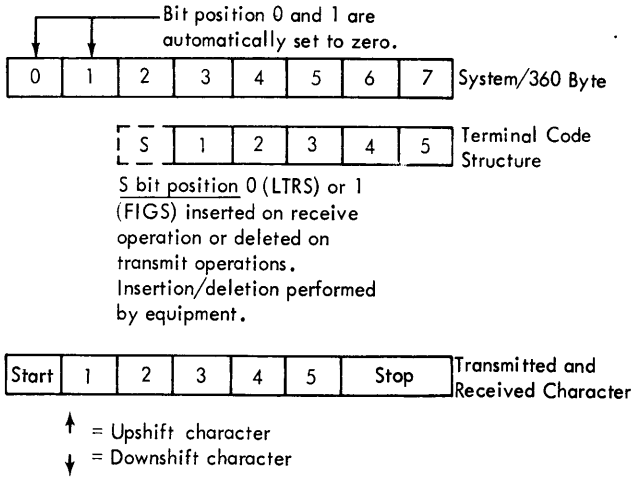


Figure 32. Code Structure for AT&T 83B2/83B3 and Western Union Plan 115A Terminal--System/360 Oriented

Polling and Addressing

Traffic over a telegraph line may occur in two basic ways: (1) terminal-to-processor or processor-to-terminal, and (2) terminal-to-terminal.

Terminal-to-Processor (Polling): The polling sequence is initiated when the program transmits, under a Write command, the end of transmission (EOT) control character sequence. This control sequence consists of a FIGS H, LTRS sequence and alerts all terminals to monitor the line. The program then transmits the polling characters and command chains to a Read command to await the terminal reply. Upon issuance of the Read command, the 2701 initiates a 2.5-second timeout. If the terminal has no message to send, it answers the polling characters with a V (or M) character. This is the negative response to polling and causes the 2701 to transfer the V or M to the I/O channel. The Read command is ended with Channel End and Device End status. If the 2.5-second timeout period ends before the terminal replies, Channel End, Device End, and Unit Check are set in the status byte and Timeout is set in the sense byte.

If the terminal has a message to send, the terminal replies to the polling characters by sending the message. In this case, the Read command ends following the transmission of the terminal's message and, upon receipt of the EOT sequence, Channel End, Device End, and Unit Exception status is set.

The EOT sequence is FIGS H, LTRS. FIGS H is the H character received while the adapter is in FIGS mode. The LTRS character must immediately follow the FIGS H character if the sequence is to be recognized as an EOT.

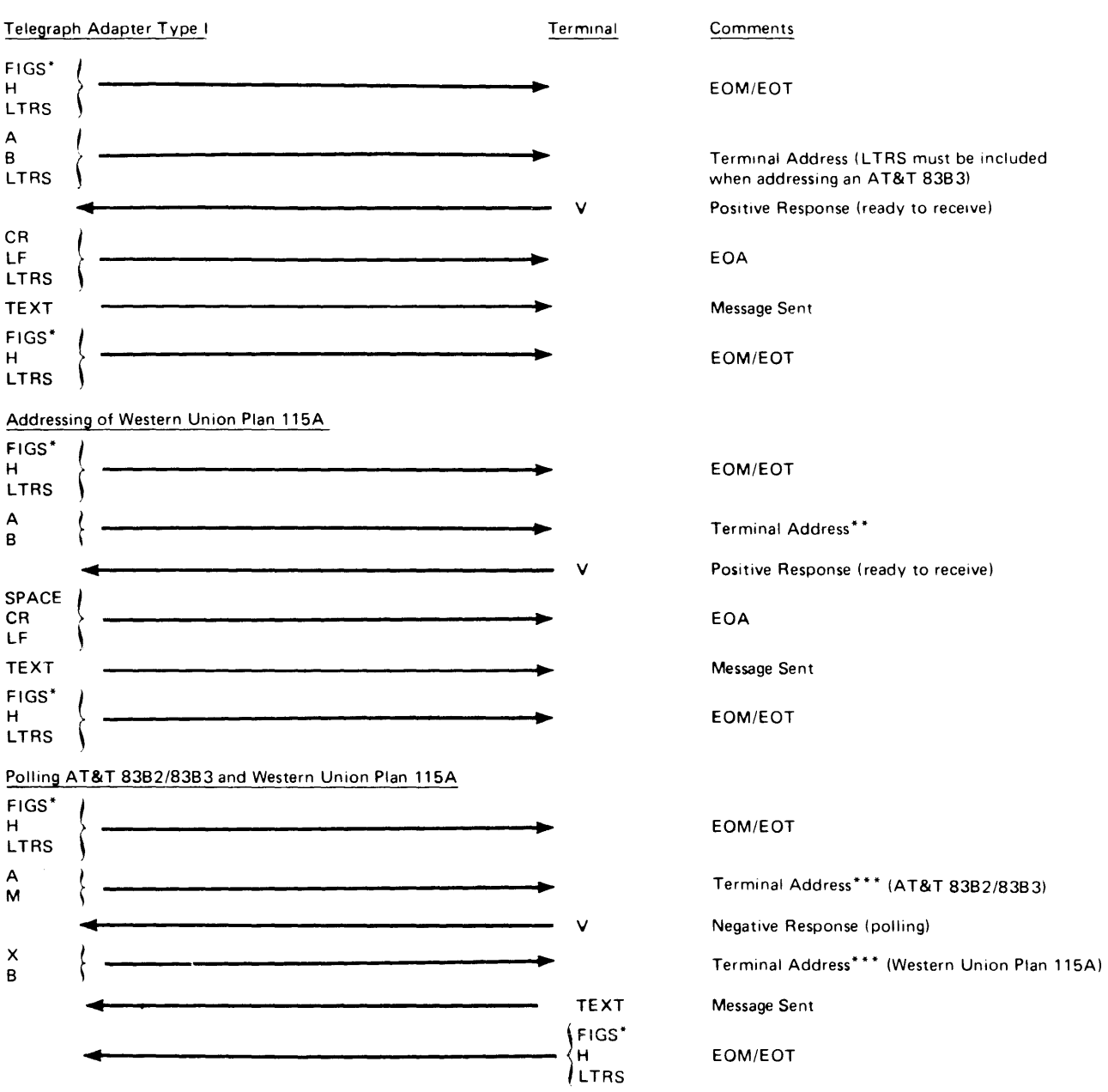
Processor-to-Terminal (Addressing): As in polling, addressing is initiated when the processor, using a Write command, transmits the EOT sequence, followed by the addressing characters. The Write command is command chained to a Read command to await the response from the terminal.

V (or M) is the positive response to addressing and results in the normal ending of the Read command with Channel End and Device End status. The Read command used to obtain the response may in turn be chained to a Write command to transmit the output message to the addressed terminal.

As in polling, if the addressed terminal does not reply within a 2.5-second timeout period, the Read command ends with Channel End, Device End, and Unit Check status and the Timeout bit set in the sense byte.

Line Control Characters

EOM/EOT	End of Message/End of Transmission Sequence (consists of upper case H and the LTRS shift character)
EOA	End of Address (consists of CR and LF characters)
V or M	Positive Response when addressing / Negative Response when polling



*The FIGS need not immediately precede the H character, but must be the last shift before the H character.

**The first character of the terminal address is the circuit designation, and the second character is the terminal on that circuit. For example, terminal B on the A circuit has an address of AB.

***The AT&T 83B2/83B3 must have M or G as the second character. Thus terminal A in the M group has an address of AM.

The Western Union Plan 115A address must have X as the first character. Thus terminal B has an address of XB.

Figure 33. Line Control Sequences--Telegraph Adapter Type I with AT&T 83B2/83B3 and Western Union Plan 115A Terminals

PROGRAMMING NOTES: With the Telegraph Adapter Type I, read-type commands following recognition of the EOT sequence or a V answerback always perform an idle-line timeout for one character time before ending. This is done to allow the line enough time to clear any superfluous character sent by the terminal following the EOT or V answerback. It also prevents initiation of a write-type command, thus preventing sending onto a busy line. This idle-line timeout is not performed if a read-type command is ended by Halt I/O or Interface Stop from the I/O channel. These cause the command to end immediately.

The program must make certain that upper-case H characters, transmitted from main storage as a text character (not as part of the EOT), do not erroneously result in an EOT sequence being transmitted. This could occur if an upper-case H is sent and is followed immediately by a lower-case character. The result will be that FIGS-H, LTRS, X (where X is the character following the upper-case H) will be transmitted by the 2701. The LTRS character will have been generated automatically by the 2701 due to the change in case from upper-case H to lower-case X.

To avoid this situation, the program must ensure that any upper-case H's that are not part of the EOT sequence are followed by a character that will not cause a LTRS character to be inserted in the outgoing data stream. This can be done, for example, by inserting a FIGS character with the shift bit set to one following any upper-case H character.

There is another possibility if the 2701 is wired for downshift on space; then the program need simply insert the Space character (regardless of the state of the shift bit) after the upper-case H. Of course, if the upper-case H is part of the EOT sequence, the program must see that a LTRS character is sent immediately following the upper-case H.

Terminal-To-Terminal Operation with Search: When operation on a multipoint line allows terminal-to-terminal traffic, a different line control is required. The sending terminal must be polled in the conventional manner under a Write command. If the terminal has no message to send, it responds with V (or M), the negative response to polling. To detect this response of the polled terminal, the processor must chain from the Write command to the Search command with a byte count of two. The Suppress Length Indication (SLI) bit should be set to zero in the CCW. When the response is V (or M), the Search command is terminated with Channel End and Device End. Because only one byte (V or M) is transferred to the channel, the channal causes a record-length interrupt to the program. The program should then proceed to poll the next terminal.

If the terminal has a message to send, polling activates the terminal tape reader and it responds with a Call Directing Code (CDC) or Station Selection Code (SSC) specifying the address(es) of the receiving terminal(s). The processor is considered a terminal and is always assigned the address AZ. Several terminal addresses can be sent to permit parallel message transmission. Each addressed terminal must reply with V (or M), positive response to addressing, to signify its readiness to receive.

Note that if the CPU is to process or log the message, the processor address must be the first address in the series of addresses sent by the terminal. If the first address received is AZ (the address of the processor), the AZ is transferred to the processor under the Search command. Since two characters are transferred to the channel, no record-length-interrupt condition occurs. The command is ended with Channel End and Device End status. The channel may then command chain to a Write command to send the V (positive answerback) to the polled terminal. This allows that terminal to start its tape reader and to continue to send the message. The Write command must be command chained to a Read command to receive the message.

If the first address received under the Search command is other than AZ, the data exchange between the polled terminal and the receiving terminal takes place without any transfer of data to the processor. However, the 2701, still under the Search command, monitors the communications line to detect the EOT sequence (FIGS H, LTRS). Under this condition, the H is transferred to the processor and ends the command with Channel End, Device End, and Unit Exception status.

The 23-second line timeout between characters is active during execution of the Search command. Note that if the first address on the tape of the polled terminal begins with A but is not followed by Z, only the A is transferred to the processor. The H of the EOT sequence is placed in the next position of main storage.

- Timeouts in Telegraph Adapter Type I Operation:

The normal 23-second line timeout between characters is pre-empted by a 2.5-second short timeout following initial selection and receipt of the first character's start bit.

- Status Byte--Telegraph Adapter Type I:

An ending status byte is sent from the 2701 to the channel at the termination of command execution. The status conditions that may be signaled by the Telegraph Adapter Type I follow.

Channel End and Device End

This status indicates that the current command has been ended normally. No conditions have occurred that require a program interrupt and the adapter is free to accept another command. This status is signaled for the following reasons:

Write and Diagnostic Write

A Halt I/O instruction has been issued.
An Interface Stop signal is received from the channel.
A Break (Space) signal is detected at stop-bit time of two successive characters.

Read, Inhibit, and Diagnostic Read

Halt I/O has been issued and there is no character in the data register. If an error or unusual condition that does not give an interrupt has been detected, the status byte may also contain Unit Check.
A V (or M) is received as the first non-shift character.

Search

Halt I/O has been issued.
A V (or M) is received as the first non-shift character.
AZ is received as the first non-shift characters.

Prepare

The addressed line has received one character and the line returned to Mark within 23 seconds of Stop-bit time.

Enable

The CE, DE status indicates that the line was successfully enabled. By using the proper command, data may be either sent or received.

Disable

The CE, DE status indicates that the line was successfully disabled and no further data may be either received or sent over the associated telegraph line.

Break

Halt I/O or Interface Stop was received from the I/O Channel.

Channel End, Device End, and Unit Exception

The conditions that cause this status to be signaled depend on the type of communications line and the command that was issued. The CE, DE, UE status is signaled for the following reasons:

Write and Diagnostic Write

The Write Command was ended immediately because it was issued to a line that was receiving data and a true start bit had been detected or at least one character was already stored in the data register at the time the command was issued.

PROGRAM NOTE: The foregoing statement does not imply that a read-type command was being executed when the Write command was issued. Once the line is enabled, data can be received by the 2701 even though a read-type command has not been issued to the line. Obviously, any data received in this manner will be lost.

Read, Inhibit, Search, and Diagnostic Read

The EOT sequence, (FIGS H, LTRS), was received. Halt I/O was issued before a character started to arrive.

Prepare

Halt I/O was issued before a true start bit was received--that is, before the line started to receive a character.

Break, Enable and Disable

The CE, DE, UE status has no meaning for these commands and should not occur.

PROGRAM NOTE: The Unit Exception status will never be signaled without accompanying Channel End and Device End status.

Channel End, Device End, and Unit Check

This status indicates that the command was ended under an error or unusual conditions. The Sense command should be issued to further define these conditions. Command ending occurs immediately with this status if any of the following sense bits are set: Data Check, Intervention Required, Equipment Check, Lost Data, or Timeout.

The CE, DE, UC status is also set if an Echo Check occurs while executing Write or Break.

Channel End, Device End, Unit Check and Unit Exception

The conditions that cause this status to be signaled to the I/O channel are a combination of the conditions that cause the command to end with Channel End, Device End, and Unit Exception status, plus one or more error conditions that cause sense bits to be set. A Sense command should be issued to determine the error conditions. The CE, DE, UC, UE status is not signaled when using the Disable command.

- Sense Byte--Telegraph Adapter Type I:

The sense bits that are set by the Telegraph Adapter Type I follow.

Intervention Required (Bit 1)

This bit is set during execution of the following commands:

Read, Inhibit, Prepare, Break, Search, and Write: if the line has not been enabled.
Read, Inhibit, Search, and Diagnostic Read: if a continuous Space signal is received for more than one character time.
Intervention Required should not be set during execution of Enable, Disable, or Diagnostic Write.

Equipment Check (Bit 3)

This sense bit is set when:
The line fails to become enabled or disabled when commanded to do so.

Data Check (Bit 4)

This sense bit is set for the following commands:

Read, Inhibit, Search, and Diagnostic Read, if the line is at Space at stop-bit time of a character (stop-bit error).
Write and Break, if an Echo Check occurs.

Data Check should not be set during Prepare, Enable, Disable, or Diagnostic Write command execution.

Overrun (Bit 5)

This bit is set during Read, Inhibit, and Diagnostic Read commands when a byte of data was lost because data service by the channel could not be obtained before the first data bit of the following character is sampled. Overrun should not occur when executing any command other than Read, Inhibit, or Diagnostic Read

Lost Data (Bit 6)

This sense bit is set when at least one "received" character is lost for reasons other than overrun. This sense bit is set during the execution of Read, Inhibit, or Diagnostic Read if:

At least one character has already been received at the time the command is issued (unless the character has been the first received under the Prepare command).
Interface Stop is signaled by the I/O channel.
Halt I/O is received when the Telegraph Adapter Type I has a character to transfer to the I/O channel.

The Lost Data sense bit should not be set when executing any command other than Read, Inhibit, or Diagnostic Read.

Timeout (Bit 7)

This sense bit is set for the following commands:

Read, Search and Diagnostic Read

If no character is received within 23 seconds after receipt of the stop bit of the previous character.
If the first character is not received within 2.5 seconds following the initial selection sequence.

Prepare

If a continuous Space signal is received for a period exceeding 23 seconds.

Timeout should not be set during Write, Diagnostic Write, Inhibit, Enable, or Disable command execution.

- Special Requirements Telegraph Adapter Type I Operation:

Message Restrictions with Telegraph Adapter Type I

Terminal-to-Processor

1. All messages transmitted by a Western Union Plan 115A Terminal from its paper

tape reader must be preceded with the sequence "A V space" (assuming that A is the assigned terminal call character).
2. A Space character received by the 2701 will not downshift (FIGS to LTRS) unless the capability for "downshift on space" has been set at installation time.
3. Text that immediately follows the sequence FIGS H, LTRS is lost. This EOT sequence must not be sent between blocks of data.

Processor-to-Terminal

1. When transmitted, the characters CR, LF, Space, and Blank must be in the same character case as the preceding character.
2. The Telegraph Adapter Type I automatically inserts the proper shift character in outgoing data when a change of character case is encountered.
3. EOA/Space must precede the transmission of text.

Terminal-to-Terminal

1. AZ is the address assigned to the processor and recognized as such by the Telegraph Adapter Type I.
2. End of Address (EOA) must precede the transmission of text: EOA for AT&T 83B2 or 83B3 terminals is CR, LF, LTRS. EOA for WU Plan 115A terminals is the Space character.

› Timing Considerations for Telegraph Adapter Type I

The timings of various operations must be taken into consideration by the program to operate the Telegraph Adapter Type I in the most efficient manner. The following are definitions of the operations listed in Figure 34.

Overrun Read

This timing indicates the maximum time for the I/O channel to accept one byte of data from the 2701 after data service has been requested by the 2701 if an overrun condition is to be avoided.

Service Write

This timing indicates the maximum time for the I/O channel to transfer one byte to the adapter after data service has been requested by the 2701, if the speed on the communications line during a write operation is not to be reduced.

Stop Write

This timing indicates the maximum delay within the 2701 from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the Telegraph Adapter Type I during a write operation.

Stop Read

This timing indicates the maximum delay within the 2701 from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the Telegraph Adapter Type I during a read operation.

Halt I/O Write

This timing indicates the maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status is presented by the Telegraph Adapter Type I during a write operation.

Halt I/O Read

This timing indicates the maximum delay within the 2701 from the time a Halt I/O is issued by the

Operation	Timing (ms)		
	45.5 bps	56.9 bps	74.2 bps
Overrun Read	153	122	94.2
Service Write	49	39	31
Stop Write	35	28	22
Stop Read	As soon as line returns to Mark		
Halt I/O Write	189	151	116
Halt I/O Read	immediate		

Figure 34. Timing of Operations for Telegraph Adapter Type I

I/O channel until the ending status is presented by the Telegraph Adapter Type I during a read operation.

- Diagnostic Provisions--Telegraph Adapter Type I:

  Two character generators are provided to simulate reception of Z or LTRS characters. These characters are generated during execution of Diagnostic Read when the diagnostic register is ready, provided the line is not enabled. Otherwise a Space character is generated.

  The LTRS character is generated under the Diagnostic Read command if the diagnostic register contains the H character. In all other cases the Z character is generated.

- Class of Adapter:

  Asynchronous Start/Stop

- Terminal Equipment Serviced:

  Common-Carrier TWX Terminals Model 33/35 Type (8-level code, 110 bps only)

- Associated Publications:

  See common-carrier representative.

- Adapter Physical-Size Classification:

  Category I

- Special Adapter Capabilities:

  Autoanswering

- Type of Operation (Transmission):

  Switched TWX Network

- Telegraph Adapter Type II Features:

  Auto Call

- Communications Services Required:

  For communication services required, consult your local IBM representative.

- Commands Decoded in Telegraph Adapter Type II:

Command	Command Code in Hexadecimal	Flag Bits 32 CD	33 CC	34 SLI	35 SKIP	36 PCI
Read	02	O	O	O	O	O
Write	01	O	O	O	X	O
Inhibit	0A	O	O	O	O	O
Prepare	06	NA	O	NA	NA	NR
Break	0D	NR	O	O	X	NR
Enable	27	NA	O	NA	X	NR
Disable	2F	NA	O	NA	X	NR
Diagnostic Read	12	O	O	O	O	O
Diagnostic Write	05	O	O	O	X	O
Dial*	29	O	O	O	X	NR

*Requires Auto Call feature.

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with with an incorrect length indication will occur.

Legend

O = Optional usage
NA = Not applicable to command
NR = Not recommended
X = Not used

The following commands can be used in Telegraph Adapter Type II operation. They are decoded in the coupled XIC.

Command	Code
Sense	04
I/O No Op	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

See generalized start/stop section for command execution and operation.

- Transmission Code Employed:

  Eight-Level TWX Code

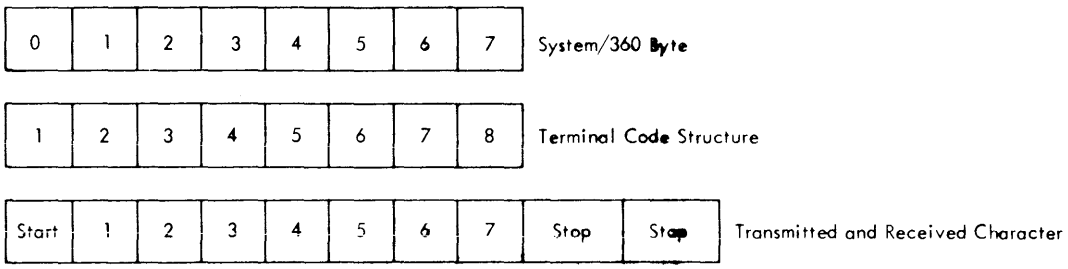
- Character Set Used:

  The transmission code used is the eight-level TWX Code. See Figure 35. When transmitting, the Telegraph Adapter Type II adds one start bit and two stop bits. When receiving, the start bit and the stop bits are deleted from the character and are not sent to main storage. Eight bits are transmitted for each character, but only seven are classified as data bits, while the eighth is the parity bit. In addition, each character has a single-bit start element and a double-bit stop element. Thus eleven bits are transmitted for each character, with the equipment operating at 110 bits per second.

- Transmission-Code Error Detection Used:

  Parity checking is optional. Some models of 33/35 equipment hold the parity bit (bit 8) in the

	S/360 Main Storage Byte Positions 0, 1, 2, 3 (1, 2, 3, 4)																
Byte Positions 4,5,6,7 (5,6,7,8)	HEX	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	0	Null			Form Feed		Line Feed	ACK			Horiz Tab	WRU		EOM			Shift In
0001	1	Null		EOT	Form Feed	EOA	Line Feed		Shift Out	SOM	Horiz Tab	WRU	Return	EOM	Vert-ical Tab	Bell	Shift In
0010	2		H	D		B			N	A			M		K	G	
0011	3		H	D	L	B	J	F	N	A	I	E	M	C	K	G	O
0100	4		(	S		"			.	!			–		+	,	
0101	5	SP	(	S	'	"	*	&	.	!	)	%	–	#	+	,	/
0110	6																
0111	7																
1000	8									X-ON							
1001	9													X-OFF			
1010	A	P			\		Z	V			Y	U		S			←
1011	B	P	X	T	\	R	Z	V	↑	Q	Y	U	]	S	[	W	←
1100	C	O			<		:	6			9	5		3			?
1101	D	O	8	4	<	2	:	6	>	1	9	5	=	3	;	7	?
1110	E																
1111	F														PAD		Delete / RO



On receive operations, the start-stop bits are deleted at the 2701.
On transmit operations, the start-stop bits are added at the 2701.

Note: When two codes are shown for a single character, the shaded indication denotes the bit configuration due to the parity bit being held in Mark Hold state. The companion bit configuration has even parity.

Figure 35. Eight-Level TWX Code--System/360 Oriented (Standard Keyboard Arrangement)

Mark state. Others transmit even parity. Parity checking, if performed, should be accomplished through programming by use of the Translate and Test instruction.

- Line-Control and Functional Characters Used:

  Identification answerback is handled by the program. Output messages can be of any length or format. Input messages can be of any length; however, certain format restrictions are imposed because of the line control used by these teletypewriter terminals. See common-carrier publications.

  The TWX line of terminals have an automatic-answering capability that provides a degree of assurance that the proper terminals are communicating with each other. Some terminals are arranged to answer with a multicharacter identification answerback, while other terminals are arranged to respond with a single-character positive-confirmation-type answerback.

- Line-Control Operations--Telegraph Adapter Type II:

  During receive operations, the following characters are recognized by the Telegraph Adapter Type II and cause termination of the I/O operation with subsequent status.

  WRU, "Who Are You," which causes the Channel End and Device End status bits to be set.
  XON, "Transmitter On," which causes the Channel End and Device End status bits to be set.
  XOFF, "Transmitter Off," which causes the Channel End and Device End status bits to be set.
  EOT, "End of Transmission," which causes the Channel End, Device End, and Unit Exception status bits to be set.

  The Delete character (all Marks) is also recognized. Transfer of Delete characters to main storage is inhibited during all read-type operations.

  The Line Break signal may be detected while the line is in transmit mode. If the line is at space level at stop-bit time of two successive characters, any write-type operation is terminated with Channel End, Device End, and Unit Check status and Intervention Required set in the sense byte.

- Polling and Addressing in Telegraph Adapter Type II Operation:

  Communication between the Telegraph Adapter Type II and the Teletype Corporation terminals is on a TWX switched-network operation. Accordingly, polling and addressing are not used. However, the TWX terminal will respond with its answerback drum whenever it receives the WRU signal. The answering station transmits first with its ID followed by ACK. See Figure 36.

- Timeouts in Telegraph Adapter Type II Operation:

  The normal 23-second line timeout is not preempted by a shorter timeout period before the first character's start bit is received. This timeout remains at 23 seconds.

- Status Byte--Telegraph Adapter Type II:

  An ending-status byte is sent from the 2701 to the I/O channel at the termination of command execution. The status conditions that may be signaled by the Telegraph Adapter Type II follow.

  Channel End and Device End

  This status indicates that the current command has been ended normally. No conditions have occurred that would require a program interrupt and the line is free to accept another command. This status is signaled under the following conditions:

  Write, Break, and Diagnostic Write

  A Halt I/O instruction has been issued.
  An Interface Stop signal is received from the I/O channel.
  When a Break (Space) signal is detected at the stop-bit time of two successive characters.

  Read, Inhibit, and Diagnostic Read

  A Halt I/O instruction has been issued.
  A WRU, XON, or XOFF character has been received.

  Prepare

  The addressed line has received one character and the line returned to Mark at stop-bit time of the character.

Keyboard Unattended, Models 33 and 35

Telegraph Adapter-II	TWX	Comments
Dial TWX Terminal	→	2701 dials TWX to perform WRU function.
	ID, ACK* ←	TWX terminal gives identification code and go-ahead signal.
TEXT	→	Message Sent.
XOFF,WRU	→	Go-ahead signal to TWX terminal.
	ID, ACK* ←	TWX terminal identification and go-ahead.
TEXT	→	Message sent.
XOFF,EOT	→	Transmission is finished: go on-hook.

Keyboard Attended, Models 33 and 35

Telegraph Adapter-II	Models 33 and 35	Comments
Dial Terminal	→	2701 dials terminal to perform WRU function
	ID, ACK* ←	Identification code and go-ahead signal.
TEXT	→	Message sent.
XOFF	→	End of text.
CR LF DEL XOFF	→	Go-ahead signal to terminal.
	TEXT ←	Message sent.
	XOFF ←	End of text.
TEXT	→	Message sent.
XOFF,EOT	→	End of text, end of transmission.

Paper Tape Reader Operation

Telegraph Adapter - II	Paper Tape Reader	Comments
Dial tape	→	2701 dials tape terminal to perform WRU function.
	ID, ACK* ←	Tape terminal identification and go-ahead to 2701.
TEXT	→	Message sent.
XOFF	→	End of text.
XON (1 to 4 char.) XOFF	→	Establishes need-to-know to terminal
	TEXT ←	Message sent.
	XOFF ←	End of text.
TEXT	→	Message sent.
XOFF,EOT	→	End of text, end of transmission.

* Format for the identification code is: CR LF RO (1-14 characters) CR LF ACK (the 2701 recognizes either ACK or XON). The 1-14 characters (terminal identity) are specified before the terminal is installed. (If less than 14 characters are specified, the remaining characters will be Null characters--hex 00.)

Note: If the terminal identity is not specified, the terminal is installed with an ID format of 20 characters of space bits (20 Null characters--hex 00).

T W X TERMINALS

Line Control Characters	Meaning
WRU	Who are you? WRU or Dial requests identification (ID).
XON	Transmitter ON.
XOFF	Transmitter OFF.
EOT	End of Transmission
DEL	Delete

Figure 36. Line-Control Sequences--Paper Tape Reader and Models 33/35 with Telegraph Adapter Type II

The addressed line has received one character but the line did not return to Mark at stop-bit time of the character; however, the line did return to Mark within 23 seconds after stop-bit time of the character.

Enable

The CE, DE status indicates that the adapter was successfully enabled and transmission in either direction may occur.

Disable

The CE, DE status indicates that the adapter was successfully disabled and no further transmission may occur.

Dial

The CE, DE status indicates that both the Data Set Ready and Data Carrier Detector signals are on--that is, the call has been answered; the connection has been established; and the local data set is ready to transmit.

Channel End, Device End, and Unit Exception

The conditions that cause this status to be signaled depend on the type of communications line and the command that was issued. This status is signaled for the following reasons:

Write and Diagnostic Write

The Write command was ended immediately because it was issued to a line that was receiving data and a legitimate start bit had been detected or at least one character was already stored in the data register at the time the command was issued.

PROGRAM NOTE: The foregoing statement does not imply that a read-type command was being executed when the Write command was issued. Once the adapter is enabled, data can be received by the 2701 even though a read-type command has not been issued to the line. Obviously any data received in this manner will be lost.

Read, Inhibit, and Diagnostic Read

The EOT character was received.

Prepare

Halt I/O was issued to the line before a legitimate start bit was received--that is, before the line started to receive a character.

Enable

Halt I/O was issued after a call had been answered.

Dial

Halt I/O was issued before the entire number was dialed.

Dial command was issued to a line already receiving data.

PROGRAM NOTE: The Unit Exception status will never be signaled without accompanying Channel End and Device End status.

Channel End, Device End, and Unit Check

This status indicates that the command was ended under an error or unusual conditions. The Sense command should be issued to further define these conditions. Command ending occurs immediately with this status if any of the following sense bits are set by the Telegraph Adapter Type II: Data Check, Intervention Required, Equipment Check, Overrun, Lost Data, or Timeout. Note that Unit Check status can be set alone (without Channel End and Device End) when the Data Check bit is set during command execution; however, Channel End and Device End are set at the termination of the command.

The CE, DE, UC status is also set if an Echo Check occurs while executing Write or Break.

Channel End, Device End, Unit Check, and Unit Exception

The conditions that cause this status to be signaled to the I/O channel are a combination of the conditions that cause the command to end with Channel End, Device End, and Unit Exception status, plus one or more error conditions that cause sense bits to be set. A Sense command should be issued to the line to determine the error conditions. The CE, DE, UC, UE status is not signaled when using the Disable command.

- Sense Byte--Telegraph Adapter Type II:

The sense bits that are set by the Telegraph Adapter Type II follow.

Intervention Required (Bit 1)

This bit is set during execution of the following commands:

Read, Inhibit, Prepare, Break, and Write

a. No data set is attached.
b. The data set has power off.
c. Data Carrier Detector signal fails.
d. Connection to remote station has not been made, or the data set is not in data mode.

Read and Prepare

When connection with the remote data set is not established before the elapse of a 23-second line timeout.

Read, Inhibit, and Prepare

If connection with the remote data set is broken after the 2701 has started to receive.

Write and Break

If a Line Break (space) signal is received during the stop-bit times of two successive characters.

Dial

The Auto Call feature sets the Intervention Required sense bit when Dial is issued and:

a. The Automatic Calling Unit (ACU) power indicator is off.
b. The ACU power indicator turns off during Dial command execution.
c. The ACU is not connected to the Telegraph Adapter Type II.

Read, Inhibit, and Diagnostic Read

If a continuous Space signal is received for more than the duration of one character time.

The Intervention Required sense bit is never set under the Diagnostic Write, Enable, or Disable command.

Provided the line is enabled, note that during execution of the Diagnostic Read command a continuous Space signal is generated after the diagnostic register has been read.

Equipment Check (Bit 3)

This sense bit is set when:

a. The line fails to become enabled when commanded to do so;
b. The line fails to become disabled when commanded to do so.

Data Check (Bit 4)

This sense bit is set for the following commands:

Read, Inhibit, and Diagnostic Read

If the line is at Space at stop-bit time of a character (stop-bit error).
Data Check will not be set during Prepare, Enable, or Disable command execution.

Overrun (Bit 5)

This sense bit is set during Read, Inhibit, and Diagnostic Read commands when a byte of data was lost because data service by the I/O channel could not be obtained before the first data bit of the following character is sampled.

Overrun should not occur when executing any command other than Read, Inhibit, or Diagnostic Read.

Lost Data (Bit 6)

This sense bit is set when at least one received character is lost for reasons other than overrun. It is set during the execution of Read, Inhibit, or Diagnostic Read if:

a. At least one character has already been received at the time the command is issued (unless the character had been the first received under the Prepare command).
b. Interface Stop is signaled by the I/O channel.
c. Halt I/O is received when the Telegraph Adapter Type II has a character to transfer to the I/O channel.
d. A line that is equipped with the Auto Call feature is commanded to Dial but the line is already off-hook.

The Lost Data sense bit should never be set when executing any command other than Read, Inhibit, Diagnostic Read, or Dial.

Timeout (Bit 7)

This sense bit is set for the following commands:

Read and Diagnostic Read

a. If no character is received within 23 seconds after receipt of the stop bit of the preceding character.

b. If the first character is not received within 23 seconds following the initial-selection sequence.

Prepare

If a continuous Space signal is received for a period exceeding 23 seconds.

Disable

If a data set on a switched network does not go on-hook within 23 seconds after being signaled to do so.

Timeout should not be set during Write, Diagnostic Write, Inhibit, or Enable command execution.

Dial

If the ACU does not receive a correct answer soon enough (as determined by an adjustable setting on the ACU).

- Special Considerations in Telegraph Adapter Type II Operation:

Message Restrictions

Terminal to Processor

1. The delete characters are recognized. The Telegraph Adapter Type II inhibits their transfer to the System/360.
2. WRU, XON, XOFF, and EOT terminate receive operations.

Processor to Terminal

The hexadecimal byte, DF, which is used as a pad character during Write command execution, causes the 2701 to send all Write Marks for one character time (including the start bit). Therefore, the pad character will not be received at the terminal as the DF (11011111) bit configuration. As a result, DF appearing in a message will result in no action at the terminal. It is used to maintain the line in a Mark-hold state for a number of character times (the number is set by the byte count in the CCW).

- Timing Considerations in Telegraph Adapter Type II Operation:

The timings of various operations must be considered when programming a line using the Telegraph Adapter Type II. The following are definitions of the operations listed in Figure 37.

Overrun Read

This timing indicates the maximum time for the I/O channel to accept one byte of data from the 2701 after data service has been requested by the 2701 if an overrun condition is to be avoided.

Service Write

This timing indicates the maximum delay within the 2701 that may accrue from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the terminal during a write operation.

Stop Read

This timing indicates the maximum delay within the 2701 that may accrue from the time the Interface Stop signal is issued by the I/O channel until the ending status is presented by the adapter during a read operation.

Halt I/O Write

This timing indicates the maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status is presented by the Telegraph Adapter Type II during a write operation.

Halt I/O Read

This timing indicates the maximum delay within the 2701 from the time a Halt I/O is issued by the I/O channel until the ending status is presented by the Telegraph Adapter Type II during a read operation.

Operation	Timing (ms)
Overrun Read	90
Service Write	21
Stop Write	15
Stop Read	As soon as the line returns to Mark
Halt I/O Write	116
Halt I/O Read	immediate

Figure 37. Timing of Operations for Telegraph Adapter Type II (at 110 bps)

The Parallel Data Adapter (PDA) provides a parallel data path into a System/360 complex. The PDA, like other I/O devices, operates over the I/O channel on a byte basis; however, in addition it presents a parallel demand-response interface to attached devices.

- Class of Adapter:

  Data Acquisition and Control (bit-parallel data on demand response basis)

- Equipment Serviced:

  Parallel Data Devices

- Associated Publications:

  IBM 2701 Data Adapter Unit--Original Equipment Manufacturer's Information, GA22-6844
  For Parallel Devices--see Device Manufacturer's representative

- Adapter Physical-Size Classification:

  Category I--for data words of 32 or fewer bits (i.e., up to two Parallel Data Expansion features)
  Category II--for data words of greater than 32 bits (i.e., more than two Parallel Data Expansion features)

- Parallel Data Adapter Features:

  Parallel Data Extension Feature

  The basic Parallel Data Adapter provides for a data word of 16 bits plus one bit of parity. Through the use of up to four Parallel Data Extension features, the data word can be extended to 48 bits. Each feature adds an additional eight bits to the data word. One parity bit is supplied for the total word, regardless of the number of Extension features used.

  Timeout Feature

  The Timeout feature is provided to guard against a hang-up condition where the PDA would wait for an indefinite time for a response from an external device. This condition could occur due to a circuit failure in the PDA, the cabling, or the external device. When this timeout protection is desired, the Read with Timeout or Write with Timeout command is used; otherwise, the Read or Write command is used. Under the timeout commands, a two-second timeout is performed from the time the Parallel Data Adapter notifies the external device that is ready for data transfer until the time that the external device responds. In detail, when the Read Ready or Write Ready interface signal is generated, the timeout begins. The timeout is reset when the external device generates either the Demand or one of the command-terminating signals (see below). The timeout will restart on the next occurrence of the Read Ready or Write Ready signal. If the external device does not respond within the two-second timeout period, the command is ended with the Channel End, Device End, and Unit Check status and with the Timeout bit set in the sense byte. If, due to an external-device failure, the Demand signal stays on for an indefinite time, this is not detected by the Timeout feature and no ending status will occur. See paragraph titled "Demand".

- Type of Operation (Transmission):

  Point-to-point, multipoint (maximum of eight Parallel Data devices per PDA interface)

- Communication Services Required:

  Maximum distance between PDA and most distant Parallel Data device is 100 ft. Connection via coaxial cable.

- Commands decoded by PDA:

Command	Command Code in Hexadecimal	Flag Bits Bit Positions 32 CD	33 CC	34 SLI	35 SKIP	36 PCI
Read	02	O	O	O	O	O
Read with Timeout*	12	O	O	O	O	O
Write	01	O	O	O	X	O
Write with Timeout*	11	O	O	O	X	O
Diagnostic Write	05	O	O	O	X	O
Diagnostic Read	06	O	O	O	O	O

* Require Timeout Feature

Legend:
O = Optional Usage
X = Not Used

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with an incorrect length indication will occur.

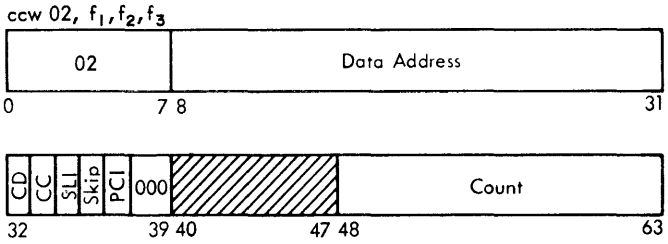
The following commands can be used in PDA operation. They are decoded in the coupled XIC.

Command	Code
Sense	04
I/O No Op	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

The PDA-decoded command's executions are as follows:

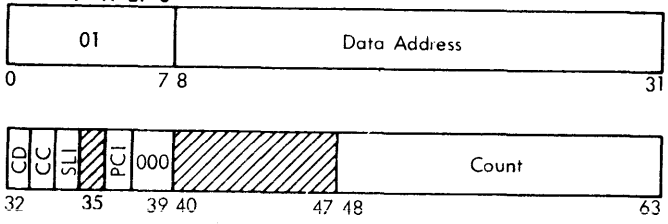
Read
ccw 02, f_1, f_2, f_3



Read

This command causes the Parallel Data Adapter to request and accept data words from the external device and present them, a byte at a time, to the System/360 channel.

