Reference/Instruction Manual

CONTROL DATA®
3228-A/3229-A MAGNETIC TAPE CONTROLLER

60100300	**Record of Revisions**
REVISION	NOTES
A	Addition of 2 Parts Lists as Appendices C and D.
B	Incorporation of Change Order 8930, which advanced
	the Product Designation to 3228/3229 - A04. This
	manual obsoletes all previous editions.
C	Table of Contents (iii), I-1, I-11 through I-13, II-31,
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	II-45, II-47, II-49, II-51, II-53, II-55, II-62, III-4,
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St. Paul, Minnesota 55112

or use Comment Sheet in back of this book.

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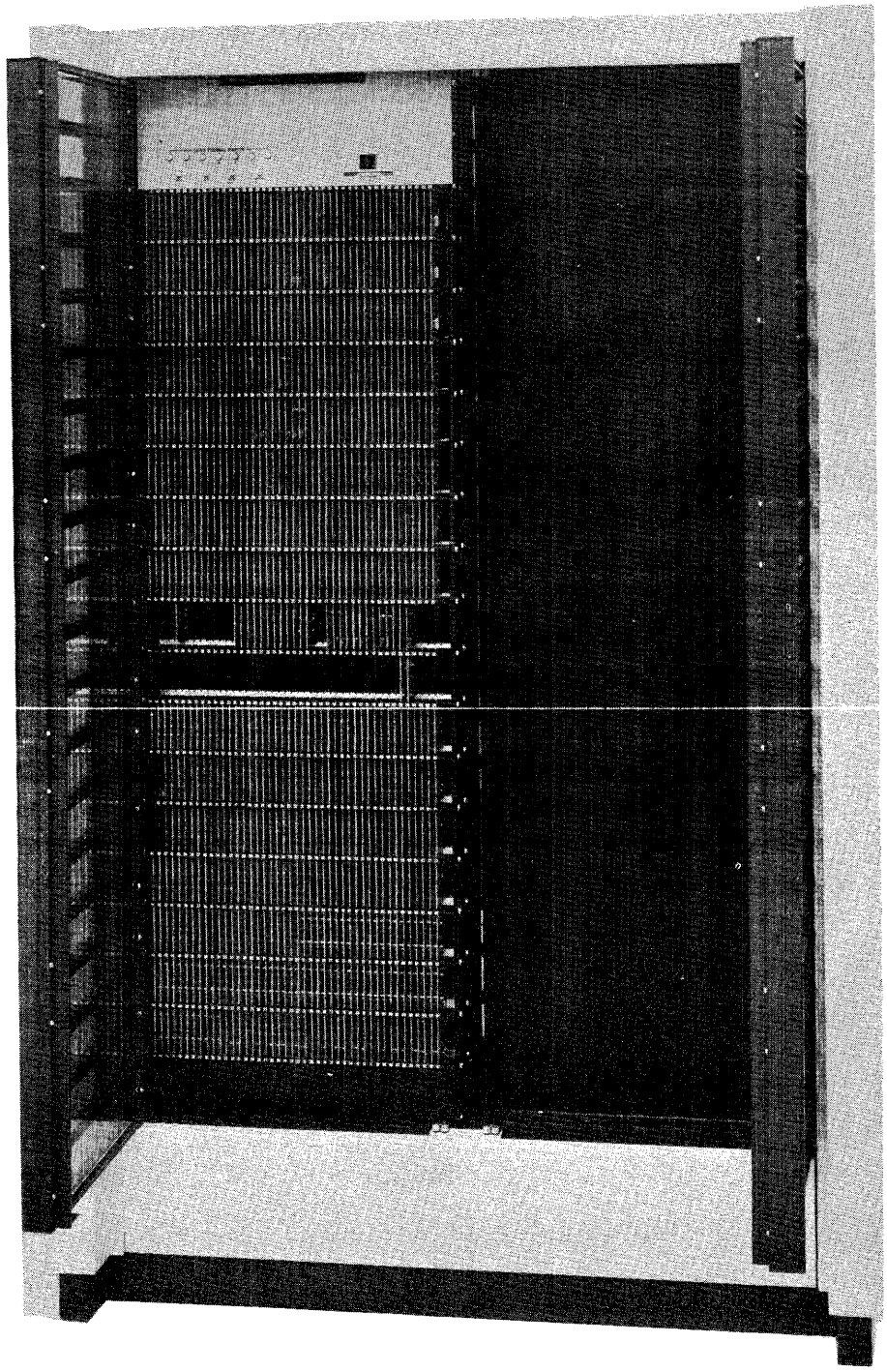

3228/3229 Magnetic Tape Controller

PART I. DESCRIPTION AND OPERATION

SECTION 1. INTRODUCTION

The CONTROL DATA* 3228/3229 Magnetic Tape Controllers are input/output devices for a Control Data 3000 series Computer System (Figure 1-2). Either controller can be connected to one 3000 series 12-bit data channel. The scheme of selection and operation follows the method inherent in any 3000 series peripheral equipment. The controller allows the data channel to select a particular tape handler and modifies and synchronizes data flow. The controllers may use all 603, all 604, all 606, or all 607 tape handlers. The 3228 may use up to four tape handlers, the 3229 up to eight. The tape handlers are selected and operated by the exchange of requests and replies typical to the 60X tape systems. The controller can read or write on one tape handler at a time. Search and rewind functions of the tape handler free the controller or the data channel for other operations. Operation of the controller using 603 or 606 tape handlers (as opposed to the higher performance 604 or 607 tape handlers) is a programming consideration.

The 603 and 604 tape handlers move tape at 75 ips, the 606 and 607 at 150 ips. In this manual, any time a delay period is mentioned by itself, it is common to either tape speed. If a delay period is mentioned, followed by another delay period in parentheses, the first delay period is for 150 ips and the second for 75 ips.

Whenever a page reference in this manual is given in parentheses, e. g. : (Page 6), it refers to a page in the 3228/3229 Magnetic Tape Controller Customer Engineering Diagrams Manual (Pub. No. 60093700).

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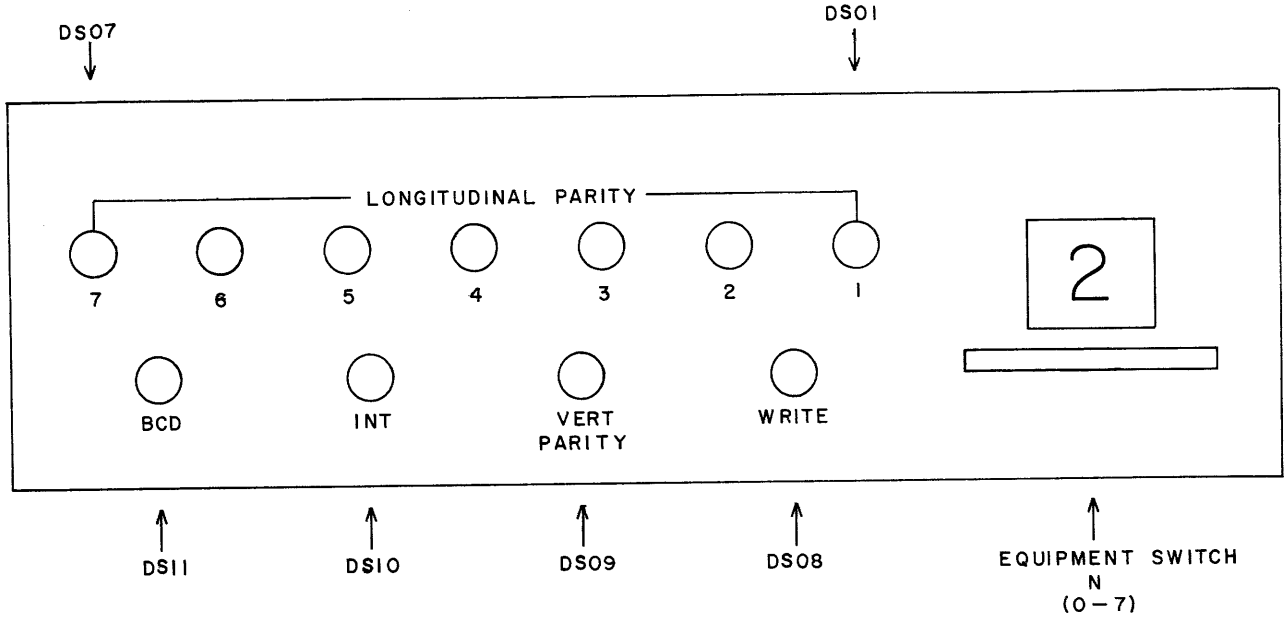


Figure 1-1. 3228/3229 Control Panel

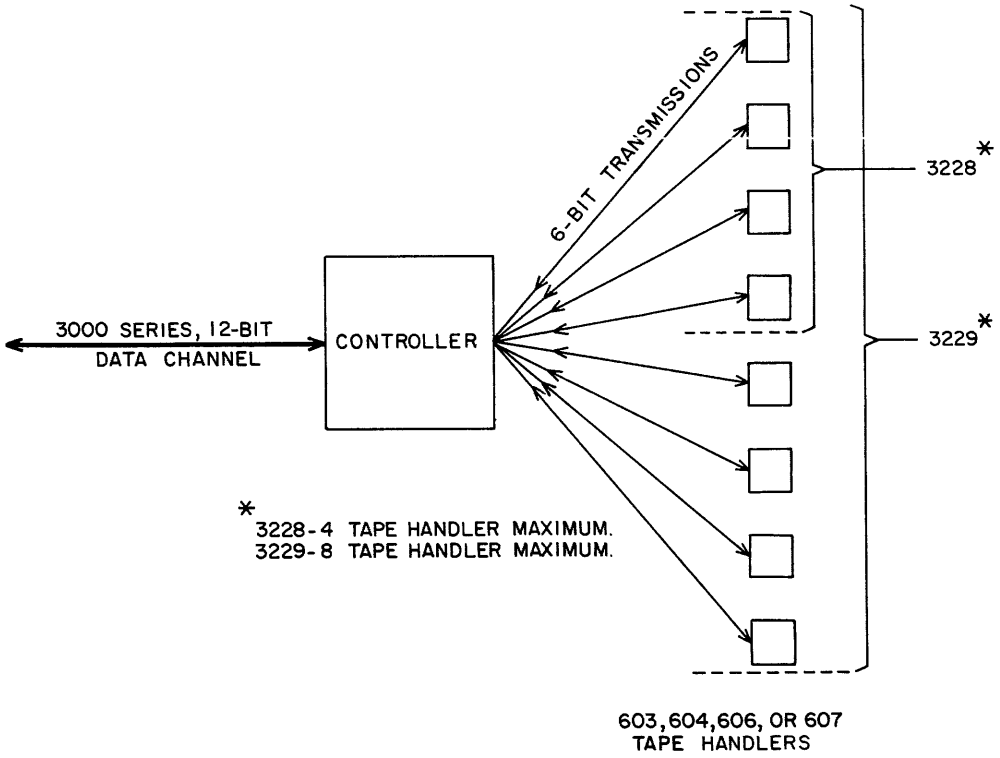


Figure 1-2. 3228/3229 Magnetic Tape System

Computer - Tape Handler operations are selected by computer EF codes and signals. These control the following functions:

1) Connect (code and signal)
    - Data Channel
    - Controller
    - Tape Handler

2) Status (on status lines after connect)

3) Function - Format (code and signal)
    - Format
        - Release
        - Parity Mode
        - Density
        - Clear
        - Reverse Read - Release Same (604/607 only)
    - Motion Directives
        - Rewind
        - Rewind Unload
        - Backspace
        - Search Forward to File Mark
        - Search Backward to File Mark
        - Write File Mark
        - Skip Bad Spot
    - Interrupt
        - Ready and Not Busy - Release Same
        - End of Operation - Release Same
        - Abnormal End of Operation - Release Same

4) Information Transfer
    - Write (signals)
    - Read (signals)

5) Assembly/Disassembly or Character (signal)

SECTION 2. DESCRIPTION

PHYSICAL DESCRIPTION

The 3228/29 controllers may be mounted in a number of different cabinets and configurations. The installation engineer can determine the accurate physical description of an actual installation by using data from the 3200 Site Preparation Manual (Pub. No. 60090100). Description of the 3228/29 control panel is in Section 3, Operation.