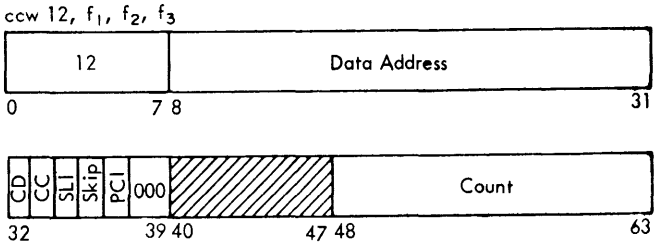
Write
ccw 01, f_1, f_2, f_3



Write

This command causes the Parallel Data Adapter to obtain bytes of data from the System/360 I/O channel, assemble them into data words, and transfer the data word to the external device.

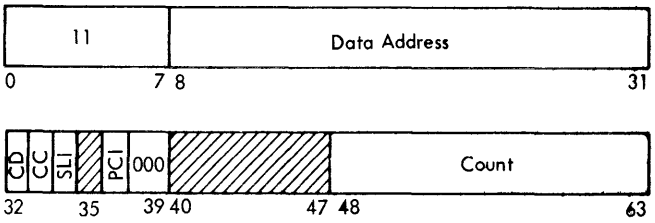
Read with Timeout
ccw 12, f_1, f_2, f_3



Read with Timeout

This command is the same as the Read command described above, except that the external device is allowed a maximum of two seconds in which to respond to a data-transfer request made by the PDA. This command is valid only when the Timeout feature is installed.

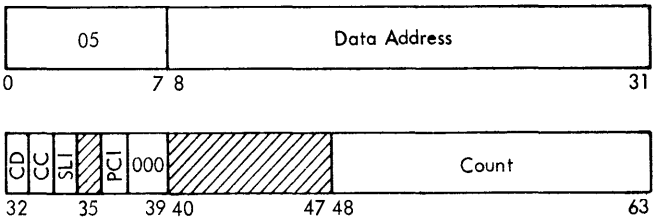
Write with Timeout
ccw 11, f_1, f_2, f_3



Write with Timeout

This command is the same as the Write command described above, except that the external device is allowed a maximum of two seconds in which to respond to a data-transfer request made by the PDA. This command is valid only when the Timeout feature is installed.

Diagnostic Write
ccw 05, f_1, f_2, f_3

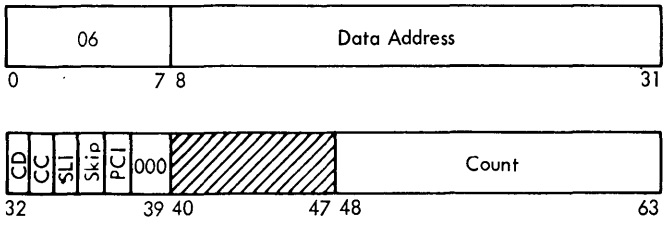


Diagnostic Write

The Diagnostic Write command operates similarly to the Write command with the following exceptions: (1) control and data-transfer operations with the external device are inhibited, and (2) after one

data word has been assembled in the Parallel Data Adapter, the Channel End and Device End status is presented to terminate the command.

Diagnostic Read
ccw 06, f_1, f_2, f_3



Diagnostic Read

This command operates similarly to the Read command with the following exceptions: (1) control and data-transfer operations with the external device are inhibited, and (2) the contents of the data-word-assembly register in the Parallel Data Adapter is transferred to the I/O channel and the Device End status is presented to terminate the command. In order to receive meaningful data from the PDA, the data-word-assembly register should be loaded through the use of the Diagnostic Write command. Care should be exercised that no operation that would change the contents of the data-word-assembly register should be allowed between the Diagnostic Write and the Diagnostic Read commands. The parity circuits are checked during the diagnostic commands independent of the state of the Suppress Parity Error line on the external interface.

- Data Transmission Code Employed:

  Optional. The PDA control functions are provided by separate leads on the interface.

- Transmission-Code Error Detection Employed:

  Parity Checking

- Parallel Data Adapter Operation:

  Operation between the Parallel Data Adapter and the external device is accomplished through the Parallel Data Adapter interface. The interface consists of a set of lines that provide for control and data transfer (Figure 38). The name and function of each line, or lines, of the interface are described below. Detailed information concerning timing and voltage levels for these lines may be obtained from the IBM 2701 Data Adapter Unit--Original Equipment Manufacturer's Information Manual, GA22-6844.

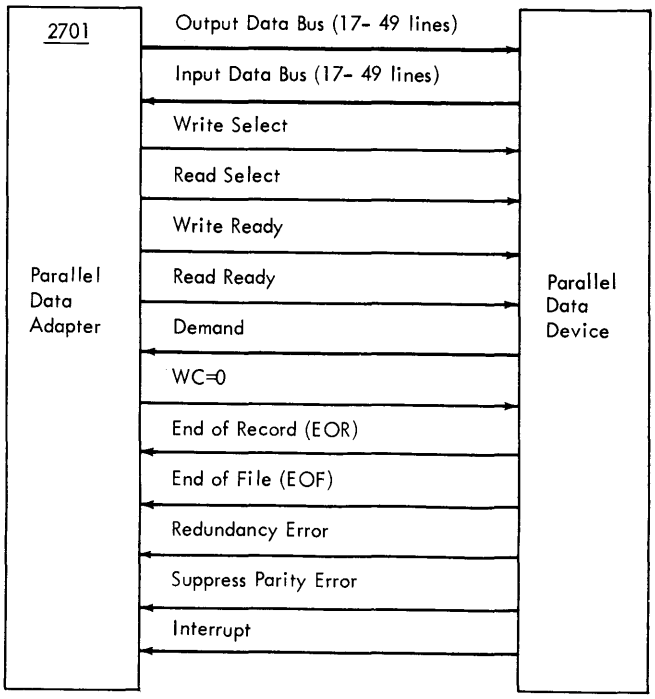


Figure 38. Parallel Data Adapter Interface

Interface Line Functions

Output Data Bus (PDA to External Device). The Output Data bus in the basic PDA consists of 17 lines. Of these, 16 are used for the transfer of output data and one line is used for the transfer of the parity bit to the external device. With the Parallel Data Extension features, the number of lines can be increased to a maximum of 49 (48 data and one parity).

Input Data Bus (External Device to PDA). The Input Data bus in the basic PDA consists of 17 lines. Sixteen lines are used for the transfer of input data and one line is used for the transfer of the parity bit from the external device. With the Parallel Data Extension features, the number of lines can be increased to a maximum of 49 (48 data and one parity).

Write Select (PDA to External Device). This line is used to notify the external device that it has been selected for a write-type operation. Write Select is signaled when the Write or Write with Timeout command from the channel is accepted by the PDA. It remains active until the command is ended.

Read Select (PDA to External Device). This line is used to notify the external device that it has been selected for a read-type operation. Read Select is signaled when the Read or Read Timeout command from the channel is accepted by the PDA. It remains active until the command is ended.

Write Ready (PDA to External Device). This signal notifies the external device that a word of data is on the Output Data Bus and that the data is stabilized and deskewed at the PDA.

The occurrence of a Demand, End of Record (EOR), End of File (EOF), or Interrupt signal from the external device resets this line.

Read Ready (PDA to External Device). This line notifies the external device that the PDA is ready to accept the next word of data over the Input Data Bus.

The occurrence of a Demand, EOR, EOF, or Interrupt signal from the external device resets this line.

Demand (External Device to PDA). The significance of the Demand signal depends on the command that is being executed:

1. Write command--The Demand signal indicates that the external device has accepted the data word on the Output Data Bus.
2. Read command--The Demand signal indicates that the data on the Input Data Bus is valid, stablized, and deskewed.

The Demand signal must be present for at least 800 nanoseconds. The maximum length of the demand signal depends on the external device and its desired data rate. Data must remain valid for the duration of the demand signal. The respective Ready signal will fall upon recognition of the Demand signal, and a second Read Ready or Write Ready signal will not be given while the Demand signal is still present.

Word Count Equals Zero (WC=0) (PDA to External Device). In a write operation, this signal is generated by the PDA to inform the external device that the channel has no additional data to transfer. In a read operation, WC=0 signals the external device that the channel will not accept any more data. Except for the case of Halt I/O, this signal also indicates that one or more bytes of the last data word accepted by the PDA has not been transferred to main storage. An EOR, EOF, or Interrupt signal must be presented by the external device before the PDA can end the command. An exception to this is the elapse of the timeout when operating under a Write with Timeout command.

End of Record (EOR) (External Device to PDA). This line indicates that the external device has completed its operation and will not generate or accept any additional data. Upon recognizing this signal, the PDA presents Channel End and Device End status to the I/O channel.

End of File (EOF) (External Device to PDA). This line indicates that the external device has completed its operation and will not generate or accept any additional data. Upon recognition of this signal, the PDA presents Channel End, Device End, and Unit Exception status to the channel. The Unit Exception status condition prevents command chaining.

Redundancy Error (External Device to PDA). This line indicates that the external device has detected a parity (redundancy) error. When this line is signaled, the PDA sets the Data Check sense bit and signals Unit Check status when the command ends. The PDA does not cause the command to end because of a Data Check. If the operation requires the command to end upon recognition of a Data Check, it should also signal EOR/EOF or interrupt after signaling Redundancy Error. See OEMI for required timings.

Suppress Parity Error (External Device to PDA). This line allows the external device to present data that is not certain to have valid parity to the PDA. When this signal from the external device is on, the PDA continues to perform parity checking on the received data word; however, it inhibits the setting of status and sense indication due to the detection of a parity error. (It is used by parallel devices that do not generate valid parity.)

Interrupt (External Device to PDA). The Interrupt line allows the external device to signal the program by means of a channel interrupt that the external device requires service. The Interrupt signal causes the Attention status to be set. When the Interrupt signal occurs during a read or write operation, Channel End and Device End status is also set along with Command Interrupt (sense bit 1).

Multidevice Operation

Up to eight external parallel devices may be connected to the Parallel Data Adapter interface.

There is almost an unlimited number of ways in which the external devices can be connected to the Parallel Data Adapter to operate via the PDA interface. The restrictions are that the maximum number of attachments be eight, that the distance limitations are not exceeded (see the IBM 2701 Data Adapter Unit--Original Equipment Manufacturer's Information Manual, GA22-6844), and that the interface procedures are not violated. Two classes of operation are considered here.

In the first, only one of the external devices is operating with the interface at any given time; the entire data word goes to and comes from that one external device.

In the second, the data work is split up between or among various external devices.

The former situation has the problem of selecting which external device will be operating with the interface at any one time. The latter has the problem of having the external devices respond properly to the interface control signals.

Selection and Addressing

A few of the many possible selection schemes are outlines in this section. Consider first the case in which only one of the external devices is operating with the PDA interface at a time.

The Parallel Data Adapter interface has two select lines, Read Select and Write Select, with no built-in capability for selecting one of the eight possible devices with which the Parallel Data Adapter can operate. The PDA has no indication of the number of devices on the interface. Various means are available to the user to do the selecting. Listed in the following are three selection schemes.

Manual Switching. This method of selection is performed by setting a manually operated switch on one of the external devices to the ON position and all others to the OFF position. Manual switching is used when ease of switching but not speed is a requirement. It is simple and economical. For an example of its application, consider several "test cells" on a test floor where only one test cell is scheduled to run at a time. The multidrop capability allows relatively quick rotation of test cells without the necessity of "cable pulling" and equipment movement.

First Word Addressing. In this method of selection, the first word of a write operation contains the addressing information. Only the device that recognizes the address will respond to further interface signals. The device, once selected, will remain selected until a new write operation is initiated. To perform a write operation, the program need only ensure that the address code appears in the first word. To perform a read operation, the program must first perform a one-word write operation to address the device. When the Write command ends, the program can command chain directly to the Read command.

The ending of the Read command does not end the selection of the external device. Only a new write operation can change the selection. (The exception to this is the case in which the external device has been reset by an operator). Additional read operations may therefore be performed with the same external device without the need of re-addressing.

Direct Control Feature. The third method of addressing is the use of the Direct Control Feature (DCF) available on the System/360 processors. With this feature, the addressing can be accomplished through the sense or timing lines. The external devices may also indicate their need of service with the use of the interrupt lines of the DCF. This device-program communication is performed independently of the PDA operation, thereby allowing for greater versatility.

Interface Control

Now consider the case in which the data word is split up between or among various external devices. In this approach, the problem of interface control arises. There is also the problem of which device should respond to the control signal from the PDA interface. One device may contain the circuit logic to respond to the interface signals, providing there are no more than seven external devices on one interface (this maximum is due to interface driver limitations). The others can be made to receive as well as drive the input lines, and thereby can monitor the input-control signals generated by other devices. This method allows each device to follow the entire interface operation.

Another approach is to allow all devices to respond to the PDA interface-control signals. The restriction here is to ensure that there are no glitches or double signals on the interface lines. For example, once one of the external devices has presented the Demand signal to the PDA interface, any or all of the other external devices can present the same signal to the inter-

face. However, once the start Demand signal has fallen, no other external device can generate it until the next Ready signal from the PDA is generated. This could be done as stated above, as all the external devices can monitor the input lines. It could also be done on a synchronous basis, using the Ready signal as the reference--i.e., the Demand signal will be given n microseconds after the Ready signal and will be dropped m microseconds later. The values for n and m need not be the same for read operations as it is for write operations.

Another approach is to set up a standard data rate. That is, the Demand will be given every p microseconds. The data rate must not exceed the speed capability of the system. (See IBM 2701 Data Adapter Unit--Original Equipment Manufacturer's Information Manual, GA22-6844.)

Another problem that may arise with sharing the data word among devices is how to perform the operation in which a data transfer is required for a specific external device, but in which any data transfer, including all zeros, is meaningful to the other external devices sharing the interface. This could be done by reserving one bit in the record to or from each external device for a validity indication. When this bit is on, the record is meaningful; when this bit is off, the record is ignored. This bit can be used on a read as well as on a write operation. The program and the external devices can test this bit; if the bit is on, it uses the record; if off, it ignores the record.

These selection schemes do not require any modification of the 2701. The 2701 has no indication of the number of external devices that are on the interface nor of the means used to select them. The program, of course, must be aware of the external-device-selection scheme used.

Speed of Operation

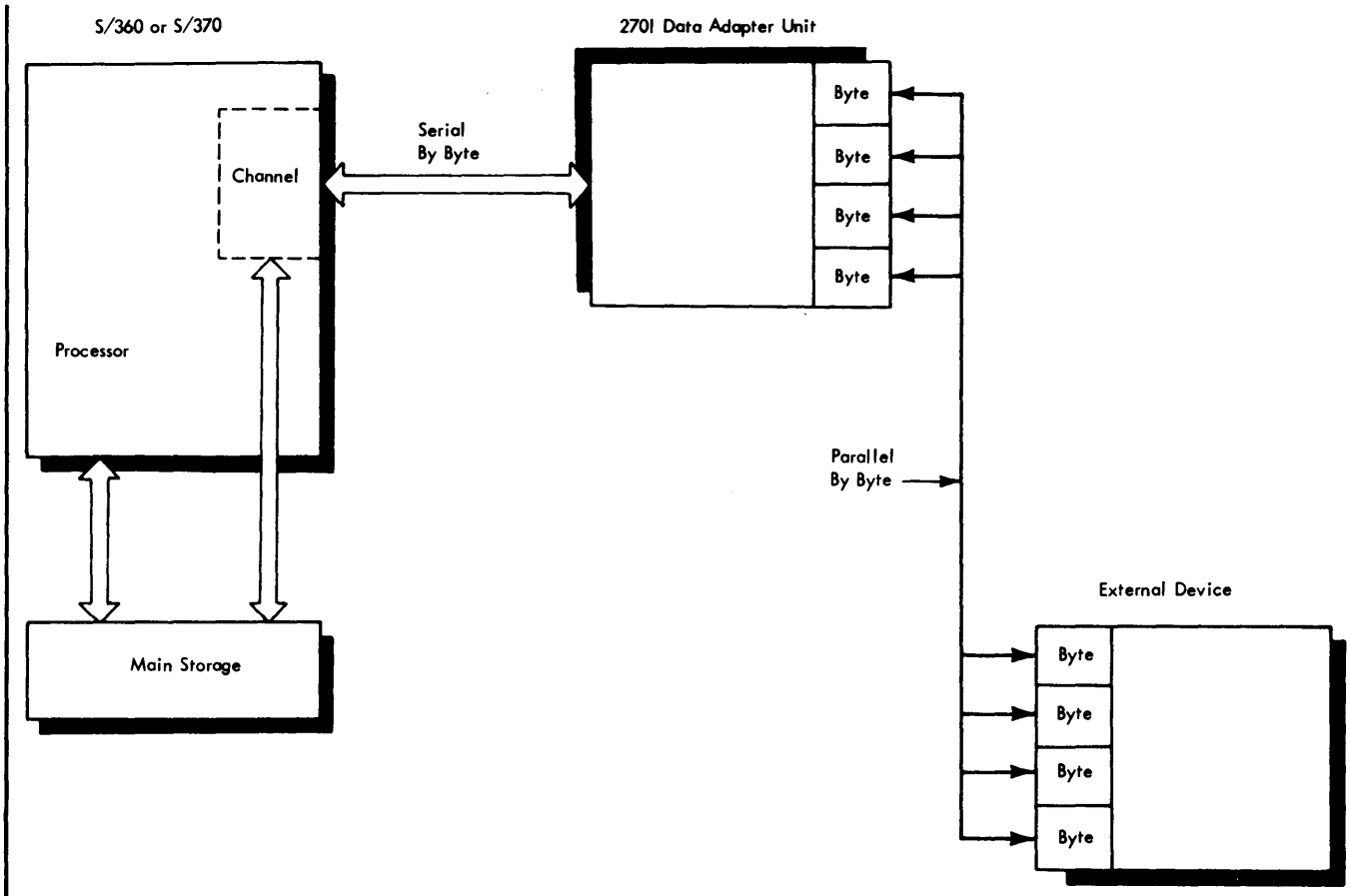
The maximum overall data rate possible for an external device is a complex function (Figure 39). It depends on parameters such as the System/360 or System/370 model used, the delay inherent in the cables, the channel, the other control units operating on the same and/or other channels, and the mode of operation (multiple-byte, or burst). The Parallel Data Adapter transfers bytes with the channel up to the maximum channel rate, depending on these parameters. See the IBM 2701 Data Adapter Unit--Original Equipment Manufacturer's Information Manual, GA22-6844.

Read Operation

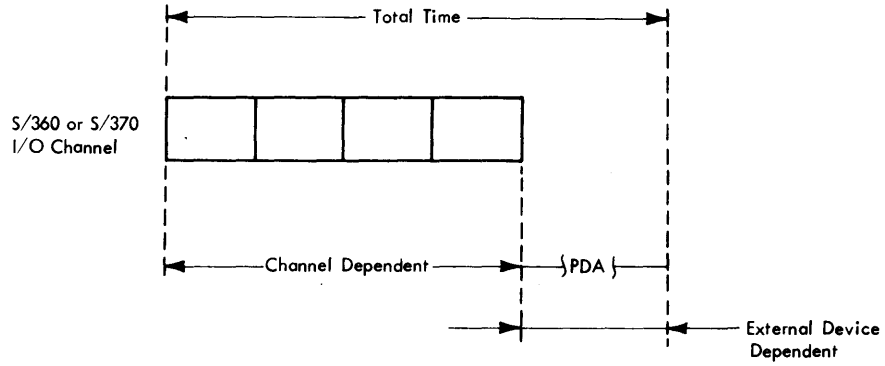
The read operation is initiated by the acceptance of a Read or Read with Timeout command. Upon the acceptance of this command, the PDA data register is reset and the Read Select and Read Ready signals are generated on the PDA interface. The PDA is then in a condition to accept the first data word from the external device. When the input data is available, valid, and deskewed on the Input Data Bus, the external device responds with the Demand signal. The Demand signal causes the dropping of the Read Ready signal. The 2701 then attempts to obtain channel selection in order to transfer the received data word to the channel. (This is not required when operating on a selector channel or when operating in record-lock mode.) When selection is successfully accomplished, the XIC-XA couple transfers the data word, one byte at a time, to the I/O channel. The mode of operation is either multiple-byte or (by setting the Normal Record Lock switch to RECORD LOCK) forced-burst mode on multiplexer channels, or burst mode on the selector channel. (See "Normal/Record Lock" description in "2701 Operational Functions" section.) After the full data word has been transferred to the channel, the PDA again signals Read Ready, thus informing the external device that the PDA is ready to accept the next data word. When data is again available, the external device signals Demand and the data transfer operation proceeds as above.

The read operation may be ended in one of several ways:

1. The external device signals End of Record (EOR) or End of File (EOF). When the external device has determined that is has completed its data transfer with the System/360, it signals either EOR or EOF. The EOR signal causes the 2701 to present Channel End and Device End status to the channel. The EOF signal causes the 2701 to send Channel End, Device End, and Unit Exception status to the channel. The Unit Exception status prevents command chaining in the channel. To ensure the acceptance and transfer of the last data word, the EOR or EOF signal should not occur until the Demand signal has fallen. Once the PDA has accepted the data word, the terminating status will not be sent until the final word has been transferred to the channel.
2. The channel can accept no more data and signals Stop. When the storage area allocated for the read operation has been filled and no



$$\text{THROUGHPUT (PER BYTE)} = \frac{\text{TOTAL TIME}}{\text{NO. OF BYTES}}$$



Note: This concept applies to all sizes (16-bit-word thru 48-bit-word) of the 2701 Parallel Data Adapter.

Figure 39. Thruput for Parallel Data Adapter

other area is available, the channel can accept no more data (byte count decremented to zero). When the PDA presents one more byte of data than the channel can accept, the channel rejects that byte and signals the 2701 to cease the data transfer. The result of this is that a data word or part of a data word, though accepted by the PDA, is unable to be placed in main storage. To be able to recognize this condition, the SLI bit in the CCW must be off. When the PDA recognizes the Stop signal from the channel, it in turn signals WC=0 and Read Ready to the external device. The WC=0 line informs the external device that the PDA will not transfer data to the System/360 channel. The Read Ready signal is made available for external devices that cannot end until they have reached a physical position or have transferred all their data. The PDA looks for the EOR , EOF, or Demand signal as the response to the Read Ready/WC=0 signals. If the external device can end immediately, it should signal either EOR or EOF. When the PDA recognizes either of these signals, it sets the terminating status as described previously (item 1). If the external device cannot end immediately, the device may signal Demand. Upon recognizing the Demand singal in response to the WC=0/ Read Ready signals, the PDA drops the Read Ready signal and sets Channel End status. The setting of Channel End status allows the channel to release the 2701 when it is operating on a selector channel, thus allowing the channel to operate with other control units. Setting this status when the 2701 is operating on a multiplexer channel in the multiple-byte mode has little use, since the multiplexer channel can operate with all control units to which it is connected. When operating in the record-lock mode on the multiplexer channel, the setting of the Channel End status allows the 2701 to release the channel and prevent channel timeout. When the external device drops the Demand signal, the PDA again signals Read Ready. The data that is received is not transferred to the channel. The Read Ready/Demand sequence continues until either the EOR, EOF, or Interrupt signal occurs, whereupon the proper terminating status is set (item 1). If the command used specifies timeout, the same timeout operation will be performed on the Ready/Demand sequence.

3. Halt I/O is received from the I/O channel. The operation for Halt I/O is the same as though an Interface Stop signal were issued by the I/O channel.
4. Interrupt is signaled by the external device. An Interrupt signal that occurs on the PDA interface while a read operation is in progress causes the immediate setting of terminating status. The Attention status bit and the Command Interrupt sense bit are also set. An Interrupt signal occurring while a command is in operation must be used with the greatest caution. When an Interrupt signal occurs between the rise of the Demand signal and the rise of the next Read Ready signal, the deliverance of the last data word to the channel is uncertain. When the Interrupt signal is generated by other than the external device currently operating on the Read command, this device either must be aware of the occurrence of the Interrupt by monitoring the Interrupt line or it must recognize the occurrence when the Read Select signal falls prior to its generating the EOR or EOF signal.
5. Timeout elapses. During the execution of a Read with Timeout command, if the external device does not respond with the Demand signal within two seconds of the occurrence of the Read Ready signal, the timeout elapses. This sets Channel End, Device End, and Unit Check status with Timeout set in the sense byte. If Channel End has been previously set, the Device End and Unit Check status will be set.

With every data word accepted by the Parallel Data Adapter, a check for correct odd parity is made. When a parity error is detected and the Suppress Parity Error is not signaled by the external device, the Unit Check status is set with the Data Check bit set in the sense byte; however, the command continues until one of the ending conditions shown above occurs.

When an ending does occur, normal or otherwise, the PDA drops the Read Select line when Device End status is set.

Write Operation

The write operation is initiated by the acceptance of either a Write or a Write with Timeout command. The Write Select signal is generated and an immediate request for data transfer is made to the channel by the PDA. When operating on the multiplexer channel and the Normal/Record Lock

switch is in the NORMAL position, the PDA forces the multiple-byte mode for the number of bytes in the data word. When the data word is assembled in the PDA, the adapter generates the Write Ready signal and, when applicable, starts the timeout (Write with Timeout).

When the external device has accepted the data word, it responds with the Demand signal. Upon detecting the Demand signal, the PDA resets the data bus, terminates the timeout (if applicable) and requests another data transfer from the I/O channel. With the transfer of each data word, the PDA drives the parity line in such a way as to maintain odd parity for the entire data word. When the external device checks this parity and detects a parity error, it may signal Redundancy Error. When the PDA recognizes the Redundancy Error signal, it sets the Data Check sense bit and adds the Unit Check status bit to the terminating status. The command is not ended by the occurrence of the Redendancy Error signal.

The write operation continues until one of the following ending conditions occurs:

1. The entire data message has been transferred from the I/O channel to the PDA. This condition is recognized by a Stop signal given by the channel when the PDA requests the transfer of another byte of data. The PDA will immediately set the WC=0 line unless a partial word of data has been accumulated prior to receiving the Stop signal from the channel. When this is the case, the PDA will go through one additional Write Ready/Demand sequence before signaling the WC=0. The data word transferred will be filled out with zeros. In this way, the partial word will be transferred to the external device, and the byte count in the CCW need not be an integral multiple of the number of bytes in the data word.

   The WC=0 signal informs the external device that the PDA will not transfer any further valid data. The response of either EOR or EOF signals causes the Channel End and Device End status to be set and the operation ended. When the response is EOF, the Unit Exception status is also set. However, as in a read operation, the Write Ready signal is generated with WC=0. When the external device cannot immediately end, it responds with the Demand signal to the WC=0/Write Ready signals. When the PDA recognizes the Demand response, it sets the Channel End status and, upon the dropping of the Demand signal, again generates the Write Ready signal. The data transferred on this Write Ready/Demand sequence is all-zeros with the proper parity bit. The Write Ready/Demand sequence continues with Write Ready being generated upon the drop of the Demand signal. When the external device sends the EOR, EOF, or the Interrupt signal, the operation is ended with the proper terminating status (item 1 under Read operation).
2. Halt I/O is received from the channel. The operation for the Halt I/O is the same as though a data-transfer Stop signal were issued by the channel.
3. The external device issues EOR or EOF signals. When the PDA recognizes an EOR or EOF signal, it sets the Channel End and Device End status. For the EOF, the Unit Exception status is also set. When the EOR or EOF signal occurs prior to WC=0 being signaled, the PDA determines whether it has obtained any bytes from the channel (a part or a full data word) that have not been accepted by the external device. When this is the case, the Unit Check status is also set and the Incomplete Data Transfer bit (bit 6) is set in the sense byte. Otherwise, the Channel End and Device End status is set. This check is not performed when the external device signals Interrupt during this condition.
4. The external device signals Interrupt. When the PDA detects an Interrupt signal on the interface during a write operation, it sets Channel End, Device End, and Attention status, together with Command Interrupt (sense bit 1), thus terminating the command. The cautions stated for the interrupt termination during read operations also apply here.
5. Timeout elapses. During the execution of a Write with Timeout command, if the external device does not respond with the Demand signal within two seconds of the occurrence of the Write Ready signal, the timeout elapses. This sets the Channel End, Device End, and Unit Check status with Timeout set in the sense byte.

Interrupts

The Parallel Data Adapter recognizes an Interrupt signal whether or not it is executing a command. When an Interrupt signal is recognized, Attention status is set. As described under the read and write operations, if a Read or Write command is being executed the terminating status is also presented. When operating without a com-

mand, the Interrupt signal causes the Attention status alone to be signaled to the channel.

- Diagnostic Considerations:

The Parallel Data Adapter operates under two diagnostic commands. The Diagnostic Write command presents one word of data to the PDA. The Diagnostic Read command causes the data stored in the PDA register to be read back to the channel. The diagnostic-read operation does not cause the data register to be reset at the start of the command as is done in the Normal read operation. The data register is reset at the end of the data transfer. During the diagnostic-read and diagnostic-write operations, the control signals to the external device are inhibited. The external device has no means of determining that a diagnostic-read or a diagnostic-write operation is occurring. If an Interrupt signal is generated by an external device during a diagnostic operation, the PDA responds as though a normal command were present by setting Channel End, Device End, and Attention status. The diagnostic operation checks the data path up to the external interface circuits.

Status Byte

The following statuses may be set by the Parallel Data Adapter:

Channel End. The Channel End status appears by itself upon the refusal of the external device to respond to a WC=0 signal on either a read or write operation. This status indicates that the 2701 PDA will transfer no additional bytes of data to or from the channel.

Device End. The Device End status indicates that the external device has completed the operation with an EOR signal and that the PDA is free to accept another command. The Device End status appears by itself only when it has been preceded by the Channel End status.

Channel End and Device End. The Channel End and Device End status indicates that the operation has been brought to a normal ending with the external device signaling EOR.

Channel End, Device End, and Unit Check. This status indicates that an unusual ending condition has occurred. The sense byte should be obtained to further define the cause of the unusual ending.

Channel End, Device End, and Unit Exception. This status indicates that the external device has ended normally with the End of File (EOF) signal.

Channel End, Device End, Unit Exception, and Unit Check. This status indicates that an unusual ending has occurred with the external device signaling the End of File (EOF). The sense byte should be obtained to further define the cause of the unusual ending.

Channel End, Device End, and Attention. Channel End, Device End, and Attention status indicates that the operation was ended in one of several ways. First, the Interrupt signal ended the command. In this case, the Command Interrupt sense bit is also set. Second, the operation was ended by the EOR signal, but the Interrupt signal was received before the ending status could be presented to the channel. In this case the Command Interrupt sense bit is not set.

Channel End, Device End, Unit Exception, and Attention. This status indicates that the operation has ended normally with the EOF signal but an Interrupt signal was received prior to the status being delivered to the channel.

Channel End, Device End, Unit Check and Attention. This status indicates that the operation has ended abnormally in one of two ways:

1. By the Interrupt signal with an unusual condition having occurred before the Interrupt signal.
2. By an EOR signal with an unusual condition, and an Interrupt has been received prior to the status being delievered to the channel.

In either case, the sense byte contains information defining the cause of the Unit Check status. The Command Interrupt bit being on indicates that the first condition occurred.

Channel End, Device End, Unit Check, Unit Exception, and Attention. This status indicates that an unusual condition has occurred during the execution of the command, that it has been ended by the EOF signal, and that an Interrupt signal has occurred prior to the status being delivered to the channel. The sense byte contains the cause of the Unit Check status.

Sense Byte

Command Interrupt (Bit 1): (Note: Sense bit 1 is defined in the System/360 Principles of Operation

Manual, Form A22-6821, as being Intervention Required. However, the condition defined for Intervention Required does not occur within the PDA operation. Therefore, only for the PDA, the name of this sense bit is changed to Command Interrupt and the following definition applies.) This sense bit is set when an Interrupt signal is received while the PDA is operating on a command. When the command has been normally ended and the Interrupt signal is received prior to the status being transferred to the channel, sense bit 1 will not be set. By testing this sense bit when the Attention status accompanies the ending status, the programmer can determine if the command was terminated by the Interrupt signal.

Data Check (Bit 4). This sense bit is set when a parity error is detected during a read operation and Suppress Parity Error is not signaled. This bit is also set when Redundancy Check is signaled during a write operation.

Incomplete Data Transfer (Bit 6). This sense bit indicates that data which was accepted by the PDA during a write operation has not been accepted by the external device. This occurs during a write operation when the EOR or EOF signal is set before the data word or partial data word accumulated in the PDA is accepted by the external device. This bit is not set during a read operation. During a read operation, an incomplete data transfer type of event occurs after the byte count has decremented to zero and more data is received by the PDA. When this occurs, the channel signals the 2701 to stop. The PDA does not prejudge this event as being an error condition, and therefore does not set Unit Check status or any sense bit. When the occurrence of this event is an error condition, the programmer may provide for an interrupt by ensuring that the SLI flag (bit 34) in the CCW is set to zero.

Timeout (Bit 7). This bit is set during execution of the Read with Timeout or Write with Timeout commands when the external device does not respond to a data transfer request within the two-second timeout period.

The IBM Terminal Adapter Type III permits the attachment of the System/360 central-computer complex to high-speed, remotely located IBM 2260/2848 Display complexes. This capability provides for the accessing and display of System/360 stored data at convenient remote locations.

- Class of Adapter:

  Asynchronous Display

- Terminal Equipment Serviced:

  IBM 2848 Display Controls with IBM 2260 Display Stations
  IBM 2845 Display Control with IBM 2265 Display Stations

- Associated Publications:

  IBM 2260 Display Station/IBM 2848 Display Control--A27-2700
  IBM 2265 Display Station/IBM 2845 Display Control--GA24-3809

- Adapter Physical-Size Classification:

  Category II

- Type of Operation (Transmission):

  Point-to-Point, Multipoint using Start/Stop Synchronization

- Communications-Line Interface Types

  EIA RS-232-A

  For further information see IBM 2701 Data Adapter Unit--Original Equipment Manufacturer's Information (GA22-6844).

- IBM Terminal Adapter Type III Features:

  None

- Communications Services Required:

  For communication services required, consult your local IBM representative.

- Commands Decoded by IBM Terminal Adapter Type III:

Command	Command Code in Hexadecimal	Flag Bits 32 CD	33 CC	34 SLI	35 SKIP	36 PCI
Read	02	O	O	O	O	O
Write	01	O	O	O	X	O
Diagnostic Read	06	O	O	O	O	O
Diagnostic Write	05	O	O	O	X	O
Write Break	41	X	X	O	X	X
Read Clear	42	X	O	O	O	X

Legend: O = Optional Usage
X = Not Used

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with an incorrect length indication will occur.

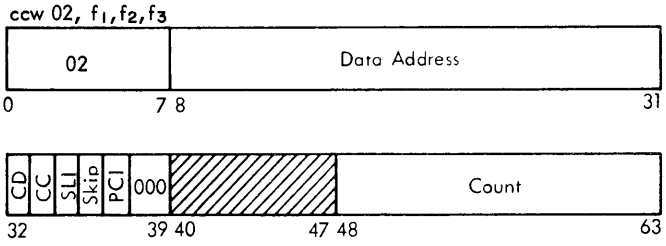
The following commands can be used in IBM Terminal Adapter Type III operations. They are decoded in the coupled XIC.

Command	Code
Sense	04
I/O No Op	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command using a CCW with a command code of '00' will result in a program check.

The commands decoded and executed by the IBM Terminal Adapter Type III are defined in the following.

Read
ccw 02, f_1,f_2,f_3

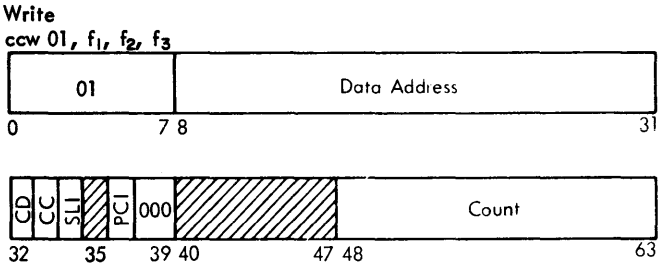


Read

This command is used to transfer incoming data to main storage. It causes bytes to be transferred from the addressed communications channel to main storage at a rate equal to the rate that data is being received from the communications channel. The IBM Terminal Adapter Type III provides for deletion of LRC characters, as well as start and stop bits, from the incoming data.

The first character must be received within a two-second period, called a line timeout, after the Read command is issued. A similar timeout occurs between consecutive received characters. When either of these two timeouts occurs, the Read command is terminated.

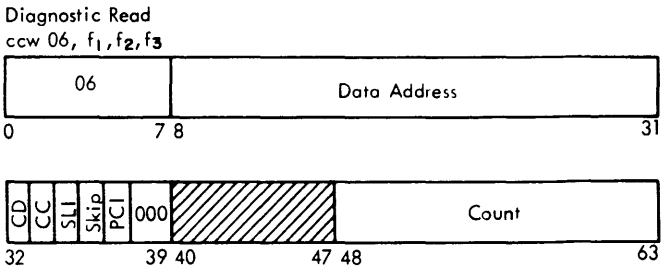
PROGRAMMING NOTE: To prevent the loss of data, the Read command should be terminated only by the reception of an ending character from the terminal. Data may be lost if the Read command is terminated by a Halt I/O instruction and is always lost if terminated by an Interface Stop signal from the channel. An Interface Stop occurs when the 2701 requests data service from the channel whenever the byte count has decremented to zero and data chaining is not flagged (CCW bit 33 set to 0).



Write

The Write command causes the IBM Terminal Adapter Type III to transfer data and control characters, residing in main storage, to the communications channel for transmission to a terminal. The data transfer rate is either 1200 or 2400 bps.

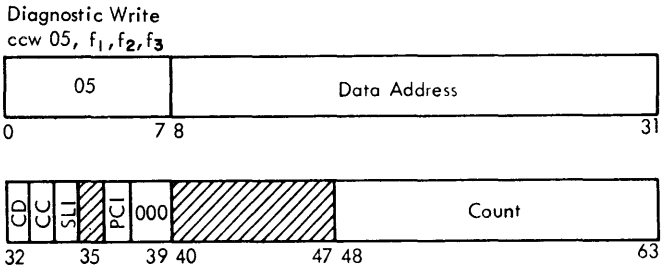
The Write command is normally ended by an Interface Stop signal from the channel. Data characters transferred serially to the communications channel are simultaneously placed in the diagnostic register. This enables the program to obtain "hash totals" after data transfers by the issuance of the Diagnostic Read command.



Diagnostic Read

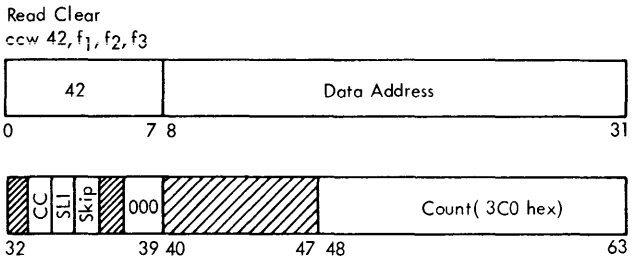
This command causes the IBM Terminal Adapter Type III to read data from the diagnostic register instead of from the communications channel. All other normal read functions are performed.

The first character read is always the character stored in the diagnostic register. This character will always be the final character (text or control) transmitted via the last Write (or Diagnostic Write) previously executed. The second character is automatically generated after the character originally stored in the diagnostic register has been transferred to main storage. This second character will be generated if it is required to end the operation. (See Figure 40.)



Diagnostic Write

This command causes the adapter to perform essentially all normal write functions; however data is blocked from going to the communications channel. The last character transmitted is placed in the diagnostic register (this character can be the LRC character). The Diagnostic Write command is ended by an Interface Stop signal or via the ETX ending sequence (See Figure 40.)



TA-III Mode	Character In Diag Reg	Command Ended by 1st Character	Sense	Status	ETX Generated Prior to Ending
Control	EOT or NAK	Yes		CE/DE/UE	No
	ETX	Yes		CE/DE	No
	ACK	Yes		CE/DE	No
	Valid Character other than ETX, EOT, NAK or ACK.	No		CE/DE	Yes
Text	**Valid Character other than ETX, EOT, ACK, NAK, STX, NUL, or CAN	No	Data Check	CE/DE/UC	Yes
	STX	No		CE/DE	Yes
	ETX	Yes		CE/DE	Yes *
	EOT	Yes		CE/DE/UE	No
	ACK	Yes		CE/DE	No
	NAK	Yes	Data Check	CE/DE/UC	No
	NUL	No		CE/DE	Yes
	CAN	No	Remote Equip Check Data Check	CE/DE/UC	Yes

*This generated ETX is considered the LRC character by the TA-III

** If the previous Write command ended with text transmission of ETX followed by LRC, this character will be the transmitted LRC character.

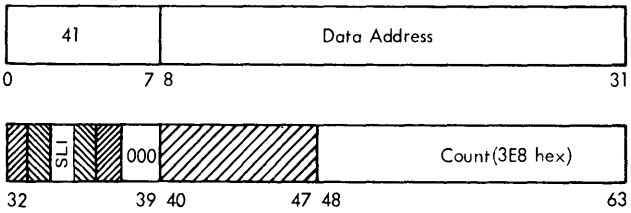
Figure 40. Conditions Causing Generation of ETX Characters and Ending of Diagnostic Read Command--IBM Terminal Adapter Type III

Read Clear

This command, with a byte count of 960 ($3C0_{hex}$), should precede the Write Break command to minimize the possibility of lost data.

All normal read functions are performed except: (1) no control characters are decoded; (2) the search operation is inhibited; and (3) the Intervention Required conditions are inhibited from setting Channel End, Device End, and Unit Check status, and Intervention Required sense bits.

Write Break
ccw 41 f_1, f_2, f_3



Write Break

The Write Break command, with a byte count of 1000 ($3E8_{hex}$), provides a tool for automatic error recovery. It should be used only when it becomes apparent that the 2848 will not respond to normal USASCII commands.

All normal write operations are performed except: (1) no control characters are decoded; (2) the communications line is held at a continuous space or zero level; and (3) the Intervention Required conditions are inhibited from setting Channel End, Device End, and Unit Check status, and Intervention Required sense bits.

NOTE: Loss of data may result through use of the Write Break command. To minimize this possibility, a Read Clear command, with a byte count of 960 ($3C0_{hex}$), should precede the Write Break.

- Effect of Interface Stop and Halt I/O Instruction on IBM Terminal Adapter Type III:

The action taken by the IBM Terminal Adapter Type III upon receipt of an Interface Stop or a Halt I/O signal depends on the command being executed and the state of the adapter. These actions are described for the following commands:

Read

If either an Interface Stop or a Halt I/O is signaled to the adapter when the Read command is being executed, the adapter terminates the command with Channel End and Device End. If data has been read into the adapter but has not been transferred to main storage, Channel End, Device End, and Unit Check status and the Lost Data sense bit are set.

Diagnostic Read

The ending status for Diagnostic Read is the same as for the Read command. If the Stop signal or HIO is issued after the first character is read, the transfer of the automatically generated ETX character is inhibited.

Write and Diagnostic Write

The command ends with Channel End and Device End status following the transmission of the last character received from the channel.

PROGRAMMING NOTE: Halt I/O should be used with caution in terminating the execution of the Read and Write commands.

- Transmission Code Employed:

The communication control and data-character structure is the USASCII code. During transmit operations, one start bit and one stop bit are added to each outgoing character by the adapter. During receive operations, the start bit and the stop bit are deleted from each character by the adapter and are not transferred to main storage.

Characters received from the IBM 2848 Control Unit are in USASCII-code format. The adapter converts the USASCII code to an eight-bit byte, which is sent to main storage. See Figure 41. Conversion is made by adding a bit (called X bit) between bit positions 6 and 5 of the USASCII code. The X bit (System/360 byte positions 0 and 2) always has the same value as the 7 bit. During transmit operations, it is the program's responsibility to send data to the IBM Terminal Adapter Type III in this eight-bit structure. The adapter then converts the eight-bit code to USASCII code for transmission to the IBM 2848.

- Transmission-Code Error Detection Employed:

Vertical Redundancy Check (VRC)
Longitudinal Redundancy Check (LRC)

These transmission-code error-detection operations are performed by the adapter during receive (read) operations. An LRC or VRC error detection results in the Unit Check bit being set in the status byte and a Data Check bit being set in the sense byte. The command under execution when the error condition is checked is not immediately terminated.

During a transmit (write) operation, the X and 7 bits of all data bytes transferred from main storage are compared. If these two bits do not match, the adapter sets the Unit Check status and the Data Check sense bits. The transferred character in error is transmitted to the terminal.

- Line-Control and Functional Characters Recognized in IBM Terminal Adapter Type III Operations:

Read Operation

The line-control operation is accomplished through the use of USASCII communication control characters--specifically, the EOT, STX, ETX, SOH, CAN, ACK, and NAK characters. All control characters that are recognized during a read operation are transferred to the channel and on to main storage.

The following line-control characters are recognized during read operations:

STX (Start of Text). Signals the start of a text message to the adapter, sets the adapter to text mode, and initiates LRC accumulation by the adapter. STX itself is not included in the LRC accumulation.

ETX (End of Text). Signals the end of a text message to the 2701 and indicates the next character is the LRC character. After the LRC is received, Channel End and Device End status are set to end the sequence. If an LRC or VRC error has been detected, the command ends with Channel End, Device End, and Unit Check status and the Data Check bit set in the sense byte. The ETX character is included in the LRC accumulation.

CAN (Cancel). Is inserted between the last text character and the ETX character to indicate a buffer-parity error in the IBM 2848 Display Control. The receipt of the CAN character sets the Unit Check bit in the status byte and the Remote

Byte Positions 4,5,6,7 (b_4,b_3,b_2,b_1)	Hex	S/360 Main Storage Byte Positions 0, 1, 2, 3 (b_7, b_6, b_X, b_5) 0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL	DLE			SP	0					@	P			@	p
0001	1	SOH	DC1				1					A	Q			a	q
0010	2	STX	DC2				2					B	R			b	r
0011	3	ETX	DC3			#	3					C	S			c	s
0100	4	EOT	DC4			$	4					D	T			d	t
0101	5	ENQ	NAK			%	5					E	U			e	u
0110	6	ACK	SYN			&	6					F	V			f	v
0111	7	BEL	ETB			'	7					G	W			g	w
1000	8	BS	CAN			(	8					H	X			h	x
1001	9	HT	EM			)	9					I	Y			i	y
1010	A	LF	SUB			*	:					J	Z			j	z
1011	B	VT	ESC			+	;					K	[			k	{
1100	C	FF	FS			,	<					L	\			l	¬
1101	D	CR	GS			-	=					M	]			m	}
1110	E	SO	RS			.	>					N	¬			n	|
1111	F	SI	US			/	?					O	_			o	DEL

Contents are shown in main storage after coversion to USASCII - 8

0	1	2	3	4	5	6	7

System/360 Byte

b_7	b_6	b_X	b_5	b_4	b_3	b_2	b_1

Main Storage Code Structure

Stop	C	b_7	b_6	b_5	b_4	b_3	b_2	b_1	Start

Transmitted and received USASCII character

The lower case alphabetic characters are converted to upper case alphabetic characters by the 2848 and displayed at the 2260 as upper case characters. In a read operation, these lower case alphabetic characters will be transmitted and stored in upper case bit configurations. Other characters indicated by shading are not used in 2848/2260 operations employing IBM TA-III.

On receive operations, the start-stop bits are deleted at 2701
On transmit operations, the start-stop bits are added by 2701

Figure 41. USASCII-8--System/360 Code Structure as Used in IBM 2848-2260 Operations

Equipment Check bit in the sense byte. The CAN character is included in the LRC accumulation.

ACK (Positive Acknowledge). If received as a response to an addressing or polling sequence beginning with SOH or EOT (adapter is in control mode), ACK means that the address has been accepted and the terminal device is ready to receive the message. ACK received as a response following the transmission of a message beginning with STX (adapter in text mode) indicates that the message was received from the adapter without an LRC or VRC error. In either case, the Read command is terminated with Channel End and Device End status. The adapter does not distinguish between ACK received in text or ACK received in control mode.

NAK (Negative Acknowledge). If received as a response to an addressing or polling sequence beginning with SOH or EOT (adapter in control mode), indicates that the 1053 Printer is not in a ready condition. The command is ended with Channel End, Device End, and Unit Exception status. A NAK response may also be received following the transmission of a text message beginning with STX (adapter in text mode) when the IBM 2848 detects a VRC or LRC error. The Read command is ended with Channel End, Device End, and Unit Check status and Data Check set in the sense byte.

EOT (End of Transmission). Sets the adapter in control mode and indicates one of the following conditions:

1. As a negative response from the IBM 2848 to a Specific Poll or General Poll, indicates that the 2848 has no message to send.
2. When the adapter receives a message from the 2848, the program sends an ACK character (via the adapter) to indicate successful receipt of the message. In return, the 2848 sends an EOT character. In this case, EOT indicates that the 2848 has no further messages to send to the adapter.
3. As a 2848 response to a write operation, EOT indicates that the 2848 detected a lost-data condition.
4. As a 2848 response to the transmission of data to the 1053 Printer, EOT indicates a printer-buffer-overrun condition (the message exceeded printer-buffer capacity).
5. As a 2848 response to an addressing sequence directed to the 1053 Printer, indicates that the Printer is busy.

When any of the preceding conditions occur, EOT is received by the adapter and the Read command is terminated with Channel End, Device End, and Unit Exception status.

No Response. No activity on the receive line within two seconds after the Read command is decoded, or two seconds between consecutive data characters, results in termination of the command with Channel End, Device End, and Unit Check status. The Timeout bit is set in the sense byte.

Write Operation

The following characters are recognized during write operations:

STX (Start of Text). Transmitted to the terminal as the first character of a text message. STX sets the adapter in text mode and causes the receiving 2848 and adapter to initiate LRC accumulation. STX (rather than ACK) may also be used as a positive response from the channel following a "Read DS MI" (Read Display Station Manual Input) operation. At this time, STX causes the keyboard of the selected 2260 Display Station to be restored and the Start symbol to be erased at the conclusion of the transmission.

ETX (End of Text). Indicates the last text character of the message has been transmitted. The LRC character is transmitted by the adapter immediately after the ETX character. The Write command is terminated with Channel End and Device End status following the transmission of the LRC character. The ETX character is included in the LRC character; however the STX is not included in the LRC accumulation. Command chaining to a Read command should be used in order to receive the answerback character from the IBM 2848.

ACK (Positive Acknowledge). Indicates the message just received contains no errors and the operation may proceed. The ACK character does not cause an automatic Write command termination. An Interface Stop must be issued to end the operation.

NAK (Negative Acknowledge). Indicates that an error was detected in a message sent by the terminal. A retransmission of the same message is being requested of the 2848. The NAK character does not automatically end the write operation. An Interface Stop must be issued to end the operation.

SOH (Start of Header). Sent as the first character of all addressing sequences containing the Write command. The adapter is placed in control mode, and an LRC accumulation is inhibited. SOH may also be used as an adapter response to a message from the 2848 when no reply from the 2848 is required.

EOT (End of Transmission). The first character of a Specific Poll, General Poll, or Read Addressed Full DS Buffer sequence. The adapter is placed in control mode, and LRC accumulation is inhibited. EOT may also be used as an adapter response to a message from the 2848 when a return reply from the 2848 is not required.

- Polling and Addressing in IBM Terminal Adapter Type III Operations:

Polling and addressing of a remote terminal is performed via the Write and Read commands initiated by a Start I/O instruction. Polling or addressing requires command chaining of the Write command to a Read command in order to receive the response from the terminal.

The IBM 2848 polling or addressing sequence consists of four characters provided by the program. (Note: The 2701 is not restricted to this four-character sequence.) The first character of either sequence designates whether it is a polling or addressing operation. An EOT character is the first character in a polling sequence. This includes the General Poll, the Specific Poll, and the Read Full DS Buffer sequences. An SOH is the first character in an addressing sequence. This includes any addressing sequences containing a Write command. In both operations, when the adapter transmits EOT or SOH, it is placed in control mode and the remote terminal should become deselected. If the remote terminal remains selected for two seconds, the adapter terminates the operation with Channel End, Device End, and Unit Check status and the Timeout sense bit set.

The characters that follow the first character in either sequence are:

1. DC (Terminal Address)--This character is the address of the 2848 Display Control.
2. DS (Component Address)--This character is the address of the 2260 Display Station or the 1053 Printer attached to the 2848.
3. Function Code--This character designates the function to be performed by the addressed device.

Polling. Polling is initiated by a polling-character sequence (provided by the program) received from the channel under the Write command. The first character received from the channel is the EOT character, which places the adapter in control mode and sets the attached display control units in a nonselected state--unless a 2848 Display Control is in transmit mode. EOT is followed by the transmission of the three remaining characters. The Write command is then terminated and command chained to a Read command to allow the adapter to receive responses from the polled remote-control units. A two-second timeout begins, following the decoding of the Read command.

Addressing. Addressing is initiated in a manner similar to polling. The addressing sequence consists of four characters that are provided by the program under the Write command. The first character received from the channel is the SOH control character, which places the adapter in control mode and sets the IBM 2848 Display Control units to receive the addressing sequence--unless a Display Control is in transmit mode. As the remaining three characters of the addressing sequence are transferred to the communications line, the CCW (channel command word) byte count is decremented to zero and Write command is terminated. Command chaining to the Read command must be utilized to receive the terminal response. A two-second timeout begins when the Read command is decoded by the 2701.

See Figures 42 and 43 for normal addressing and polling examples.

- Timeouts in IBM Terminal Adapter Type III Operation:

Timeout Summary for Read and Write

The line timeout is two seconds immediately following issuance of the Read command and before the first start bit is received, or between each character.

A timeout of two seconds is provided after EOT or SOH is transmitted in a Write command for the Display Control unit previously selected to become deselected. This timeout will occur only in a multipoint system configuration. A timeout can also be generated if Clear to Send is not received within two seconds after a Write command is initiated.

2701 (TA III)	Line Control Operation	2848
Control Mode	EOT + DC + DS + Function →	Control Mode
CE/DE, Unit Check, Timeout	← No response*	Terminal not operating
CE/DE, Unit Exception	← NAK*	Terminal not ready or has no information to transfer
	← STX + Data + ETX + LRC	Text Mode
	ACK** →	Correct data
	NAK** →	Incorrect data (Retransmission Requested)
Text Mode (CE/DE if good data; CE/DE, Unit Check, Data Check if VRC or LRC in error)	← Data + ETX + LRC	Second block of data
Control Mode, CE/DE Unit Check, Unit Exception	← EOT	End of Transmission (EOT)

* 2848 may respond with NAK or give no response.
** 2701 may respond with NAK or ACK.

See 2848/2260 SRL (A27-2700) for detailed sequences

Figure 42. Line-Control Sequences, Normal Polling Operations--IBM Terminal Adapter Type III with IBM 2848

2701 (TA III)	Line Control Operation	2848
Control Mode	SOH + DC + DS + Function →	Control Mode
CE/DE, Unit Check, Timeout	← No response*	Terminal not operating
CE/DE, Unit Exception	← NAK*	Terminal not ready
CE/DE	← ACK*	Terminal ready
Text Mode (CE/DE after LRC)	STX + Data + ETX + LRC →	Text Mode
CE/DE, Unit Check, Timeout	← No response*	
CE/DE, Unit Check, Data Check	← NAK*	
CE/DE	← ACK*	

* 2848 may respond with NAK or ACK or give no response.

See 2848/2260 SRL (A27-2700) for detailed sequences.

Figure 43. Line-Control Sequences, Normal Addressing Operations--IBM Terminal Adapter Type III with IBM 2848

- Status Byte--IBM Terminal Adapter Type III:

  An ending-status byte is sent from the 2701 to the channel at the termination of command execution. The status conditions that may be signaled by the IBM Terminal Adapter Type III, together with their meanings, are:

  Channel End and Device End. Indicates that the current command has been ended normally. No interrupt conditions occurred and the adapter is free to accept another command.

  Channel End, Device End, and Unit Exception. Indicates that the command was ended by unusual conditions. These conditions will cause command chaining to be suppressed.

  Channel End, Device End, and Unit Check. Indicates that the command was ended by error or unusual conditions. The Sense command must be issued to the adapter to further define the error. Command ending occurs immediately with this status if any of the following sense bits are set: Intervention Required, Lost Data, or Timeout. Note that Unit Check status can be set alone (without Channel End and Device End) when the Data Check, Overrun, or Remote Equipment Check bit is set during command execution.

  Channel End, Device End, Unit Check, and Unit Exception. Indicates that a combination of the conditions that caused the command to end with Channel End, Device End, and Unit Exception, plus one or more error conditions that cause sense bits to be set. Unit Check is set each time a sense bit is set.

  Figure 44 lists the status and sense bits that can be set by the adapter, together with the conditions that cause them to be set.

- Sense Byte--IBM Terminal Adapter Type III

  The byte transferred to main storage during the execution of the Sense command is:

Bit Position	Designation
0	Command Reject
1	Intervention Required
2	Bus Out Check
3	Remote Equipment Check
4	Data Check
5	Overrun
6	Lost Data
7	Timeout

  Figure 44 lists the status and sense bits that can be set by the adapter, together with the conditions that caused them to be set.

- Diagnostic Considerations:

  Upon completion of the Diagnostic Write command, a Diagnostic Read command is normally issued to the line under test. Following the acceptance of the Diagnostic Read command, the contents of the diagnostic register (excluding the start and stop bits) are transferred to the data register and into main storage.

  The adapter may automatically generate an ETX character. If generated, the ETX character is also transferred to main storage.

  The Diagnostic Read command is terminated with the appropriate status and/or sense conditions. See Figure 40.

2701 Status Bit (s) set	2701 Sense Bit (s) set	Active Command	Initiating Condition	TA-III Mode
CE, DE		Read Diagnostic Read **	Recognition of an ACK Character	Text/Control (Mode Unchanged)
			Recognition of ETX character followed by receipt and check of LRC character (no LRC error detected.)	Text (Adapter remains in Text mode following command termination)
			Receipt of Halt I/O or Channel Stop no character remains in TA-III to be transferred.	Text/Control (Mode Unchanged)
		Write Diagnostic Write	Recognition of ETX character followed by transmission of accumulated LRC character.	Text (Adapter remains in TEXT mode following command termination)
			Receipt of Halt I/O or Channel (Interface) Stop.	Text/Control (Mode Unchanged)
		Write Read Diagnostic Read Diagnostic Write	Recognition of an ETX character	Control (Adapter remains in Control mode following command termination)
CE/DE/UC	Intervention Required (Bit 1)	Read	Detecting loss of Carrier On signal from data set while information is being received.	Text/Control (Mode Unchanged)
		Write	Detecting loss of Serial Clock Transmit (SCT) signals when using Western Electric Data Set 201B1*	Text/Control (Mode Unchanged)
		Read Write	Detecting loss, or absense of Data Set Ready signal from Western Electric Data Set 202D* or Interlock signal from Western Electric Data Set 201B1*	Text/Control (Mode Unchanged)
		Write Diagnostic Write	Clear to Send signal from data set drops during execution of command.	Text/Control (Mode Unchanged)
	Data Check (Bit 4)	Read Diagnostic Read **	Recognition of a NAK (in text mode) character.	Text (Adapter remains in Text mode following command termination)
			Recognition of an ETX character followed by receipt and check of LRC character (an LRC error is detected).	Text (Adapter remains in TEXT mode following command termination)
	Lost Data (Bit 6)	Read Diagnostic Read	Receipt of a Halt I/O or Channel Stop when the TA-IIi contains character still to be sent to the channel.	Text/Control (Mode Unchanged)
	Data Check/ Intervention Required (Bit 1&4)	Read	Detection of a NUL character and invalid stop-bit.	Text/Control (Mode Unchanged)
	Timeout (Bit 7)	Read Diagnostic Read	Lapse of two seconds following decoding of a Read Command or Diagnostic Read Command without receipt of first valid character, or two second lapse between two consecutive characters.	Text/Control (Mode Unchanged)
		Write	Clear to Send line from the data set fails to rise within two seconds after rise of Request to Send and decoding a Write Command.	Text/Control (Mode Unchanged)
			Data set Carrier Detect does not drop within two seconds after TA-III transmits EOT or SOH. (Multipoint Configurations).	Control (Adapter remains in Control mode following command termination).

Figure 44. Status and Sense Bit Generation in IBM Terminal Adapter Type III Operation (part 1 of 2)

2701 Status Bit (s) set	2701 Sense Bit (s) set	Active Command	Initiating Condition	TA-III Mode
UC	Remote Equip. Check (Bit 3)	Read Diagnostic Read	Recognition of cancel (CAN) character.	Text (Adapter remains in Text mode)
	Data Check (Bit 4)	Read Diagnostic Read	Detection of false stop bit (line at space at stop bit time).	Text/Control (Mode unchanged)
			Recognition of a VRC error.	Text/Control (Mode unchanged)
		Write Diagnostic Write	Recognition that bit positions 0 and 2 (USASCII - 8) are not equal.	Text/Control (Mode unchanged)
	Overrun (Bit 5)	Read	Character lost due to inability to obtain I/O channel service.	Text/Control (Mode unchanged)
CE/DE/UE		Read Diagnostic Read	Recognition of an EOT character	Text/Control (Adapter ends in Control Mode)
			Recognition of a NAK (in control mode) character.	Control (Adapter remains in Control mode following command execution

Notes:

1. Western Electric Data Set 201B1* incorporates a clock for timing purposes.
2. * Or equivalent.
3. ** While in Diagnostic Read, recognition of the first character as ETX followed by the transfer of the LRC (in this case the generated ETX) will set the channel End and Device End.

Figure 44. Status and Sense Bit Generation in IBM Terminal Adapter Type III Operation (Part 2 of 2)

The Synchronous Data Adapter Type I services a family of Tele-processing equipment classified as Synchronous Transmit/Receive (STR) terminals (See Figure 46). All of this type equipment uses similar circuitry and operates in a similar manner. Some STR equipment such as the IBM 7740, IBM 1130 (with Communications Adapter), IBM System/360 Model 20 (with Communications Adapter), and IBM System/360 Models 30, 40, 50, 65, and 75 (via the IBM 2701 equipped with an SDA-I) are operated through programmed sequences.

In STR transmission, the code bits of one character are followed immediately by the code bits of the next character; this provides faster transmission than in start/stop operations, in which each character is preceded by a start bit and followed by one or more stop bits. This, together with the greater tolerance of transmission line jitter and distortion, permits substantially faster transmission speeds with STR than with Start/Stop equipment.

- Class of Adapter:

  Synchronous Transmit Receive (STR)

- Terminal Equipment Serviced:

  Figure 45 shows the terminals that communicate with the 2701 SDA-I.

- Associated Publications:

  IBM 7702 Magnetic Tape Transmission Terminal--A22-6702
  IBM 7711 Data Communication Unit--A22-6808
  IBM 1130 Computing System--A26-5916

- Adapter Physical Size Classification:

  Category II

- Special Adapter Capabilities:

  Early Channel End

- Type of Operation (Transmission):

  Point-to-Point and Switched Network

- Synchronous Data Adapter Type I Features:

Communications-Line Interface

Two types of communications-line interface are available for the SDA-1:

EIA RS-232

Digital compatible with common carrier 5701, 5703, 8801, and 8803 wideband services.

For further information see IBM 2701 Data Adapter Unit--Original Equipment Manufacturers' Information (GA22-6844).

Dual Communication Interface

A basic SDA-I is attached to only one communications channel. With the Dual Communications Interface feature, an SDA-I can be attached to two communications channels. Under program control, the SDA-I operates with one communications channel at a time. For further details, see the Set Mode command.

Auto Call

If the SDA-I contains the Auto Call feature and is attached to an Automatic Calling Unit (ACU), the program can originate a call by "programmed dialing" of a remote terminal over a switched network. The Auto Call feature is available on interface A only. The Auto Call feature has been described in the "2701 Operational Functions" section. For further details on the Auto Call feature as applied to the SDA-I, refer to the Dial command.

Independent of the Auto Call feature, the SDA-I can automatically answer a call originated from a remote terminal in a switched network.

Internal Clock

The Internal Clock feature provides clock signals of three speeds: 1200 bps, 2000 bps, and 2400

Terminal	Speed (bps)	Communication Services (Note 1)	2701 Adapter Required*	Second Interface*
IBM 1013	1200 Note (2) 2000 (2) 2400 (2)	C4, D3 Note (3) C5, D6 (3) D7	7696 7696 7696	3462 3462 3462
IBM 7702	1200 Note (2) 2000 (2) 2400 (2)	C4, D3 Note (3) C5, D6 (3) D7	7696 7696 7696	3462 3462 3462
IBM 7711	1200 Note (2) 2000 (2) 2400 (2) 19.2K 40.8K	C4, D3 Note (3) C5, D6 (3) D7 E3, F3 E1, F1	7696 7696 7696 7695 7695	3462 3462 3462 3461 3461
IBM 1130 with 7690*	1200 Note (2) 2000 (2) 2400 (2)	C4, D3 Note (3) C5, D6 (3) D7	7696 7696 7696	3462 3462 3462
IBM 2701	1200 Note (2) 2000 (2) 2400 (2) 19.2K 40.8K	C4, D3 Note (3) C5, D6 (3) D7 E3, F3 E1, F1	7696 7696 7696 7695 7695	3462 3462 3462 3461 3461

*** Feature Codes**

Notes

(1) Communication service designations are as follows:

C4 and C5--Common carrier public switched telephone network or equivalent privately owned services.

D3, D6, and D7--Common carrier leased type 3002 voice grade channel or equivalent privately owned services.

E1, E3, F1, and F3--Common carrier wideband services or equivalent privately owned services.

(2) Internal Clock (4703*) is required if the attached external data set does not provide its own clocking.

(3) On communication services C4 or C5, Autocall is available. For detailed information, consult your local IBM representative.

Figure 45. Synchronous Transmit Receive (STR) Terminals that Communicate with the 2701 SDA-1

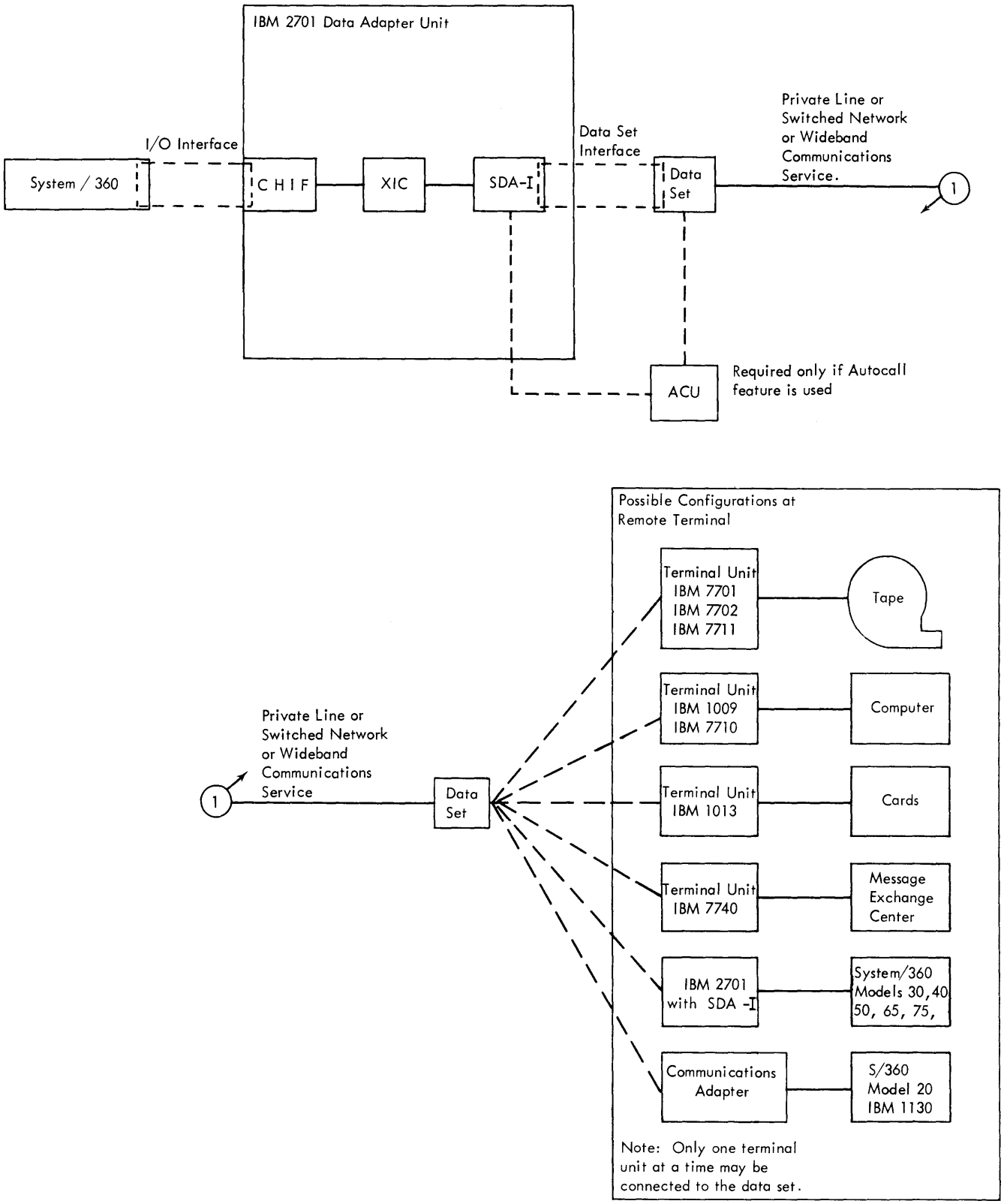


Figure 46. SDA-I in System/360 Environment

bps. The clock is turned on and speed of operation is selected under program control. For further details, see the Set Mode command.

- Communications Services Required:

  For communication services required, consult your local IBM representative.

- Commands Decoded in SDA-I:

Command	Command Code in Hexadecimal	Flag Bits 32 CD	33 CC	34 SLI	35 Skip	36 PCI
Write	01	O	O	O	NA	O
Read	02	O	O	O	O	O
Test Write	05	O	O	O	X	O
Set Mode	23	NR	NR	O	X	NR
Test Read	12	O	O	O	O	O
Send Inquiry	3B	O	O	R	X	NR
Error	17	NA	O	NA	X	NR
Send EOT	37	O	O	R	X	NR
Send TEL	1B	O	O	R	X	NR
Prepare	06	NA	R	NA	NA	NR
Enable	27	NA	O	NA	X	NR
Disable	2F	NA	O	NA	X	NR
Test Sync	33	O	O	R	X	NR
Step Count	07	NA	O	NA	X	NR
Dial*	29	O	O	NA	X	NR

*Requires Auto Call feature.

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with an incorrect length indication will occur.

Legend
O= Optional Usage
NA= Not applicable to command
NR= Not recommended
R= Recommended
X= Not used.

The following commands can be used in SDA-I operation. They are decoded in the coupled XIC.

Command	Code
Sense	04
I/O NO OP	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

The SDA-I command operations are as follows:

Preliminary Notes on SDA-I Command Operation

The Test Input-Output and I/O No Op commands are decoded and executed within the XIC. The Sense command is decoded in the XIC, but is executed by both the XIC and the SDA-I, Under this Sense command, two sense bytes are delivered to the I/O channel, sense byte 1 having been maintained in the XIC sense register, and sense byte 2 having been held in the SDA-I.

SDA-I Decoded Commands

Enable, Set Mode, Dial, and Disable are the only commands that can be accepted before the SDA-I is turned on--i.e., before the SDA-I is placed in the operational mode.

NOTE: In any given transmission sequence, the SDA-I is turned on by the first Enable command that follows a Set Mode command, or by issuing a Set Mode command followed by a Dial command.

The following information describes the command considerations and functions when the command normally ends--i.e., how it ends if there are no errors or unusual conditions encountered. For details on unusual endings refer to the "Status" and "Sense" paragraphs. For information on how commands may be sequenced to achieve system operation, refer to the "Description of Operation" paragraphs.

Command Considerations

SDA-I Operational. The SDA-I must be in the operational mode before the majority of SDA-I decoded commands can be accepted. The effects of placing the SDA-I in operational mode follow:

In switched network operation, placing the SDA-I in the operational mode:

1. Activates a signal that informs the attached data set that the SDA-I is ready to operate and gives the data set permission to go "off-hook" and into the data mode of operation. With this permission given, the data set will go off-hook and into data mode when a remote terminal calls (rings) during Enable execution, or when so directed by the attached Automatic Calling Unit (ACU) during Dial execution. As soon as it is off-hook and in data mode, the data set signals that it is ready. This signal allows the SDA-I to proceed.

NOTE: The terms "on-hook" and "off-hook" denote the supervisory state of the communications-facility signal control. They are derived from the two states of the handset in a telephone subset--i.e., the handset is either on the cradle or off the cradle. On-hook means on the cradle and the communications facility is logically disconnected. Off-hook means off the cradle and the communications facility is logically connected.

2. Permits the SDA-I to request the data set for permission to transmit over the communications channel in accordance with the selected communications mode--i.e., full-duplex, half-duplex, or four-wire half-duplex (refer to "Communications Modes").

In leased private-line operation, the SDA-I operational mode allows the SDA-I to request permission to transmit over the communications channel in accordance with the selected communications mode.

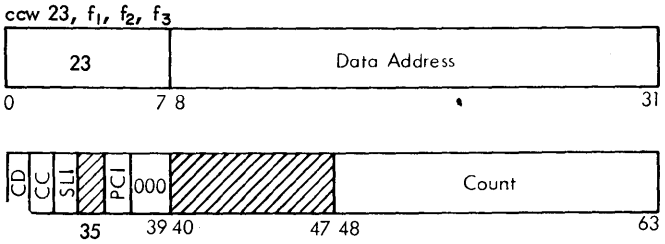
Normal/Record Lock Switch. The 2701 SDA-I Normal/Record Lock switch must be in NORMAL at all times. Thus, on a multiplexer channel, the SDA-I releases the channel at the end of each channel-initiated selection sequence. Thereafter, except during execution of a Sense command, an SDA-I operates in byte-multiplex mode. In the case of a Sense command, both sense bytes 1 and 2 are delivered to main storage in multiple-byte mode.

No Control Immediate Commands. None of the commands decoded in the SDA-I are of the "control immediate" type--i.e., none are of the type where Channel End status is included in the initial status. The SDA-I accepts a command with all-zero status response and later presents an ending status to the channel even though the command is of the type that requires no byte transfers.

NOTE: In any single data transmission, the sequence in which the Set Mode, Enable, and Dial commands is issued determines the programming effects of each of these commands.

Command Descriptions

Set Mode
ccw 23, f_1, f_2, f_3



Set Mode

The Set Mode command can be issued whether the SDA-I is in the operational mode or not. Execution of this command establishes operating conditions specified by the two mode bytes delivered from main storage to the 2701. The first Set Mode in a transmission sequence--i.e., the first Set Mode command after an I/O reset or a Disable command--conditions the SDA-I to remember that a mode has been set. This conditioning remains activated until the time the SDA-I is taken out of the operating mode by an I/O reset or a Disable command.

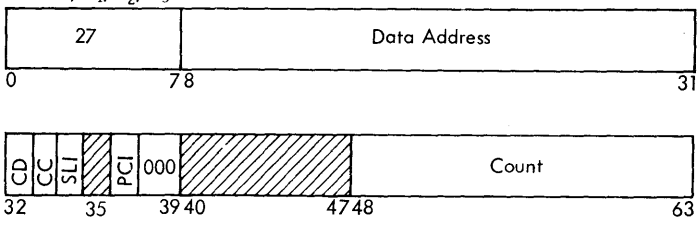
The mode bytes delivered from main storage are stored in the SDA-I mode register. The operating conditions determined by the bits in these bytes are shown in Figure 47. (Note that bit 7 is the only effective bit in mode byte 2.)

If the interrupt mode is selected (bit 7 of byte 2 is off), the Set Mode command ends with Channel End and Device End status. If the interrupt mode is suppressed (bit 7 of byte 2 is on), the Set Mode command ends with Channel End, Device End, and Unit Exception status.

Set Mode followed by either Enable or Dial turns the SDA-I on--i.e., places it in operational mode; however, Enable followed by Set Mode does not place the SDA-I in the operational mode.

PROGRAMMING NOTE: The SDA-I mode can be changed after an I/O operation has started. The following command description (Enable) provides an example of mode modification. To minimize multiplexer channel interference, it is recommended that Set Mode not be command chained to the Enable command (i.e., Set Mode bit 33 should be set to zero).

Enable
ccw 27, f_1, f_2, f_3



Enable

Private-Line Operation. Set Mode followed by Enable turns the SDA-I on--i.e., places the SDA-I in the operational mode. The operational mode allows the SDA-I to request permission to transmit over the communications channel and to proceed with execution of other commands.

Byte	Bit Positions	Names	Set Mode Function
1	0	Intermediate Block Mode	This bit set to one sets the Intermediate LRC mode. The sending SDA-I and the receiving SDA-I not only perform a longitudinal redundancy check (LRC) at the end of each record, but also perform this check whenever a group-mark character (148N) or record-mark character (280N) is detected With this bit off, the LRC is performed only at the end of record.
1	1	Test Mode	This bit position set to one places the SDA-I in the test mode. This mode is prerequisite for the Test Write and Test Read commands. Except for Read, Write, and Dial, other commands can be executed also in test mode.
1	2 and 3	Dual Communi-cation Interface	This double bit combination selects the operational data interface. If the dual communication interface feature is not installed, interface A (bit 2 on alone) must be selected. With this feature installed: a. Bit 2 on bit 3 off causes SDA-I to select interface A and ignore interface B. b. 3 on 2 off causes the SDA-I to select interface B and ignore interface A. c. 2 on and 3 on causes the SDA-I to monitor both the A and B interface for ringing, but operate with neither. d. Both 2 off and 3 off is an invalid combination which sets Unit Check Status and Write Data Check (bit 0 of sense byte 2).
1	4 and 5	Internal Clock Speed Selection	Both bits being off causes SDA-I to use the data set clock. The other combinations cause SDA-I to use the internal clock, as follows: a. 4 not 5 selects speed X (1200 bps) b. 5 not 4 selects speed Y (2000 bps) c. 4 and 5 selects speed Z (2400 bps)
1	6 and 7	Communi-cation Mode	This double bit combination determines the STR communication mode. (The STR mode, half-duplex, full duplex, or four-wire half-duplex, must be compatible with that of the attached data set and line.) a. Bit 6 on bit 7 off gives the half-duplex mode. b. 7 on 6 off gives the full- duplex mode. c. 6 on and 7 on gives the four-wire half duplex mode. d. 6 off and 7 off is an invalid combination which sets Unit Check status and Write Data Check (bit 0 of sense byte 2).
2	7	Interrupt Mode	If off, this bit places the SDA-I in the interrupt mode, If the mode, even though SDA-I is not executing a command, it will interrupt the program with Attention and Unit Check under any of the following conditions, provided a command execution does not start within 0.5 seconds:* a. A selected data set signals "ringing". With bits 2 and 3 both on (see above) either data set signals "ringing". b. An end-of-transmission (EOT), an inquiry (Inq), or a Tel signal is received from remote terminal. c. After character phase has been established, character phase is lost for the period of Command Time-out (approximately 25 seconds). If the SDA-I is not in interrupt mode, it can give its status to the I/O channel only during a command execution, or upon receipt of Tel.