FUNCTIONAL DESCRIPTION

CLEAR

Prior to initial use of the tape controller, the system should be cleared. There are five possible ways of clearing the controller:

1) Clear Channel (100 μsec)
   This instruction clears all activity in the data channel and clears the tape handler connection.

2) Clear (2 μsec)
   This instruction clears the tape handler connection but the controller remains "connected" in the sense that Status signals are still available for the data channel.

3) Release
   This instruction clears only the connection for a connected tape handler (not relevant in a 3228/3229 - used for compatibility).

The latter two Function instructions (Clear and Release) can only be used after the controller is connected to a tape handler.

4) Power On MC
   When power is applied to the 3228/29, all tape handlers connected are cleared. Logic in the controller is also cleared, and no Status signals are available to the data channel.

5) External MC
   This clears all tape handlers connected and clears the logic in the controller. No Status signals are available to the data channel after executing this operation.

Both Master Clear operations place the 3228/29 in binary format.

CONNECT

The computer sends a 12-bit Connect code over the data channel to the tape controller. A manual Equipment Selection switch on the tape controller locks out all Connect codes except the ones having the correct bit combinations in bits 9, 10, and 11. These bits must match the switch setting on the 3228/29 or the processor will not make the connection. Bits 0, 1, and 2 may have octal values of 0 - 7. These bits determine with which of the tape handlers the 3228/29 will communicate. Bits 3, 4, 5, 6, 7, and 8 are not used. If none of the controllers or any other equipments physically connected to the processor via data channels have the proper switch setting, or a parity error occurs in the Connect code, an Internal Reject is generated by the computer.

STATUS

After the desired tape handler has been connected, it is usually necessary to check the status of the handler before attempting any further operations.

Ready (XXX1)

A Ready indicator on the tape handler lights when it is in a Ready condition, i.e., power has been applied and the tape handler is in Automatic mode. When in Automatic mode, the tape handler is controlled by the tape controller.

The Ready signal is not present when the tape handler is manually operated from its control panel.

Read/Write Control (and/or) Busy (XXX2)

This signal is present:

1) If the tape handler is Ready.
2) During and for 5 ms after any operation requiring tape motion (Read, Write, etc.).
3) Whenever the data channel begins executing or is executing a Read/Write instruction.

This signal will not be present if:

1) The tape handler is not Ready.
2) The channel begins executing or is executing a Read/Write instruction, and/or:
   a. Lost Data has occurred in a previous operation.
   b. Interrupt On Abnormal End of Operation has occurred in a previous operation and the Interrupt signal is still present.

Write Enable (XXX4)

This signal is present only when the file protection ring is on the tape reel. When this signal is absent, it is impossible to write on tape, although information may be read from the tape.

File Mark (XX1X)

This signal is present when the tape handler has searched for and located an End of File Mark. It is also present immediately after writing an End of File Mark. This signal drops when: (1) reading/writing begins on a new record, or (2) a Backspace, Search End of File Mark Forward, or Search End of File Mark Backward operation is initiated.

Load Point (XX2X)

This signal is present when the tape is at Load Point. The signal drops when tape motion begins.

End of Tape (XX4X)

This signal is present when the End of Tape marker is detected. The signal drops when tape has been rewound past the End of Tape marker.

Density (X1XX)

See table 1-2

Density (X2XX)

See table 1-2

Lost Data (X4XX)

This signal appears during a Write operation (Write signal present) if the tape controller is ready to accept information but the Data signal from the data channel is absent.

When the Lost Data signal appears during a Write operation, tape motion stops. Further Write operations are impossible until the Lost Data signal is cleared with a new Function or Connect code.

The Lost Data signal also appears during a Read operation (Read signal present) when the tape controller has data ready for output, but the Data signal from the data channel is absent.

If the Lost Data signal appears during a Read operation, reading continues until the end of the record. Further Read operations are impossible until the Lost Data signal is cleared with a new Function or Connect code. (Any legal Function code listed in table 1-2 will clear the Lost Data signal.)

The Lost Data signal is meaningless when the tape controller is attached to a 160/160-A via a 3681 adapter. However, this signal must be cleared if Read/Write operations are to continue.

End of Operation (1XXX)

This signal indicates that an operation is completely finished.

Parity Error (2XXX)

This signal indicates that a parity error has occurred during a Read/Write operation. This signal drops when reading begins on a new record. A Clear Channel instruction, External Master Clear or a Power On Master Clear causes this signal to drop. The Parity Error signal also appears when an End of File Mark is sritten or read in Binary mode.

SELECT FUNCTION CODES

The following information refers to the Function codes used with the Function instruction, i.e., the lower 12 bits which specify the operation. An octal 0 or 4 in bits 3, 4, and 5 of the Function code indicates format, an octal 1 in bits 3, 4, and 5 indicates tape motion, and an octal 2 in bits 3, 4, and 5 indicates Interrupt.

The proper tape handler must be connected before a Function instruction can be issued. If an error occurs in the Function code (assuming the proper unit is connected), a Parity Error signal appears on a transmission parity error line and the computer issues an Internal Reject after 100 usec.

Once a function (Backspace, Rewind, etc.) is initiated on a tape handler on a given channel, it is possible to connect another tape handler on the same channel, perform some operation on the second tape handler, and reconnect the first tape handler when the operation on the second handler terminates.

FORMAT

Release (0000)

A Release code clears the existing unit connection for a tape handler.

Binary (0001)

A 0001 code allows all information to be written or read in binary notation. A parity generator makes the total number of 1 bits odd in the transverse (vertical) direction on a total of seven separate tracks on tape. The End of Record check character makes the longitudinal number of bits in each of the seven tracks even. During Read or Write operations, a constant transverse parity check is made. A parity error is indicated on a status line if a vertical parity error is detected.

Coded (0002)

A 0002 code allows all information to be written or read in binary coded decimal (BCD) notation. A parity generator makes the total number of 1 bits even in the transverse (vertical) direction on the seven tracks on tape. Constant parity checks during Read/ Write operations are performed in the same manner as in binary format.

556 BPI Density (0003)

200 BPI Density (0004)

A 0003/0004 code permits all information to be written onto or read from the tape at 556/200 density.

Clear (0005)

A 0005 code clears all existing tape handler connections. It is desirable to issue this code when the channel has completed all operations on one or more tape handlers.

800 BPI Density (0006)

A 0006 code permits all information to be written or read onto or from the tape at 800 density. (On 604/607 Tape Handlers only.)

Set Reverse Read (0041)

This code is used for a Reverse Read operation. (See Reverse Read section.) (On 604/ 607 Tape Handlers only.)

Clear Reverse Read (0040)

This code clears the condition established by the 0041 Format code.

All of the Format codes (0000-0006, 0041, 0040) result in a Reject if attempted when the Read/Write control is busy.

Rewind (0010)

A 0010 code rewinds tape at high speed (225-400 inches/second) to the Load Point. Any further Rewind instructions will initiate an immediate Reply. A Load Point signal appears on a status line when the operation is complete.

Rewind Unload (0011)

A 0011 code rewinds tape at high speed until all the tape is on the supply reel. All further operations on this tape are locked out until the tape has been reloaded manually.

Backspace (0012)

A 0012 code backspaces tape one record length. If the Load Point occurs than at the beginning of the tape, this code will backspace tape from Load Point to one record length behind the Load Point.

Search End of File Mark Forward (0013)

Search End of File Mark Backward (0014)

A 0013/0014 code searches forward/reverse until an End of File Mark is detected. A File Mark signal appears on a status line when the operation is complete. If no file marks are detected, tape motion continues until tape is completely off the supply reel.

Write End of File Mark (0015)

A 0015 code writes 17_8 as an End of File Mark (even transverse parity) in both binary and BCD format. Writing an End of File Mark does not change the current format.

Skip Bad Spot (0016)

A 0016 code moves and erases tape 6 inches in a forward direction. If Interrupt On End of Operation is selected, Interrupt will occur when the Skip Bad Spot operation is complete.

NOTE

Codes 0010-0016 result in a Reject if attempted when the Read/Write control is busy.

INTERRUPT

All desired Interrupt instructions must come before a Read or Write operation, but can occur during any other operation. The Equipment Selection switch determines which line the Interrupt signal is transmitted on. For example, if the Equipment Selection switch is set to 5, any Interrupts coming from the controller will be transmitted on interrupt line 5. Any new Interrupt instruction clears the existing Interrupt signal. This signal is also cleared by releasing all three possible Interrupts or doing a Master Clear.

Interrupt on Ready and Not Busy (0020)
Release Interrupt on Ready and Not Busy (0021)

The 0020 code allows a tape unit to send an Interrupt signal out on the channel when this tape handler is in a Ready and Not Busy condition, i. e., when power is applied, the unit is in Automatic mode, and all tape motion has ceased. Release Interrupt on Ready and Not Busy code 0021 clears this condition.

Interrupt on End of Operation (0022)
Release Interrupt on End of Operation (0023)

A 0022 code allows a tape handler to send an Interrupt signal out on the channel after:

1) An End of Operation
2) A File Mark has been located in a Search File Mark Forward or Backward operation
3) Load Point has been detected during a Rewind operation, or
4) A Skip Bad Spot operation has been completed.

Release Interrupt on End of Operation code 0023 clears this condition.

Interrupt on Abnormal End of Operation (0024)
Release Interrupt on Abnormal End of Operation (0025)

A 0024 code allows a tape unit to send an Interrupt signal out on a channel after an abnormal operation occurs. The abnormal operations are: End of Tape, File Mark, Load Point, Transverse Parity Error, Lost Data, and Connected Tape Handler Becoming Not Ready. In all but the last case, the Interrupt occurs when one or more of these conditions is encountered and an End of Record check character is written or read by the

tape unit. In the case of Interrupt on Connected Tape Handler Becoming Not Ready, Interrupt occurs immediately when the handler goes from a Ready to a Not Ready condition (e.g., if someone were to turn off the power on the tape unit). Interrupt on Connected Tape Handler Becoming Not Ready will not occur: (1) during a Connect operation or (2) when a 0000 Function instruction (Release Connected Unit) is being executed.

A new Read/Write operation cannot start until the Interrupt signal is cleared by one of the methods mentioned previously in this chapter under the Interrupt section. Release Interrupt on Abnormal End of Operation code 0025 clears this condition.

The processor will enter an Interrupt routine and process the Interrupt. A Stop Channel Activity instruction (in the processor Interrupt routine) will terminate data channel activity and store the present word count, etc. When the Interrupt signal is cleared (in the processor Interrupt routine), reading may be initiated by a new Read instruction.

The processor will enter an Interrupt routine and process the Interrupt. When the Interrupt signal is cleared (in the processor Interrupt routine), writing may be initiated by a new Write instruction.

INFORMATION TRANSFER

Write

After the tape handler has been connected and format chosen, the programmer should check status for a Write Enable (bit 2 in the Status Reply code). If this signal is not present, the protective ring is probably missing from the tape reel. It is possible to write on the tape only when this condition has been corrected. (If the Write Enable is not present, the data channel hangs up.) If the Write Enable is present, accompanied by the Ready signal, the Write operation may begin.

Read

In a Read operation, the order of events is similar to the Write operation. After connecting, checking status, and choosing the proper format, the Read operation begins. It is not necessary to check for a Write Enable, since Read operations from the tape are possible when the protective ring is not present on the tape reel.

During Read and Write operations, the programmer may choose to check status periodically. He may also program one or more Interrupts to let the computer know when

the present operation is complete.

Reverse Read (On 604/607 Tape Handlers Only)

The 322X can read information in a reverse direction from tape. Six-bit frames are read from tape and assembled into 12-bit bytes and sent to the data channel. When a word is read in a reverse direction from tape and entered into storage, it is identical to the word which was initially written on the tape from storage. There is no change made in the final order of the bits during a Reverse Read operation.

To initiate a Reverse Read operation (assuming format has already been selected and all tape motion has stopped), a 322X controller must first receive the Function code 0041 (Reverse). When the Read instruction is executed in the processor, the Reverse Read operation will begin. A Reverse Assembly signal will be sent to the data channel from the 322X to indicate that the 12-bit bytes should be assembled in reverse order.

Transverse and longitudinal parity checking occurs as in a normal Read operation with one exception: if the first frame read is a record check character, no vertical parity check is made on that character. Vertical parity checking is performed on all remaining frames.

If a Reverse Read is attempted from Load Point, there will be no tape motion. The Read operation will halt indefinitely.

Parity errors and Interrupts may be handled as if the operation were a Normal Read. An End of Record signal is returned to the data channel when a record gap is reached.

If a Backspace function is selected during the time a Reverse Read format is selected, the tape will "backspace" forward.

The Function code 0042 (Clear Reverse) should be issued when the Reverse Read operation terminates.

DATA CONVERSIONS

Transmission Parity

All information transfer between the data channel and the controller uses 12 bits of data and 1 parity bit (odd parity). The controller checks the accuracy of the parity bit during a Write operation and generates the bit during a Read operation.

Illegal BCD

The tape handler generates a sprocket pulse whenever it senses a bit in a frame on the tape. Therefore, if a 6-bit data character of all zeroes is written in BCD mode, the tape handler will not recognize the frame and an error would occur. To prevent this, the controller automatically converts a character of all zeroes to 12_8 when writing and 12_8 to all zeroes when reading. This makes 12_8 BCD an illegal number in relation to the computer.

Assembly/Disassembly

Example I in table 1-1 shows the order in which the two characters in each data channel word are written on tape. Example IV shows the order in which data on tape is assembled to the data channel. Example V shows the assembly during a Reverse Read.

Suppress Assembly/Disassembly

If the Suppress Assembly/Disassembly signal is sent to the controller during a Write operation, bits 6 through 11 of the Data Channel word are discarded and only bits 0 through 5 are written on the tape (table 1-1, examples II and III).

If the signal is sent to the controller during a Read operation (forward or reverse), bits 6 through 11 of the Data Channel input word are packed with zeroes (examples VI, VII, and VIII).

Programming Considerations:

1) If data is to be assembled from a tape that was recorded in Suppress Assembly/Disassembly mode, assembly difficulties may be encountered. The problem is that in Suppress Assembly/Disassembly mode, an odd number of frames may be written on the tape. If this occurs, and the tape is read forward, the controller will automatically fill in bits 6 through 11 of the last input word with zeroes. If an odd number of frames are written, and a Reverse Read is attempted, the inverted assembly will be one frame out of order and bits 0 through 5 of the last Data Channel word will be filled in with zeroes (table 1-1, example IX).

2) If a Reverse Read is attempted in Suppress Assembly/Disassembly mode, the check character may be read to the Data Channel as the last frame (first Data Channel character). If no check character exists (check character = zero because of an even number of bits in each tape channel), the last frame will be read as the first Data Channel character (table 1-1, examples VII and VIII).

TABLE 1-1. ASSEMBLY/DISASSEMBLY BYTE ORDER

Data Channel →	Tape	
Write Word I 6 5 4 3 2 1 K I G E C A L J H F D B	To Frame 1 2 3 4 5 6 7 8 9 10 11 12 13 A B C D E F G H I J K L CC Tape Motion ←	$\overline{\text{SUPP. A/D}}$
Write Word II 6 5 4 3 2 1 K I G E C A L J H F D B	To Frame 1 2 3 4 5 6 7 A C E G I K CC	SUPP. A/D EVEN NUMBER OF WORDS
Write Word III 5 4 3 2 1 I G E C A J H F D B	To Frame 1 2 3 4 5 6 A C E G I CC	SUPP. A/D ODD NUMBER OF WORDS

Tape →	Data Channel	
Read Frame IV 1 2 3 4 5 6 7 8 9 10 11 12 13 A B C D E F G H I J K L CC	To Word 6 5 4 3 2 1 K I G E C A L J H F D B	$\overline{\text{SUPP. A/D}}$ FORWARD EVEN NUMBER OF FRAMES
Read Frame V 1 2 3 4 5 6 7 8 9 10 11 12 13 A B C D E F G H I J K L CC	To Word 6 5 4 3 2 1 A C E G I K B D F H J L	$\overline{\text{SUPP. A/D}}$ REVERSE EVEN NUMBER OF FRAMES
Read Frame VI 1 2 3 4 5 6 7 A B C D E F CC	To Word 6 5 4 3 2 1 F E D C B A 0 0 0 0 0 0	SUPP. A/D FORWARD EVEN NUMBER OF FRAMES
Read Frame VII 1 2 3 4 5 6 7 A B C D E F CC	To Word 7 6 5 4 3 2 1 A B C D E F CC 0 0 0 0 0 0 0	SUPP. A/D REVERSE EVEN NUMBER OF FRAMES CC ≠ ALL ZEROES
Read Frame VIII 1 2 3 4 5 6 7 A B C D E F CC	To Word 6 5 4 3 2 1 A B C D E F 0 0 0 0 0 0	SUPP. A/D REVERSE EVEN NUMBER OF FRAMES CC = ALL ZEROES
Read Frame IX 1 2 3 4 5 6 7 8 A B C D E F G CC	To Word 4 3 2 1 0 B D F A C E G	$\overline{\text{SUPP. A/D}}$ REVERSE ODD NUMBER OF FRAMES

6-bit bytes (A B C) zero (0) check character (CC)

Read/Write time for one 6-bit frame:

For the 603/604 tape handler:

200 bpi -- 66.6 μsec
556 bpi -- 24 μsec
800 bpi -- 16.6 μsec (604 only)

For the 606/607 tape handler:

200 bpi -- 33.3 μsec
556 bpi -- 12 μsec
800 bpi -- 8.3 μsec (607 only)

SWITCHES AND INDICATORS

EQUIPMENT SELECTION SWITCH

An Equipment Selection switch is associated with each channel. The setting of this switch designates the controller as equipment number N. Any Interrupts coming from the controller will be transmitted on one of the eight Interrupt lines corresponding to the setting of the Equipment Selection switch.

When a controller is connected to a tape handler, a white indicator in the Equipment Selection switch is illuminated. When a tape handler is in use, the Equipment Select switch on the tape handler lights.

If a transmission parity error occurs during a Function, Read, or Write operation, a red indicator in the Controller Equipment Selection switch lights.

LONGITUDINAL PARITY

At the end of an operation involving longitudinal parity checking, none of the Longitudinal Parity indicators should be lit. If one or more are lit, it indicates a longitudinal parity error has occurred.

WRITE

The Write indicator is illuminated during Write and Write End of File Mark operations. The Write indicator remains on until the Write operation terminates.

VERTICAL PARITY

A Vertical Parity Error indicator lights if a vertical parity error occurs during an operation. This light is lit until a new record is begun.

INTERRUPT (INT)

This indicator lights when an Interrupt occurs. This light is lit until the Interrupt signal drops.

BCD

This indicator lights when BCD mode is selected or an End of File Mark is written on tape.

TABLE 1-2. FUNCTION CODES AND STATUS RESPONSES

TAPE MOTION			
Rewind	0010	Search End of File Mark Backward	0014
Rewind Unload	0011	Write End of File Mark	0015
Backspace*	0012	Skip Bad Spot	0016
Search End of File Mark Forward	0013		
FORMAT			
Release	0000	Clear	0005
Binary	0001	Density (800 BPI)	0006
Coded	0002	Set Reverse Read	0041
Density (556 BPI)	0003	Clear Reverse Read	0040
Density (200 BPI)	0004		
INTERRUPT			
Interrupt on Ready and Not Busy	0020	Release Interrupt on End of Operation	0023
Release Interrupt on Ready and Not Busy	0021	Interrupt on Abnormal End of Operation	0024
Interrupt on End of Operation	0022	Release Interrupt on Abnormal End of Operation	0025
STATUS RESPONSE			
XXX1 Ready		X1XX Density (1 in bit 6 indicates 556 BPI) (0 in bit 6 and bit 7 indicates 200 BPI)	
XXX2 Read/Write Control and/or Busy		X2XX Density (800 BPI) 1 in bit 7	
XXX4 Write Enable		X4XX Lost Data	
XX1X File Mark		1XXX End of Operation	
XX2X Load Point		2XXX Transverse or Longitudinal Parity Error	
XX4X End of Tape			

* If a Backspace operation is executed when Reverse Read is set, tape is moved in a forward direction.

PART II. THEORY OF OPERATION

SECTION 1. CONNECT

The controller receives a 12-bit Connect code accompanied by a Connect signal from the Data Channel. The Connect code, AXXB, selects the controller (A) and the tape handler (B)(Figure 2-1). The sequence of events followed during a Connect is shown in Figures 2-1 and 2-2. A timing chart for the Connect sequence is shown in Figure 2-3.

TABLE 2-1. CONNECT SEQUENCE

Connect code and signal from the data channel. Check code for transmission parity error. (Page 1) *
+0.2 μsec - start Connect timing chain (T 1). (Page 2) Set Connect FF - prevent Interrupt during Connect. Clear Controller Connect FF if parity error or if not proper Connect code for controller. Set Reject FF if Read/Write Active and controller is reselected.
+1 μsec - enable T 2 if proper Connect code and if Reject FF is not set. (Page 2) Set Controller Connect FF - permits further operation. Light Controller Connect indicator.
+1 μsec - enable T 3 Set tape handler Select FF according to Connect code in conjunction with setting of the tape handler Equipment Selection switch. (Page 4)
+1 μsec - enable T 4 If proper tape handler is selected, set Reply FF - send Reply signal to data channel. (Page 2) If no tape handler is selected, set Reject FF - +2 μsec send Reject signal to data channel. Clear Connect FF - allows Interrupt to perform.
Connect code and signal drops after the data channel receives either the Reply or Reject signal.