*If a command is accepted within 0.5 seconds after the interrupt condition, the command ends immediately after the channel accepts the initial status. The command ends with Channel End, Device End, and Unit Check status, and the appropriate sense bit.

Figure 47. Set Mode Bit Functions

Switched-Network Operation. In conjunction with Set Mode, the Enable command allows an attached data set to automatically answer calls from a remote terminal. The programmer may select the command sequence that suits his requirements. Enable is accepted whether the SDA-I is on or off.

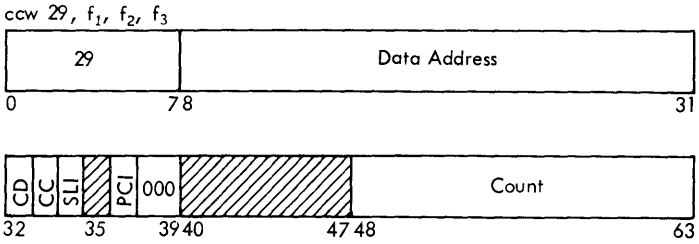
If Enable is issued before the first Set Mode in a ccw sequence, Enable ends immediately and does not turn on the SDA-I. When used in this manner, Enable must be followed by a Set Mode, which places the SDA-I in the interrupt mode and selects one or both data-set interfaces for monitoring. If, for example, both interfaces are selected, the sequence is as follows:

The SDA-I has been previously reset (taken out of the operational mode) by Disable or an I/O reset.
The program issues an Enable command.
The program issues a Set Mode command, placing the SDA-I in the interrupt mode, and selects both data-set interfaces for monitoring.
A data set signals "ringing."
The SDA-I interrupts the program with Attention and Unit Check.
The program issues a Sense command to determine which data set is ringing.
The program issues a Set Mode command to select only the ringing data set.
The program issues an Enable command to place the SDA-I in the operational mode and allow the data set to answer the call. The Enable command ends when the data set activates the Data Set Ready signal to indicate that it has answered the call.

If, in the preceding example, the original Set Mode has selected only one interface for monitoring, the sequence would be the same except that the second Set Mode command would not be necessary. Either of these monitoring sequences is used to avoid tieing up a selector channel while waiting for a remote terminal to call. It has limited usefulness on the multiplexer channel.

If the first Enable command in a sequence is issued after Set Mode, Enable execution places the SDA-I in the operational mode and gives the data set permission to answer calls. In this case, the Enable command ends with Channel End and Device End when the data set activates Data Set Ready to indicate that it has answered a call. Enable is used in this manner when no program interruption is desired and operation is restricted to one data set.

Dial
ccw 29, f_1, f_2, f_3

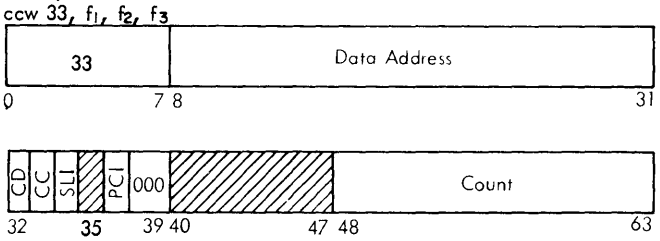


Dial

If the SDA-I has the Auto Call feature, the Dial command causes an attached Automatic Calling (ACU) to dial the remote terminal specified by the digits received from main storage. The Dial command must be preceded by a Set Mode command, which selects data-set interface A to operate with the Auto Call feature.

After the last digit has been dialed, the ACU waits for a tone signal, which indicates that a connection has been made. If this signal is received before the Dial command timeout period (approximately 40 seconds) expires, the ACU turns the communications line over to the data set. The data set then activates Data Set Ready to cause the Dial command to end normally--i.e., with Channel End and Device End status. When the timeout period completes, the command is ended with Channel End, Device End, and Unit Check, with the Simeout sense bit set to one.

Test Sync
ccw 33, f_1, f_2, f_3



Test Sync

The Test Sync command is accepted only if the SDA-I is on (operational). The program may issue this command at any time to verify that a connection has been made with an operational STR-type remote terminal. This verification consists of determining that the SDA-I has established "character phase" (synchronization) with the remote terminal. As described under non-controlled operation, character phase is established when the SDA-I receives and recognizes two consecutive idle characters.

Test Sync ends normally with Channel End and Device End as soon as character phase is

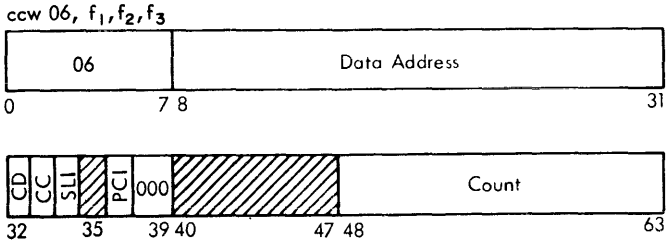
established; however, each time the terminal reaches the end of its own idle-burst transmission, and if character phase has not yet been established, the SDA-I requests one more byte from main storage. This byte is neither buffered nor 4-of-8 checked, nor transmitted to the remote terminal. By honoring this SDA-I byte request, the program extends the execution time of Test Sync--i.e., extends the time duration of the attempt to establish character phase.

Failure to establish character phase over an extended period causes the continuance of this one-byte fetch process. The process continues until the I/O channel signals Interface Stop or a Halt I/O is issued to end the Test Sync command. Ending status results in Channel End, Device End, and Unit Check and Timeout sense bit set to one.

The program should set the byte count to one less than the number of idle-burst transmissions to be allowed before ending the command.

PROGRAMMING NOTE: The attempt to establish and maintain character phase will continue as long as the SDA-I is in the operational mode, regardless of how the Test Sync ends.

Prepare
ccw 06, f_1, f_2, f_3

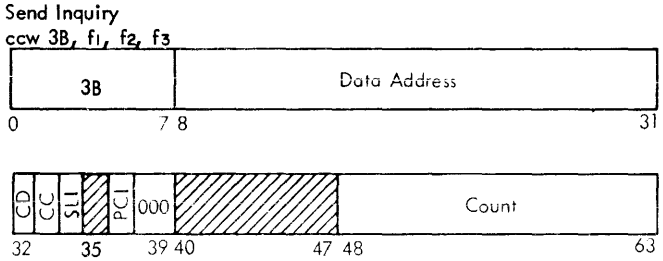


Prepare

The program issues this command to cause the SDA-I to monitor the received bit stream for an Inquiry control signal from the remote terminal. (Refer to "Control Characters" and "Control Signals" for a description of Inquiry and other STR control signals.) Prepare is accepted only if the SDA-I is in the operational mode.

The Prepare command ends normally with Channel End and Device End when an Inquiry signal is received from the remote terminal.

Send Inquiry
ccw 3B, f_1, f_2, f_3



Send Inquiry

The program issues this command to cause the SDA-I to transmit a limited number of Inquiry signals to the remote terminal and to monitor the communications channel for a reply. Send Inquiry is accepted only if the SDA-I is in the operational mode.

The program issues Send Inquiry under either of the following conditions:

1. The program is attempting to establish the SDA-I as the sending terminal and to determine that the remote terminal is ready to receive data. In this case (initial inquiry), the command ends normally with Channel End and Device End when the remote terminal responds with any of the three possible reply signals (ACK 1, ACK 2, or ERR) to indicate that it is ready to receive.
2. The program is requesting a reply to the last record it has transmitted--i.e., the outstanding record. (Normally, the reply is received while still executing the Write command that caused the record to be sent.) If, however, a timeout occurs before a reply is received, the Write command ends with Unit Check status and the command Timeout sense bit set. In this case, the program may issue the Send Inquiry command to request that the remote terminal provide the outstanding reply. The Send Inquiry command ends normally with Channel End and Device End when the reply (ACK 1, ACK 2) is received.

Each time the SDA-I transmits an Inquiry (Inq) signal to the remote terminal, the SDA-I requests one additional byte from main storage. This byte is neither buffered nor 4-of-8 checked, nor transmitted to the remote terminal. By providing for the transfer of an additional dummy byte, the program, via the channel, gives permission to the SDA-I to transmit another Inquiry signal if no reply has been received by the end of its next 515-ms delay (idle burst). If a reply is not received over an extended period, inquiry/reply cycles will continue until the I/O channel signals Interface Stop or Halt I/O is issued to end the Send Inquiry command with Channel End, Device End, and Unit Check status and the Timeout sense bit set. The program should set the byte count to one less than the number of idle-burst transmissions to be allowed before ending the command.

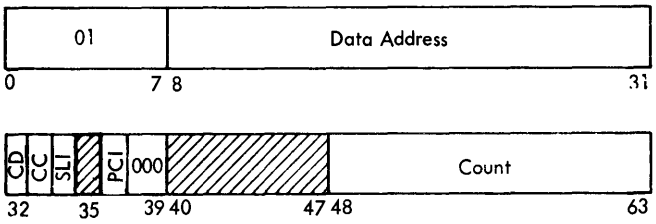
PROGRAMMING NOTE: The programmer is cautioned not to issue a Send Inquiry command immediately following a Read command that ended with Channel End, Device End, and Unit Exception status when operating with the IBM 1009, 1013, 7701, 7702, 7710, and System/360 Model 20. The Unit Exception status indicates that an EOT was received prior to entering data mode (i.e., receipt of SOR). The above-listed equipment requires an EOT response to an EOT from the terminal.

When an EOT is received, the SDA-I will generate an EOT response in approximately one-half second. If a Send Inquiry command is received by the 2701 from the program prior to the transmission of the response EOT, an Inq is transmitted in place of the EOT response.

When operating with the above devices, the Inq response to the EOT causes recycling on the line and possible operator intervention.

If a Send Inquiry operation is desired when operating with these devices, it is recommended that a one to one and a half second delay be used (i.e., between receipt of the Channel End, Device End, and Unit Exception status and the issuance of the Send Inquiry).

Write
ccw 01, f_1, f_2, f_3



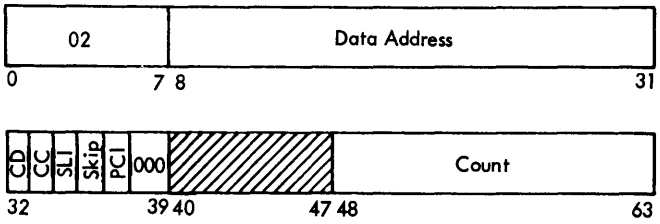
Write

The program issues a Write command to send a single record from main storage to a remote terminal. A series of Write commands may be used to send a group of records in a single transmission (command chaining employed). For a Write to be accepted, the SDA-I must be in the operational mode. Additional acceptance requirements are:

1. For the first Write in a transmission, the SDA-I must have received a reply to an Inquiry signal sent under a Send Inquiry command.
2. For Write commands after the first Write in a transmission, the SDA-I must have received a reply for the last record sent.

A Write command ends with Channel End and Device End when the SDA-I receives a good reply back from the remote terminal (within the command timeout period) for the record sent under that command. If an error reply is received, the command ends with Channel End, Device End, and Unit Check status, and the Error Reply sense bit set to one.

Read
ccw 02, f_1, f_2, f_3



Read

The program issues a Read command to receive a single record from the remote terminal. A series of Read commands must be issued to receive a group of records in a single transmission. For Read to be accepted, the SDA-I must be in the operational mode. The following sequence, covering the first two Read commands in receiving a transmission, shows how the Read command ends normally:

1. The program issues a Read command to its SDA-I--i.e., the receiving (local) SDA-I.
2. The SDA-I transmits a reply to the initial inquiry previously received from the sending terminal while the SDA-I was executing Prepare. For this initial reply, ACK 1 and ACK 2 or ERR is acceptable to the sending terminal.
3. The reply signal permits the sending terminal to transmit the start-of-record (SOR) control signal followed by the data characters of the first record.
4. Upon receipt of SOR, the SDA-I enters the receive-data mode.
5. After receiving the last data character of the first record, the SDA-I receives the end-of-transmittal-record (EOTR) control signal from the sending terminal.
6. Upon receiving EOTR, the SDA-I performs an LRC operation. If the LRC indicates no errors, the first Read command ends normally.
7. If no errors occurred in the first record, the second Read command is issued to the SDA-I.
8. Because it is now executing the second Read and the first record contained no errors, the SDA-I transmits a good reply about the first record.
9. The good reply permits the sending terminal to send SOR, followed by the data characters of the second record.
10. Upon receipt of SOR, the SDA-I enters the receive-data mode.
11. After receiving the last data character of the second record, the SDA-I receives the EOTR for the second record.

12. Upon receiving the EOTR, the SDA-I performs an LRC operation. If the LRC indicates no errors, the second Read command ends normally.
13. If the program finds no errors in the second record, it issues the Read command for the third record; etc.; etc.

If the EOT is received while executing the Read command but before entering data mode (due to receipt of SOR), the command is ended immediately with Channel End, Device End, and Unit Exception status set. If data mode is not entered, the receipt of EOT causes the Read command to be ended immediately with Channel End, Device End, and Unit Check status set and the EOT sense bit set.

PROGRAMMING NOTES:

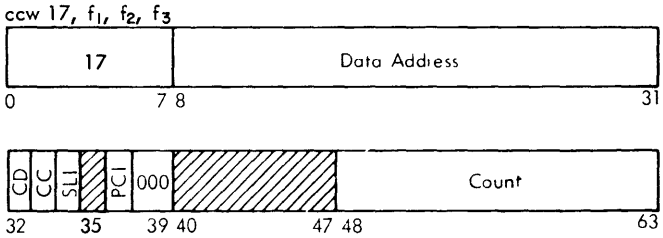
1. As soon as a receiving SDA-I receives a Read command for record n+1, but before it goes into a receive-data condition, the receiving SDA-I transmits a reply for record n. The sending terminal must have the reply for a record n before it can begin to send n+1. If the SDA-I detected a 4-out-of-8 LRC error, it ends the Read command with Channel End, Device End, and Unit Check status with the Data Check sense bit set to one. If retransmission of the record is desired, the Error command should be issued.
2. The programmer is cautioned not to issue a Send Inquiry command immediately following a Read command that ended with Channel End, Device End, and Unit Exception status when operating with the IBM 1009, 1013, 7701, 7702, 7710, 7711, and System/360 Model 20. The Unit Exception status indicates that an EOT was received prior to entering data mode (i.e., receipt of SOR). The above-listed equipment requires an EOT response to an EOT from the terminal.

   When an EOT is received, the SDA-I will generate an EOT response in approximately one-half second. If a Send Inquiry command is received by the 2701 from the program prior to the transmission of the response EOT, an Inq is transmitted in place of the EOT response.

   When operating with the above devices, the Inq response to the EOT causes recycling on the line and possible operator intervention.

   If a Send Inquiry operation is desired when operating with these devices, it is recommended that a one to one and a half second delay be used (i.e., between receipt of the Channel End, Device End, and Unit Exception status and the issuance of the Send Inquiry).

Error
ccw 17, f_1, f_2, f_3

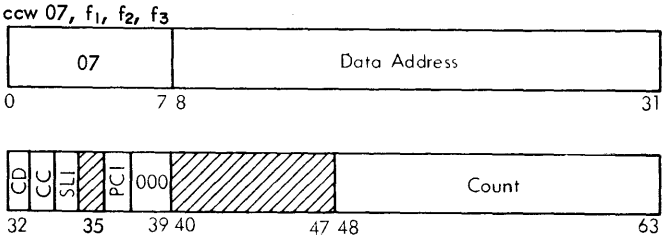


Error

The Error command is accepted only if the SDA-I is in the operational mode. No data bytes are transferred during execution of the Error command.

The Error command is issued by the program associated with the receiving station when it requires retransmission of a record that has been successfully received by the SDA-I. The Error command forces the SDA-I to send an error reply as the outstanding reply. Upon receipt of the error reply, the sending terminal retransmits the record.

Step Count
ccw 07, f_1, f_2, f_3



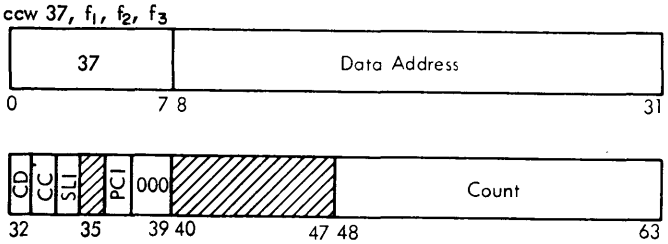
Step Count

The Step Count command is accepted only if the SDA-I is in the operational mode. No data bytes are transferred during execution of Step Count.

The program may issue the Step Count command after being informed by the receiving SDA-I that it has detected an error in the record count (Record Count Check). (Record Count Check indicates a lost or duplicate record.) If the receiving program wishes the transmission to continue despite Record Count Check, it issues the Step Count command to change the state of the receive odd/even counter in its SDA-I. When the next Read command is issued, the receiving SDA-I

transmits a "bad" reply to request that the record be retransmitted. Now, because the receive odd/even counter has been complemented, and the sending terminal retransmits the record with the same SOR, the record count should appear correct to the receiving SDA-I.

Send EOT
ccw 37, f_1, f_2, f_3



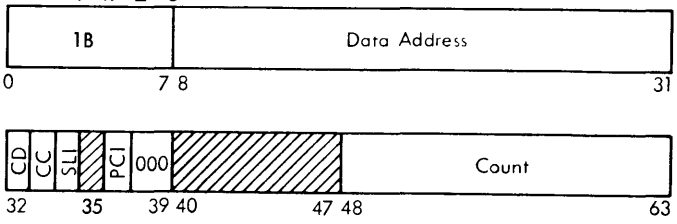
Send EOT

For the Send EOT command to be accepted, the SDA-I must be in the operational mode. The program issues this command to cause the SDA-I to transmit the end-of-transmission (EOT) control signal to the remote terminal. The Send EOT command ends with Channel End and Device End when the EOT response is received. When the Inq response is received, the command ends with Channel End, Device End, and Unit Check status with the Inquiry sense bit set to one.

Either the sending terminal or the receiving terminal initiates the EOT to tell the remote terminal that it wishes to end the current data transmission. The responding EOT informs the initiating terminal that the remote terminal has received and understood the initial EOT.

Each time the SDA-I transmits an EOT signal under this command, the SDA-I requests one additional byte from main storage. This byte is neither buffered nor 4-of-8 code checked, nor transmitted to the remote terminal. By providing for the transfer of an additional dummy byte, the program, via the channel, gives permission to the SDA-I to transmit another EOT signal if no responding EOT has been received by the end of its next 515-ms delay (idle burst). If a responding EOT is not received over an extended period, the EOT/reply/EOT cycles continue until the I/O channel signals Interface Stop or Halt I/O is issued to end the Send EOT command with Channel End, Device End, and Unit Check status and the Timeout sense bit set. The program should set the byte count to one less than the number of idle-burst transmissions to be allowed before ending the command.

Send TEL
ccw 1B, f_1, f_2, f_3



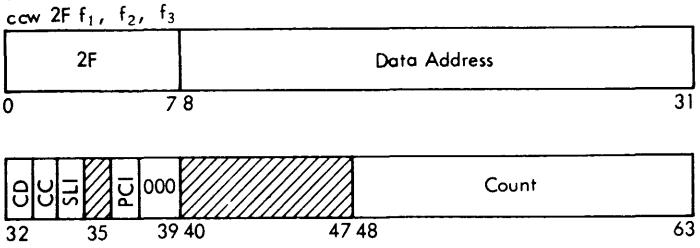
Send Tel

For the Send Tel command to be accepted, the SDA-I must be in the operational mode. The program issues this command to cause the SDA-I to transmit a Tel signal to the remote terminal. The remote terminal should automatically respond with a Tel signal. The Send Tel command ends normally with Channel End and Device End when the Tel response is received.

Either terminal initiates the Tel exchange to tell the remote terminal that the local terminal wishes to communicate by some alternate method, usually telephone. The responding Tel signal tells the initiating terminal that the remote terminal has received and understood the initial Tel signal. Normally, Tel should be sent only after a transmission of records has been completed--i.e., it should be sent after, or in place of, EOT.

Each time the SDA-I transmits a Tel signal, the SDA-I requests one byte from main storage. This byte is neither buffered nor 4-of-8 checked, nor transmitted to the remote terminal. By providing for the transfer of an additional dummy byte, the program, via the channel, gives permission to the SDA-I to transmit another Tel signal if no reply has been received by the end of its next 515-ms delay (idle burst). If a reply is not received over an extended period, the Tel/reply/Tel cycles will continue until the I/O channel signals Interface Stop or Halt I/O is issued to end Send Tel with Unit Check status and the Timeout sense bit set. The program should set the byte count to one less than the number of idle-burst transmissions to be allowed before ending the command.

Disable
ccw 2F f_1, f_2, f_3



Disable

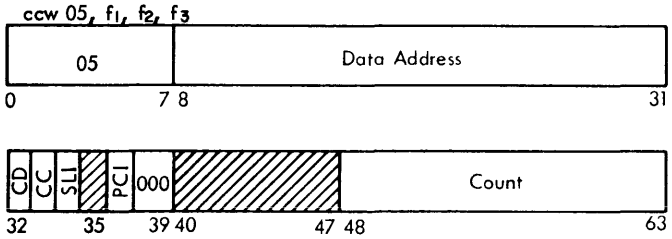
The Disable command, which can be accepted whether or not the SDA-I is in the operational mode, causes a general reset of the SDA-I, including the Set Mode field. If the SDA-I had been in the operational mode, this reset takes the SDA-I out of the operational mode. In a switched network, this reset also places the data set out of data mode and places it "on-hook."

The SDA-I is reset immediately after the I/O channel accepts the initial status. However, the Disable command is ended only after completion of a delay of approximately three seconds. The Disable command always ends normally--i.e., with Channel End and Device End. The ending status should never include Unit Check.

Test Write and Test Read Commands

NOTE: The Test Write and Test Read commands are used for diagnostic purposes. The Test bit should be set to one in the Set Mode command for these commands.

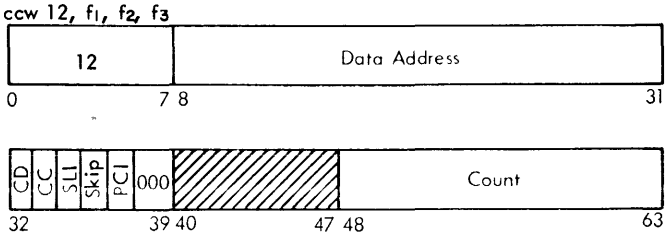
Test Write
ccw 05, f_1, f_2, f_3



Test Write. For the Test Write command to be accepted, the SDA-I must be in the operational mode, and must have been placed in the test mode by a Set Mode command. Test Write operates similar to Write, with the following exceptions:

1. The SDA-I transmit-section output is looped back to the SDA-I receive-section input.
2. Test Write includes diagnostic provisions described later under "Diagnostic Provisions."
3. The SDA-I section simulates control signals normally received from the remote terminal.

Test Read
ccw 12, f_1, f_2, f_3



Test Read. For the Test Read command to be accepted, the SDA-I must be in the operational mode, and must have been placed in the test mode by a Set Mode command. As in the case of Test Write, the SDA-I transmit-section output is looped back to the SDA-I receive-section input.

Test Read operates similarly to Read except that the data is generated within the SDA-I instead of being received from a remote terminal. This generated data flows sequentially through the adapter's transmit and receive circuits, and then to the I/O channel. Test Read includes diagnostic provisions described later under "Diagnostic Provisions." Test Write and Test Read are intended primarily for Customer Engineering test purposes.

Description of Command-Sequence Operation of SDA-I

The function of each SDA-I command has been described. The following paragraphs present some examples of how these commands can be sequenced to permit the SDA-I to accomplish its overall purpose--i.e., control-data transfers between IBM System/360 main storage and a remotely located STR-type terminal. These examples assume normal operation (i.e., no errors or unusual conditions occur).

Leased-Line Sequences

To send data on a leased line to a remote terminal, the command sequence could be as follows:

Disable	Ensures that sense registers are reset, and the SDA-I is "off." Ends with Channel End and Device End. Command chained to:
Set Mode	Selects proper communications interface and suppresses the interrupt mode. Ends with Channel End, Device End, and Unit Exception.
Enable	Turns the SDA-I on--i.e., places the SDA-I in the operational mode. Ends with Channel End and Device End when the data set signals "Ready." Command chained to:
Test Sync	Checks whether SDA-I has obtained synchronism (character phase) with remote terminal. Ends with Channel End and Device End when character phase is established.
Send Inquiry	Asks the remote terminal for a reply that indicates its readiness to receive data. Ends with Channel End and Device End when the reply is received. Command chained to:
Write	Issued by program to permit SDA-I to send one record of data to the remote terminal. Ends with Channel End and Device End when remote terminal transmits a "good" reply to indicate that it has successfully received the record.

The transmission would continue with one Write Command for each record of data. After all records in a given transmission have been sent and replied to, the program can issue the Send EOT command to inform the remote terminal that the transmission has been completed.

To receive data on a leased line, a typical command sequence could be as follows:

Disable	Ensures that sense registers are reset and that the SDA-I is off. Ends with Channel End and Device End. Command chained to:
Set Mode	Selects proper communications interface and suppresses interrupt mode. Ends with Channel End, Device End, and Unit Exception.
Enable	Turns the SDA-I on--i.e., places the SDA-I in the operational mode. Ends with Channel End and Device End when the data set signals "Ready." Command chained to:
Prepare	Looks for an Inquiry (Inq) signal from the remote terminal to establish the local terminal as the receiving data terminal. Ends with Channel End and Device End when an Inq signal is received. Command chained to:
Read	Permits the local SDA-I to reply to the initial inquiry and receive the first data record. Ends with Channel End and Device End if no errors are detected during receipt of record and a successful LRC operation is performed at end of record.

Each time a record is successfully received, the program issues another Read command to allow the SDA-I to send a "good" reply for that record, and receive the next record.

Switched-Network Sequences

To use the Auto Call Feature to initiate a call on a switched network and send data, one command sequence could be as follows:

Disable	Ensures that data sets are "on-hook," sense registers are reset, and the SDA-I is off. Ends with Channel End and Device End. Command chained to:
Set Mode	Selects proper communications interface and suppresses interrupt mode. Ends with Channel End, Device End, and Unit Exception.
Dial	Places the SDA-I in the operational mode and provides the dialing digits to the Automatic Calling Unit (ACU). Ends with Channel End and Device End when the ACU signals that it has returned the communications line to the data set. Command chained to:
Test Sync	Checks whether SDA-I has obtained synchronism (character phase) with remote terminal. Ends with Channel End and Device End when character phase is obtained. Command chained to:
Send Inquiry	Asks the remote terminal for a reply to indicate its readiness to receive data. Ends with Channel End and Device End when the reply is received. Command chained to:

Write — Issued by program to permit SDA-I to send one record of data to the remote terminal. Ends with Channel End and Device End when remote terminal replies to indicate that it has successfully received the record.

The transmission would continue with one Write command for each record of data. After all records in a given transmission have been sent and replied to, the program can issue the Send EOT command to inform the remote terminal that the transmission has been completed.

To use the Auto Call Feature to initiate a call on a switched network, and receive data from the remote terminal, one command sequence could be as follows:

Disable — Ensures that data sets are "on-hook," sense registers are reset, and the SDA-I is off. Ends with Channel End and Device End. Command chained to :

Set Mode — Selects proper interface and suppresses interrupt mode. Ends with Channel End, Device End, and Unit Exception.

Dial — Places the SDA-I in the operational mode and provides the dialing digits to the Automatic Calling Unit (ACU). Ends with Channel End and Device End when the ACU signals that it has returned the communications line to the data set. Command chained to :

Prepare — Looks for an Inquiry signal from the remote terminal to establish the local terminal as the receiving data terminal. Ends with Channel End and Device End when an Inq is received. Command chained to:

Read — Permits the local SDA-I to reply to the initial inquiry and receive the first data record. Ends with Channel End, and Device End if no errors are detected during receipt of record and a successful LRC operation is performed at end of record.

Each time a record is successfully received, the program issues another Read command to allow the SDA-I to send a "good" reply to that record and receive the next record.

To monitor both communications interfaces on an SDA-I with the Dual Communications Interface feature, and answer when one communications interface signals "ringing," one command sequence could be as follows:

Disable — Ensures that data sets are "on-hook," sense registers are reset, and the SDA-I is off. Ends with Channel End and Device End. Command chained to :

Enable — Does not place SDA-I in operational mode, but allows it to interrupt the program if the SDA-I is placed in the interrupt mode. Ends with Channel End and Device End. Command chained to :

Set Mode — Selects both communications interfaces and the interrupt mode. Ends with Channel End and Device End. When a data set signals "ringing" the SDA-I sets the corresponding sense bit (A ringing or B ringing) and interrupts the program with Attention and Unit Check status.

Sense — Causes the XIC/SDA-I couple to deliver two sense bytes to main storage. This permits the program to determine which interface is ringing.

Set Mode — Selects the ringing interface and suppresses the interrupt mode. Ends with Channel End, Device End, and Unit Exception.

Enable — Places the SDA-I in the operational mode, and allows the data set to go "off-hook" and into data mode to answer the call. Ends with Channel End and Device End when data set signals "Ready". If the SDA-I wished to establish itself as the sending data terminal, the above Enable command would be command chained through a Test Sync, Send Inquiry, and Write sequence. If the SDA-I wished to receive data, the above Enable would be command chained through a Prepare and Read sequence.

PROGRAMMING NOTE: The Auto Call feature is not required to answer calls automatically on a switched network.

To monitor either interface A or interface B alone, the preceding procedure is followed except when using the Set Mode command. Under this circumstance, only the specific interface is set.

Effects of Interface Stop

The effect of the Interface Stop signal depends on the command being executed and the state of the SDA-I at the time Interface Stop is received.

Because no byte transfers ever occur during execution of Enable, Disable, Prepare, Error, or Step Count, the Interface Stop signal never affects these commands.

Set Mode

The I/O channel issues Interface Stop to indicate that it has transferred two mode bytes to the SDA-I. If the interrupt mode has been set, and no error or unusual conditions have occurred, Set Mode ends with Channel End and Device Device End status. If the interrupt mode has been suppressed, and no error or unusual conditions have occurred, Set Mode ends with Channel End, Device End, and Unit Exception status.

Dial

The I/O channel issues Interface Stop to indicate that it has transferred the last dialing digit to the SDA-I. Dial ends normally (Channel End and Device End status) when the Automatic Calling Unit (ACU) returns the communications channel back to the data set. As the ACU is operating in the answer-detect mode, the ACU returns the communications channel to the data set when the ACU detects that a connection has been made.

Test Sync

When Test Sync execution starts, the byte count in the channel command word (CCW) specifies the upper limit on the number of attempts (idle-burst/reply cycles) to establish character phase. If this limit is reached without establishing character phase the I/O channel issues Interface Stop, and the Test Sync ends with Channel End, Device End, and Unit Check status, and the Timeout sense bit.

Send Inquiry

When Send Inquiry execution starts, the byte count in the CCW specifies the upper limit on the number of attempts (inquiry/reply cycles) to obtain a reply from the remote terminal. If this limit is reached without obtaining a reply, the I/O channel issues Interface Stop and the Send Inquiry command ends with Channel End, Device End, and Unit Check status, and the Timeout sense bit set.

Write and Test Write

The I/O channel issues Interface Stop to indicate that the last character of a record has been trans-transferred to the SDA-I. The command ends normally (Channel End and Device End status) when the remote terminal (or simulated remote terminal in the case of Test Write) transmits a "good" reply.

Read and Test Read

If the channel issues Interface Stop while the SDA-I is executing Read or Test Read and is in the data mode, the remaining data characters of the incoming record will be lost. Interface Stop, however, does not end the command. The SDA-I checks the remaining portion of the record for transmission errors, and the command ends at its normal ending point, i.e., after the LRC checking operation at the end of the record. If no errors have been detected, the command ends with Channel End, Device End, and Unit Check status, and the Receiving sense bit set.

Sense

Interface Stop causes the Sense command to end immediately with Channel End and Device End status. Normally, however, the Sense command ends with Channel End and Device End status as soon as the SDA-I has delivered the second sense byte to the I/O channel. The XIC/SDA-I couple delivers the two sense bytes in one selection sequence in a multiple-byte mode.

Send EOT

When Send EOT execution starts, the byte count in the CCW specifies the upper limit on the number of attempts (Send EOT/Receive EOT cycles) to obtain a responding EOT from the remote terminal. If the limit is reached without obtaining a responding EOT, the I/O channel issues Interface Stop and the Send EOT command ends with Channel End, Device End, and Unit Check status, and the Timeout sense bit set.

Send Tel

When Send Tel execution starts, the byte count in the CCW specifies the upper limit on the number of attempts (Send Tel/Receive Tel cycles) to obtain a responding Tel signal from the remote terminal. If the limit is reached without obtaining a responding Tel, the I/O channel issues Interface Stop and the Send Tel command ends with Channel End, Device End, and Unit Check status, and the Timeout sense bit set.

Effects of Halt I/O Instruction on SDA-I Operations

Halt I/O does not affect the SDA-I's execution of the Disable, Error, or Step Count commands.

Set Mode

Upon receipt of Halt I/O, the SDA-I immediately terminates the Set Mode command execution. If the mode register contains a "good" mode at the time Halt I/O is received, Set Mode ends with Channel End and Device End status. If the mode register contains a "bad" mode at the time Halt I/O is received, Set Mode ends with Channel End, Device End, and Unit Check status, and the Write Data Check sense bit set.

If Halt I/O terminates the first Set Mode command after the SDA-I has been placed in the "off" mode by an I/O reset or the Disable command, the SDA-I is not considered to have accepted a Set Mode command. That is, another Set Mode must be issued before an ensuing Enable or Dial can place the SDA-I in the operational mode. If the SDA-I was already in the operational mode at the time it accepted Set Mode, termination of Set Mode by Halt I/O does not take the SDA-I out of the operational mode.

Enable

Halt I/O does not affect an Enable command that is issued before the first Set Mode command after the SDA-I has been turned off. If, however, the SDA-I has executed a Set Mode command and receives Halt I/O before the data set has answered a call during Enable execution, the Enable command is aborted and ends immediately with Channel End, Device End, and Unit Exception status. The SDA-I is taken out of the operational mode by an Enable command ending with Unit Exception.

Dial

If, during Dial execution, the SDA-I receives Halt I/O before the Automatic Calling Unit has transferred the communications line to the data set, Dial command execution is aborted, and the ending status is Channel End, Device End, and Unit Exception. Halt I/O has no effect if received by the SDA-I after the Automatic Calling Unit has transferred the communications line to the data set. The SDA-I is taken out of the operational mode by a Unit Exception status.

Test Sync

If the SDA-I receives Halt I/O before character phase is established, Test Sync ends immediately with Channel End, Device End, and Unit Check status, and the Timeout sense bit set. If the ending status had already been set before the SDA-I received Halt I/O, Halt I/O has no effect on Test Sync. Regardless of how Test Sync ends, the SDA-I continues the attempt to establish and/or maintain character phase.

Prepare

If the SDA-I receives Halt I/O before receiving an Inquiry (Inq) signal from the remote terminal, Prepare ends immediately with Channel End, Device End, and Unit Check status, and the Timeout Sense bit set. If ending status had already been set before the SDA-I received Halt I/O, then Halt I/O has no effect on Prepare.

Send Inquiry

If the SDA-I receives Halt I/O before receiving a reply from the remote terminal, the Send Inquiry command ends immediately with Channel End, Device End, and Unit Check status, and the Timeout sense bit set.

Write and Test Write

If the SDA-I receives Halt I/O while it is sending data or waiting for a reply to an outstanding record, the Write or Test Write command ends immediately with Channel End, Device End, and Unit Check status. No sense bits are set. If the SDA-I is sending data when Halt I/O is received, it not only ends the command but also alerts the remote terminal to the situation by transmitting EOI instead of EOTR after the last data character.

Read and Test Read

If the SDA-I receives Halt I/O while executing Read or Test Read, the command ends immediately with Channel End, Device End, and Unit Check status, but does not set a sense bit.

Send Tel and Send EOT

If Halt I/O is received before the normal ending of either of these commands--i.e., before receipt of the responding Tel or EOT from the remote terminal--the command ends immediately with Channel End, Device End, and Unit Check status, and the Timeout sense bit set.

Sense

Receipt of Halt I/O causes Sense to end immediately with Channel End and Device End status.

- Transmission Code Employed:

4-out-of-8 Code

This transmission code consists of an eight-bit character in the fixed-count, 4-out-of-8 coding structure. In this structure, all characters consist of four 1 bits and four 0 bits.

The 64 data characters, plus six special control characters, provide a set of 70 possible characters. See Figure 48.

- Transmission-Code Error Detection Employed:

LRC (Inherent fixed-count, 4-out-of-8 code detection)

- Line-Control and Functional Characters Employed:

When the SDA-I is engaged in sending or receiving data, it must, from time to time, control line activity with the remotely located terminal with which it is communicating. The signals used for control purposes generally consist of two character sequences, consisting of a leader control character and a trailer control character.

The control characters are shown in Figure 49. Each STR-adapted piece of equipment emits idle characters (18RO) to establish and maintain character phase between the two STR-adapted terminals. Very briefly, character phase has been established when an SDA-I or STR-equipped terminal receiving a continuous succession of bits can tell where one eight-bit character ends and the next begins. Synchronism is established at the initiation of the transmission and is normally maintained for the duration of the complete operation. This compares with start/stop transmission, which uses synchronization bits before and after each character to establish and maintain synchronism.

None of the control characters, except the end-of-transmission (EOT) trailer and the Tel trailer, is a valid data character.

Control signals may be divided into three groups:

1. Those that may be transmitted by either a sending or a receiving STR-adapted terminal.
2. Those transmitted only by a sending STR-adapted terminal.
3. Those transmitted only by a receiving STR-adapted terminal.

Figure 50 lists all control signals and briefly describes their functions.

To give an insight into SDA-I operation, Figure 51 shows the sequence of the control-signal exchange between terminals for a two-record message. The table begins with the assumption that character phase has been established.

- SDA-I Timeout Summary:

The SDA-I uses the following timeouts:

Reset timeout (approximately 3 seconds)
Transmit timeout (515 ms)
Receive timeout (approximately 3 seconds)
Command timeout (approximately 25 seconds)
Asynchronous Interrupt timeout (approximately 0.5 seconds)

Reset Timeout

The SDA-I is reset (placed in the "off" mode) immediately after a system reset or immediately after the I/O channel accepts initial SDA-I status for a Disable command. However, the SDA-I waits for approximately three seconds before acknowledging that it has completed the reset. This timeout ensures that SDA-I circuits and the communications circuits have returned to a quiescent state before the channel program issues new commands.

Transmit Timeout

The 515-ms (millisecond) transmit timeout determines the length of idle-burst transmissions during noncontrolled operation. (Refer to "Idle-Burst Exchanges.")

Byte Pos 4,5,6,7 (8,4,2,1)	HEX	S/360 Main Storage Byte Position 0,1,2,3 (N,X,O,R) 0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	0																Blank
0001	1								A				/		J	1	
0010	2								B				S		K	2	
0011	3				SOR2 / ACK2		SOR1 / ACK1	C			3	T		L			
0100	4								D				U		M	4	
0101	5				TL		CL	E			5	V		N			
0110	6				<		[	F			6	W		O			
0111	7		7	X		P				G							
1000	8								H				Y		Q	8	
1001	9				Idle		Inq / Error	I			9	Z		R			
1010	A				\		EOT	?			0	‡		!			
1011	B		#	'		$											
1100	C				;		TEL				@	%		*			
1101	D			+++						‡							
1110	E		>	See Note		-				+ &							
1111	F	:															

0	1	2	3	4	5	6	7	S/360 Byte Structure

N	X	O	R	8	4	2	1	Terminal Code Structure

1	2	4	8	R	O	X	N	Transmitted and Received Structure

Note: When sending to a 1013, 1009, 7701, 7702 or 7710 operating in BCD mode or 7711 in Even Parity mode, the 0010 1110 bit pattern ('2E') should be transmitted to write a CA on tape or skip a column on a card. When these machines read CA or blank column in the BCD mode, the 0010 1110 bit pattern will be sent. When communicating in bin, odd parity or mixed Parity with these machines, the ROXN (bit pattern 1111 0000 will be used for Blank.