*Page numbers in parentheses refer to the 3228/3229 Magnetic Tape Controller Customer Engineering Diagrams Manual (Pub. No. 60093700).

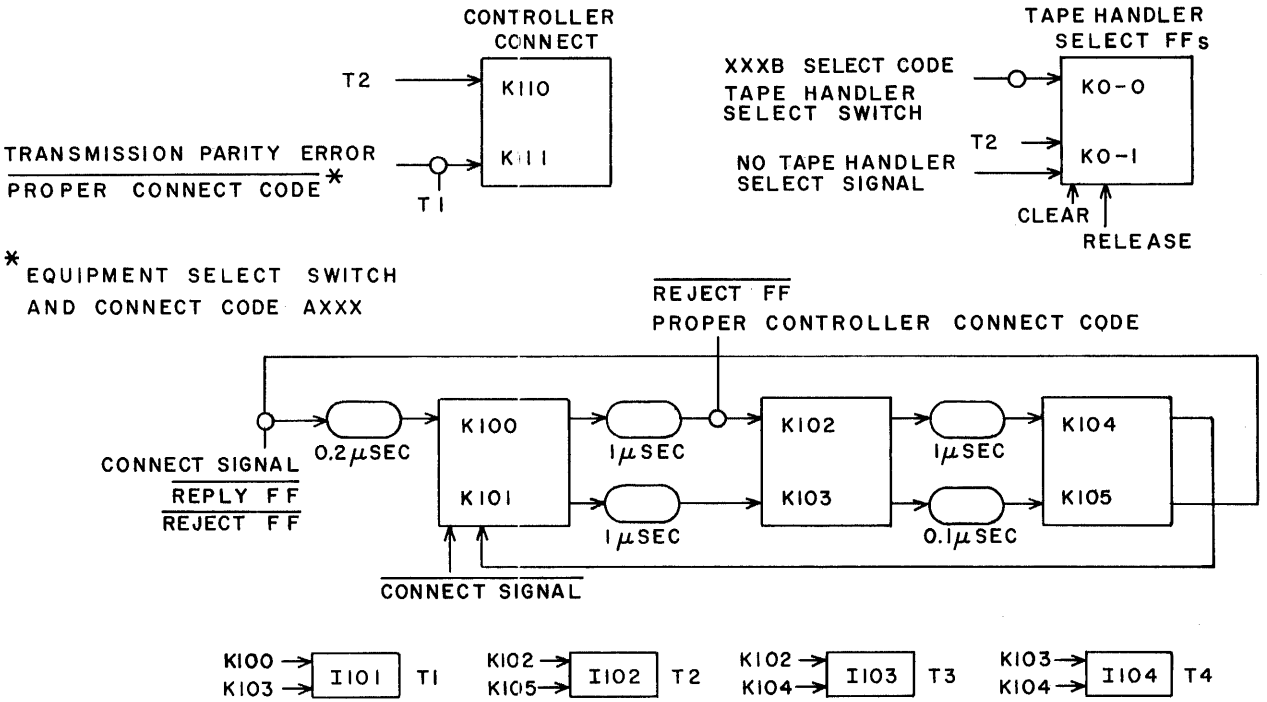


Figure 2-1. Connect FFs

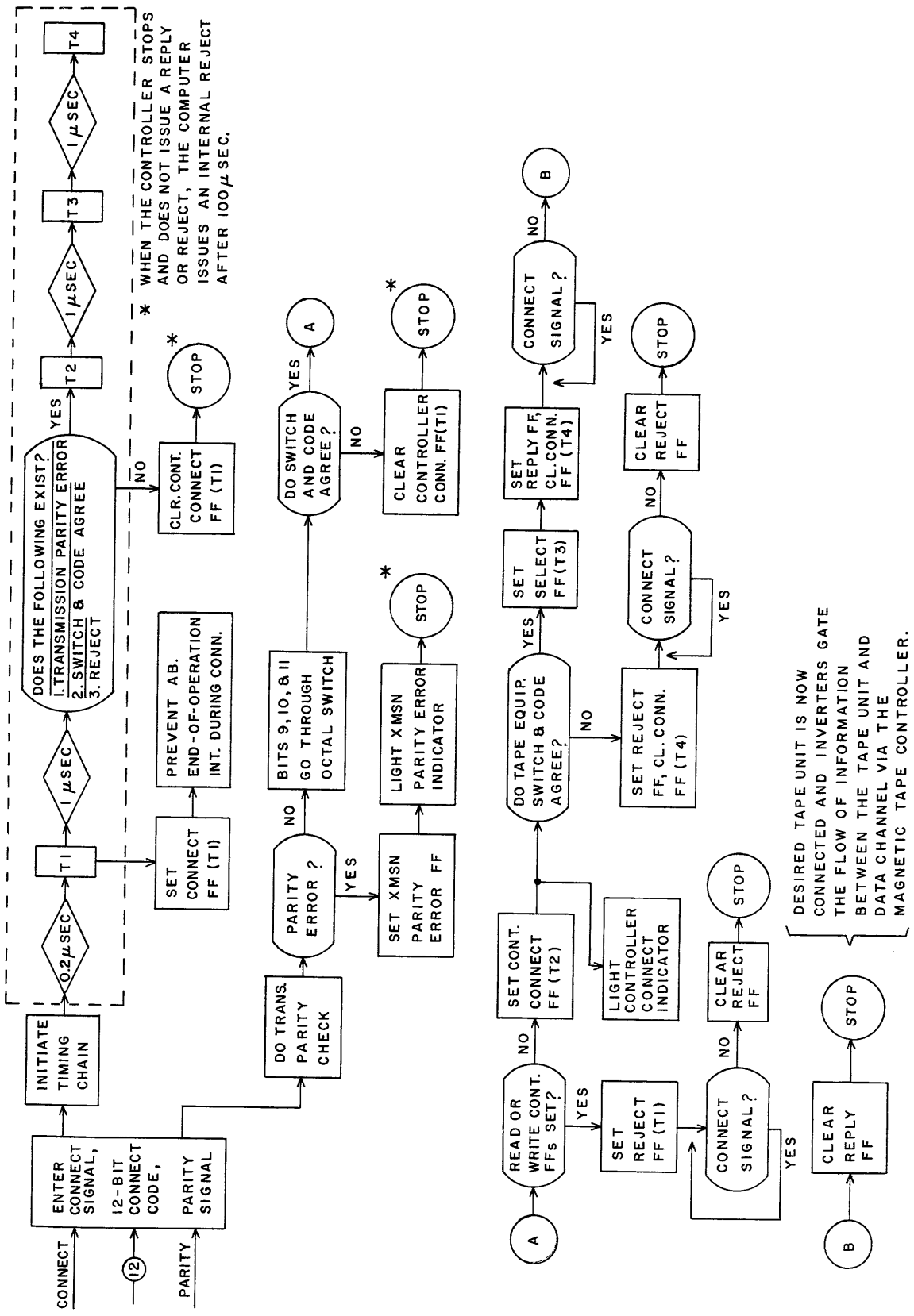


Figure 2-2. Connect Operation

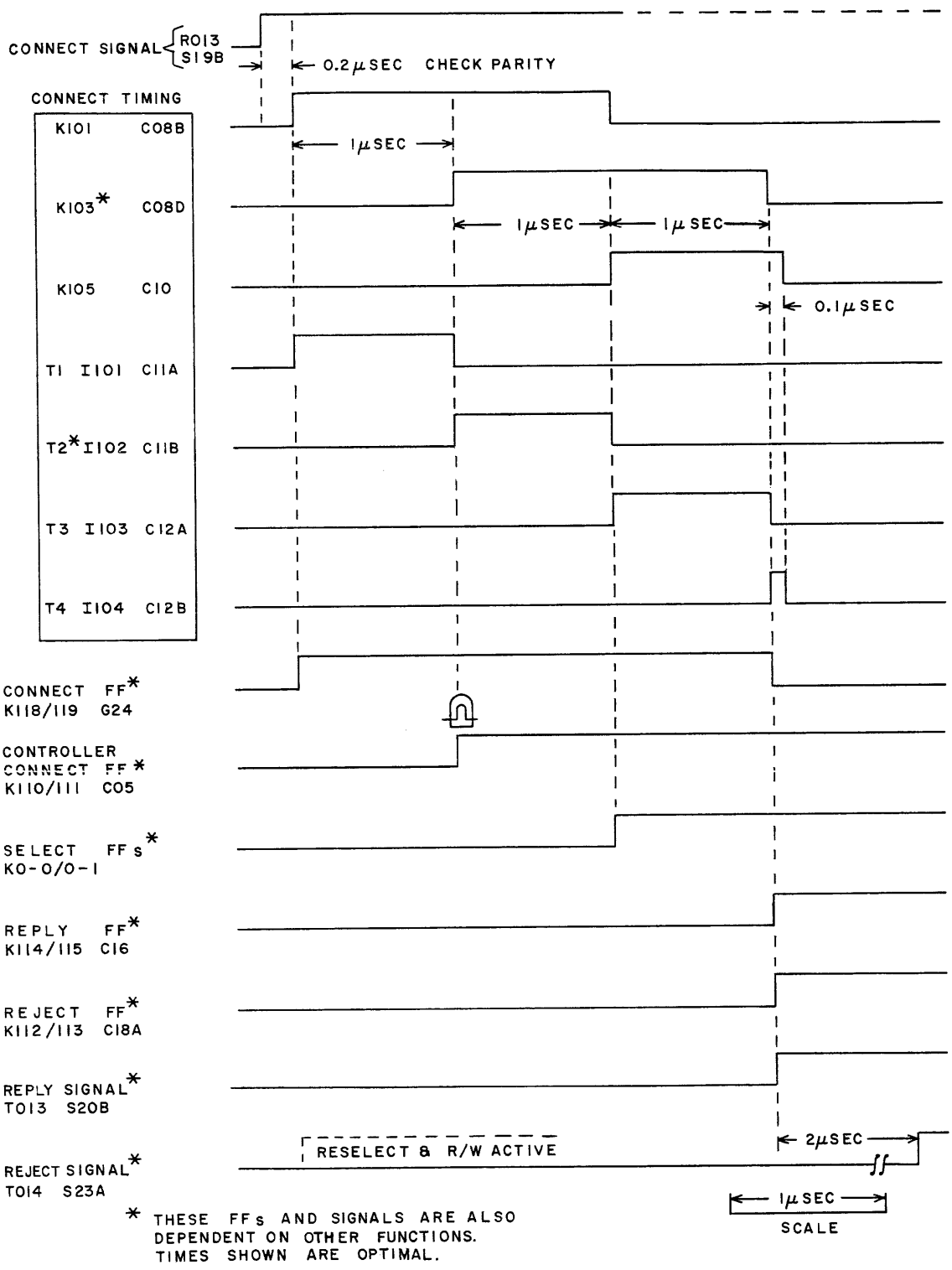


Figure 2-3. Connect Timing

SECTION 2. FUNCTION SELECTION

The controller receives a 12-bit Function code accompanied by a Function signal after the Connect exchange. The Function code, XXCD, selects the tape format for a Read or Write operation (C = 0, 4), certain tape motion directives (C = 1), and Interrupt requests (C = 2) (Table 2-2). Each selection is recorded by a FF which controls the necessary controller/tape handler operation. (These operations are explained later in this manual.) The different techniques used to set these FFs (which record the function selection) are shown in Figure 2-4.