Figure 48. System/360 Byte Relationship of 4-out-of-8 Code

SIGNAL MEANING	SIGNALS EXCHANGED	
	SENDING STR	RECEIVING STR
Sending STR announces it is ready to send data and requests receiving STR to reply as to its status.	Inquiry → TL (14RO) | Inq-Error (18RX)	
A reply by the receiving STR acknowledging inquiry and saying it is ready to receive data.		← Ack 2 (see note at end of table) CL (14RX) | SOR 2-Ack 2 (12RO)
Sending STR says that this control signal will be followed by all the data characters of the next record, an odd-numbered record (in this case, the first record).	SOR 1 → TL (14RO) | SOR 1-Ack 1 (12RX)	
	Data characters of first record →	
Sending STR says all data characters of the record have been sent. The second character of this control signal is the LRC character which should be identical with the LRC character developed at the receiving STR.	EOTR → TL (14RO) | LRC Character	
A reply by the receiving STR saying that the odd-numbered record just received (in this case, the first record) has been successfully stored.		← Ack 1 CL (14RX) | SOR 1-Ack 1 (12RX)
Sending STR says that this control signal will be followed all the data characters of the next record, an even-numbered record (in this case, the second record).	SOR 2 → TL (14RO) | SOR 2-Ack 2 (12RO)	
	Data characters of second record →	
Same meaning as the EOTR signals at end of first record.	EOTR → TL (14RO) | LRC Character	
A reply by the receiving STR saying that the even-numbered record just received (in this case, the second record) has been successfully stored.		← Ack 2 CL (14RX) | SOR 2-Ack 2 (12RO)

Note 1. Figure assumes that character phase has been established.

Note 2. Though Ack 2 is the actual reply to inquiry, Ack 1 or Error is also accepted as a good reply.

Figure 49. Line Control Sequences--SDA-I Operations

	Control Signal	Leader (First Character) 1 2 4 8 R O X N	Trailer (Second Character) 1 2 4 8 R O X N	Functions and Remarks
		7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	← S/360 Byte Relationship
Transmitted by either sending or receiving STR equipment.	IDLE	Idle 1 8 R O	(Not a two character sequence)	Equipment generated and transmitted to (a) establish and (b) maintain synchronism. Automatically deleted at receiving terminal. IDLE characters may be inserted into message whenever a character is not available. Continuous stream of idle characters generated for synchronization purposes at beginning of each record transmission. In half duplex operation, each terminal alternately transmits and receives IDLE characters for 1.5 seconds. End of IDLE sequence is recognized when a Control leader (CL) precedes an IDLE.
	End of Idle* (EOI)	Control Leader 1 4 R X	Idle 1 8 R O	Only for change of direction of transmission during idle periods. Reception in receive data condition indicates a transmission error.
	TEL*	Control Leader 1 4 R X	4 8 R X	May be originated by either terminal to request communication by an alternate method. (e.g. telephone conversation). Receiving terminal should respond with TEL. Turns on alarm & lights in some STR equipment and may print a console message. Reception in receive data condition indicates a transmission error.
	EOT*	Control Leader 1 4 R X	2 8 R X	Either terminal initiates an EOT exchange to tell the other terminal that it wishes to end the present data transmission. The responding EOT tells the initiating terminal that the remote terminal has received and understood the initial EOT. Reception in receive data condition indicates transmission error.
Transmitted only by sending STR equipment	Inquiry* (Inq)	Transmit Leader 1 4 R O	Inq 1 8 R X	Equipment generated control signal. Calls for a reply from the receiving machines (Ack 1, Ack 2, Err), i.e. transmitting terminal asks receiving terminal if it is ready to receive messages. Always has a transmit leader (TL) character preceding it.
	Start of Record 1 (SOR 1) Start of Record 2 (SOR 2)	Transmit Leader 1 4 R O Transmit Leader 1 4 R O	SOR 1 1 2 R X SOR 2 1 2 R O	Conditions both sending and receiving machines for transmission of data. Transmitted by sending equipment as first character in each transmitted message. SOR 1 used for the first and all following odd-numbered transmittal records. SOR 1 correlates with ACK 1. SOR is automatically generated at transmitter and deleted at receiver. SOR is used in conjunction with ACK to lessen likelihood of loss or duplication of messages.
	End of Transmittal Record (EOTR)*	Transmit Leader 1 4 R O	Longitudinal Redundancy Check character	Ends the send data conditions and calls for a reply from the receiving equipment.
Transmitted only by receiving STR equipment	Acknowledge 1 (ACK 1)*	Control Leader 1 4 R X	ACK 1 1 2 R X	Acknowledges the correct reception of a record preceded by SOR 1.
	Acknowledge 2 (ACK 2)*	Control Leader 1 4 R X	ACK 2 1 2 R O	Acknowledges the correct reception of a record preceded by SOR 2. ACK correlates to Inq indicating receivers ability to receive.
	Error* (ERR)	Control Leader 1 4 R X	Err 1 8 R X	Calls for a repeat transmission of the last transmitted record. Correlates to Inq, SOR 1, SOR 2.

*Signal causes a change of direction of transmission

Transmit Leader (TL) A control character used to precede inq, SOR 1, SOR 2, and the LRC. Expands transmit operation of STR equipment.

Control Leader (CL) A control character used to precede ACK 1, ACK 2, ERR, EOT, TEL, and IDLE. Expands control operation of STR equipment.

Figure 50. STR Control Signals

Control Character Name	4 out of 8 Code Structure							
	1	2	4	8	R	0	X	N
Transmit Leader (TL)	1	0	1	0	1	1	0	0
Control Leader (CL)	1	0	1	0	1	0	1	0
SOR-1 ACK-1 [(Leader) (TL) (CL)]	1	1	0	0	1	0	1	0
SOR-2 ACK-2 [(Leader) (TL) (CL)]	1	1	0	0	1	1	0	0
INQ ERR [(Leader) (TL) (CL)]	1	0	0	1	1	0	1	0
IDLE	1	0	0	1	1	1	0	0
TEL* (Leader - CL)	0	0	1	1	1	0	1	0
EOT* (Leader - CL)	0	1	0	1	1	0	1	0

* Valid data characters.

Figure 51. STR Line Control Characters

The transmit timeout is also used during execution of the Test Sync, Send Inquiry, Send Tel, and Send EOT commands. At the end of each transmit timeout during execution of these commands, the SDA-I transmits the appropriate control signal (EOT, Inq, Tel, or EOT) and requests a service byte from the I/O channel. This request gives the I/O channel the opportunity to end the command by signaling Interface Stop.

Receive Timeout

The three-second receive timeout has two functions:

1. If the SDA-I is operating in the half-duplex mode and has not yet established character phase, the SDA-I alternately transmits idles for the period of the transmit timeout, and examines the incoming line for the period of the receive timeout.
2. Once the SDA-I has established character phase, it must continuously monitor the operating conditions to be certain that character phase is being maintained. In the full-duplex mode, character phase is considered to be lost if the SDA-I does not receive data or idles for the period of the receive timeout. In the half-duplex and four-wire half-duplex modes, character phase is considered to be lost if the SDA-I does not send data, receive data, receive idles, or receive a control signal for the period of the receive timeout.

Command Timeout

During command execution, certain conditions initiate the command-timeout period (approximately 25 seconds). If this timeout goes to completion--i.e., is not interrupted by an event that ought to occur--the command ends with Unit Check status and the Timeout sense bit is set. Refer to "Timeout Sense Bit" for more detailed information.

Asynchronous Interrupt Timeout

Whenever the SDA-I is not executing a command and encounters an Attention and Unit Check condition, it waits approximately one-half second before attempting to present this status to the I/O channel. If the SDA-I does not accept a command within this period, it interrupts the program by presenting Attention and Unit Check status to the I/O channel. If the SDA-I does accept a command within this period, the command ends with Channel End, Device End, and Unit Check status, and the appropriate sense bit.

- Status and Sense Bytes--SDA-I Operation:

Status Bytes

Status bytes (indicating various status conditions) are sent from the 2701 to the I/O channel at various stages of command execution. The status conditions that may be signaled by the use of the SDA-I, by command, are presented in two command-execution references--i.e., initial-selection status conditions and after-initial-selection status conditions.

Initial-Selection Status

The following list specifies the various conditions under which an XIC/SDA-I couple terminates an initial-selection sequence with the command-reject response (Unit Check status and the Command Reject sense bit):

1. The program presents a command that is neither a valid XIC-decoded command nor a valid SDA-I-decoded command.
2. The program presents a normally valid SDA-I command, but the SDA-I cannot accept the command for one of the following reasons:

a. Dial command is presented to an SDA-I that is not equipped with the Automatic Call Feature.
b. Dial is issued at a time when a data set interface has not been selected.
c. One of the following commands is issued when the SDA-I is not operational.

Test Sync	Step Count
Prepare	Send EOT
Send Inquiry	Send Tel
Read	Test Write
Error	Test Read
Write	

d. Write or Read is issued when the SDA-I is in test mode.
e. Test Write or Test Read is issued when the SDA-I is not in test mode.
f. Write or Test Write is issued before a reply has been received to an inquiry or an outstanding record.

NOTE: Status Modifier (status bit 1) and Control Unit End (status bit 2), CSW bits 33 and 34 respectively, are not applicable in SDA-I operation.

After-Initial-Selection Status

Refer to the System/360 Principles of Operation manual, GA22-6821, for the generalized meanings of Channel End and Device End. When separately presented to the channel, Channel End means that no data transfers or no further data transfers will be required to complete a command that is still being executed.

An SDA-I sets Device End in the status register to signal that the current command has been successfully executed or that the SDA-I has detected an error, and wishes to end the command immediately. As soon as the SDA-I sets Device End, alone or in combination with other status bits, and before the channel has accepted the ending status, the XIC command register is cleared, and the command is said to be ended.

If the SDA-I has the "Early Channel End" installation option, it affects only the Enable, Dial, Prepare, Write, Read, Test Write, a Test Read and Disable commands. The purpose of Early Channel End operation is to free a selector channel to service other attached I/O devices while waiting for Device End from the SDA-I. (This purpose will not be accomplished, however, if command chaining is specified in the current command's channel command word.) Normally--i.e., without this option--the SDA-I sets Channel End and Device End simultaneously, after all parts of a command execution have been completed. With the Early Channel End option, the SDA-I sets Channel End separately, before Device End or any other status bits, as soon as it is determined that command execution requires no data transfers or no further data transfers.

Non-Early Channel End Operation

The following information describes the conditions under which an SDA-I without the Early Channel End option sets the various possible ending status bytes. For a command-by-command summary of combined status and sense endings, refer to "Command Ending Summaries" located later in this publication.

Channel and Device End. The SDA-I always sets this status as soon as any SDA-I decoded command (except Set Mode) ends normally. Set Mode can end normally with Channel End and Device End (interrupt mode) or with Channel End, Device End, and Unit Exception (suppress interrupt mode). For a description of the function of each SDA-I decoded command and how it normally ends, refer to "SDA-I Commands."

Channel End, Device End, and Unit Check. This ending status is possible with any SDA-I decoded command except Disable. (Channel End and Device End is the only ending status that can be presented for Disable, and for the Sense command.)

With reference to Unit Check status, note that:

a. Whenever the ending status includes Unit Check, the channel must issue the Sense command to obtain the sense bytes that indicate the condition that caused Unit Check.
b. With one exception (the Write command), the SDA-I sets Device End whenever it sets Unit Check. Thus, the command is ended immediately after Unit Check is set. When the SDA-I detects an error during Write execution, it sets Unit Check status and the appropriate sense bit. (Equipment Check or Write Data Check), and transmits EOI to the remote terminal and then waits for the error reply before ending the Write command. (Refer to "Sense Bytes" for the conditions that cause Equipment Check and Write Data Check.)

c. When the SDA-I sets Unit Check because of a Bus Out Check, Device End is not automatically set.

Channel End, Device End, and Unit Check status is presented to the I/O channel in and following situations:

a. A command has ended with an error, or other unusual conditions. Refer to "Command Ending Summaries" for details.
b. Set Mode, Enable, or Dial has ended normally, or with an error or other unusual conditions, but a selected or monitored data set has signaled ringing before the I/O channel could accept the ending status.
c. One of the commands noted in the following sentence has ended normally, or with error or unusual conditions, but an SDA-I interrupt control signal (Tel, EOT, or Inquiry) has been received before the channel could accept ending status. This applies to the Enable, Dial, Test Sync, Prepare, Send Inquiry, Write, Read, Error, Step Count, Send EOT, and Send Tel commands.

Channel End, Device End, and Unit Exception. This ending status can be set only when one of the following commands is ended as specified.

Set Mode. The interrupt mode has been suppressed by bit 7 of mode-byte 2 being set to one.

Enable. In switched-network operation, Enable has been successfully ended by Halt I/O before a call was answered.

Dial. Dial has been successfully ended by Halt I/O before the Automatic Calling Unit transferred the communications line to the data set.

Prepare. Prepare has been successfully ended by Halt I/O before an Inq was received from the remote terminal.

Read and Test Read. EOT was received in place of a data record--i.e., after transmitting the reply to previous record and before receiving SOR for the expected record.

Channel End, Device End, Unit Check, and Unit Exception

This ending status is presented to the I/O channel in either of the following situations:

a. Set Mode, Enable, or Dial ends with Channel End, Device End, and Unit Exception, as described in the preceding paragraph, but a selected or monitored data set signals ringing before the channel accepts ending status.
b. Prepare, Read, or Test Read ends with Channel End, Device End, and Unit Exception, as described in the preceding paragraph, but an interrupt control signal (Tel, Inquiry, or EOT) is received before the I/O channel accepts ending status.

Early Channel End Operation

Note that:

1. Early Channel End affects only the Enable, Dial, Disable, Prepare, Write, Read, Test Write, and Test Read commands.
2. Even for the affected commands, Channel End and Device End, as well as any other status bits, may be simultaneously presented to the I/O channel if error or other unusual conditions caused termination of data transfers and termination of command execution to occur simultaneously. In other words, the error or unusual condition occurred before Channel End would normally be set.

Sense Bytes

When an error or other unusual conditions occurs, the 2701 sets at least one of the 16 bits contained in two sense bytes. Sense byte 1 is maintained in the XIC and sense byte 2 in the SDA-I. When set, each sense bit represents the occurrence of a specific condition or conditions. The sense bit names, indicating the conditions the bits represent, are as follows:

Sense Byte 1

Bit	Name
0	Command Reject
1	Intervention Required
2	Bus Out Check
3	Equipment Check
4	Data Check
5	Overrun
6	Receiving
7	Timeout

Sense Byte 2

Bit	Name
0	Write Data Check
1	Error Reply
2	Record Count Check
3	End of Transmission (EOT)
4	Alternate Mode (Tel)
5	Inquiry
6	A Ringing
7	B Ringing

PROGRAM NOTE: Whenever an initial or ending status byte includes Unit Check, the program should issue the Sense command to obtain the sense bits to further define the error or unusual condition.

Sense Byte 1

Though the XIC sense register is physically located in the XIC, Command Reject and Bus Out Check are the only bits in sense byte 1 set by the XIC. All remaining bits in sense byte 1 (and in byte 2) are set by the SDA-I.

The XIC sense register (sense byte 1) is reset when the 2701 is reset, or when the I/O channel presents a command other than Test I/O, I/O No Op, or Sense.

Command Reject (Byte 1, Bit 0). The XIC sets this sense bit together with Unit Check status under any of the following conditions:

a. The I/O channel presents a command that is neither a valid XIC-decoded command nor a valid SDA-I decoded command.
b. The I/O channel presents a valid SDA-I command, but the SDA-I cannot accept the command for one of the following reasons:
   (1) The Dial command is presented to an SDA-I that is not equipped with the Automatic Call feature.
   (2) The Dial command is issued at a time when a data-set interface has not been selected.
   (3) One of the following commands is issued when the SDA-I is not operational:

Test Sync	Error
Prepare	Step Count
Send Inquiry	Test Write
Write	Send EOT
Read	Send TEL
Test Read	

   (4) Write or Read is issued when the SDA-I is in test mode.
   (5) Test Write or Test Read is issued when the SDA-I is not in test mode.
   (6) Write or Test Write is issued before a reply has been received to an inquiry or an outstanding record.

The Command Reject sense bit is never set when Enable, Set Mode, or Disable is received.

Intervention Required (Byte 1, Bit 1). This bit is set by the SDA-I with Unit Check status if a data set or an ACU becomes nonoperational after the SDA-I is operational and is executing any SDA-I decoded command except Disable.

Bus Out Check (Byte 1, Bit 2). If the XIC detects a parity error on the Bus Out lines, it sets this bit with Unit Check status, but does not interrupt command execution.

Equipment Check (Byte 1, Bit 3). This bit indicates an SDA-I equipment malfunction. The SDA-I sets this bit if it detects any of the following conditions:

a. During Write and Test Write, a non-4-of-8 data character or transmit leader (TL) has been shifted out of the transfer shift register.
b. During Send Inquiry, a non-4-of-8 transmit leader has been shifted out of the transmit shift register.
c. During Read or Test Read, the XIC Read Parity line and the SDA-I buffer P bit fail to agree.

When not in test mode, the SDA-I sets Equipment Check with Unit Check status. In test mode, Equipment Check does not cause Unit Check.

Equipment Check should never be set during any of the following commands: Set Mode, Enable, Dial, Prepare, Send Tel, Send EOT, Step Count, Error, Test Sync, Disable, or Sense.

Data Check (Byte 1, Bit 4). During Read or Test Read, the SDA-I sets this bit with Unit Check status if it detects one of the following conditions:

a. A receiving LRC check occurred during a record (intermediate LRC) or at the end of a record.
b. A 4-of-8 check occurred while in data mode.
c. Receipt of a trailer not preceded by a leader while in data mode.

Data Check should never be set during any command other than Read or Test Read.

Overrun (Byte 1, Bit 5). The SDA-I sets this bit with Unit Check status under the following conditions:

a. During Write, channel data service cannot be obtained for the period of the command timeout (approximately 25 seconds).
b. During Read or Test Read, a received data character is lost because data service could not be obtained from the I/O channel by the time the last bit of the following character is received.

Overrun should never be set during any command other than Write, Read, or Test Read.

Receiving (Byte 1, Bit 6). During Read or Test Read, the SDA-I sets this bit with Unit Check status when the I/O channel signals Interface Stop before the channel has taken the last character of an incoming record. In this case, some characters of the data record are lost.

Receiving should never be set during any command other than Read or Test Read.

Timeout (Byte 1, Bit 7). Immediate Setting. The SDA-I immediately sets the Timeout sense bit together with Unit Check status, if any of the following events occurs:

1. During Dial, the ACU activates the ACR (Abandon Call and Retry) in the following way. Each time the ACU deactivates the PND (Present Next Digit) line, it starts the abandon-call-and-retry timeout. (The timeout period is adjustable 7.5 seconds to 40 seconds.) The ACU then activates the ACR line if neither of the following events occurs before the end of this timeout:
   a. SDA-I presents the next digit.
   b. The remote station answers the call after all digits have been dialed (applicable only to ACU's that can detect when remote station has answered the call).
2. During Test Sync, Send Inquiry, Send Tel, or Send EOT, the I/O channel signals Stop or Halt I/O before the normal ending of the command.
3. During Prepare, the I/O channel signals Halt I/O before the normal ending.

Timeout (Byte 1, Bit 7). Command Timeout. During command execution, certain conditions start the command-timeout period (approximately 25 seconds). If this timeout goes to completion--i.e., is not interrupted by an event that ought to occur--the Timeout sense bit is set with Unit Check status.

Dial. (a) The command timeout is started each time the SDA-I asks the channel for the next dialing digit, and is interrupted when the channel delivers the digit. (b) The command timeout is started when the SDA-I delivers the last dialing digit to the ACU. It is interrupted when the ACU gives the communications channel to the data set.

Enable. If the SDA-I is in the interrupt mode, the command timeout is started by Enable execution. Also, regardless of the interrupt mode, the command timeout is started when the selected data set signals "ringing." In either case, the timeout is interrupted by a normal ending of the Enable command--i.e., by the data set answering a call.

Prepare. The command timeout is started by Prepare execution if the SDA-I is in the interrupt mode. The timeout is interrupted by a normal ending of the Prepare command--i.e., by receipt of an Inquiry signal from the remote terminal.

Write. The command timeout is started each time the SDA-I must transmit idles while waiting for the channel to deliver a data byte. It is interrupted when the channel delivers a data byte. If the command timeout goes to completion, the Timeout sense bit and the Overrun sense bit (byte 1, bit 5) are both set.

Write. The command timeout is started while waiting for a reply to the record just sent to the remote terminal. It is interrupted by the reply.

Read. The command timeout is started if the SDA-I requests permission to transmit over a half-duplex communications channel. The command timeout is interrupted if the SDA-I drops this request.

Read. The command timeout is started by receipt of an idle character and is interrupted by receipt of a non-idle character.

Read. The command timeout is started if character phase is lost. It is interrupted by re-establishing character phase and receiving a non-idle character.

Any Command Except Enable. The command timeout is started whenever the SDA-I is waiting for the data set to grant its request for permission to transmit over the communications channel. The timeout is interrupted when the data set grants the request.

Timeout Sense Bit (Byte 1, Bit 7) with Attention and Unit Check. The command timeout is started if all the following conditions are satisfied.

The SDA-I is in the interrupt mode.
Test Sync or Prepare has been successfully executed.
No command is being executed.
Character phase is lost.

The command timeout is interrupted if character phase is re-established. If the command timeout goes to completion, the Timeout sense bit is set with Attention and Unit Check status.

Sense Byte 2

All bits of sense byte 2 are held in the SDA-I. The following gives the conditions that set and reset these bits.

Write Data Check (Byte 2, Bit 0). The SDA-I sets this sense bit, as follows:

1. During Write, the SDA-I sets the Write Data Check sense bit with Unit Check status if the I/O channel transfers a non-4-of-8 character, or an STR control character, to the SDA-I. (Recall that control characters are transferred between the local and remote terminals, but never to or from the I/O channel.)
2. During Test Write, the SDA-I sets the Write Data Check sense bit if the I/O channel transfers a non-4-of-8 character or an STR control character to the SDA-I. As a diagnostic provision, however, Unit Check is not set and Test Write execution is allowed to proceed. For more detail, refer to "Diagnostic Provisions."
3. During Read, the SDA-I sets the Write Data Check sense bit with Unit Check status if the receive shift register assembles a CL control character not followed by an ACK or ERR trailer while in receive data mode. Recall that a sending STR-adapted terminal normally transmits an EOTR signal (TL + LRC) after the last data character of a record. However, as soon as a sending terminal detects an error in its own transmission, it transmits EOI (CL + idle) to alert the receiving terminal.
4. During Test Read, the SDA-I sets the Write Data Check sense bit, but not Unit Check, if the receive shift register assembles a CL control character not followed by an ACK or ERR trailer while in receive data mode.
5. During Set Mode, Enable, or Dial, the SDA-I sets the Write Data Check sense bit with Unit Check status if the I/O channel has transferred an invalid mode-control word to the SDA-I.

Write Data Check should never be set during Prepare, Send Inquiry, Send Tel, Send EOT, Step Count, Error, Test Sync, Disable, or Sense commands.

The Write Data Check sense bit is reset when the 2701 is reset, or when the SDA-I starts to execute the next SDA-I decoded command.

Error Reply (Byte 2, Bit 1). During Send Inquiry Inquiry, Write, or Test Write, the SDA-I sets this bit with Unit Check status if it receives a "bad reply" to an outstanding record. A bad reply may be an error signal, or the wrong ACK signal--i.e., ACK 1 instead of ACK 2 or vice versa. An error signal indicates that the receiving terminal detected an error in the reception of a record. A wrong ACK signal indicates a discrepancy between the odd/even record counts maintained at both the sending and receiving locations.

Error Reply should never be set during any command other than a non-initial Send Inquiry, Write, or Test Write.

The Error Reply sense bit is reset when any of the following events occurs:

The 2701 is reset.
The SDA-I executes Send Inquiry.
The SDA-I enters send-data mode or receive-data mode.
The SDA-I executes Send Tel or Send EOT.

Record Count Check (Byte 2, Bit 2). During Read or Test Read, the SDA-I sets this bit together with Unit Check status if the sending terminal (or simulated sending terminal) precedes a record with the wrong start-of-record (SOR) signal and, upon retransmission of the same record, once again precedes it with the same erroneous SOR. (SOR 1 precedes odd-numbered records and SOR 2 precedes even-numbered records.) SOR is considered wrong when its odd/even count does not agree with the count kept by the receiving terminal. A wrong SOR indicates a lost or a duplicate record.

Record Count Check should never be set during any command other than Read or Test Read.

The Record Count Check sense bit is reset by either of the following events:

The 2701 is reset.
The I/O channel at the receiving station issues the Step Count command to change the odd/even record count kept in the receiving equipment.

EOT (Byte 2, Bit 3). If the SDA-I is on, it sets the EOT sense bit when it receives an EOT signal from the remote terminal, unless: (a) the SDA-I is executing Send EOT or Disable, or (b) the SDA-I is executing Sense and has already transmitted the second sense byte to the channel. (Refer to the Send EOT commands for the function of the EOT signal.)

The SDA-I sets the EOT sense bit with Unit Check status if it receives an EOT signal while executing a command other than Send EOT, Sense, or Disable.

The SDA-I sets the EOT sense bit with Attention and Unit Check status if all the following conditions are satisfied:

a. The SDA-I is in interrupt mode.
b. The EOT signal is received when the SDA-I is not executing a command.
c. The SDA-I does not start to execute a command for at least 0.5 seconds after receipt of EOT.

If an SDA-I, in interrupt mode, receives an EOT signal while not executing a command, but starts to execute a command within 0.5 seconds of receipt of EOT, the SDA-I treats the EOT signal as if it had been received during execution of the latest command.

If the SDA-I is not in interrupt mode and receives and EOT signal while not executing a command, it sets the EOT sense bit, but takes no further action until the next SDA-I decoded command is accepted. At that time, the EOT sense bit is treated as if the EOT signal had been received during execution of this latest command.

Any of the following conditions resets the EOT sense bit:

a. Reset of the 2701.
b. Acceptance of the next command if the SDA-I is in test mode.
c. When not in test mode, a proper ending to a Send Inquiry, Send Tel, or Send EOT command.
d. Sending an EOT signal.

Alternate Mode, Tel (Byte 2, Bit 4). If the SDA-I is on, it sets the Tel signal from the remote terminal unless: (a) the SDA-I is executing Send Tel or Disable, or (b) the SDA-I is executing Sense and has already transmitted the second sense byte to the channel. (Refer to the Send Tel command for the function of the Tel signal.)

The SDA-I sets the Tel sense bit with Unit Check status if it receives a Tel signal while executing a command other than Send Tel, Disable, or Sense.

Regardless of interrupt mode, the SDA-I sets the Tel Sense bit with Attention and Unit Check status if the SDA-I receives a Tel signal while not executing a command and does not start to execute a command within 0.5 seconds of receipt of Tel.

Any of the following conditions resets the Tel sense bit:

a. Reset of the 2701.
b. Acceptance of next command if the SDA-I is in test mode.
c. When SDA-I is not in test mode, a proper ending to a Send Inquiry, Send Tel, or Send EOT command.

Inquiry (Byte 2, Bit 5). The SDA-I sets the Inquiry sense bit upon receipt of any Inq signal from the remote terminal, unless the SDA-I is in one of the following conditions:

1. The SDA-I is executing Prepare, Read, or Disable at the time the Inq signal is received.
2. The SDA-I is executing Sense and has already transmitted the second sense byte to the channel.

If the Inquiry sense bit is set while a command is being executed, the SDA-I sets this bit together with Unit Check status.

If the SDA-I is in interrupt mode and no command is being executed when the Inq signal is received, and if the SDA-I does not start to execute a command within 0.5 seconds of receipt of Inq, the SDA-I sets the Inquiry sense bit together with Attention and Unit Check status.

If the SDA-I is not in interrupt mode and receives an Inquiry signal while not executing a command, it sets the Inquiry sense bit, but takes no further action until the next SDA-I-decoded command is accepted. At this time, the Inquiry sense bit is treated as if the Inq signal had been received during execution of this latest command.

The Inquiry sense bit is reset when either of the following events occurs:

a. The 2701 is reset.
b. The I/O channel accepts sense byte 2 during Sense execution.

A Ringing (Byte 2, Bit 6). The SDA-I sets the A Ringing sense bit under the following conditions:

1. The SDA-I sets the A Ringing bit with Attention and Unit Check status if all the following conditions are satisfied:
   a. An Enable command has been issued, executed, and ended prior to Set Mode. Though this Enable does not turn on the SDA-I, it permits the SDA-I to interrupt the program.
   b. A Set Mode command has selected interface A and the Interrupt mode. (Interface B may or may not also be selected.)
   c. Data Set A signals ringing when it is on-hook and the SDA-I is not executing a command.
   d. The SDA-I does not start to execute a command for at least 0.5 seconds after ringing.
2. The SDA-I sets the A Ringing bit with Unit Check status if all the following conditions are satisfied:
   a. The Set Mode command is being executed and interface A has been selected. (Interface B may or may not also be selected.)
   b. Data set A signals ringing when it is on-hook.

The A-Ringing bit should never be set during any command other than Set Mode. The A Ringing sense bit stays on until the second byte of a Sense command.

B Ringing (Byte 2, Bit 7). The SDA-I sets the B Ringing sense bit under the following conditions:

1. The SDA-I sets the B Ringing bit with Attention and Unit Check status if all the following conditions are satisfied:
   a. An Enable Command has been issued, executed, and ended, prior to Set Mode. Though this Enable does not turn on the SDA-I, it permits the SDA-I to interrupt the program.
   b. A Set Mode command has selected interface B and the interrupt mode. (Interface A may or may not also be selected.)
   c. Data set B signals ringing when it is on-hook and the SDA-I is not executing a command.
   d. The SDA-I does not start to execute a command for at least 0.5 seconds after ringing.
2. The SDA-I sets the B Ringing Bit with Unit Check status if all the following conditions are satisfied:
   a. The Set Mode command is being executed and interface B has been selected. (Interface A may or may not also be selected.)
   b. Data set B signals ringing when it is "on-hook".

B Ringing should never be set during any command other than Set Mode. The B Ringing

sense bit stays on until the second byte of a Sense command.

- SDA-I Timing Considerations:

  The following are definitions of timings, summarized in Figure 52 that must be considered when programming the SDA-I:

  Overrun Read

  This is the maximum permissible time the SDA-I can wait without incoming data characters being lost.

  Service Write

  When transmitting a message, this is the maximum permissible time the SDA-I can wait before inserting an Idle character.

  Halt I/O Write

  During a Write command, this is the maximum time for the SDA-I to present ending status after the channel has issued Halt I/O.

  Halt I/O Read

  During a Read command, this is the maximum time for the SDA-I to present ending status after the channel has issued Halt I/O.

  Time per Command Byte Count (Test Sync, Send Inquiry, Send Tel, Send EOT)

  This is the time interval between dummy data-service requests that step the command byte count. The dummy service request is made each time the SDA-I transmits EOI after having so far failed to achieve the normal command ending. The command byte count should be set to one less than the number of dummy service requests to be made before giving up and ending the command with Interface Stop.

  Reset Timeout

  When the SDA-I is reset, either by an I/O reset or by a Disable command, this 3.2-second timeout ensures that SDA-I circuits have sufficient time to attain a quiescent state before the next command is executed. In the case of a Disable command, the command ending (Channel End and Device End) is delayed until this timeout is completed. In the case of an I/O reset, the 2701 cannot load its command register until this timeout is completed.

  With a multiplexer channel, a basic SDA-I releases the I/O interface after every single byte transfer, with one exception. During Sense execution, both sense bytes are delivered to the channel in one selection sequence.

Timing Name	Time
Overrun Read	8 bit periods minus 1 μs
Service Write	7 bit periods minus 1 μs
Halt I/O Write	Immediate
Halt I/O Read	Immediate
Time Per Command Byte Count	0.5 second to 3 seconds
Reset Timeout	3.2 seconds + 17 ms

Figure 52. Timing Considerations in a Basic SDA-I Operation

- SDA-I Special Considerations:

  Message Restrictions

  1. All data characters are exchanged between main storage, the I/O channel, the XIC, the SDA-I, and the data set in the 4-of-8 code. (Refer to "Data Coding.")
  2. In the 4-of-8 code, 70 characters are possible. Of these, 64 are valid data characters. The remaining six are reserved for STR control characters. The processor never transfers a control character to the I/O channel as part of a data record.
  3. Record lengths must be compatible with the remote terminal capability.
  4. Blank (hex 40) should be: (a) ROXN in 4-of-8 code if remote terminal is operating in binary mode or mixed mode, or (b) 2480 in 4-of-8 code if the remote terminal is operating in BCD mode.
  5. If the remote receiving terminal is operating in the mixed mode, the first character of a record determines whether the remote terminal stores the record in odd or even parity. If the record is to be stored in odd parity, the first character should be B (C2 in hex, 2ROX in 4-of-8). If the record is to be stored in even parity, the first character should be U (E4 in hex, 4RON in 4-of-8). Note that the first character (U or B) is deleted from the message at the remote terminal.

Command-Ending Summaries

The following paragraphs summarize the combined status and sense endings for each command except Disable, Sense, Error, Step Count, and Test Read. Disable and Sense must have the normal ending of Channel End and Device End. Error and Step Count can have only one unusual ending--i.e., Channel End, Device End, Unit Check, and Intervention Required. The differences between Test Read and Read are covered under "Diagnostic Provisions."

With reference to these command-ending summaries, note the following:

1. These summaries do not show Bus Out Check in any endings. If the 2701 detects a Bus Out Check, it sets Unit Check but does not interrupt command execution.
2. Except for Set Mode and Dial, these summaries do not cover Intervention Required. Unless the SDA-I is in test mode, this sense bit is set together with Unit Check status, and the current command is ended immediately, under either of the following conditions:
   a. A selected Automatic Calling Unit is nonoperational at the time of Set Mode, or becomes nonoperational before the Dial Command can be fully executed.
   b. The data set becomes nonoperational at any time after it has been connected to the communications channel--i.e., at any time after it has signaled Data Set Ready.
3. The effects of Interface Stop are indicated by IS, the effects of Halt I/O are indicated by HI/O, and the effects of communications line activities are indicated by COMM. Normal endings are unmarked.

Set Mode Endings

HI/O IS — CE and DE. Normal ending if interrupt mode has been selected. The I/O channel has issued Interface Stop or Halt I/O after successfully transferring two "good" mode bytes to the SDA-I.

HI/O IS — CE, DE, and UC. Normal ending if interrupt mode has not been selected. The I/O channel has issued Interface Stop or Halt I/O after successfully transferring two good mode bytes to the SDA-I.

HI/O — CE, DE, UC, and Write Data Check. (a) A "bad" mode byte has been set during execution of Set Mode, or (b) the I/O channel has issued Halt I/O before the first byte could be placed in the mode register.

COMM — CE, DE, UC, and A or B Ringing. Ending if Set Mode ends with Unit Exception (as in preceding CE, DE, and UE ending), but a selected or monitored data set signals ringing before the channel accepts the ending status.

COMM — CE, DE, UC, and Intervention Required. The selected data set is not operational, or has become not operational before Set Mode ending status was accepted.

COMM — CE, DE, UC, and EOT. EOT received while executing Set Mode.

COMM — CE, DE, UC, and Tel. Tel Received while executing Set Mode.

COMM — CE, DE, UC, and Inq. Inq received while executing Set Mode.

Enable Endings (Non-Early Channel End Operations)

CE and DE. Normal ending. (a) If the Enable does not turn the SDA-I on--i.e, if this Enable command has been issued prior to any Set Mode--the normal ending means that Enable has conditioned the SDA-I to interrupt the program with Attention and Unit Check if a data set signals ringing after a Set Mode places the SDA-I in interrupt mode. (b) In switched-network operation, if Enable follows Set Mode, this ending means that the SDA-I is on, and that the data set has answered a call. (c) In private-line operation, if Enable follows Set Mode, this ending means that the SDA-I has been turned on, and the selected data set is ready.

HI/O — CE, DE, and UE. The SDA-I is on and the channel has ended the Enable command by issuing Halt I/O before the data set could answer a call.

COMM CE, DE, UC, UE, and A or B Ringing. This is the ending if Enable ends with UE (as in the immediately preceding ending), but a selected or monitored data set signals ringing before the channel accepts ending status.

COMM CE, DE, UC, and Timeout. (a) If in interrupt mode, this is the ending if no ring was received and answered for period of command timeout, (approximately 25 seconds). (b) Regardless of interrupt mode, this is the ending if a ring is received but is not answered within command-timeout period.

COMM CE, DE, UC, and Write Data Check. Enable has turned on SDA-I while SDA-I is in a mode that is acceptable while SDA-I is off, but is considered bad as soon as the SDA-I turns on. These modes are: (a) No communications mode selected; (b) Two data set interfaces selected; and (c) Selections of the internal clock when it has not been installed.

Dial Endings

IS CE and DE. Normal ending. The channel has transferred the dialing digits to the SDA-I and has issued Interface Stop to indicate the last dialing digit; the Automatic Calling Unit has successfully dialed a station; and the local data set has been connected to the line. (Refer to Dial command to see when this ending means that a connection has been made with a remote terminal, and when it means only that the dialing operation has been completed.)

HI/O CE, DE, and UE. Dial has been ended by Halt I/O before the Automatic Calling Unit could transfer the communication line to the data set. (Note: Halt I/O has no effect if it is issued after the communication line has been transferred to the data set.)

HI/O CE, DE, UC, UE, and A or B Ringing. Dial has been ended by Halt I/O as in the immediately preceding ending, but a selected or monitored data set has rung before the channel accepted the ending status.

COMM CE, DE, UC, and Write Data Check. Dial execution has been attempted with the SDA-I in an invalid mode.

COMM CE, DE, UC, and Timeout. (a) The Automatic Calling Unit has signaled the SDA-I to abandon the call and retry, or (b) the command-timeout period has reached completion during Dial, either because the I/O channel has failed to honor a service request or because, after all digits have been presented, the dialing operation has not completed.

COMM CE, DE, UC, and Intervention Required. (a) The selected interface is not wired to operate with the Automatic Call Feature, or (b) the Automatic Calling Unit is not operational, or (c) the data line was occupied at the time Dial was attempted.

COMM CE, DE, UC, and Inq. An Inquiry signal was received before the I/O channel accepted Dial ending status.

COMM CE, DE, UC, and Tel. A Tel signal was received before the I/O channel accepted Dial ending status.

COMM CE, DE, UC, and EOT. An EOT signal was received before the I/O channel accepted Dial ending status.

Test Sync Endings

CE and DE. Normal Ending. SDA-I has established character phase with remote terminal.

HI/O IS CE, DE, UC, and Timeout. (a) Character phase had not been established when the I/O channel issued Interface Stop after a predetermined number of SDA-I service requests. (Command byte count should be set to one less than the number of service requests to be allowed before giving up and ending this command.) (b) Channel has issued Halt I/O before character phase could be established.

COMM CE, DE, UC, and EOT. An EOT signal was received before the I/O channel accepted Test Sync ending status.

COMM CE, DE, UC, and Tel. A Tel signal was received before the I/O channel accepted Test Sync ending status.

COMM CE, DE, UC, and Inq. An Inquiry signal was received before the I/O channel accepted Test Sync ending status.

Prepare Endings (Non-Early Channel End Operation)

CE and DE. Normal ending. An Inquiry signal has been received after the SDA-I established character phase.