If the Function code is illegal, the controller sends the data channel a Reject signal (Figures 2-5 and 2-6). If the code is legal, a Reply signal is sent to the data channel after any necessary processing delays. The Reply or Reject signal permits the Function code and signal to drop.

TABLE 2-2. FUNCTION CODES

FORMAT		TAPE MOTION DIRECTIVES	
0000	Release	0010	Rewind
0001	Binary	0011	Rewind Unload
0002	Coded	0012	Backspace
0003	556 Density	0013	Search Forward
0004	200 Density	0014	Search Backward
0005	Clear	0015	Write File Mark
0006	800 Density	0016	Skip Bad Spot
0040	Clear Reverse Read		
0041	Reverse Read		
INTERRUPT			
	0020		Ready and Not Busy
	0021		Release Ready and Not Busy
	0022		End of Operation
	0023		Release End of Operation
	0024		Abnormal End of Operation
	0025		Release Abnormal End of Operation

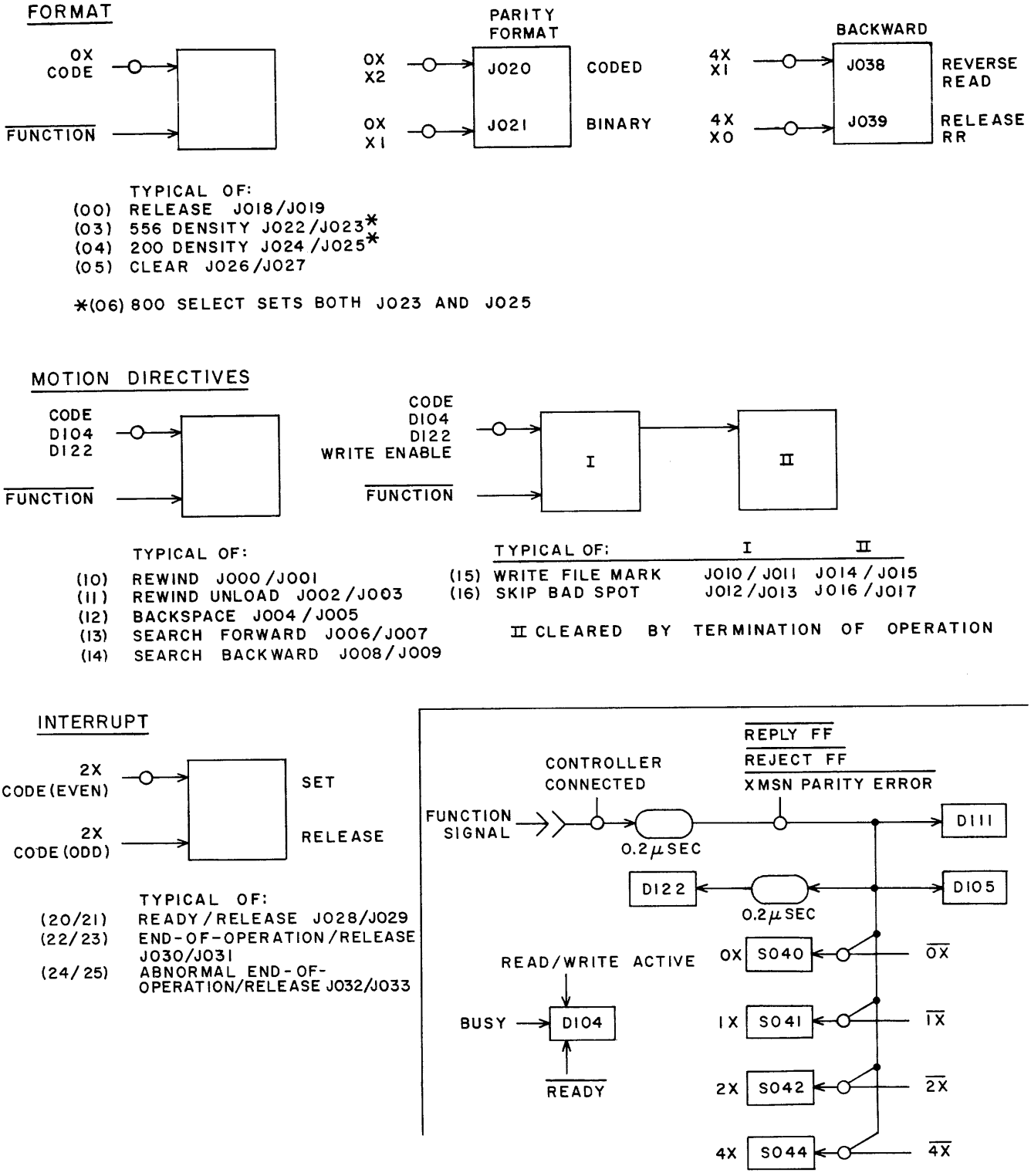
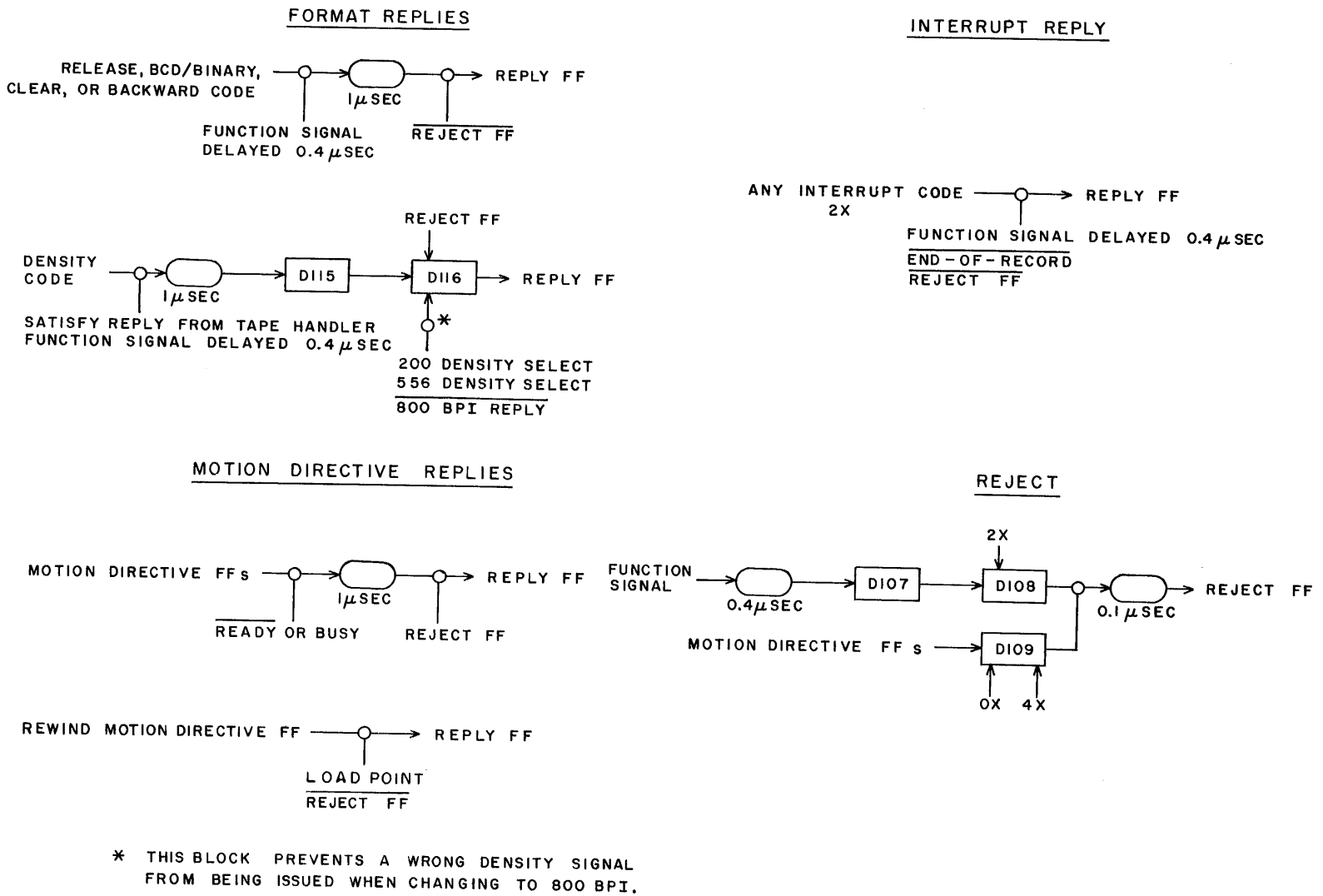


Figure 2-4. Function Select FFs



* THIS BLOCK PREVENTS A WRONG DENSITY SIGNAL FROM BEING ISSUED WHEN CHANGING TO 800 BPI.