HI/O CE, DE, UC, and Timeout. Program has ended this command by issuing Halt I/O before an Inquiry signal was received from remote terminal.

HI/O CE, DE, UC, Timeout, and EOT. Prepare has been ended by Halt I/O as in the immediately preceding ending, but EOT was received before the I/O channel could accept ending status.

HI/O CE, DE, UC, Timeout and Tel. Prepare has been ended by Halt I/O as in the immediately preceding ending, but a Tel signal was received before the I/O channel could accept ending status.

HI/O CE, DE, UC, Timeout, and Inquiry. Prepare has been ended as in the immediately preceding ending, but an Inq signal was received before the I/O channel could accept ending status.

COMM CE, DE, UC, and Timeout. SDA-I is in interrupt mode and no Inquiry was received for the command timeout period (approximately 25 seconds).

COMM. CE, DE, UC, and EOT. SDA-I has received and EOT signal while waiting for Inq.

COMM CE, DE, UC, and Tel. SDA-I has received a Tel signal while waiting for Inq.

Send Inquiry Endings

CE and DE. Normal ending. An acceptable reply has been received from remote terminal. In case of initial Inquiry, ACK 1, ACK 2, or ERR reply is acceptable. In case of an Inquiry about an outstanding record, the reply must be ACK 1 or ACK 2, and must agree with the record count maintained in the local terminal.

HI/O IS CE, DE, UC, and Timeout. (a) A reply had not yet been received when channel issued Stop after a predetermined number of Inquiry-Reply cycles. (Command's byte count should be set to one less than the number of Inquiry/Reply cycles to be performed before ending this command.) (b) Channel has aborted the Send Inquiry command by issuing Halt I/O before a reply could be received.

COMM CE, DE, UC, and Error Reply. A bad reply (error or wrong ACK) has been received to an outstanding record.

COMM CE, DE, UC, and Equipment Check. A serial 4-of-8 check has occurred within the SDA-I.

COMM CE, DE, UC, and Tel. Tel was received while executing Send Inquiry, or before the I/O channel accepted the ending status.

COMM CE, DE, UC, and EOT. EOT was received while executing Send Inquiry, or before the I/O channel accepted the ending status.

COMM CE, DE, UC, and Inq. Inq was received while executing Send Inquiry, or before the I/O channel accepted the ending status.

Write Endings (Non-Early Channel End Operations)

IS CE and DE. Normal ending. Channel has issued Interface Stop after all characters of a record have been transferred to SDA-I; SDA-I has successfully

sent the record to the remote terminal; and the remote terminal has transmitted a good reply.

HI/O CE, DE, and UC. Channel has issued Halt I/O while SDA-I was in data mode. The SDA-I alerts the remote terminal to the error situation by transmitting EOI instead of EOTR. If the program wishes to resume data transmission, it must issue an initial Send Inquiry.

COMM CE, DE, UC, Equipment Check, and Error Reply. As the result of a serial 4-of-8 check at the transmit shift register, the SDA-I has transmitted a bad reply.

COMM CE, DE, UC, Timeout, and Overrun. The channel has not given data service for a continuous period for the command timeout (approximately 25 seconds). The SDA-I has transmitted EOI to the remote terminal instead of the normal EOTR.

COMM CE, DE, UC, and Timeout. The command-timeout period (approximately 25 seconds) has elapsed without a reply to an outstanding record.

COMM CE, DE, UC, Write Data Check, and Error Reply. Character transferred from channel was a control character or a non-4-of-8 character. The SDA-I has transmitted EOI instead of the normal EOTR, and the remote terminal has transmitted a bad reply.

COMM CE, DE, UC, and Error Reply. A bad reply (ERR or wrong ACK) has been received to an outstanding record.

COMM CE, DE, UC, and Inq. Inq received while a record was outstanding.

COMM CE, DE, UC, and Tel. Tel received while a record was outstanding.

COMM CE, DE, UC, and EOT. EOT received while a record was outstanding.

Test Write Endings

IS CE and DE. Normal ending. Channel has issued Interface Stop after all characters of a record have been transferred to SDA-I. SDA-I has successfully sent the record to the simulated remote terminal, and the simulated remote terminal has transmitted a good reply.

COMM CE, DE, and Write Data Check. Channel has transmitted a control character or a non-4-of-8 character. Note that Write Data Check does not cause Unit Check to be set in a Test Write command.

COMM CE, DE, and Equipment Check. A serial 4-of-8 check has occurred. Note that Equipment Check does not cause Unit Check to be set in a Test Write command.

COMM CE, DE, UC, and Inq. An Inq was received while executing Test Write.

COMM CE, DE, UC, and Tel. A Tel was received while executing Test Write.

COMM CE, DE, UC, and EOT. An EOT was received while executing Test Write.

HI/O CE, DE, and UC. Program has ended Test Write by issuing Halt I/O.

NOTE: Detection of an error by the receiving portion of the SDA-I (simulated remote terminal) causes the receiving portion of the SDA-I to reply while the sending portion is still in a send-data condition. Thus, the sending SDA-I does not recognize the reply. To obtain the outstanding reply, the channel must issue the Send Inquiry command. The ending will be CE, DE, UE, Error Reply, and sense bits. The sense bits will include Data Check or Record Count Check as the cause of the bad reply, with one exception. This exception is that the first bad SOR will cause an error reply, but will not send Record Count Check. The sense bits may also include bits that were set in the sending portion of the SDA-I.

Read Endings

CE and DE. Normal ending. The end-of-record LRC has been successfully performed on a record received without error. (If, after a successful end-of-record LRC, the program detects an error, the program must issue the Error command before the next Read.)

HI/O — CE, DE, and UC. The channel has ended the Read command by issuing Halt I/O.

HI/O IS — CE, DE, UC, and Receiving. Part of a record has been lost because the channel issued Interface Stop while SDA-I was receiving data characters of a record. In case of Interface Stop, the SDA-I checks the remaining portion of the record for transmission errors, and Read ends at its normal ending point--i.e., after the LRC check operation.

COMM — CE, DE, UC, and Equipment Check. The Read command ended when the Read Parity line failed to agree with the SDA buffer P-bit.

COMM — CE, DE, UC, and Data Check. The Read command ended when the SDA-I detected one of the following errors: (a) A non-4-of-8 character in the receive register; (b) Receipt of a trailer control character not preceded by a leader; (c) An LRC check.

COMM — CE, DE, UC, and Overrun. The Read command ended when the I/O channel did not honor a data-service request soon enough to permit the next incoming character to be placed in the SDA-I buffer. (Refer to "Timing Considerations.")

COMM — CE, DE, UC, and Timeout. The Read command ended when the remote terminal has transmitted no data characters for command-timeout period (approximately 25 seconds).

COMM — CE, DE, UC, and Write Data Check. The remote terminal has detected an error while sending data and has notified the local terminal by terminating the data stream with EOI (CL + idle) instead of EOTR (TL + LRC).

COMM — CE, DE, UC, and Record Count Check. The sending terminal has transmitted a record with a "bad" SOR and, upon receiving an error reply, has retransmitted the record with a "bad" SOR.

COMM — CE, DE, and UE. EOT has been received while executing Read, but prior to entering data mode--i.e., EOT has been received in place of a data record.

COMM — CE, DE, UC, and Tel. Tel has been received while executing Read, but prior to entering data mode.

COMM — CE, DE, UC, UE, and EOT. Read has ended as in preceding CE, DE, UE ending, but another EOT was received before I/O channel could accept ending status.

COMM — CE, DE, UC, UE, and Tel. Read has ended as in the preceding CE, DE, UE ending, but a Tel signal was received before the I/O channel could accept ending status.

COMM — CE, DE, UC, UE, and Inquiry. Read has ended as in the preceding CE, DE, UE ending, but an Inq signal was received before the I/O channel could accept ending status.

Send Tel Endings

CE and DE. Normal ending. The SDA-I has transmitted a Tel signal to the remote terminal and has received a responding Tel.

HI/O IS — CE, DE, UC, and Timeout. (a) The I/O channel has issued Interface Stop after a predetermined number of Tel-reply cycles has failed to produce a responding Tel signal from the remote terminal. (The command's byte count should be set to one less than the number of times the Tel signal is to be sent to the remote terminal before giving up and ending the command. Refer to "Timing Considerations.") (b) The channel has issued Halt I/O before a responding EOT has been received from the remote terminal.

COMM — CE, DE, UC, and EOT. EOT received instead of Tel.

COMM CE, DE, UC, and Inquiry. Inq received instead of Tel.

Send EOT Endings

CE and DE. Normal ending. The SDA-I has transmitted an EOT signal to the remote terminal and received a responding EOT.

HI/O IS CE, DE, UC, and Timeout. (a) The I/O channel has issued Interface Stop after a predetermined number of EOT/reply cycles have failed to produce a responding EOT signal from the remote terminal. (The command's byte count should be set to one less than the number of times the EOT signal is to be sent to the remote terminal before giving up and ending the command. Refer to "Timing Considerations.") (b) The channel has issued Halt I/O before a responding EOT has been received from remote terminal.

COMM CE, DE, UC, and Tel. Tel received instead of EOT.

COMM CE, DE, UC, and Inquiry. Inq received instead of EOT.

- SDA-I Diagnostic Provisions:

SDA-I operation includes a test mode that can be used for on-line diagnosis. Figure 53 outlines the test mode operations. Whether the SDA-I is on-line or off-line, bit 1 of mode byte 1 places the SDA-I in test mode. In this mode:

1. The SDA-I can accept all commands except Read and Write. The latter two commands are replaced by Test Read and Test Write, which can be accepted only if the SDA-I is in test mode. Use of these two test commands limits the possibility of an on-line SDA-I losing data or writing test data into the remote system. (Refer to "Test Read" and "Test Write" for a brief description of how these commands operate.)
2. The output of the SDA-I transmit shift register (Send Data line) is looped back to the receive shift register input (Receive Data). When the SDA-I is on-line, the loopback is internal--i.e., the Send Data line is connected directly to the Receive Data line.
3. To permit testing operations to proceed, the SDA-I simulates control signals that normally come from the remote terminal.
4. Related to item 3, note that: (a) Before executing the first Test Write in a sequence, Send Inquiry must be executed. Execution of Send Inquiry in test mode causes a simulated reply that permits the first Test Write to be accepted. (b) Before executing the first Test Read in a sequence, Send Inquiry must be executed. Execution of Send Inquiry in test mode causes a simulated reply that permits SDA-I transmit circuits to start generating data characters when the first Test Read is executed.

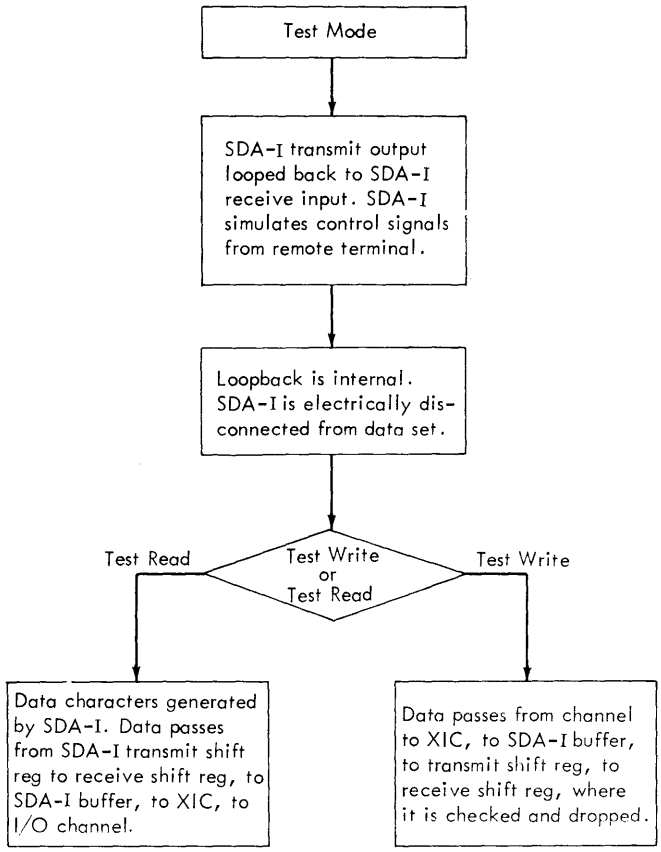


Figure 53. Test Read and Test Write--SDA-I Operation

Test Mode, On-Line

In this mode, the loopback is internal and the SDA-I is electrically disconnected from the data set. Thus, test-mode diagnostic programs run independently of the data set.

Test Write is executed similarly to Write except that:

1. Command timeout is inhibited during Test Read.
2. During Test Read, the Write Data Check and the Equipment Check sense bits will not cause Unit Check status. However, the other checks (Receiving, Overrun, Out, Char, and Record) will cause Unit Check in Test Read.

The Synchronous Data Adapter--Type II (SDA-II) provides the System/360 with the ability to communicate with other processing systems (System/360 and others) and terminals that belong to the Binary Synchronous family of machines.

- Class of Adapter

  Binary Synchronous

- Remote Equipment Serviced:

  Figure 54 shows the terminals that communicate with the 2701 SDA-II.

- Associated Publications:

  General Information--Binary Synchronous Communications--
  A27-3004

  NOTE: For detailed information on a specific terminal or station, refer to the appropriate publications.

- Adapter Physical-Size Classification:

  Category II

- Type of Operation (Transmission):

  Point-to-Point, Multipoint or Switched Network

- Communications Services Required:

  For communications services required, consult your local IBM representative.

- SDA-II Features:

  Transmission Codes

  A versatility of transmission codes is used: EBCDIC, USASCII, and Six-Bit Transcode.

Dual Code

The SDA-II may be selected to operate in one of these three transmission codes. The Dual Code feature permits the selection of a second transmission code independent of the code initially selected. At any one time, the SDA-II may operate with only one code. The selection of the operational code is under program control via the Set Mode operation.

Communications-Line Interface Types

Three types of communications-line interfaces are available with the SDA-II:

EIA RS-232-A

CCITT V24

Digital compatible with common carrier 5701, 5703, 5751, 8801, and 8803 wideband services.

For further information see IBM 2701 Data Adapter Unit--Original Equipment Manufacturers' Information (GA22-6844).

Dual Communication Interface

A basic SDA-II is attached to only one communications channel. With the Dual Communication Interface feature, an SDA-II can be attached to two communications channels. The SDA-II can operate only one of the two communications channels at a time. Selection of the operational communications channel is by program control, using the Set Mode command.

IBM 1200-Bit-Per-Second Line Adapter

The IBM 1200-bps Line Adapter, which is housed under the covers of the 2701, operates at data rates up to 1200 bps. This line adapter can be used on either a switched network or on dedicated voice grade lines.

Terminals	Speed (bps)	Communication Services (Note 1)	2701 Adapter Required* (Note 5)	Second Interface*
IBM S/360 or S/370 equipped with either an IBM 2701 (with SDA-II 7698*), or an IBM 2703 with 7710* (Synchronous Line Set). Note: The IBM 2703 requires an RPQ to operate at 7200 bps	1200	C5, D5 Note (4)	7698 Note (2)	3464
	2000	C5, D6 (4)	7698 (2)	3464
	2400	D7, D7SB	7698 (2)	3464
	4800	D8	7698 (2)	3464
	7200	D9, D9SB	7698 (2)	3464
IBM 2701 with 7697* (SDA-II with Wideband Interface).	19.2K	E3, F3	7697 Note (2)	3463
	40.8K	E1, F1	7697 (2)	3463
	50.0K	E2, F2	7697 (2)	3463
	230.4K	F4	7697 (2)	3463
IBM System/3 with 2074* (Binary Synchronous Communication Adapter).	1200	C4, D5 Note (4)	7698 Note (3)	3464
	2000	C5, D6 (4)	7698 (3)	3464
	2400	D7, D7SB	7698 (3)	3464
	4800	D8	7698 (3)	3464
	7200	D9, D9SB	7698 (3)	3464
	19.2K	E3, F3	7697 (3)	3463
	40.0K	E1	7697 (3)	3463
	50.0K	E2, F2	7697 (3)	3463
IBM System/360 Model 20 with 2074* (Binary Synchronous Communication Adapter) - - Note (3), or an IBM System/360 or System/370 equipped with an IBM 3705 - - Note (2).			Mod. 20 3705	
	1200	C4, D5 Note (4)	7698 Note (3) (2)	3464
	2000	C5, D6 (4)	7698 (3) (2)	3464
	2400	D7, D7SB	7698 (3) (2)	3464
	4800	D8	7698 (3) (2)	3464
	7200	D9, D9SB	7698 (3) (2)	3464
	19.2K	E3, F3	7697 (3) (2)	3463
	40.8K	E1	7697 (3) (2)	3463
	50.0K	E2, F2	7697 (3) (2)	3463
IBM System/360 Model 25 with 4580* (Integrated Communication Attachment), 7551* or 7552* (Synchronous Data Adapter).	1200	C4, D5 Note (4)	7698 Note (3)	3464
	2000	C5, D6 (4)	7698 (3)	3464
	2400	D7	7698 (3)	3464
	4800	D8	7698 (3)	3464
IBM System/370 Model 135 with 4640* (Integrated Communication Adapter), or 9649* - 9656* (Synchronous Data Adapter Type II).	1200	C4, D5	7698 Note (3)	3464
	2000	C5	7698 (3)	3464
	2400	D7	7698 (3)	3464
	4800	D8	7698 (3)	3464
	7200	D9	7698 (3)	3464
IBM 1130 System with 7690* (Synchronous Communication Adapter).	1200	C4, D5 Note (4)	7698 Note (2)	3464
	2000	C5, D6 (4)	7698 (2)	3464
	2400	D7	7698 (2)	3464
	4800	D8	7698 (2)	3464
IBM 2780	1200	C4, D5 Note (4)	7698 Note (2)	3464
	2000	C5, D6 (4)	7698 (2)	3464
	2400	D7	7698 (2)	3464
	4800	D8	7698 (2)	3464
IBM 2770 System	1200	C4, D5 Note (4)	7698 Note (3)	3464
	2000	C5, D6 (4)	7698 (3)	3464
	2400	D7	7698 (3)	3464
IBM 3735	1200	C4, D5	7698 Note (3)	3464
	2000	C5, D6	7698 (3)	3464
	2400	D7	7698 (3)	3464

* Feature Codes

Figure 54. Binary Synchronous Terminals that communicate with the 2701 SDA-II (Part 1 of 2)

Terminals	Speed (bps)	Communication Services (Note 1)	2701 Adapter Required* (Note 5)	Second Interface*
IBM 2715 Model 2	1200	C4, D5 Note (4)	7698 Note (3) (6)	3464
	2000	C5, D6 (4)	7698 (3) (6)	3464
	2400	D7	7698 (3) (6)	3464
	4800	D8	7698 (3) (6)	3464
IBM 1800 System with 7550* (Communication Adapter).	1200	C4, D5 Note (4)	7698 Note (3)	3464
	2000	C5, D6 (4)	7698 (3)	3464
	2400	D7	7698 (3)	3464
	4800	D8	7698 (3)	3464
IBM 3271 IBM 3275	1200	D5 Note (7)	7698 Note (3) (6)	3464
	2000	D6 (7)	7698 (3) (6)	3464
	2400	D7 (7)	7698 (3) (6)	3464
	4800	D8	7698 (3) (6)	3464

* Feature Codes

Notes

(1) Communication service designations are as follows:

C4 and C5--Common carrier public switched telephone network or equivalent privately owned services.

D5, D6, D7, and D8--Common carrier leased type 3002 voice grade channel or equivalent privately owned services.

E1, E2, E3, F1, F2, F3, and F4--Common carrier wideband services or equivalent privately owned services.

(2) Appropriate transmission code must be specified--EBCDIC (9060*), ASCII (9061*), or 6-bit Transcode (9062*).

(3) Appropriate transmission code must be specified--EBCDIC (9060*) or ASCII (9061*).

(4) On communication services C4 or C5, Autocall (1314*) can be used. For required Automatic Calling Units, consult your local IBM representative.

(5) If adapter 7698* is to operate at 1200 bps or 2400 bps, a Synchronous Clock (7692* or 7693*) may be required. For further information, consult your local IBM representative.

When operating adapter 7698* at 2400 bps there are additional restrictions and limitations to the communication services and operations. For detailed information see General Information--Binary Synchronous Communications, GA27-3004.

(6) Transparency (8029*) is required.

(7) Specify four-wire-duplex communication services.

Figure 54. Binary Synchronous Terminals that communicate with the 2701 SDA-II (Part 2 of 2)

The IBM 1200-bps Line Adapter can have (also under the covers of the 2701) an Auto Answer feature, or an Automatic Call Originate feature, or both.

When the IBM 1200-bps Line Adapter is used with the SDA-II, either the Synchronous Clock feature, or the 600/1200 Selectable Synchronous Clock feature is required.

For specifications and restrictions see Planning and Installation of a Data Communications System Using IBM Line Adapters, GA24-3435 (second revision or later).

Auto Call

The Auto Call feature permits programmed dialing of remote stations/terminals with the use of the Dial command. This feature can be used with an external Automatic Calling Unit, or with the internal Automatic Call Originate feature of the IBM 1200-bps Line Adapter.

Transparency

The Transparency feature provides for the transmission of data that may be independent of the

selected transmission code. Examples of such format-independent data are packed-decimal data, programs (both source or object), core images, or other binary data. The Transparency feature provides for the unrestricted use of all possible bit patterns within the selected code level (six or eight bits). For example, all 256 bit patterns in an eight-bit code transmission are permitted, completely independent of the existence of any of the data-link control characters within the data.

Synchronous Clock

This feature is required whenever the modem (data set) does not supply the 2701 with timing pulses for bit sampling. The Synchronous Clock feature is available in the following bit rates: 1200 and 2400 bps for domestic use; 600, 1200, 2000, and 2400 bps for World Trade use. (The Synchronous Clock speed, once selected, can be modified only by an equipment change to the SDA-II.)

The Synchronous Clock feature can be used with either the basic communication interface, the Dual Communication Interface, or both. If specified for both interfaces, both must operate at the same speed (bit rate).

If this feature is specified for only one interface, the other interface, if installed, must operate at a speed determined by the bit rate applicable to the attached data set.

600/1200 Selectable Synchronous Clock

This feature provides a synchronous clock with the ability to manually select the operating speed of 600 or 1200 bps for the SDA-II or Dual Communication Interface when operating with an unlocked external modem or the IBM 1200-bps Line Adapter.

If this feature is required for both lines when using the Dual Communication Interface, both lines will operate at the same selected speed.

The 600/1200 Selectable Synchronous Clock cannot be used if the Synchronous Clock feature is used.

Station Selection

The basic SDA-II is designed to operate on a multipoint line as a master station only. The Station Selection feature permits the 2701 equipped with SDA-II to operate as either a master station on a non-centralized multipoint network or as a tributary station on a centralized or non-centralized multipoint network. The Station Selection feature reduces interference to the main program that would otherwise be caused by interstation transmissions on the multipoint line. See Figure 55.

- Special Capabilities:

The following is a brief description of special capabilities that are standard with the basic SDA-II operation; however, they are significant enough to be highlighted.

Autoanswer

This capability allows the program to condition the SDA-II to automatically answer an incoming call when operating upon a switched network. This autoanswer capability is further enhanced by the interrupt mode described later in this SDA-II section.

Autopolling

Autopolling permits substantial reduction in CPU interference during consecutive pollings to terminals attached to the SDA-II. This function of the SDA-II permits acceptance of negative responses from polled terminals without causing interruptions to the CPU program to service the negative responses (as exists in Write-Read command type polling).

The autopoll operation uses the Poll command (in lieu of the Write-Read commands) to poll terminals (stations) attached to the SDA-II. For detailed information see "Polling Operations".

Early-Channel-End Operation

This capability allows the 2701 to minimize the time that it must hold the selector channel for a specific operation. This is accomplished by permitting the 2701 to set the Channel End status to the selector channel during the operation of certain commands when the 2701's need for the channel operation ceases, although it is not yet ready or able to set Device End status.

The SDA-II must be wired at installation time for the early-channel-end operation and is applicable only when the 2701 is attached to the selector channel.

With early-channel-end, the Disable, Adprep, and Prepare commands set only the Channel End

status bit, immediately after the command is accepted. Device End (and other status bits involved) may be delayed until the command reaches the normal ending point. Even for these three commands, however, Device End (as well as other status bits that may be involved) may nevertheless be signalled simultaneously with Channel End.

The early-channel-end operation will have no effect on channel operation when the command-chaining flag bit (CCW bit 33) is set.

- Transmission Codes Used in SDA-II Operation:

EBCDIC
USASCII
Six-Bit Transcode

EBCDIC (Extended Binary-Coded-Decimal Interchange Code)

This eight-bit code allows transmission of 256 different bit patterns. The following characters are currently assigned in EBCDIC:

9 data-link-control characters (not including the Unit Separator character, which is used as the ITB, Intermediate Block Check character)
52 aphabetic characters (upper and lower case)
10 numeric characters
22 end-to-end characters
33 special graphics (including space)

EBCDIC is the internal code used in System/360, thus permitting maximized utilization of communications facilities, of channel-to-control-unit data paths, and of the 2701, CPU, and system. Information is stored in main storage directly as received without need for translation. See Figure 56.

USASCII (United States of America Standard Code for Information Interchange)

The USASCII code structure as transmitted over the communication line consists of seven data bits plus a parity check (odd) in the eighth bit position. USASCII provides up to 128 bit patterns, all of which have assigned characters as follows:

9 data-link-control characters (not including Unit Separator, which is used as the ITB character)
52 alphabetic characters (upper and lower case)
10 numeric characters
23 end-to-end characters
33 special characters (including space and delete)

If processing of the received data is required, translation to the processor code must first be performed. See Figure 57.

Six-Bit Transcode

Six-Bit Transcode provides for transmitting 64 bit patterns assigned the following character representations:

9 data-link-control characters (not including US, Unit Separator, which is the ITB character)
26 alphabetic characters (upper case)
10 numeric characters
12 special characters (including space)
6 end-to-end characters

Six-Bit Transcode provides a limited character set to attain higher line throughput. Program translation to the processing code must be used when processing of the data is required. See Figure 58.

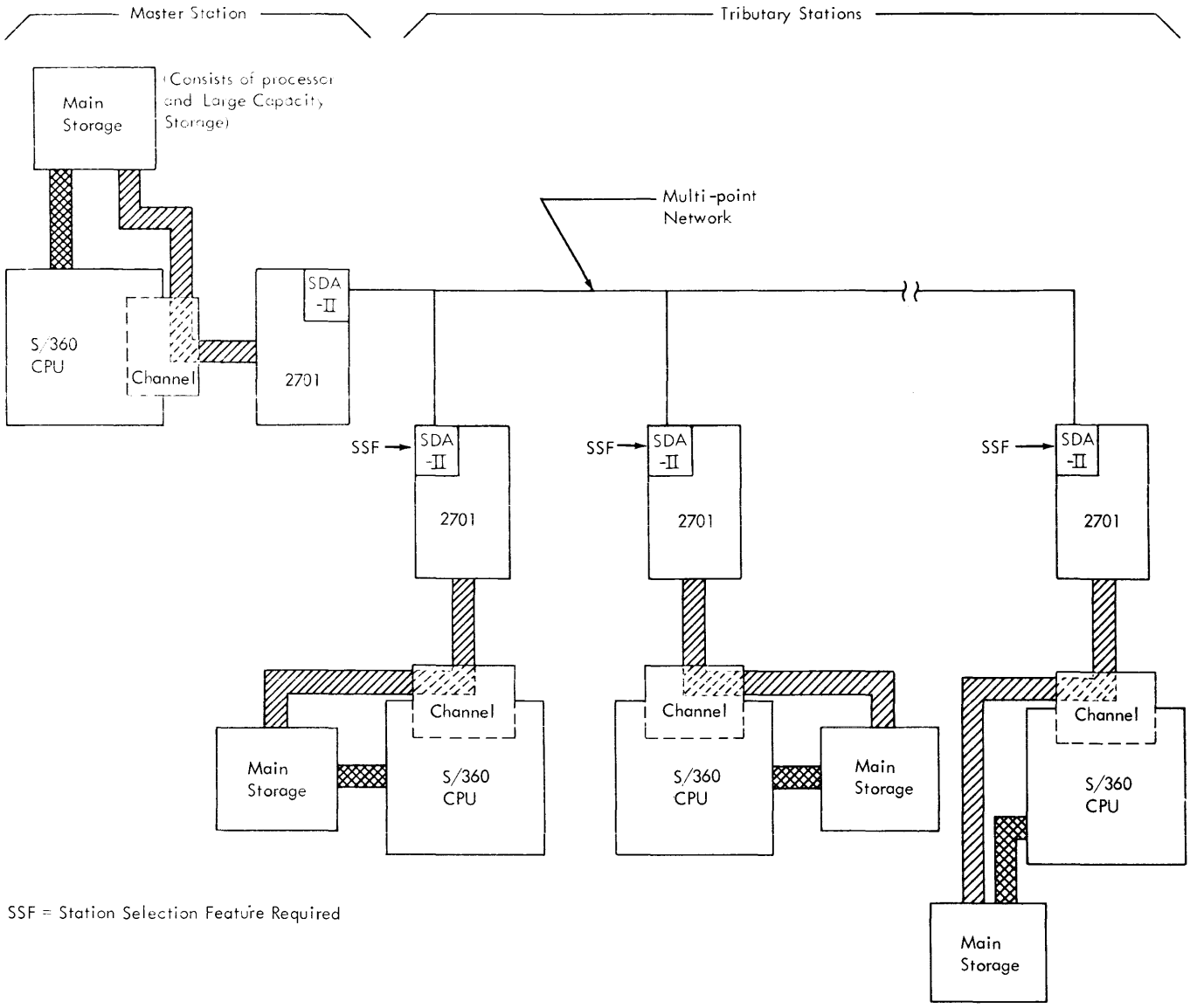


Figure 55. SDA-II in Multi-Station Operation

Byte Positions 4,5,6,7 (4,5,6,7)		S/360 Main Storage Byte Positions 0, 1, 2, 3 (0, 1, 2, 3)															
		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
	Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL	DLE	DS		SP	&	-									0
0001	1	SOH	DC1	SOS				/		a	j			A	J		1
0010	2	STX	DC2	FS	SYN					b	k	s		B	K	S	2
0011	3	ETX	DC3							c	l	t		C	L	T	3
0100	4	PF	RES	BYP	PN					d	m	u		D	M	U	4
0101	5	HT	NL	LF	RS					e	f	v		E	N	V	5
0110	6	LC	BS	EOB / ETB	UC					f	o	w		F	O	W	6
0111	7	DEL	IL	PRE / ESC	EOT					g	p	x		G	P	X	7
1000	8		CAN							h	q	y		H	Q	Y	8
1001	9		EM							i	r	z		I	R	Z	9
1010	A	SMM	CC	SM		¢	!		:								
1011	B	VT				.	$	,	#								
1100	C	FF	IFS		DC4	<	*	%	@								
1101	D	CR	IGS	ENQ	NAK	(	)	-	'								
1110	E	SO	IRS			+	;	>	=								
1111	F	SI	IUS*	BEL	SUB	¦	¬	?	"								

0	1	2	3	4	5	6	7	S/360 Byte
0	1	2	3	4	5	6	7	Transmitted and received character
0	1	2	3	4	5	6	7	EBCDIC Structure

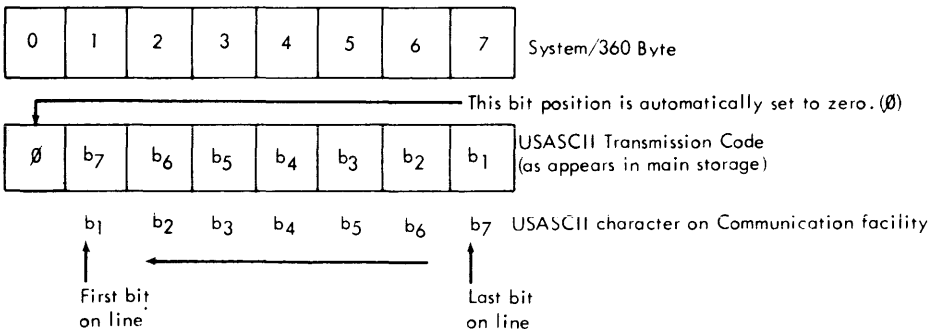
*Used as the ITB control character

Notes:
1. During receive operations, the DLE character, followed by any of the bit configurations in columns 6 or 7, will cause the command to be ended. However, only those bit configurations indicated by an [▨] are valid.
2. The following DLE sequences are defined. '70' = ACK0
   '61' = ACK1
   '6B' = WACK
   '7C' = RVI
3. '1F' This bit configuration performs the Intermediate Block Check (ITB) function.

[▨] Duplicate Assignment

Figure 56. Extended Binary Coded Decimal Interchange Code (as used in Binary Synchronous Communication)

Byte Positions 4, 5, 6, 7, (b_4, b_3, b_2, b_1)	HEX	S/360 Main Storage Byte Positions 0, 1, 2, 3 (Ø, b_7, b_6, b_5) 0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL	DLE	SP	0	@	P	\	p								
0001	1	SOH	DC1	!	1	A	Q	a	q								
0010	2	STX	DC2	"	2	B	R	b	r								
0011	3	ETX	DC3	#	3	C	S	c	s								
0100	4	EOT	DC4	$	4	D	T	d	t								
0101	5	ENQ	NAK	%	5	E	U	e	u								
0110	6		SYN	&	6	F	V	f	v								
0111	7	BEL	ETB	'	7	G	W	g	w								
1000	8	BS	CAN	(	8	H	X	h	x								
1001	9	HT	EM	)	9	I	Y	i	y								
1010	A	LF	SUB	*	:	J	Z	j	z								
1011	B	VT	ESC	+	;	K	[	k	{								
1100	C	FF	FS	,	<	L	\	l	¬								
1101	D	CR	GS	-	=	M	]	m	}								
1110	E	SO	RS	.	>	N	^	n	~								
1111	F	SI	US*	/	?	O	-	o	DEL								



*Used as the ITB control character

Notes:

1. During receive operations, the DLE character, followed by any character appearing in column 3, causes the command to be ended.
2. The following DLE sequences have been defined:
   '30' = ACK0
   '31' = ACK1
   '3B' = WACK
   '3C' = RVI
3. '1F' This bit configuration performs the Intermediate Block Check (ITB) function.

Figure 57. Code Structure--USASCII (as used in Binary Synchronous Communication)

		S/360 Main Storage Byte Positions 0, 1, 2, 3 (Ø, Ø, 0, 1)			
Byte Positions 4,5,6,7 (2,3,4,5)		0000	0001	0010	0011
	Hex	0	1	2	3
0000	0	SOH	&	-	0
0001	1	A	J	/	1
0010	2	B	K	S	2
0011	3	C	L	T	3
0100	4	D	M	U	4
0101	5	E	N	V	5
0110	6	F	O	W	6
0111	7	G	P	X	7
1000	8	H	Q	Y	8
1001	9	I	R	Z	9
1010	A	STX	SPACE	ESC	SYN
1011	B	.	$	,	#
1100	C	<	*	%	@
1101	D	BEL	US	ENQ	NAK
1110	E	SUB	EOT	ETX	EM
1111	F	ETB	DLE	HT	DEL

Notes:
1. During receive operations, the DLE characters, followed by the characters in hex positions '20' thru '27' and '30' thru '37', cause the command to be ended.
2. The following DLE sequences are defined.
   '20' = ACK0
   '23' = ACK1
3. '1D' This bit configuration performs the Intermediate Block Check (ITB) function.

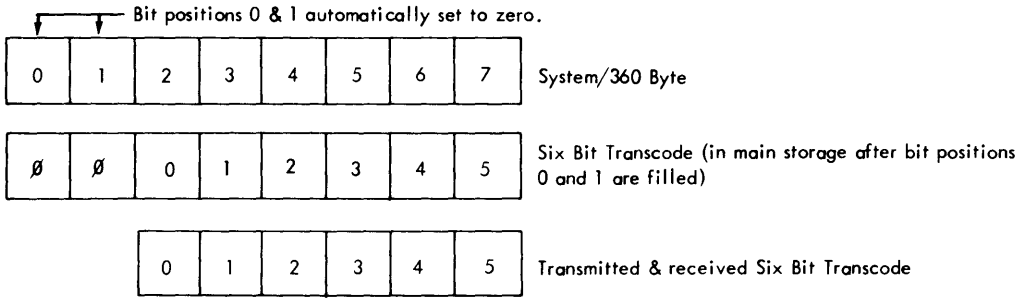


Figure 58. Six-Bit Transcode (as used in Binary Synchronous Communication)

Notes

For the three transmission codes, bit-position 7 of the byte in main storage is always transmitted onto the communications line as the first bit. The first bit received from the communications facility always goes to bit-position 7 of the byte in main storage.

- Transmission-Code Error Detection Employed with SDA-II:

Transmission Code	Type of Checking		
	Transparency Not Installed	Transparency Installed And	
		Activated By 'DLE STX'	Not Activated
EBCDIC USASCII SBT	CRC-16 VRC/LRC CRC-12	CRC-16 CRC-16 CRC-12	CRC-16 VRC/CRC-16 CRC-12

CRC = Cyclic Redundancy check
VRC = Vertical Redundancy check
LRC = Longitudinal Redundancy check

Figure 59. Error-Detection Methods in SDA-II

VRC/LRC

This transmission-error-detection method consists of a combination of the vertical redundancy check (VRC) and the longitudinal redundancy check (LRC). Thus, an odd VRC parity check is performed on each transmitted character, including the LRC character. The LRC check is an even longitudinal check on the total data bits (not including parity) of the transmitted block of characters comprising the message block. The LRC is accumulated at both the sending station and the receiving station during the block transmission. This accumulated value becomes the block-check character (bcc). The transmitted bcc is automatically compared with the bcc accumulated at the receiving station for an equal condition, signifying correct receipt of the transmitted block.

VRC/CRC

This transmission-error-detection method consists of a combination of a vertical redundancy check and a cyclic redundancy check (CRC). The VRC is performed as above; however a VRC check is not performed on the CRC character.

The CRC makes use of a circuit-implemented polynomial that treats the transmitted message as a binary number, and performs modulo 2 division operations on this binary number (carries not considered). The two variations of the polynominal (CRC_{16} and CRC_{12} for eight-bit and six-bit codes respectively) are:

CRC_{16}

$X^{16} + X^{15} + X^2 + 1$.

The CRC_{16} polynomial has the prime factors $(X+1)$ and $(X^{15} + X + 1)$.

CRC_{12}

$X^{12} + X^{11} + X^3 + X^2 + X + 1$.

The CRC_{12} polynomial has the prime factors $(X + 1)$ and $(X^{11} + X^2 + 1)$.

Both the sending and the receiving stations perform this operation independently. Only the remainder is transmitted to the receiving station, at which point the two CRC values are compared. Equal comparison indicates accurate transmission.

CRC

This checking method, as outlined above, may be used in place of the other listed checking methods.

- Commands Decoded by Synchronous Data Adapter--Type II:

Command	Command Code in Hexa-decimal	Flag Bits Bit Positions 32 CD	33 CC	34 SLI	35 SKIP	36 PCI
Set Mode	23	NR	NR	O	X	NR
Enable	27	NA	R	O	X	NR
Dial*	29	O	O	O	X	NR
Write	01	O	O	O	X	O
Read	02	O	O	O	O	O
Prepare	06	NA	R	O	NA	NR
Disable	2F	NA	O	O	X	NR
Poll	09	O	R	R	X	O
Address Prepare**	1E	NR	R	R	NR	NR
Search**	0E	O	O	R	NR	NR

*Requires Auto Call feature

**Requires Station Selection Feature

NOTE: For any CCW with a byte count of one, the SLI bit must be set. If the SLI bit is not set, an I/O interrupt with an incorrect length indication will occur.