Figure 2-5. Function Reply/Reject

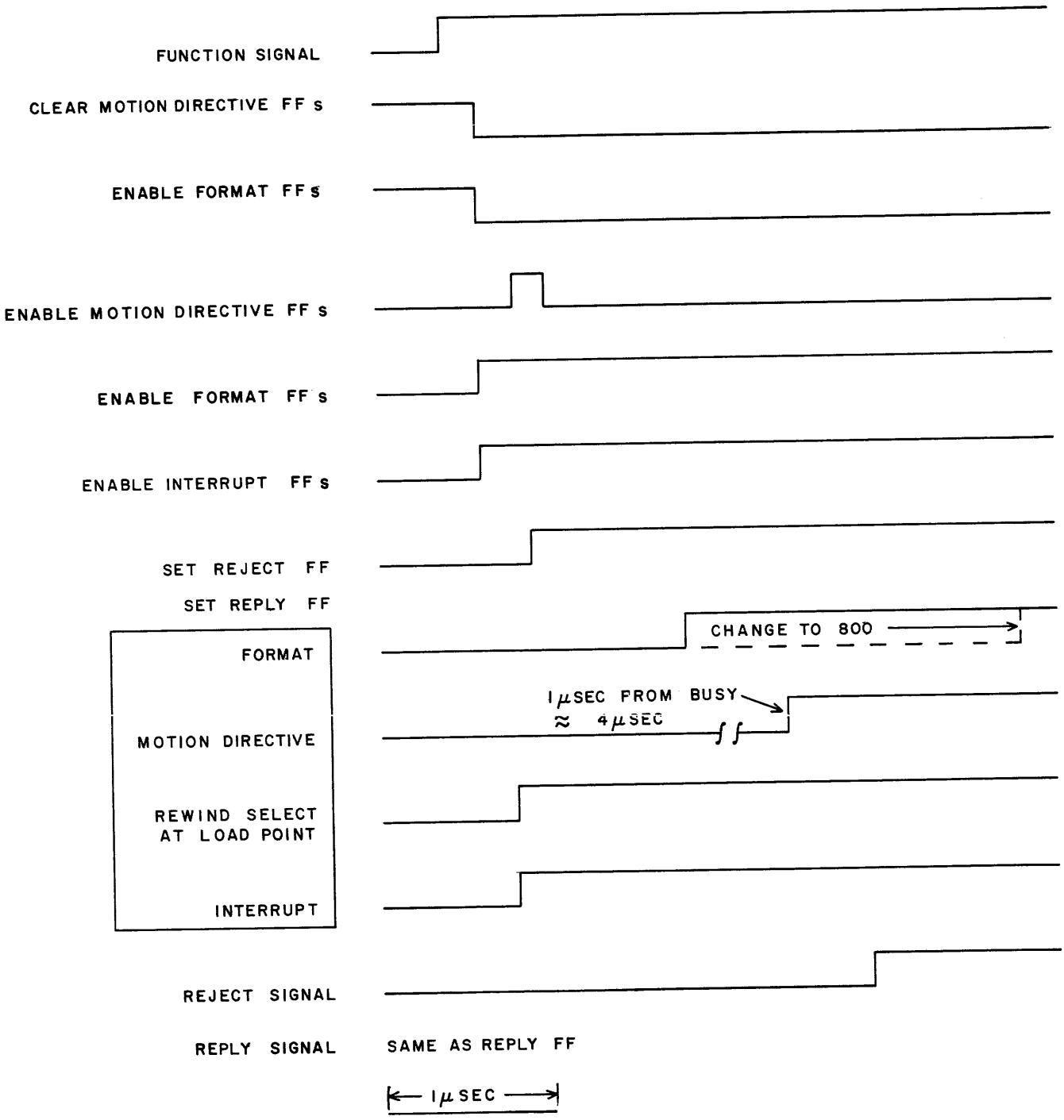


Figure 2-6. Function Select Timing

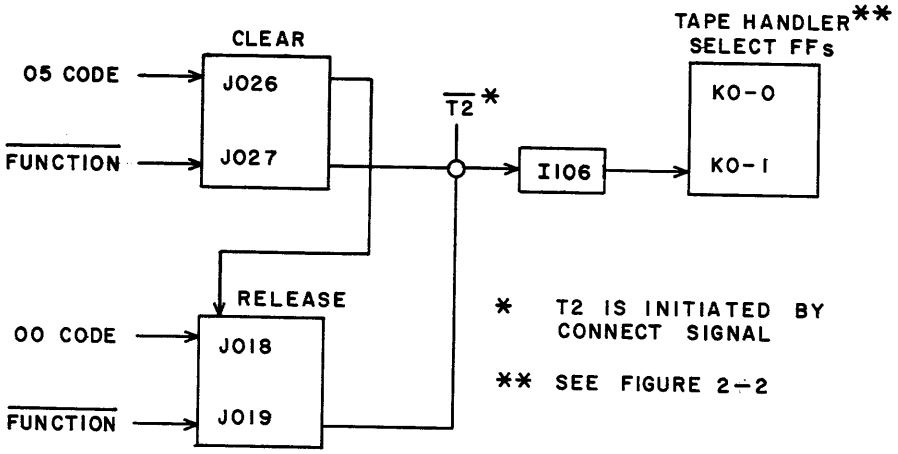


Figure 2-7. Clear and Release

SECTION 3. FUNCTION OPERATION (FORMAT)

This section is presented using only simplified logic drawings and flow charts. More detailed information may be found in the Diagram Manual.

Format Function	Figure	Flow Chart Figure	Diagram Page
Parity Mode	2-8	2-9	3, 9, 12
Clear		2-10	2, 3
Release		2-11	2, 3
Density	2-12	2-13, 2-14, 2-15	3, 5, 7, 8, 11
Reverse Read	2-16	2-17, 2-18	3, 5, 11