Legend:

O = Optional Usage
NA = Not applicable to command
NR = Not recommended
X = Not used
R = Recommended

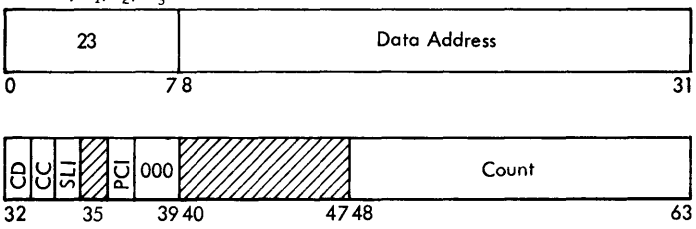
The following additional commands can be used in SDA-II operations, they are decoded in the coupled XIC

Sense	04
I/O No Op	03
Test Input-Output	00

NOTE: The Test Input-Output operation may be issued only via a Test I/O (TIO) instruction. An attempt to issue a Test Input-Output command by using a CCW with a command code of '00' will result in a program check.

The SDA-II command operations are as follows:

Set Mode
ccw 23, f_1, f_2, f_3



Set Mode

The Set Mode command is used by the program to to select the SDA-II options that are program selectable. These are Intermediate Block Check (ITB) (used or not used), Communication Interface Selection (A or B), Test Mode Selection (Test or non-Test), Transmission Code Used (A or B), Interrupt Mode (used or not used).

In SDA-II operations, the Set Mode command is a control command with a single byte transfer (i. e., the byte count set to one).

The definitions of the bit positions of the "mode byte" fetched from main storage (location designated by the data address field of the Set Mode CCW) are as follows:

Bit Position	Name	Function
0		Not used.
1	Intermediate Block Check (ITB)	When set to 0, no EIB character is sent to main storage following an ITB, ETB, or ETX character. When set to 1, if a Read command is being executed, an Error Index byte is generated and sent to main storage immediately following the ITB, ETB, or ETX character. Bits 0, 1, 2, 3, 6, and 7 of the Error Index byte are undefined. Bit 4 of the EIB will be set if a data check was detected in the preceding block. Bit 5 of the EIB will be set if an overrun condition was detected in the preceding block.
2	Dual Communication Interface	When set to 0, selects the basic communication interface (Interface A). When set to 1 selects the other communication interface (Interface B).
3	Test Mode	When set to 0, places the SDA-II in normal (non-test) mode. When set to 1, places the SDA-II in test mode (permitting all commands to be executed by the SDA-II; however, signals are not transmitted to the data set interface).
4	Dual Code (used when Dual Code feature is installed)	When set to 0, selects transmission code A (first code). When set to 1, selects transmission code B (second code). (This bit must be set to 0 if Dual Code feature is not installed.)
5	Interrupt Mode	When set to 0, places SDA-II in non-interrupt mode. When set to 1, permits interrupt mode of operation.
6 and 7		Not used.

Once the SDA-II mode has been set, it remains set until the SDA-II is reset or a new Set Mode command is accepted. Once the mode is reset, the adapter is considered off and will not accept operational commands (such as Read or Write) until the mode is once again set.

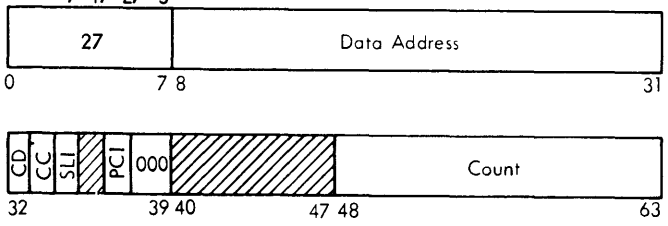
The existing mode setting may be changed by the issuance of a new Set Mode command. In this circumstance, the old mode is completely reset and the new mode is set exactly as specified in the mode byte obtained from main storage.

If a mode requires the existance of a feature (e.g., Dual Code feature), the associated bit is not checked for accuracy. If the feature is not installed, the related bit position must contain a zero; otherwise a non-operational function will be selected.

The unused bits (0, 6 and 7) may be either zero or one without meaning or effect. When the SDA-II sets the mode, it ends the command with Channel End and Device End status.

If the Halt I/O instruction is issued before the mode is set, the command is ended with Channel End, Device End, and Unit Exception status. In this case, the mode will not be set. If the mode has been set prior to receiving the Halt I/O, the mode setting will remain as set, and the Set Mode Mode command will be ended with Channel End and Device End status.

Enable
ccw 27, f_1, f_2, f_3



Enable

Enable is a control command used to turn the SDA-II ON (the SDA-II becomes "enabled").

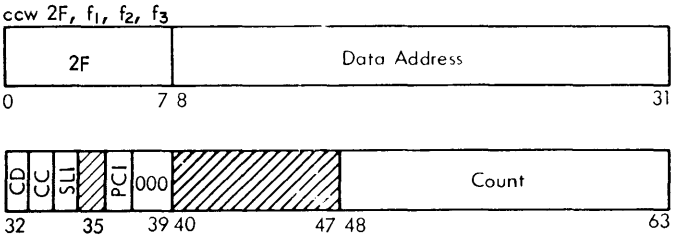
When operating on a switched network, the Enable command conditions the SDA-II to answer an incoming call. The command is ended with Channel End and Device End status when the data set signals that an incoming call is being answered. If the interrupt-mode bit (bit 5 of mode byte) is set to one, the Enable command will end with Channel End, Device End, and Unit Check status plus the Timeout sense bit set to one, if an incoming call is not answered within six seconds.

When operating on a private line, the Enable command ends immediately with Channel End and Device End status upon enabling (conditioning) the SDA-II.

The SDA-II remains enabled until a Disable command is issued.

If a Halt I/O is issued before a call is answered (switched network only), the SDA-II is reset.

Disable
ccw 2F, f_1, f_2, f_3



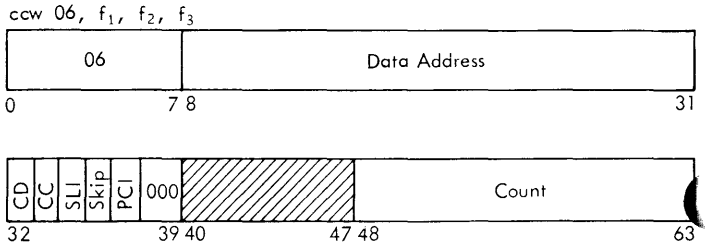
Disable

This command is used to reset the line--i.e., it deconditions the enabling operation provided originally by either the Enable or Dial command.

If operating on a switched network, the execution of the Disable command terminates an outstanding call. This command ends within three seconds of command initiation (to permit data that may be temporarily stored in the data set to be transmitted over the line) with Channel End and Device End status.

When disabled, the line will not automatically answer any incoming calls.

Prepare
ccw 06, f_1, f_2, f_3



Prepare

This command may be used in contention-type communications systems to prepare the SDA-II for execution of a read-type operation. When enabled, (on a private line or on a switched network where the connection has been established), the SDA-II monitors the line for character phase (two or more SYN characters) whenever the SDA-II is not operating on a write-type operation. This includes the periods in which the SDA-II is command-free.

The Prepare command instructs the SDA-II to end the command with Channel End and Device End status when character phase (Synchronization with the remote station) is established.

The command ends immediately if character phase has been established before the Prepare command is accepted and has not been reset by an end character sequence. If data had been lost, the Read command (which would normally follow the Prepare command upon detection of Channel End, Device End status) will have the Unit Check status and Lost Data sense bit set when the Read command is ended.

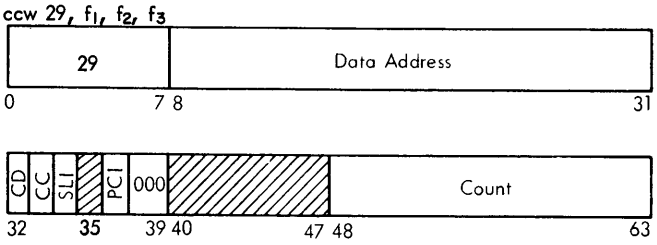
The Prepare command will be accepted only if the line has been previously enabled by the Enable or Dial commands. No data transfer to main storage occurs during the Prepare command execution.

PROGRAMMING NOTE: The Prepare command should be used with caution when operating on a switched network. Due to the nature of the Prepare command, the SDA-II provides no timeouts to protect against a "hang-up" condition.

This hang-up could result in continuous billing when operating on a Direct Distance Dialing (DDD) network.

When using the Prepare command in contention-type operations and the program wishes to bid for the line, the program should issue the Halt I/O instruction to terminate the Prepare command.

Dial
ccw 29, f_1, f_2, f_3



Dial

This command permits the program to automatically dial a remote BSC-equipped station over a switched network. Before Dial will be accepted, a mode to select Interface A must be set in the SDA-II by the Set Mode command. The Dial command is command-rejected if the Auto Call feature (ACF) is not installed or if Interface A is not selected.

PROGRAMMING NOTE: To ensure proper operation, a Disable command should precede the Dial command after an Enable command has been ended with the Timeout sense bit set (interrupt mode set).

When the Dial command is executed, bytes are transferred from main storage to dial equipment (provided by the common carrier). The transferred bytes represent the dial digits required for switching purposes. All dial codes are regarded as decimal digits and must be supplied from main storage. The SDA-II does not check if the transferred characters are valid dial digits. Only the four low-order bits of the dial digit are transferred to common-carrier equipment.

The relationship between the dialing character in main storage and the dial digits is as follows:

Main Storage	Dialing Digit	Alphabetic Equivalent
x x x x 0 0 0 0	0	
x x x x 0 0 0 1	1	
x x x x 0 0 1 0	2	ABC
x x x x 0 0 1 1	3	DEF
x x x x 0 1 0 0	4	GHI
x x x x 0 1 0 1	5	JKL
x x x x 0 1 1 0	6	MNO
x x x x 0 1 1 1	7	PRS
x x x x 1 0 0 0	8	TUV
x x x x 1 0 0 1	9	WXY

Bits xxxx (four high-order bits of byte) can be set to either 0 or 1.

The value in the byte count field of the Dial CCW must equal the number of digits to be dialed. The SDA-II presents the dial digits to the common-carrier Automatic Calling Unit (ACU) at the rate set by the ACU. After the last digit has been presented to the ACU, the I/O channel signals Interface Stop to the 2701.

When the dial operation is successfully completed, the SDA-II sets Channel End and Device End status.

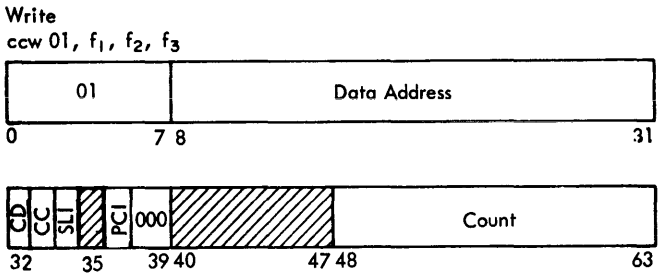
Failure to complete the dialing operating within a time interval (adjustable at the ACU) causes the command to end with Channel End, Device End, and Unit Check status with the Timeout sense bit set. Under this condition, the SDA-II must be disabled by a Disable command.

Upon successful completion of the dialing operation, the Dial command should be followed by a Write command to initiate the circuit-assurance mode of Binary Synchronous Communication operations.

Upon the completion of the data communication with the remote station, the "call" is normally terminated by the issuance of the Disable command.

If the Automatic Calling Unit is nonoperational, sense bit 1 (Intervention Required) is set to one and the Dial command is ended with Channel End, Device End, and Unit Check status. If the common-carrier dial-switching equipment is not available within three seconds of the initiation of the Dial command (e.g., no dial tone), the command will end with the Equipment Check sense bit set to one.

PROGRAMMING NOTE: The Dial command turns the SDA-II on and must be preceded by the Set Mode command if the mode has not been previously set. The Dial command can be chained to a Read, Prepare, Search, Poll, or Address Prepare command as well as to the Write command.



Write

The Write command is used to transfer information from main storage to a remote station. The number of bytes used in the write operation is variable and is established by the byte count(s) in the Write CCW(s). The SDA-II generates the signals necessary to maintain bit and character synchronization; however the SDA-II does not generate any message-framing character (e.g., STX, ETX, etc.)--all such characters must be provided by the program.

The Write command is used to send a single record. The End character (ETB, ETX, ENQ, EOT, NAK, DLE-Control), if it is to be sent, must be sent under the control of the Write command which sent the control or nontransparent text block.

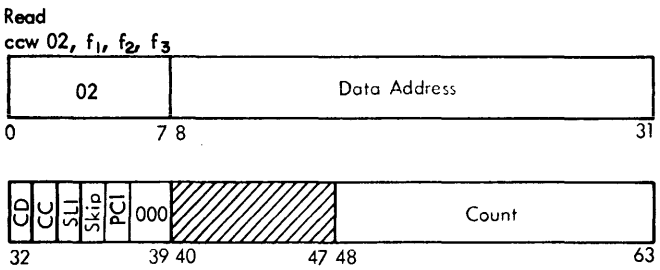
This command will end with Channel End and Device End status when any of the following occur:

a. An ETX or ETB control character, followed by one additional byte, is recognized in the data. (The additional byte is not transmitted on the communications line.)
b. An Interface stop is signaled from the channel.
c. A Halt I/O is signaled from the channel.

The command is ended with Channel End, Device End, and Unit Check when the interface to the data set detects an error condition. One pad character is sent following the last character of data or bcc at the end of the command (except in transparent mode).

If an end character is being sent before the end of the command, it is the program's responsibility to insert a pad character following the end character. (Example: EOT, pad, SYN, SYN, character, ...)

PROGRAMMING NOTE: All Write commands will normally be set for command chaining to a Read command to prevent loss of data. An exception to this requirement occurs when the Write command is used for sending EOT to a remote station.



Read

This command transfers characters from a BSC-equipped remote station to main storage. The Read command will be accepted only if the adapter is on.

Characters are transferred from the communications lines to the I/O channel, in bytes, as they are received from the communications line. Characters are not transferred to the I/O channel unless the adapter is in character phase. The SYN and all block check characters are deleted from incoming normal (nontransparent) data. All deleted characters, and the SOH or STX character which sets text mode, are excluded from the bcc check.

The Read command will end with Channel End and Device End when a valid ENQ, ETB, or ETX is detected in the data stream. The read command will also end with Channel End and Device End (1) if text mode has not been set by SOH or STX during the read operation, and (2) if a valid EOT, NAK, or the DLE-Stick sequence has been detected in the data stream. If the Read command ends with EOT, the Unit Exception status bit will also be presented to the I/O channel.

For the Read command to end, the ENQ, EOT, NAK, and DLE-Stick sequence must be followed by a good pad format. If a good pad format is not presented, the ENQ, EOT, NAK, and DLE-Stick

sequence will be treated as data, and character phase will remain on. Character phase is reset when the Read command ends.

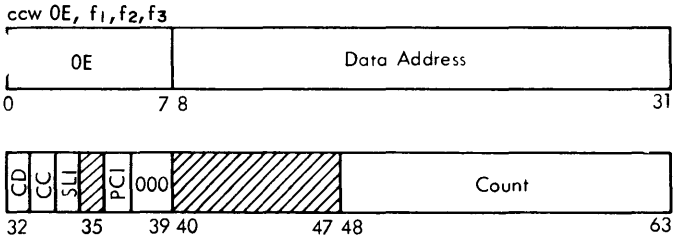
The read operation will end with Unit Check set in addition to Channel End, Device End, and an appropriate sense bit, if any of the following occur:

a. An Interface Stop is signaled by the I/O channel.
b. A Halt I/O is signaled by the I/O channel.
c. The adapter detects a Data Check or Overrun.
d. A data set failure is detected.

If the time interval between the sequence of SYN's followed by a non-SYN character is greater than three seconds, or if the time interval between the acceptance of the Read command and the receipt of either SOH or STX or an End character is greater than three seconds, the command will be ended with Channel End, Device End, and Unit Check status and the Timeout sense bit set to one.

NOTE: See section entitled "Operations of SDA-II" for additional information on write and read operations in normal data and transparent data modes.

Search
ccw 0E, f_1,f_2,f_3



Search

This read-type command is used when the SDA-II equipped 2701 is operating as a noncentralized master station in a multipoint network. The Search command permits the 2701 to monitor terminal-to-terminal transmissions without transferring the message data to main storage or requiring interrupts (except when the terminal-to-terminal operation is complete and the line has returned to control mode).

The Search command must be preceded by a terminal poll operation (performed via either the Poll command or a Write command). In order to ensure correct performance, command chaining from the Poll or Write command to the Search command must be performed.

The polled terminal answers the polling operation with either an EOT character or a selection address. (Since the line is configured for noncentralized operation, where direct terminal-to-terminal communication is possible, a polled terminal cannot answer with STX or SOH. The selection-address sequence either to the master station or another terminal on the line, is required).

The SDA-II places all characters (except SYN's) that are received from the polled terminal into main storage until an SOH or STX is received from the terminal. (The characters placed in main storage include the selection address and response).

If the selection address belongs to the SDA-II, the Search command ends with Channel End and Device End status.

Upon the detection of the SOH or STX characters, the SDA-II follows the terminal-to-terminal transmission currently on the line and performs the following services:

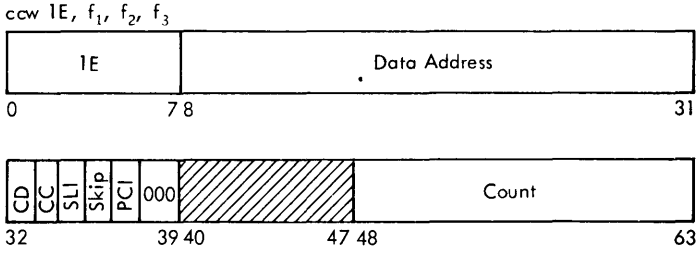
-- Upon detection of turnaround characters, disestablishes and re-establishes character phase (synchronization).
-- Recognizes when bcc characters are being transmitted, and does not decode them.
-- Performs line-timeout operations to prevent a line hang-up condition.

Upon the SDA-II's recognition of an EOT in terminal-to-terminal transmissions, it ends the Search command with Channel End, Device End, and Unit Exception status.

Before going into text mode, the one-second timeout is utilized and the timeout condition is reset every time a new "ending" character is detected. If the one-second timeout condition is recognized before entry into text mode, or a three-second timeout is recognized after entering text mode, the Search command ends with Channel End, Device End, and Unit Check status with the Timeout sense bit set to one.

PROGRAMMING NOTE: Fast-selection operation, as defined in the publication General Information--Binary Synchronous Communications, GA27-3004, is not permitted with the Search command.

Address Prepare
ccw 1E, f_1, f_2, f_3



Address Prepare

This command (Adprep) is used by an SDA-II operating as a tributary (non-master) station. For the command to be accepted, the SDA-II must be equipped with the Station Selection feature. The Adprep command is a pseudo-Read command in that the SDA-II goes through all the actions of a Read command, yet does not transfer data to main storage.

When the SDA-II accepts the Adprep, the SDA-II monitors the receive line, following all data on the line. If the Adprep command is accepted and character phase has not been established (the sync pattern has not been detected), the SDA-II starts a three-second timeout, during which it must establish character phase followed by one of the following three conditions:

a. SDA-II Address. When the SDA-II detects its selection address, the command ends with Channel End and Device End (CE, DE) status. This allows chaining to a read command. If the SDA-II detects its poll address, the command ends with Channel End; Device End; and Status Modifier (CE, DE, SM) status. This allows status modifier command chaining to a read command.
b. Text-Mode Entry. Upon entering text mode (as a result of recognizing STX or SOH), the SDA-II will cease looking for its address until an EOT is detected. The SDA-II monitors the data stream while in text mode, using the three-second timeout for recognition of SYN characters, similar to the Read-command operation.
c. End-Character Recognition. The recognition of a new SYN and an EOT character will cause the three-second timeout to be reinitiated, and the SDA-II will continue to monitor for a new SYN and its address or an EOT character.

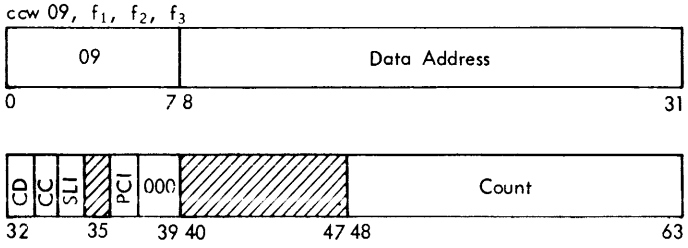
If a timeout occurs or if sync is established before the Adprep command is issued, the SDA-II looks for an EOT before any of the preceding conditions can be recognized .

The SDA-II decodes up to three addresses--the group address, the poll address, and the selection address.

The group address is used when a station wishes to receive a transmission as part of a group of stations, with one of the group of stations predesignated (via programming) as the responding station.

The polling and selection addresses must be one bit apart, with the bit in bit-position 6 used to determine which is which; bit 6 being 0 indicates a polling address and bit 6 being 1 indicates a selection address.

Poll
ccw 09, f_1, f_2, f_3



Poll

This command is a pseudo-Write command in that the SDA-II goes through the actions of a normal Write command until the ENQ control character is detected in the data received from the main storage. After the ENQ is detected, one additional character (the index character) is obtained from main storage under the same count control. After the ENQ has been transmitted to the line, the SDA-II enters receive mode (however, the Poll command is not ended). When in receive mode, the SDA-II looks for the receipt of character phase. The following conditions may occur:

a. Recognition of Character Phase. Upon receipt of character phase, the SDA-II operation ends with Channel End, Device End, and and Status Modifier status if the first non-SYN character (following recognition of character phase) is not an EOT character. If the first non-SYN character is an EOT, the SDA-II returns to transmit mode and requests additional characters from main storage. The old index character is destroyed.
b. Timeout. Following the transmitting of the ENQ, a three-second timeout is initiated. At the end of three seconds, if the SDA-II is not in character phase, the Poll command ends with Channel End, Device End, and Status Modifier status. The Read or Search command, used under a status-modifier command-chaining operation, will be ended with Channel End, Device End, and Unit Check status with the Timeout bit set to one.

The Poll command should be status-modifier command chained to either a Read or a Search command. The first character sent into main storage during the Read or Search command execution is the last index character obtained from main storage in the previous Poll. After the index character has been transferred to main storage, the SDA-II immediately forwards to main storage the data received via the communication line (as stated above). If the Timeout sense bit had been set during the Poll command execution, the SDA-II ends the chained-to Read (or Search) command with Channel End, Device End, and Unit Check status and with the Timeout sense bit set to one.

- Line Control Characters Recognized by SDA-II:

Use of Data-Link Characters by SDA-II during Transmit Operations

In binary synchronous communications, transmit operations are those operations occurring when data is transferred from main storage to a remote station via the SDA-II and associated communications facilities. The SDA-II is said to be in transmit mode when transmitting information in this direction.

See the publication, General Information--Binary Synchronous Communications, Form GA27-3004, for a conceptual discussion of the total binary-synchronous operation, including line-control characters, description of data-link control procedures, control-character sequencing, and transmission-code structures.

The following discussion of control characters relates to the various applicable data-link control characters as implemented by the SDA-II.

SYN

SYN characters are generated at the beginning of the execution of the Write command and are inserted into the data stream as time-fill whenever a character is not available in sufficient time during a write transmission. SYN characters are not included in the block-check-character (bcc) accumulation (see later section on "Transmission-Code Checking").

When time-fill is needed in a program operating in nontransparent mode, the programmer can insert a SYN character. The SYN characters, however, will be deleted by the receiving equipment.

For synchronization purposes, while the SDA-II is in normal text mode, two SYN characters per second are inserted into the data stream.

SOH and STX

The SDA-II monitors for the presence of these two control characters, Upon detection of either SOH or STX, the SDA-II enters into text mode and intiates block-check-character accumulation. After the SDA-II has entered text mode, any subsequent SOH or STX characters detected are treated as non-control characters (i.e., data characters).

In any particular data block, the SOH or STX that initiated bcc accumulation is not included in the bcc accumulation; however, any ensuing STX or SOH characters in the data block are included in the bcc accumulation.

During transmission, exit from text mode is accomplished in the SDA-II by detecting either an ETX or ETB control character, or an Interface Stop, or by the Halt I/O instruction.

ETB and ETX

These control characters remove the SDA-II from text mode and also transmit the block check character(s) and trailing pad. The SDA-II goes into receive mode (i. e., stops transmitting) to search for a sync pattern when:

a. The bcc(s) have been transmitted and one additional byte has been received from the channel (which will not be transmitted).
b. An Interface Stop has been signaled by the channel.
c. A Halt I/O has been signaled by the channel.

EOT and NAK

These two control characters are not acted upon when the SDA-II is executing a Write command.

ITB

The ITB character breaks a message into shorter or intermediate blocks for error checking without causing a reversal of transmission direction. ITB is immediately followed by the block check character(s). Another message block, preceded by the sync pattern (SYN-SYN), follows the ITB and block check

character (bcc) as the SDA-II begins accumulation of a new bcc. The SDA-II continues to transmit.

DLE

The DLE control character, plus a defined follower character, initiates a control sequence--for example, DLE STX in a control sequence, which places the SDA-II in transparent mode.

ENQ

The ENQ control character is not recognized as a control character if detected while executing a Write command. Under a Poll, the ENQ character turns the SDA-II from transmit mode to receive mode.

The ENQ does not signal "End" to the program while executing a Poll command.

Pad (Trailing)

A trailing pad is an all- "1's" character. The SDA-II generates a trailing pad at the end of every nontransparent Write command or Poll Write sequence. If the SDA-II is not in text mode, the program must insert the trailing pad immediately following the EOT, NAK, ENQ, or DLE-Stick. This applies to transmission of these characters if a character phasing sequence and additional characters are to be transmitted by the same command. Only one pad character may be transmitted after any end character.

DLE-Stick

DLE-Stick will be ignored as a control character in transmit mode.

Use Of Data-Link Characters By SDA-II During Receive Operations

For binary-synchronous communications, receive operations are those operations occurring when data is received from a remote station. The SDA-II is considered to be in receive mode whenever it is not in transmit mode (provided the adapter is enabled).

SYN

All SYN characters are deleted from the received data stream by the SDA-II before the received data is transferred to main storage (except in transparent mode). Any SYN characters detected by the SDA-II in the received data stream are not included in the block-check-character accumulation.

SOH and STX

Either of these two control characters initiate the bcc accumulation. Their initial detection sets the SDA-II in text mode. The initial SOH or STX control characters are not included in the bcc accumulation. Subsequent SOH and STX characters in a data block are included in bcc accumulation. Exit from text mode is accomplished when the SDA-II signals "End" to the program.

ITB

Detection of this character in a read operation indicates the character(s) following will be block check character(s). The bcc accumulation is reset immediately after the bcc comparison has been completed. The SDA-II remains in text mode and starts accumulation of a new bcc, with the next character (except SYN) following the last bcc.

If bit position 1 of the mode byte has been set to 1 by the Set Mode command, an Error Index byte (EIB) is generated and sent to the channel immediately following the ITB, ETB, or ETX character. The EIB reflects the condition of the last block of data received. The EIB informs the program of data-check or overrun conditions detected while the block of data was being received. These conditions set to 1 the following bits in the EIB:

Bit Position	Condition
4	Data check
5	Overrun

The EIB character is stored in the byte location immediately following the ITB (or ETB or ETX) character of the data block involved in the read operation.

No line turnaround occurs when the ITB character is used to break a long record into shorter blocks. The record will end normally on detection of an ETB or ETX character.

ETB

The ETB character terminates a block consisting of multiple intermediate blocks. It signals that the block check character(s) will follow next. A bcc comparison is performed and a reply, called for by the ETB, is made as line turnaround occurs. The Error

Index byte is generated and sent to the channel under the same conditions as those described for the ITB character.

ETX

ETX signals the end of a message. If the message has been broken into shorter transmission blocks by the use of ITB or ETB, the ETX indicates the end of the last transmission block. ETX signals the SDA-II that the next character(s) will be the block check character(s). The ETX character calls for a reply to the transmission. ETX, though similar to the ETB character, is not permitted to terminate a heading. The Error Index byte is generated and sent to the channel under the same conditions as those described for the ITB character.

ENQ and NAK

When ENQ or NAK is followed by a pad character, the Read command signals End to the I/O channel and resets character phase. This does not, however, change the SDA-II from the receive mode. No bcc comparison is performed after detection of these characters. The SDA-II searches for a new sync pattern.

NOTE: In text mode, the NAK character is not a control character, but is treated as data.

DLE

This control character, followed by a defined follower character sequence, initiates a control sequence.

Stick

A Stick character is defined below. The symbol "x" denotes positions which may be either "0" or "1".

	0	1	2	3	4	5	6	7
EBCDIC	0	1	1	X	X	X	X	X
USASCII	X	0	1	1	X	X	X	X
Six-Bit Transcode	(0	0)	1	X	0	X	X	X

The DLE-Stick sequence will be handled as an End control character if text mode is not set. The DLE-Stick sequence will be treated the same as the NAK character in the adapter.

When not in text mode, a DLE followed by this group of characters and a pad character will end a read type command with Channel End, Device End status. Some of the defined DLE-Stick sequences are ACK 0, ACK 1, WACK, and RVI.

Pad Characters

To ensure that the first and last characters of a transmission are properly transmitted by the data set, a pad character is added before and after each transmission.

Leading Pad: The one-character pad (leading pad) preceding each initial synchronizing pattern ensures that the station will not start sending its synchronizing pattern before the other station is prepared to receive. The leading pad character may consist of alternating '0' and '1' bits (hex '55') or a SYN character.

Trailing Pad: When transmitting, a pad character (trailing pad) is added following each transmission to ensure that the last significant character is sent before the data set transmitter turns off. The trailing pad character consists of all '1' bits (hex 'FF').

When receiving, the SDA-II checks for the four low-order '1' bits of the pad character following an EOT, NAK, ENQ, or DLE-Stick control sequence. If these end characters are not followed by a pad character, the ending sequence is inhibited; character phase is not reset; and the characters received on the line are transferred to the channel.

EOT

A valid appearance of EOT (used in all systems) is the only means of ending a message transfer. A valid EOT is defined as the SYN, SYN, EOT, pad sequence.

When not in text mode, an EOT, followed by a pad, will end the Read command with Channel End, Device End, and Unit Exception status. No bcc check is performed after an EOT. The adapter will remain in receive mode. When the adapter is in text mode, the EOT will be treated as a data byte.

During a Poll/Read sequence, if an EOT character is received as the first non-SYN character after character phase, the SDA-II will return to transmit mode to continue polling.

- Operations of SDA-II:

The SDA-II, in conjunction with the stored program, operates in compliance with the data link control outlined in the publication, General Information--Binary Synchronous Communications, GA27-3004.

Write Operations

When enabled and not specifically operating on a write-type command, the SDA-II is in receive mode, continuously scanning the line for the synchronization pattern used to establish character phase. Once character phase is established, it is maintained until a line-turnaround character is detected, a timeout occurs, or the 2701 is reset.

When a Write command is accepted, the SDA-II determines if "receiving" character phase has been established. If it has, the Write command is ended immediately with Channel End, Device End, and Unit Exception status. If character phase has not been established, the SDA-II generates a sufficient number of characters to ensure that the line is stabilized and that the remote station has sufficient information to obtain synchronization. (With the Internal Clock feature installed, this consists of one pad character and five SYN characters; otherwise it is one pad character and two SYN characters.)

The SDA-II obtains the first two bytes from main storage (via the I/O channel) in a multiple-byte mode. When the first of these characters has been transmitted, the SDA-II requests the transfer of the next byte (character). If, by the time channel service is obtained, the second character has been or is in the process of being transmitted, the SDA-II obtains the next two bytes in the multiple-byte mode; otherwise only the next byte is obtained. This process continues until an ending condition occurs. If, at any time, a character is not obtained from the channel before all the buffered characters have been transmitted, the SDA-II will generate a SYN character as time-fill.

The SDA-II will generate and insert two SYN characters into the data stream at a nominal rate of once per second. This allows long message transmissions without the danger of the receiving station missing an ending character and thus remaining in false synchronization for an extended period of time.

All characters (except SYN and the SOH or STX, which set text mode) that are transmitted in normal (nontransparent) text mode are included in the block-check-character (bcc) accumulation. The bcc is reset by the transmission of the first STX or SOH. The bcc is transmitted to the remote station following the transmission of an ETB, ETX or ITB character.

The normal end of the transmission will be initiated by the transmission of the bcc character when signaled by ETB or ETX, or by an Interface Stop being initiated due to the byte count being decremented to zero.

NOTE: The EOT, ENQ, NAK, ACK 0, ACK 1, WACK, or RVI sequences do not cause the transmission to end; therefore, when ending a write operation with one of these characters, the byte count in the initial CCW must be exact.

When an Interface Stop is received, the SDA-II transmits all characters previously received from the I/O channel and then transmits a single pad character before setting the ending status. When the ending was initiated by the ETX or ETB, the pad character follows the bcc transmission. (The pad character is not considered a data character; its purpose is to ensure proper operation of the SDA-II with the communications facilities. It is generated within the SDA-II and will be deleted at the receiving station.)

Read Operations

When enabled, the SDA-II will continuously monitor the communications line for character phase, when it is not specifically operating under a write-type operation. Character phase is established at the SDA-II by its decoding (at specific bit times) of the last eight bits (six in the case of Six-Bit Transcode) received from the communications line. (This operation requires a bit-clocking signal to be provided by either the attached data set or by the Internal Clock feature.) If the decoded eight (or six) bits is the SYN character, the SDA-II does not decode again until the next character (six or eight bits) has been clocked in. If this character is also the SYN character, character phase (synchronization) has been established. If not, the SDA-II returns to decoding at every bit time. This process continues until character phase has been established.

Once character phase is established, every character other than the SYN characters is included in the bcc accumulation.

When a Read command is being executed, the assembled character (other than SYN) is passed on to main storage via the I/O channel. (See "Transparent Operations" section for exceptions to the above.) The bcc accumulation is reset when the first STX or SOH is received.

When the first non-SYN character is assembled from the line (Read command being executed), the SDA-II requests channel service. If channel service is obtained after the following character has been assembled, both characters are passed to the I/O channel and on to main storage in the multiple-byte mode; otherwise a single-byte transfer occurs.

If the third character has been assembled and a Read command is not present, the Lost Data

sense bit and the Unit Check status bit will be set. When a Read command is present and channel service is not obtained before the SDA-II must lose a character (all buffers being full), the Overrun sense bit and the Unit Check status bit are set.

During the receive operation, the SDA-II attempts to decode all incoming characters. The characters that are decoded and the action taken are described above. If character parity checking is employed, the parity of each character is checked. A control character must have proper parity to be decoded. When a parity error is detected, the Data Check sense bit and the Unit Check status bit are set.

When a normal ending condition occurs, the SDA-II transfers all received characters to the I/O channel, clocks off a pad character, and sets the ending status. (The transfer to the I/O channel and the clocking off of the pad character are overlapped--the pad character is not a data character and is not transferred to the I/O channel.)

A normal ending is one that is initiated by the receipt of a proper data-link control character. Endings caused by a Halt I/O instruction, an Interface Stop, a timeout, communications facility malfunctions, or 2701 resets are not considered normal.

When the ending is initiated by a decoded ETB, or ETX, the SDA-II receives the bcc from the remote station and compares it to the bcc developed in the SDA-II. The Data Check sense bit and the Unit Check status bit are set if the two bcc's do not match. The bcc is also checked when an ITB character is decoded; however, with the ITB, the receive operation is not ended. After the bcc compare operation is completed, the bcc accumulation is reset.

When the ending is set by a decoded ENQ, DLE sequence, NAK, or EOT, a bcc compare is not performed. When the ending is caused by an EOT, the Unit Exception status is set.

Several timeouts are employed during receive operations. These are described under "Timing Considerations in SDA-II Operations."

Transparent Operations

Transparent operation permits the unrestricted use of all bit patterns within each transmission code level (six or eight bits). Transparent-text mode is useful in transmitting messages containing:

Binary data
Fixed and floating point data
Packed-decimal digits
Logical information
Encrypted data
Grouped short messages
Foreign codes
Unedited information
Source programs
Object programs

Transparency can be obtained as an optional feature, thus permitting transparent operations in addition to the normal operations. Note that transparency is used for message-reading and message-writing operations only; all responses, inquiries, and other data-link control sequences are transmitted in normal mode.

The transparent operations are similar to the read and write operations previously described. The differences and highlights between normal read and write and transparent read and write operations are given below:

Transparent-Read Operations

The SDA-II enters transparent-read mode by the receipt of the two-character sequence, DLE STX. While in this mode (and operating under a Read command), the SDA-II performs in the following manner:

1. It ceases to act upon all control characters except DLE.
2. Upon decoding a DLE, the SDA-II remembers the detection of DLE, inhibits its inclusion in the bcc accumulation, deletes the DLE from the data stream (i. e., does not transfer it to main storage), and examines the next receive character. If the next character is:
   a. ETX, ENQ, or ETB, the SDA-II performs the normal ending as though the character were received in a normal text transmission.
   b. Another DLE character, the SDA-II treats it as a transparent data character; i. e., it is included in the bcc accumulation and it is transferred to main storage. The SDA-II then returns to transparent operation where it acts only upon the DLE character. If the next character after the second DLE happens to be an ending character (e. g., ETX), the SDA-II does not act upon it as it is not part of a two-character DLE sequence. (It is a DLE DLE ETX sequence that

causes the ETX to be a transparent-data character.)

c. A SYN character, the character is deleted from the data stream and also from the bcc accumulation. The SDA-II returns to transparent operation.
d. An ITB character, this indicates that the following character(s) will be the bcc(s). Transparent mode is reset, but the adapter will remain in text mode and will begin accumulation of a new bcc. To reenter transparent text mode, DLE-STX must be received. Both the DLE and the STX will be included in the new bcc accumulation.
e. None of the above characters, the SDA-II sets the Data Check sense bit and the Unit Check status bit and returns to transparent operation.

Transparent-Write Operations

The object of a transparent-write operation is to transfer data from main storage to a remote station without any restrictions on the binary format of the data.

The transparent operation, as defined for BSC line control, requires the transmitter to insert a DLE whenever a character within the data has the same bit configuration as the DLE character (see Figure 60). The problem for the transmitter is how to permit the transmission of a true DLE ending sequence without inserting a DLE character that would break up the ending sequence and thus make it unrecognizable to the receiving station. The technique used for the SDA-II is to require two Write commands. The information specified in the first Write command contains the DLE STX control characters, which set the transparent mode within the SDA-II and the receiving station.

The second Write command (which must be command chained from the first Write command) contains the DLE ending sequence. When operating under the second Write command, the SDA-II does not generate a DLE upon detection of a DLE.

The SDA-II enters transparent write mode by the receipt of the two-character sequence DLE-STX from main storage. While in this mode, the SDA-II performs in the following manner:

1. It ceases to act upon all control characters except DLE.
2. Upon decoding a DLE in the data stream received from main storage, the SDA-II inhibits its inclusion in the bcc accumulation, but transmits the DLE. A second DLE is generated by the SDA-II to form the DLE-DLE sequence. The generated DLE is included in the bcc accumulation.
3. It inserts DLE-SYN characters in the data stream as time-fill whenever data is not available from main storage. The DLE-SYN characters will not be included in the bcc accumulation.
4. It inserts DLE-SYN characters in the data stream at a variable rate to maintain bit and character synchronization. The DLE-SYN characters will not be included in the bcc accumulation.
5. When an Interface Stop signal is received, the SDA-II ends the first Write command with Channel End and Device End and inserts DLE-SYN characters into the data stream to maintain bit and character synchronization. The DLE-SYN will not be included in the bcc accumulation. The DLE-SYN characters will be generated until the second Write command is received or until three seconds elapse. If the three-second timeout occurs, the SDA-II will cease generating DLE-SYN characters and revert to receive mode.
6. Between the first and second Write commands, the SDA-II will command-reject commands other than Sense, Test I/O, and I/O No Op.
7. When the second Write command is received within three seconds: (1) the doubling of the DLE by the SDA-II is inhibited, and (2) the ending sequence DLE-ETB, DLE-ETX, DLE-ITB, or DLE-ENQ received from main storage ends transparent mode. These ending sequences perform the same functions as the ETB, ETX, ITB, and ENQ in normal data. If none of these sequences occur before Interface Stop is signaled to the second Write command, the SDA-II leaves transparent mode and ends the command with Channel End and Device End.