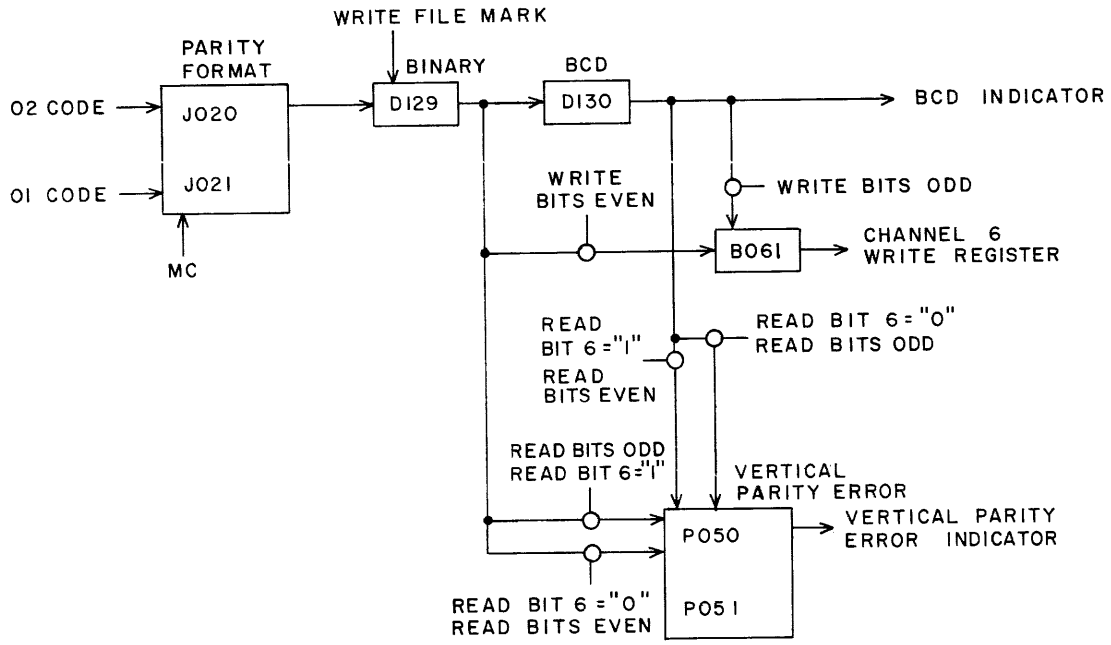


Figure 2-8. Parity Mode

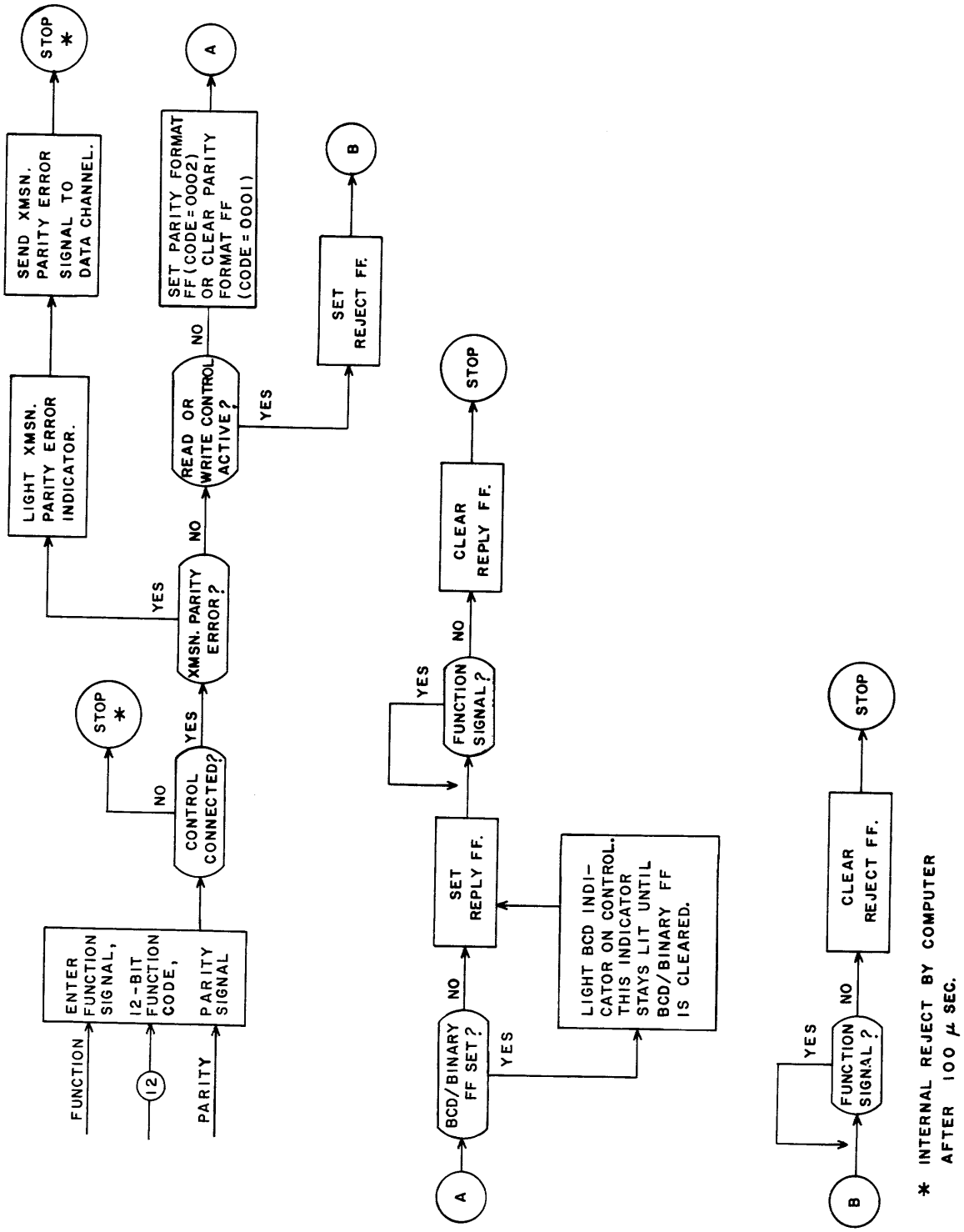


Figure 2-9. Binary Mode Operation

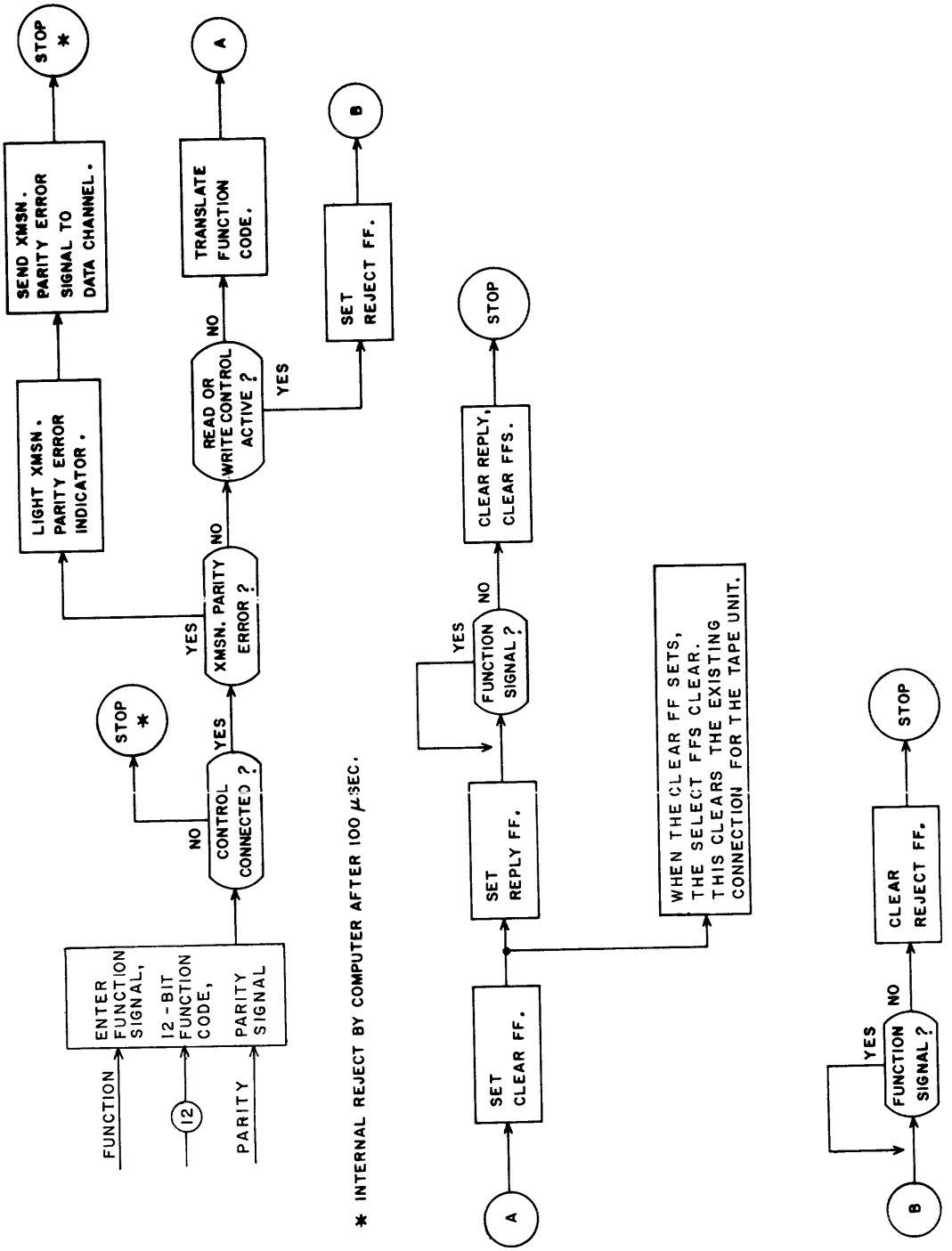


Figure 2-10. Clear Operation

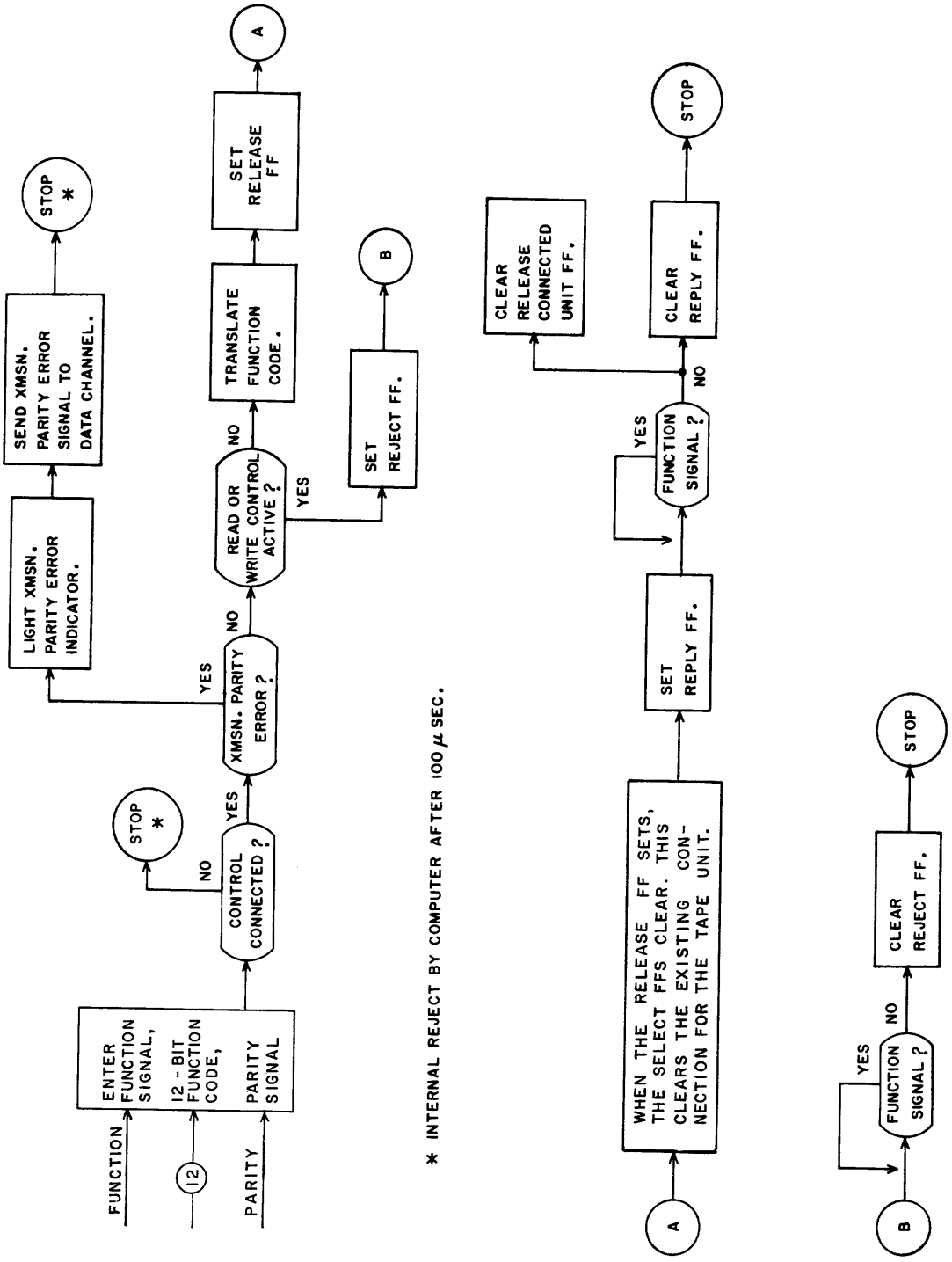


Figure 2-11. Release Operation

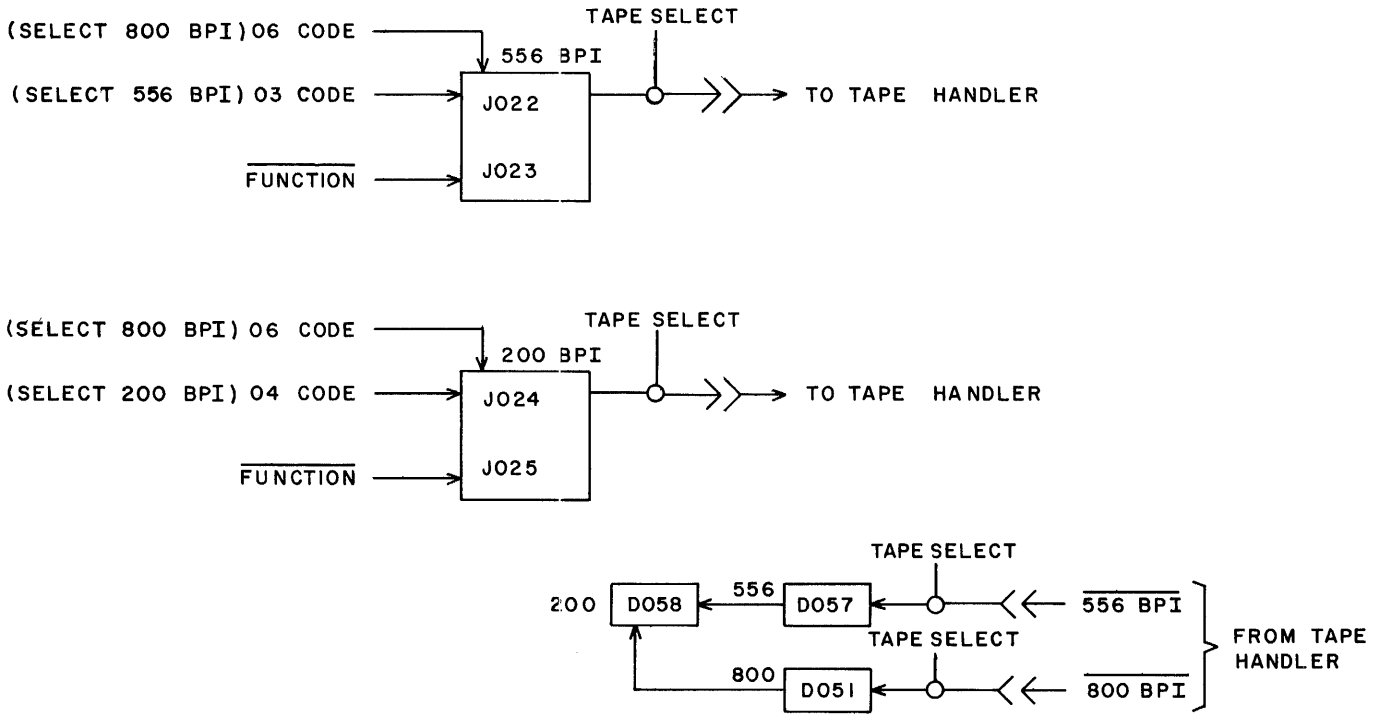