   If the second Write command is not received within three seconds: (1) the Write command is ended immediately with Channel End, Device End, and Unit Check, and (2) the Timeout sense bit is set to 1, and (3) transparent mode is reset. A Sense command must be issued to accept the Timeout sense; otherwise the SDA-II will continue to command-reject commands other than Sense, Test I/O, I/O No Op, and Write.

PROGRAMMING NOTES: For both read and write operations, a DLE ITB sequence causes the SDA-II to exit from transparent mode, yet continue in text mode.

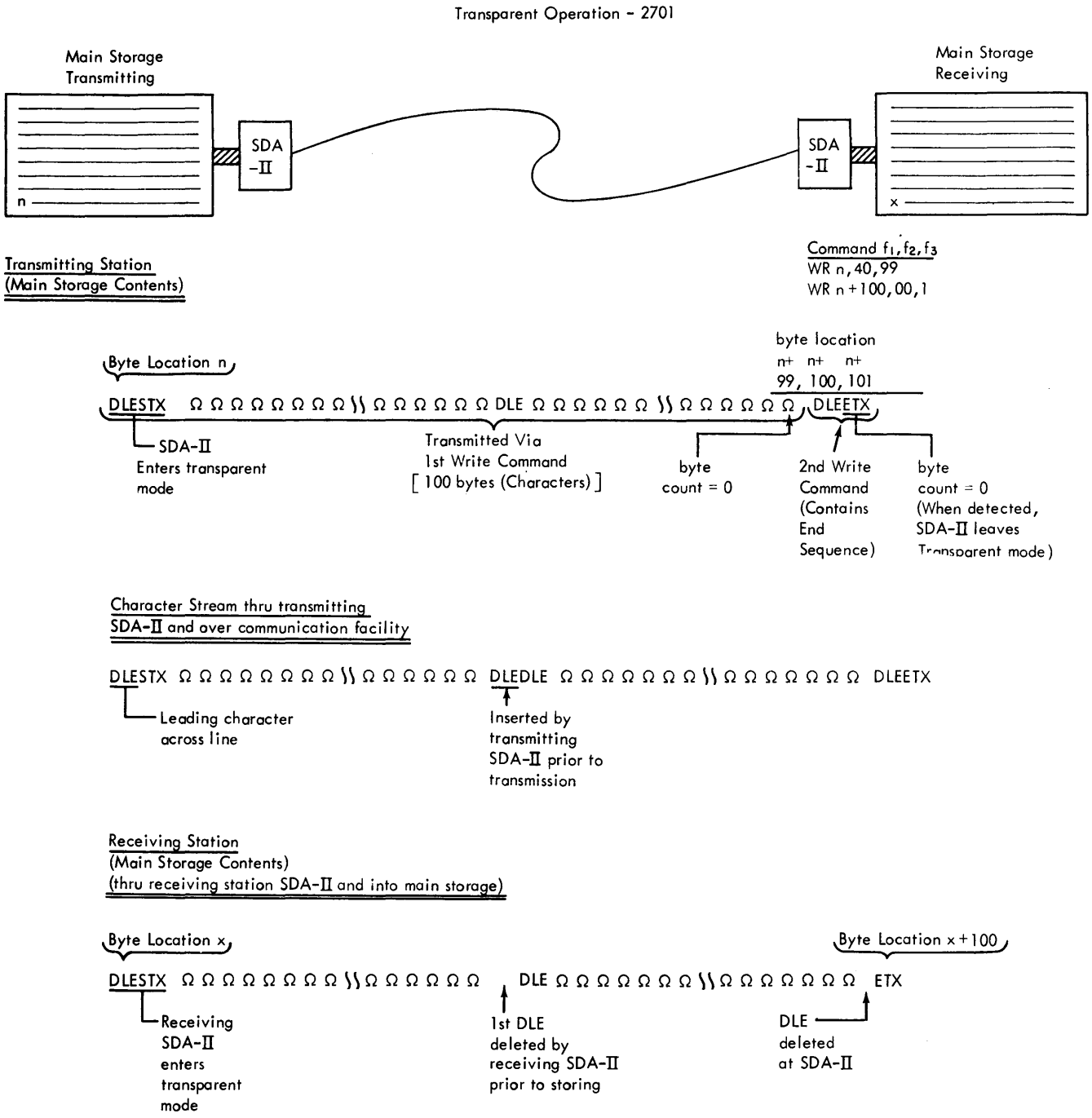


Figure 60. SDA-II Transparent Operations

The SDA-II sends the block-check character (bcc) after ETB, ETX, or ITB.

The DLE SYN is used in transparent text mode to maintain character phase. The DLE SYN sequence cannot be used as a programmed time-fill.

In transparent operations, VRC checking used with the ASCII code is suspended following the initial DLE STX sequence except on the ending control characters.

The DLE ITB sequence is followed by the bcc SYN SYN sequence (double SYN must be inserted by programmer). If the data following is to be in transparent mode, the DLE STX sequence must follow the SYN characters. In this case, the DLE and STX characters are included in the bcc accumulation, since the SDA-II does not leave text mode via the ITB character when the SDA-II is in intermediate-block mode.

Intermediate-Block-Checking Operation

The intermediate-block-checking mode of operation is standard. The Set Mode command determines if the Error Index byte is generated at the receiving station after ETX, ETB, or ITB.

The SDA-II performs a bcc operation after each ITB, ETB, or ETX; however, no line turnaround response occurs after an ITB. This operation is useful in grouping short records into more efficient longer records but still retaining the block-checking function on the individual blocks. The ITB function may also be used to take maximum advantage of the error-checking capability for long records. (The CRC_{16} is most capable for records of about 4000 characters or less). When the record size exceeds approximately 4000 characters, the ITB character may be used to break up long records into shorter records without requiring a line turnaround and response on the shortened record.

The ITB write and read operations are similar to normal operations described above. The differences and highlights are given below.

Intermediate-Block-Write Operation

When operating under a Write command, the SDA-II decodes for the ITB character. This is in addition to the other decode operations.

When ITB is detected, the SDA-II transmits the bcc following the ITB transmission. As is normally done, the bcc accumulation is reset upon the bcc transmission. The Write command is not ended and the text mode is not reset.

The use of an STX character to precede the next block is optional. When used, the STX is included in the bcc accumulation and does not reset the bcc accumulation.

Intermediate-Block-Receive Operation

When operating under a Read command, the SDA-II decodes the received data for the ITB character. This is in addition to the other SDA-II decode operations.

When an ITB character is detected, the SDA-II receives the bcc and performs the block-check-compare operations upon it; however, the SDA-II does not end the Read command as is normally done upon the detection of the ETB or ETX character. The SDA-II generates an additional byte that is transferred to main storage immediately following the ITB character. This additional byte is called the Error Index Byte (EIB) and is used to inform the program of any error status detected in the block just received. The format of the EIB (only two bit positions are affected) is:

Bit Position	Error Condition
4	Data Check
5	Overrun

(The error conditions are due to events described by the sense bits of the same names.)

The EIB for each block is independent of previous blocks. For example, if the first block experianced a data check and the remaining blocks did not, then only the EIB following the ITB character for the first block will indicate Data Check.

When the last text block is received, the block is terminated with either ETX or ETB. The bcc compare operation will be performed as normal and the Read command will be ended as normal, except that if the ITB mode bit is set in the mode register, an EIB for the last block is placed in main storage following the ETX or ETB and before the SDA-II presents the ending status to the I/O channel.

The ending status and sense information reflects the entire read operation. That is, if any of the individual blocks experiences a data check or overrun, the ending status will include the Unit Check status and the sense byte will have either or both sense bits set.

If all the blocks were received error-free, and no other error has occurred, then the ending status will be Channel End and Device End.

PROGRAMMING NOTES:

1. The EIB character will be placed in main storage following every block ended with ITB, ETB, or ETX, when the ended intermediate-block-check bit is set in the mode byte by the Set Mode command. No EIB character will be sent to main storage following ITB, ETB, or ETX characters if the intermediate-block-check bit is not set.

2. When the status and sense information indicate that a Data Check or Overrun condition has occurred, and it is desired to determine in which block(s) the error has occurred, the program must check every EIB--as an error could have occurred in several of the blocks. The EIB may be located in normal data by use of a Translate and Test (TRT) instruction testing for the ITB character. Once found, the EIB is always at the next higher address (unless data chaining was employed). Using a fixed block length is a necessity because the bit configuration for the ITB character can occur in the data.

Polling Operations

Polling is a technique used to have a master (control) station invite another (tributary) station on the same line to transmit. Polling is normally performed on multipoint facilities--i.e., the control and at least two tributaries; however it is possible to perform polling on point-to-point facilities (i.e., the control and only one tributary). The basic advantages of this would be to have a more orderly control of the schedule at which the "central station" must be prepared to receive. Another advantage would be the ease of accomplishing component addressing.

Polling may be accomplished either by a Write command sending the polling sequence and command chained to a Read command to receive the reply, or by use of the Poll command.

The Poll command has the advantage of minimizing the processor interference during idle periods when the tributary stations have no data to send. During these periods, the terminals would be responding to the polling sequences with the EOT character (the negative response to polling). This would cause an I/O interrupt at fairly frequent intervals if the write/read type of polling were being used.

The Auto Poll operation utilizes the Poll command.

The Poll command (see command section of SDA-II for its description) operates in conjunction with a polling table (or poll list) developed for the particular installation and maintained in main storage.

Each station to be polled has a stored poll entry which contains three parts:

1. Station Address. The station address is variable in length; however, the first character must uniquely identify one station on the communications line.
2. ENQ Control Character. This character is used to indicate the end of the addressing sequence to the polled terminal. The ENQ signals the end of the polling address and requests a response from the addressed terminal.
3. Index Character. The index character identifies the polled terminal back to the program when there is a non-negative acknowledgment of the polling sequence. The index character is fetched from its main storage location and is retained in the SDA-II; however it is not transmitted onto the line. With the receipt of a non-negative poll response, the index character is the first character to be transferred to main storage under a read-type command.

Thus a three-terminal poll list could conceptually appear as follows:

AX ENQ Index	1st Terminal Polled
BX ENQ Index	2nd Terminal Polled
CX ENQ Index	3rd Terminal Polled
EOT	Poll List Termination

To perform polling, the communications line must be in control mode. This is accomplished by transmitting an EOT character. The EOT may have been previously transmitted. If it is desired to transmit an EOT prior to polling, it may be done under a Write CCW. This CCW is command chained to a Poll CCW, which provides for the polling list.

Under the Poll command, the SDA-II initially operates the same as under a Write command. The SDA-II obtains a character from main storage until it accepts the ENQ character. It then accepts one additional character, the index character. After the address and the ENQ have been transmitted, the SDA-II enters into receive mode, where it is conditioned to establish character synchronization and receive the terminal's response. The index character is held within the SDA-II.

There are three possible responses to a Poll:

1. Positive Response (polled terminal has information to transmit). This is recognized by the SDA-II by the first non-SYN character received not being an EOT character. This causes the Channel End, Device End, and Status Modifier status bits to be set. This status condition should cause chaining to a read-type command. Under this command

the first character returned to main storage is the index character.

2. Negative Response (polled terminal has no message to transmit). This is indicated by the receipt of an EOT at the SDA-II. Receipt of the EOT does not cause any status or sense bits to be set; thus no interrupt occurs. The SDA-II then returns to the transmit mode. It fetches the next address from main storage and repeats the operation. With the negative response, the retention of the last index character by the SDA-II ceases.
3. No Response Received (at the SDA-II from the polled terminal). With the transmission of the ENQ, a three-second timeout is initiated. At the end of this three seconds, if neither a positive nor negative response has been received by the SDA-II, the Poll ends with Channel End, Device End, and Status Modifier status set. In the same manner as for a positive response to polling, status-modifier chaining to the read-type command is initiated. After the read-type command has been accepted and the index character is transferred to main storage, and if no additional data is received, the command ends with Channel End, Device End, and Unit Check status and the Timeout sense bit set.

NOTE: It is suggested that an EOT sequence be generated as an initialization to polling and the same terminal be repolled. This should be repeated before determining that the terminal has not answered.

As stated in 2 above, when negative responses are received from the terminal(s), the SDA-II continues through the polling list. When the polling process has proceeded through the entire polling list, the I/O channel signals Interface Stop. When this occurs, the SDA-II ends the command by setting Channel End and Device End status.

Programming Considerations

A polling sequence can typically be written as follows:

			Remarks
CCW	Write	CC	EOT
CCW	Poll	CC	Polling List
CCW	TIC or I/O No Op		
CCW	Read or Search		Message Received

The initial Write CCW is used to transmit an EOT at the beginning of the polling operation to reset all terminals. Subsequent polls, after the first within a given sequence, do not require this Write command execution.

The Poll command starts the polling operation. The data-address field in the CCW must specify the address of the polling list as described above. The byte-count field must be exactly the length of the polling list. Command chaining must be employed. This command will be normally ended by a positive response to the polling request. In this case, the SDA-II sets Channel End, Device End, and Status Modifier status, which causes status-modifier chaining to the Read (or Search) command. Or the command may be ended by the SDA-II processing to the end of the polling list. In this case, the SDA-II sets the Channel End and Device End status, which causes command chaining to the TIC (or I/O No Op) command. Two variations of the CCW sequence can be employed to accommodate reaching the end of the polling list. These are:

1. Automatically reinitiate the polling operation by using a TIC (Transfer in Channel) command.
2. Terminate the polling operation and cause a program interrupt by using the I/O No Op command.

In the first case, the CCW sequence could be:

CCW	Write	CC
CCW	Poll	CC SLI
CCW	TIC	CC SLI
CCW	Read or Search	

In this case, the TIC would contain the byte address of the Poll command in the data-address field of the Poll command. This would cause a channel branch back to the Poll command and then reinitate polling.

In the second case, the end-of-poll-list (count equals zero) causes the channel program to command chain to the I/O No Op command. The I/O No Op should not be chained and thus results in a terminating interruption of the polling operation. The sequence would be:

CCW	Write	CC
CCW	Poll	CC
CCW	I/O NO OP	
CCW	Read or Search	

The Read or Search command provides for the movement of the positive response that was re-

ceived from the polled terminal to main storage. The response will be preceded by the index character that had been retained in the SDA-II. The index character will be stored in the main-storage byte location specified in the data-address field of the Read or Search command. The response and the remainder of the message (where applicable) will occupy the immediately following byte locations in main storage.

The index character, which serves as an identification medium, can consist of any character (alphabetic, numeric, or special character). As it can also be employed as a count value in the control of terminals polled, it is recommended that the assignment of characters be sequential to determine the location in the poll list the polling operation was at when a positive response was received.

After a positive response to polling has been processed, it may be desired to reinitiate polling. This can be done by either restarting at the beginning of the polling list or by restarting the polling where it left off.

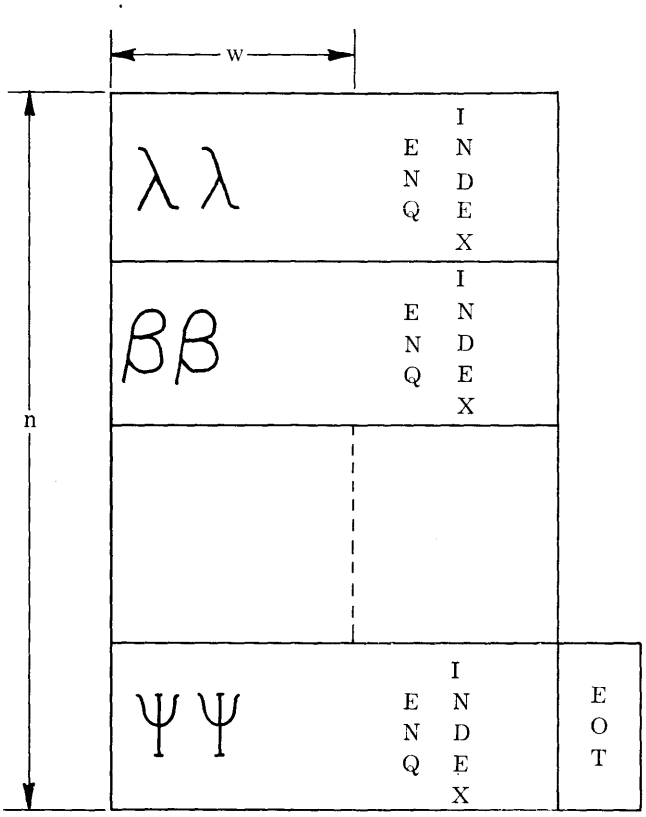
For the "once-through" channel program, the original program can be used by altering the data-address field of the second Poll CCW to correspond to the entry point in the poll list.

For the "wrap-around" channel program, the original program may be altered as follows:

	Command	Flags	Byte Count	Remarks
(1)	Write	CC	1	EOT
(2)	Poll	CC, SLI	N	The data address should indicate the desired entry point in the polling list. The count must exactly equal the remaining bytes in the polling list.
(3)	TIC	SLI	--	to CCW (5)
(4)	Read/ Search	SLI	--	See note 1
(5)	Poll	CC, SLI	M	The data address should reflect the start of the polling list. The count must indicate the total length of the polling list.
(6)	TIC	SLI	--	to CCW (5)
(7)	Read/ Search	SLI	--	

NOTE 1: If the data or command chaining of the Read or Searc command indicated in CCW (4) is desired, then the Read or Search should be replaced with a TIC to CCW (7) or some other area that contains the desired channel program.

At times terminals may have to be removed from the poll list. One approach, which does not require the construction of a new poll table, is to replace the poll entry to be removed with SYN characters. In this case, the user program must maintain the location of the terminal entry in the polling list. Where there may be multiple entries of a terminal in the polling list, this may become cumbersome. To avert this problem, it is suggested that the polling list have the following construction.



n = number of entries
w = number of bytes in each polling address

Table Length = n(w+2) + 1

Station Selection Feature Operation

To remove a terminal from the active polling list, place the entire entry for that terminal after the EOT at the end of the list. The complete entry (polling address, ENQ, index) remains intact. The reverse action is taken to return the poll to the active list.

The effect of transmitting the deleted terminal's address is voided by the transmission of the EOT. The SYN characters are required to regain character phase, which is normally terminated upon the receipt of the EOT character. The EOT character at the end of the poll list is required to protect against the last terminal entry being removed from the polling list. Without this EOT to cause the termination of the character phase at the tributary station, the poll list could be ended with the stations in false character phase. If this did occur, it would take approximately three seconds for the line to recover and normal polling to resume.

Early-Channel-End Operation

The "early channel end" (ECE) mode of operation may be used only when the SDA-II is operating on a selector channel. During ECE operation, some SDA-II commands (Disable, Prepare, and Adprep) set the Channel End status bit ahead of the Device End (and other status bits) when need for the I/O channel is completed (i.e., as soon as the command has been accepted by the channel. This operation frees the selector channel as quickly as possible, thereby permitting it to operate the other attached I/O devices. For ECE to be meaningful, command chaining must not be specified (CCW bit 33 must be zero) for the applicable commands.

Interrupt Mode of Operation

The interrupt mode of operation is selected by the Set Mode command. This mode of operation should be selected only when the SDA-II is operating on a switched network and connected to a selector channel.

When the interrupt mode is set and the SDA-II is not on (Enable command has not been issued), the SDA-II sets Attention status to the I/O channel when the data set signals that a call is coming in. The call cannot be answered unless an Enable command is issued. Note that the selector channel must be free for the Attention status to be presented to the program. When the program receives the Attention status, it should issue an Enable command to answer the incoming call.

When the interrupt mode is set, the SDA-II can accept an Enable command before an incoming call has been indicated. In this case, the SDA-II is turned on and becomes enabled; that is, the SDA-II signals the data set to automatically answer an incoming call. If a call is not answered within six seconds, the Enable command is ended with Channel End, Device End, and Unit Check status and the Timeout sense bit set. The SDA-II stays on and enabled--i.e., the data set still automatically answers a call. The program should immediately issue another Enable command or a Disable command, because in its present condition, the SDA-II cannot signal the Attention status. A Dial command should not be issued until the SDA-II has first been disabled.

Test Mode of Operation

This mode of operation permits diagnostic testing of the SDA-II and is selected by the Set Mode command. During this mode of operation, characters are not transferred to, or received from, the local data set. During the test mode of operation, the Write command and the transmit portion of the Poll command are executed in the normal manner. During the test receive operations, the establishment of character phase with the remote terminal is simulated when the Prepare command is executed. The bcc character accumulated during the execution of the last Write command or transmit portion of the last Poll command can be read in.

- Timing Considerations in SDA-II Operation:

During write operations, the SDA-II, while in test mode, will generate two contiguous SYN characters every second.

During read operations in Test mode, the SDA-II will continuously look for SYN characters. With a READ Command in the SDA-II, two SYN characters followed by a non-SYN character must be detected in the text within three seconds of the previous SYN sequence. If not, the Timeout sense bit will be set and the command will end with Channel End, Device End, and Unit Check.

During transparent mode of operation, the second Write command must be accepted within three seconds after the Interface Stop signal is received. If not, the next Write command will be ended with Channel End, Device End, and Unit Check status and the Timeout sense bit set. From the time the first Write command ends, any and all commands other than Write, Sense, Test Input-Output, and I/O NO OP will end with Unit Check and Command Reject until the Write command is accepted.

Once the timeout completes, the timeout sense bit is held in abeyance until the Write command is issued. This Write command will then end with the Timeout bit set.

Disable

The command will take three seconds from the receipt of the command until the SDA-II initiates Channel End and Device End status. (Exception during test mode: the duration is only 17 milliseconds.)

Data Set Interface

When the Request to Send signal is raised in the data-set interface, the SDA-II must detect Clear to Send within three seconds. If not, Channel End, Device End, and Unit Check with the Intervention Required sense bit set will end the write-type command.

Interrupt Mode

The execution of the Enable command in interrupt mode must terminate within six seconds. The Enable command will end with Channel End, Device End, and Unit Check, and Timeout sense bit set if "ringing" is not detected on the selected data-set interface.

Dial

When the common carrier's Automatic Calling Unit signals Abandon Call and Re-try (ACR) while the SDA-II is executing a DIAL command, the command will be terminated and the Timeout sense bit will be set along with Channel End, Device End, and Unit Check set in the status byte. The length of time before the ACU signals ACR is set on the Automatic Calling Unit.

Adprep

When the SDA-II accepts the Adprep Command, it monitors the receive line, following all data on the line. When the Adprep command is accepted and character phase is not established, the SDA-II starts a three-second timeout during which it must establish character phase followed by one of the following three conditions:

1. SDA-II's Address. The command is ended under the following two statuses: the SDA-II ends the command with Channel End and Device End when a selection address is recognized, or the SDA-II ends the command with the Status Modifier bit set when a poll address is recognized.
2. End Character. This causes the three-second timeout to be restarted and the adapter to continue to look for a new character phase.
3. STX or SOH characters. Upon recognition of STX or SOH, the SDA-II enters text mode and ceases looking for its address until control mode is set.

The SDA-II monitors the data while in text mode, utilizing the three-second timeout, for recognition of SYN characters as the normal Read command does. If any timeout occurs or if character phase is on when the command is accepted, the adapter will look for a new character phase followed by EOT before any of above three conditions are sought.

Poll Command

After the ENQ character is transmitted, the adapter goes into receive mode (Channel End and Device End are not set) looking for character phase. At this time a Timeout condition can occur.

Following the sending of the ENQ character, a three-second timeout is initiated. At the end of three seconds, if the SDA-II is not in character phase, the command will end with Channel End, Device End, and Status Modifier. The Status Modifier signal should cause command chaining to a Read or Search command. The Read or Search command puts the stored index character into main storage, and initiates a three-second timeout. At the end of this timeout, the SDA-II ends the Read or Search command with Channel End, Device End, and Unit Check status with the Timeout sense bit set.

Search

All data received before going into Text Mode (recognition of STX or SOH), including the first STX or SOH character, will be sent to main storage. Before going into text mode, the one-second timeout is utilized and is reset every time a new end character is detected. If the one-second timeout finishes prior to going into text mode, then the command ends with Channel End, Device End, and Unit Check status with the Timeout sense bit set. While in text mode, no data is sent to the main storage and the SDA-II monitors all data and responses. The command will end with Channel End, Device End, and Unit Exception on the recognition of an EOT character, or with Channel End, Device End, and Unit Check with the Timeout bit set if the three-second timeout occurs after entering text mode.

- Effects of Halt I/O Instruction by Command

A Halt I/O (HIO) instruction can be issued to the 2701 during the execution of an SDA-II command. When HIO is issued, various actions take place, depending on the command being executed.

Command	HIO Action
Set Mode	If HIO is received before the Set Mode byte has been accepted from main storage, the command ends immediately with Channel End, Device End, and Unit Exception status. The SDA-II is reset. If HIO is issued at other times, it has no effect on the Set Mode command's execution.
Enable	On a switched network, if the HIO is received when the data set is not operational (i.e., before the call has been answered), the command is ended with Channel End, Device End, and Unit Exception status. Otherwise, HIO has no effect on the normal execution of the Enable command and the SDA-II is not reset.
Dial	A HIO received before the Interface-Stop signal has been transmitted to the SDA-II (e.g., the entire number has not been dialed) results in aborting the dialing operation, the resetting of the enable and dial circuitry, and the immediate ending of the command with Channel End, Devcie End, and Unit Exception status. If HIO is received after the Interface Stop signal has been received, the dialing operation proceeds normally.
Write	HIO causes the SDA-II to complete the transmission of all characters received prior to the HIO. The SDA-II then terminates the command with Channel End and Device End.
Read	HIO causes the SDA-II to stop transferring data to the I/O channel. The Unit Check status and Lost Data bits are set to one. Part of the data will always be lost when the HIO is issued during a Read command execution. The command ends immediately with Channel End, Device End, and Unit Check.
Prepare	If HIO is issued before character phase is established, the command ends immediately with Channel End, Device End, and Unit Exception status. If HIO is issued after character phase has been established, there is no effect.
Adprep	If HIO is issued before the group, selection, or polling address is recognized, the command ends immediately with Channel End, Device End, and Unit Exception status. Otherwise, the operation is not affected.
Search	HIO causes the cessation of data transfer to main storage. Unit Check status and Lost Data are set to one. The command ends immediately with Channel End, Device End, and Unit Check status. Part of the data will be lost when the HIO is issued.
Poll	HIO causes the command to end immediately with Channel End and Device End status. HIO should not be used with the Poll command.
Disable	HIO has no effect on the Disable command.
Sense	HIO causes this command to end immediately with Channel End and Device End status.

- Effects of Interface Stop by Command

When the byte count in the current command is decremented to zero and data chaining is not specified, a condition known as Interface Stop occurs when the SDA-II requests the next byte from the channel. This condition signals the 2701 that no additional bytes are to be transferred between main storage and the 2701. If the last character transferred from the channel causes the SDA-II to end the command, then the next byte will not be requested and the Interface Stop will not occur.

Various actions take place, depending upon the command being executed, as follows:

Command	Action
Set Mode	Command ends normally when Interface Stop is signaled if no error or unusual condition occurred during execution. The ending status is Channel End and Device End.

Dial — Interface Stop is used to indicate that the last dialing digit has been transferred to the SDA-II.

After the last dialing digit is transferred to the common-carrier dialing equipment, the Automatic Call feature awaits a signal from the data set that the connection has been established. If the call cannot be answered at the remote station, the Dial command ends with Channel End, Device End, and Unit Check status and the Timeout bit set to one.

Read — The Interface Stop signal causes the command to cease transferring data to the channel. The Unit Check status and the Lost Data bit are set to one. Since any data that has been read but not transferred to main storage will not be transferred, part of the received data will always be lost as a result of an Interface Stop signal.

Write — Interface Stop signal indicates the last character has been transferred under the current command. The SDA-II sends any characters it has buffered to the line and ends with Channel End and Device End status. The SDA-II goes into receive mode after transmitting the last character. If the SDA-II was operating in transparent mode, it will continue in transparent synchronism by sending transparent sync idles (DLE SYN) for three seconds or until another Write command is issued.

Search — The Interface Stop causes the command to cease transferring data to the channel and stop monitoring for valid addresses. Unit Check status and Lost Data bit are set to one. Part of the received data will always be lost when the Interface Stop occurs.

Poll — The Interface Stop signal indicates that the last character has been transferred from main storage to the SDA-II under the current Poll command. The SDA-II sends any buffered characters and ends the command with Channel End and Device End status. The SDA-II goes into receive mode after the last character is transmitted. Note that the program must ensure that the byte count is exactly as large as the poll list so that the last character transferred by the Poll command is the index character for the last poll in the list.

Enable, Disable, Adprep, Prepare — No data-byte transfers occur with the execution of these commands; accordingly, Interface Stop is never signaled.

Sense — Interface Stop signal causes this command to end immediately with Channel End and Device End status.

- Status and Sense Bytes--SDA-II Operations

Status bytes (indicating various status conditions) are sent from the 2701 to the I/O channel at various stages of operations. The status conditions that may be signaled by the use of the SDA-II, by command, are presented in three command-execution references--i.e., initial selection time; during command execution after initial selection; and as the interrupt status when no command is being currently executed.

Initial Selection Status

All zeros

Signaled to the I/O channel in response to Start I/O indicating "command accepted." In response to Test I/O, it indicates that no command is being executed and no status is outstanding.

Busy

Signaled to the I/O channel as the response to any command selection (including Test Input-Output) while the SDA-II is executing a valid command. Busy status can be signaled in combination with any of the other status bits, in response to any command selection (excepting Test Input-Output when no command is currently being executed) occurring when the SDA-II is storing outstanding status.

Unit Check

Signaled to the channel as the "command reject" response to any invalid SDA-II command. This will also be the response to Prepare, Adprep, Search, Poll, Write, and Read if the SDA-II was not turned on by Enable or Dial. It will be signaled to the Dial command if the wrong data-set

interface has been selected by the Set Mode command or the Automatic Calling Unit feature is not installed. It will also be signaled to any command (other than a Write) if the SDA-II never executed the second Write command in a transparent-write sequence.

After Initial-Selection Status Without Early Channel End

The after initial-selection status bit that can be signaled depends on whether or not the SDA-II is wired for "Early Channel End" operation.

Channel End and Device End

This status is set by the 2701 when each of the valid SDA-II commands reaches its "normal" ending point; it is defined as "normal" ending status. The specific ending conditions for each command is given below:

Set Mode. The Set Mode byte was accepted and the I/O channel signaled Interface Stop.

Enable. The SDA-II is on; a data set is selected and is "off-hook" in data mode. In switched-network operation, a call was answered.

Dial. The dial operation is complete and the local data set is connected to the line and in data mode.

Disable. The SDA-II is turned off and was reset. In switched-network operation, the data set went "on-hook."

Prepare. The SDA-II is in character phase.

Write. The data was successfully sent. ETB or ETX followed by a bcc was sent or Halt I/O or Interface Stop signal was received. The command is ended with this condition after the "pad" character has been transmitted.

Read. The record was successfully received without error.

Sense. The I/O Channel signaled Interface Stop or Halt I/O or the 2701 successfully transferred the sense byte. This is the only ending status that can be signaled for this command.

Adprep. The SDA-II's address was successfully decoded as a selection address or group address.

Search. This command will end with Channel End and Device End when the SDA-II's address is detected as the first character received on the line that is transferred to main storage after the index character. The Channel End and Device End appears as first End character following the above condition.

Poll. This command will end with Channel End and Device End when either a Halt I/O or Interface Stop signal is detected during the command's operation.

Channel End, Device End, and Unit Check

This status is set when ending any valid SDA-II command (except Sense) with either error or other unusual conditions outstanding. The Sense command must be issued to the 2701 to obtain the sense byte that further defines this status.

Channel End, Device End, and Unit Exception

This status will be set when ending commands under the conditions defined for each below:

Set Mode. A Halt I/O was received prior to the mode byte being accepted by the SDA-II. The adapter is off.

Enable. In switched-network operation, the command was successfully aborted by Halt I/O before a call was answered.

Dial. The command was successfully aborted by Halt I/O prior to the Interface Stop signal being received.

Prepare. The command was successfully aborted by Halt I/O before character phase was established with the remote terminal.

Write and Poll. Command will not be executed. The Write or Poll command is ended immediately when it is issued and character phase is on.

Read. This command will end with this status condition whenever an EOT character is recognized.

Search. This command will end with this status condition whenever an EOT character is recognized.

Adprep. This command will end with this status condition whenever Halt I/O is received prior to the SDA-II's address being detected.

Channel End, Device End, Unit Check, and Unit Exception

This status will be presented if a command ends under conditions described immediately above. Before this status is accepted by the I/O channel, the conditions described under Channel End, Device End, and Unit Check appears causing Unit Check status to be set. A Sense command should be issued to determine the error condition.

Channel End, Device End, and Status Modifier

Adprep. This command will end with this status condition upon the recognition of the SDA-II's poll address.

Poll. This command will end with this status condition upon recognition of a non-EOT character following the establishment of character phase or the SDA-II failing to recognize character phase within three seconds following the transmission to the ENQ character. A Read or Search command should be issued to place the index byte into main storage and the incoming data if the SDA-II is in character phase. The Read or Search Command will end the CE, DE, UC status and with the Timeout sense bit being set if the SDA-II did not enter character phase.

After-Initial-Selection Status (Status Due to Early Channel End Operations)

This optional capability is used with selector channels only. When the SDA-II is set at installation time for Early Channel End operation, only certain SDA-II commands will set Channel End status (alone) as soon as all activities with the I/O channel are complete, ahead of Device End and any other status bits. These commands are Disable, Adprep, and Prepare; all other SDA-II commands are unaffected. It should be noted, however , that even for the above affected commands Channel End and Device End, as well as other status bits, may be signaled to the I/O channel simultaneously. Another possibility is that the command execution ending Device End (and other status) was set before Channel End was accepted by the I/O channel. The purpose of such operation is to free a selector channel as quickly as possible, so it can be used to operate other attached I/O devices (provided no command chaining is specified in the current command's CCW). Device End may then be delayed until all other aspects of the command's execution are complete.

Channel End

For Disable, Adprep, and Prepare, this status is set immediately after the command is accepted (as no data transfers occur during their execution).

Device End

For Disable, Adprep, and Prepare commands, this is normal ending status, signaled when the command has reached its normal ending point. The specified ending conditions for each command are the same as presented in the section covering Channel End and Device End.

Device End and Unit Exception

This status will be signaled only when ending Adprep or Prepare under conditions described in "After Initial Selection--Channel End, Device End, and Unit Exception."

Device End and Status Modifier

This status will be signaled when a poll address is detected under the Adprep command.

Interrupt Status

Attention

Presented to the selector channel when the SDA-II has been conditioned by the program through the Set Mode command, and no command is being executed when the following condition occurs. Ringing is signaled by an "on-hook" data set; the SDA-II is in interrupt mode; and the Enable or Dial command has not been issued to turn the SDA-II on.

Sense Information

The byte transferred to main storage during the execution of the Sense command is:

0	Command Reject
1	Intervention Required
2	Bus Out Check
3	Equipment Check
4	Data Check
5	Overrun
6	Lost Data
7	Timeout

Command Reject

Set with Unit Check status by the 2701 when a command is not accepted by the SDA-II. Test Input-Output, Sense, or I/O No Op will never end with this sense bit set.

This error condition will occur on a Dial command when the Automatic Call feature is not installed or Interface A is not selected by the set-mode byte. Command Reject is also signaled to the Write, Adprep, Poll, Search, Read, and Prepare commands when these commands are presented to the SDA-II and the adapter has not been turned on (i. e. , an Enable command issued either an I/O reset or a Disable command). Command Reject is also signaled to the Enable command if a legitimate mode is not outstanding.

Command reject is also signaled to any command (except Write, Sense, Test Input-Output, and I/O No-Op) when the SDA-II is in transparent-write and the second Write command has not been received.

The command will end immediately upon recognition of this condition.

Intervention Required

This bit is set with Unit Check status when the selected data or dialing equipment is not operational--i. e. , "power off" on data set or ACU or the equipment is "on-hook" or not in "data mode." The commands that may end with this sense bit are Prepare, Write, Read, Adprep, Search, Poll, and Dial. The command will end immediately upon recognition of this condition.

Equipment Check

The SDA-II sets this bit along with Unit Check status when the SDA-II detects an internal error condition. This error appears only with the Dial command when the Call Request signal of the SDA-II is not present within three seconds after the Dial command has been accepted by the adapter. The command will end immediately upon the recognition of this error condition.

Data Check

This bit is set along with the Unit Check status when the SDA-II detects an erroneous parity (USASCII only) or bcc check on received data. The command will go to its normal ending condition. This sense bit may occur on either the Search or the Read command. The Poll command may have the Data Check condition occur during its execution but the Unit Check and Data Check sense bit will not appear until the succeeding Read or Search commands. This error conditions may be set in the EIB during intermediate-block-checking mode, and the error condition will be retained for the final status condition. The error bit will be set only in each EIB on which the error occurs.

Overrun

This bit is set with Unit Check status when a received character is "lost" within the adapter due to the I/O channel not maintaining the speed of the incoming data. The command will go to its normal ending condition. This error condition is set in the EIB during intermediate-block-checking mode and the error condition will be retained for the final status condition. This sense condition is set only for the Read and Search commands.

Lost Data

This bit is set with Unit Check status when received characters are "lost" due to the lack of a read-type command in the SDA-II. This error will occur if a read-type command is missing when the first character is seen after the SDA-II has attained synchronism. (The SDA-II will always be in a read mode when a command is not in the adapter, the exception being transparent write). Data may be "lost" when a Halt I/O or an Interface Stop signal is recognized in the adapter during a Read command (or Search prior to entering data mode) prior to an End character being recognized.

If a read-type command is missing when characters are lost, then the next Write or Poll command will end with Unit Exception status condition with the Lost Data sense bit being held in abeyance until the Read command is issued. The Read command will end with Device End, Channel End, and Unit Check status.

It should be noted that the "lost" data will always be either at the beginning or end of the data or the entire transmission.

When intermediate-block mode is specified, the setting of Lost Data (if the condition appears) is not included in the EIB. However, it will be included in the sense information at the end of the Read command.

This error condition should not appear during a Dial command.

Timeout

This bit is set with Unit Check status when one of the adapter timeout sequences occurs. This bit will occur on a Read command when the command is issued and a control character (other than SYN) is not detected within three seconds. Also, during a Read command, while the adapter is in Text mode, a double SYN sequence must be seen followed by a non-SYN character. Timeout occurs also when the Read or Search command follows a Poll command if the termainl does not respond to the polling sequence within three seconds. This bit is also set on a Disable command, if at the end of three seconds after the adapter has accepted the Disable command, the data set has not gone "on-hook."

This bit is set on transparent-write if the second Write command is not issued within three seconds after the Interface Stop signal is detected on the first Write command. When the condition appears all commands (except Sense, I/O No Op, Write, and Test Input-Output) will be ended with command Reject until a Write command is issued.

This bit is set during a Dial command if the ACU's (Automatic Calling Unit) ACR (Abandon Call and Retry) line turns on. This indicates that the call was not established in the alloted period of time, and the Dial command should be repeated.

During the execution of the Search command, Timeout is set if the time interval between character phase while in text mode exceeds three seconds, or if the time duration while out of text mode, exceeds one second. Also, when a Search command follows a Poll command, this bit will be set if the terminal does not respond to the polling sequence within three seconds. During a write-type command, the Request to Send lead to the data set is raised. The data set must present the Clear to Send signal to the adapter within three seconds. During an Enable command on a switched network, the command must end within six seconds while in Interrupt mode or the Timeout bit will be set.

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