Figure 2-12. Density

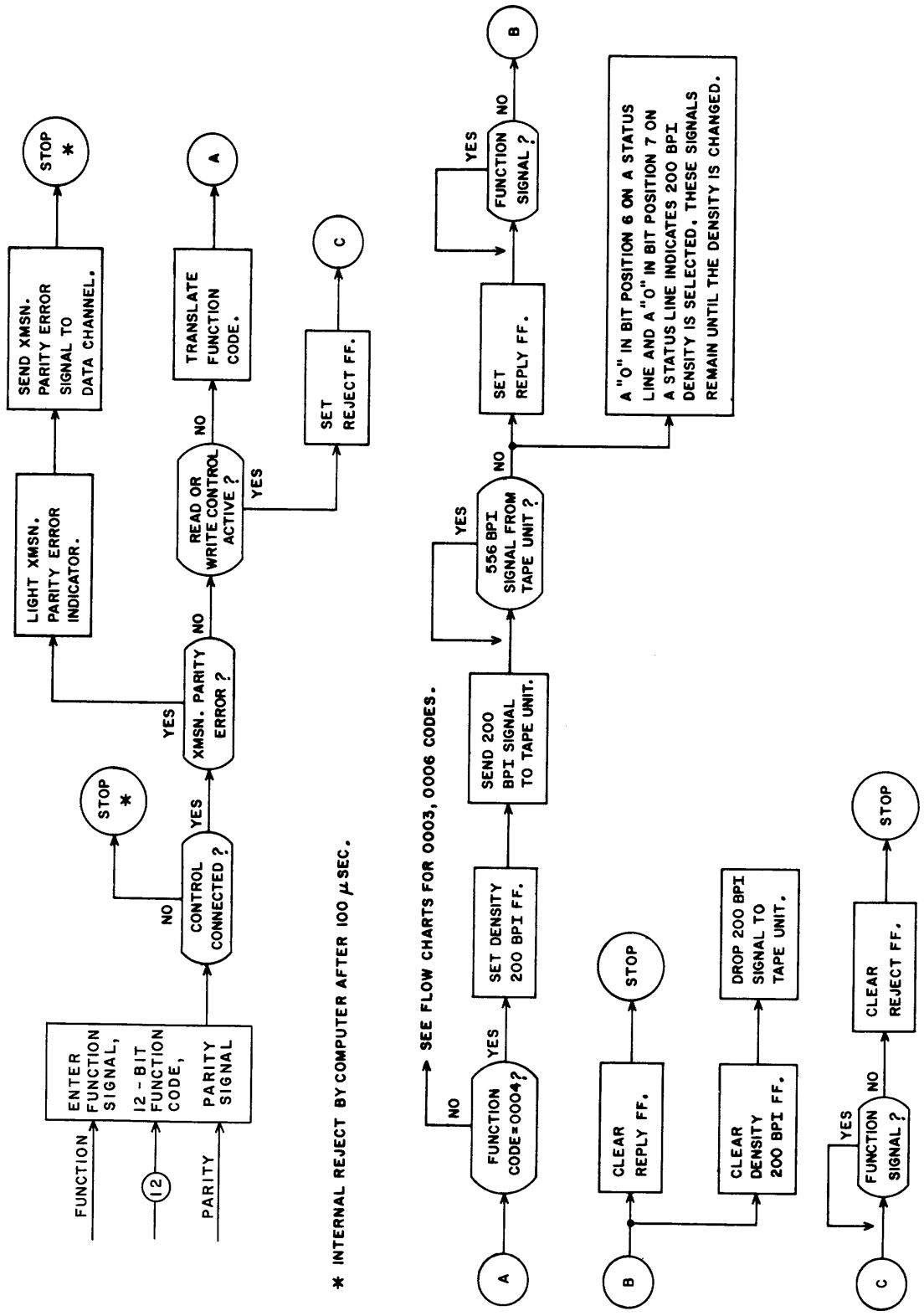


Figure 2-13. 200 BPI Operation

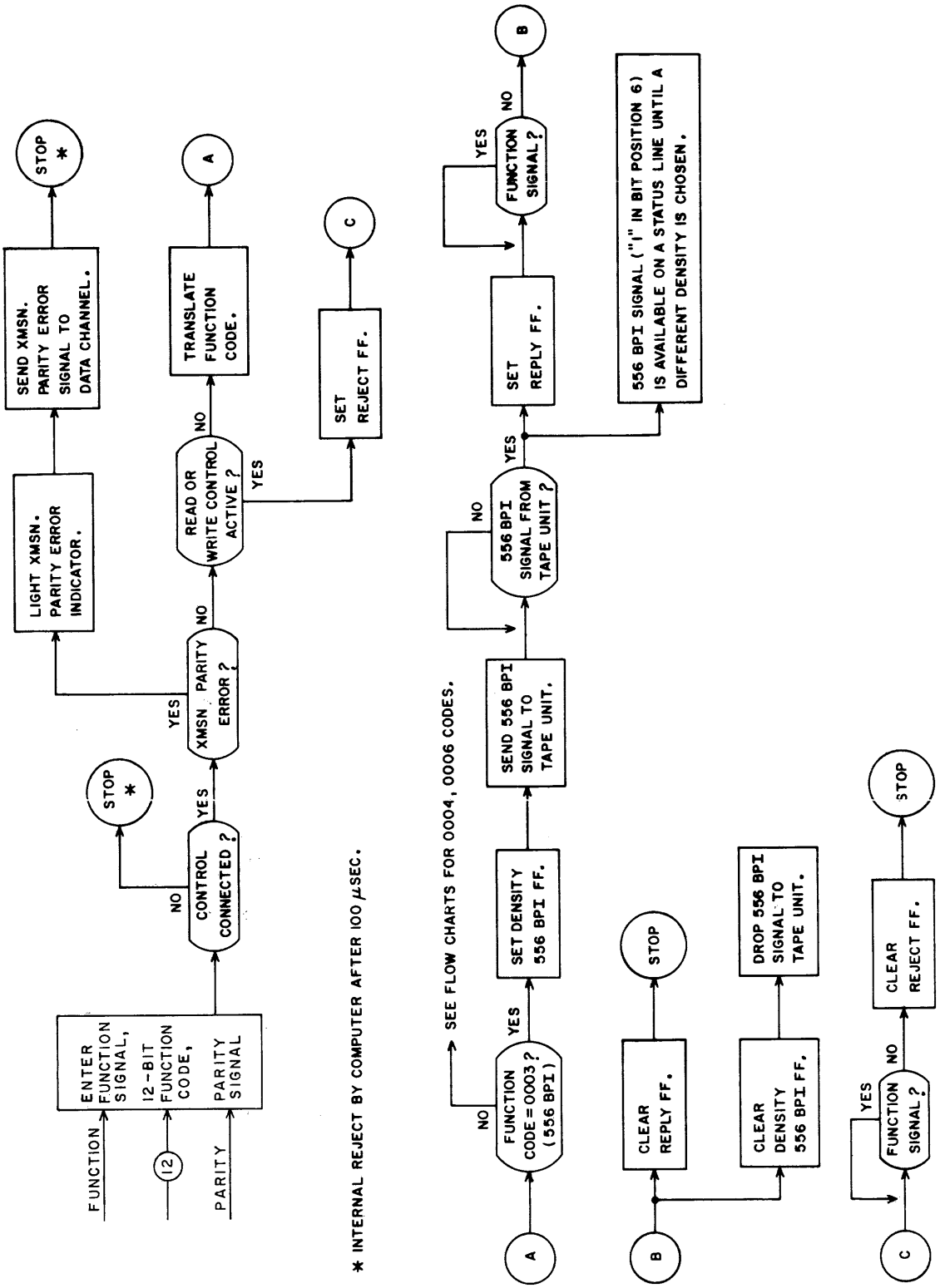


Figure 2-14. 556 BPI Operation

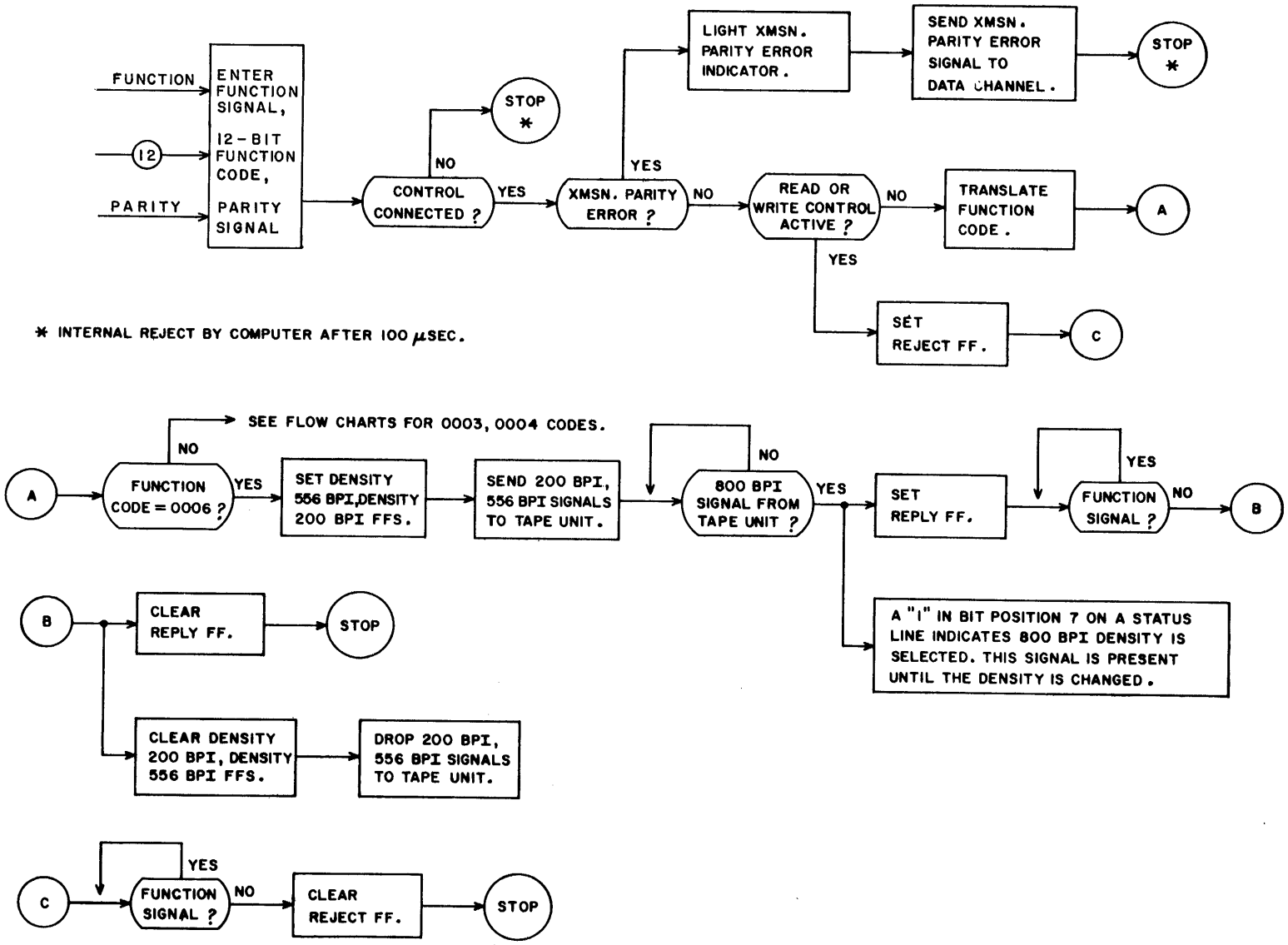


Figure 2-15. 800 BPI Operation

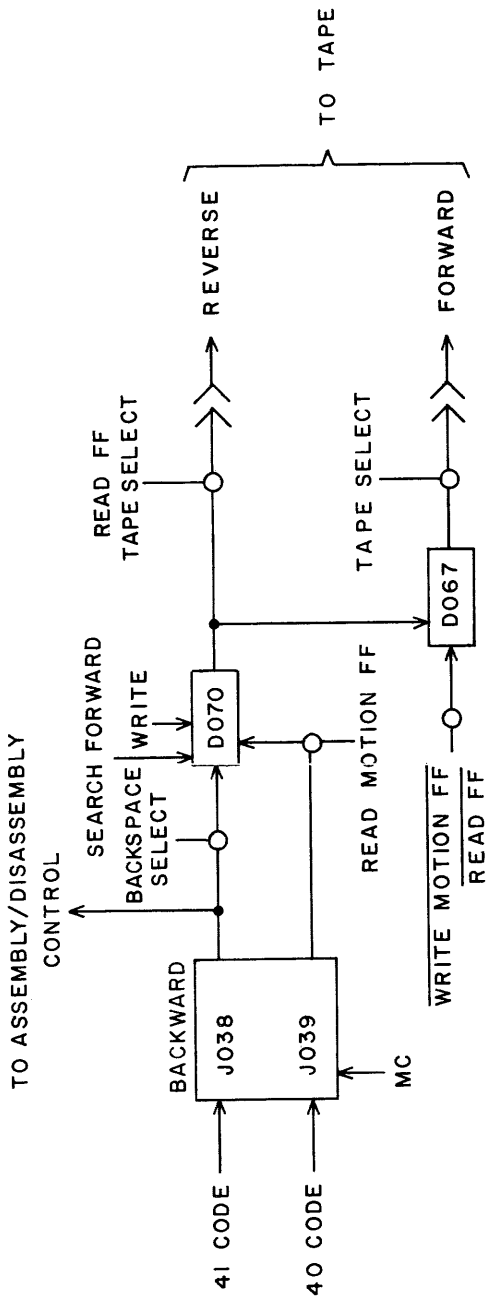


Figure 2-16. Tape Motion Signals

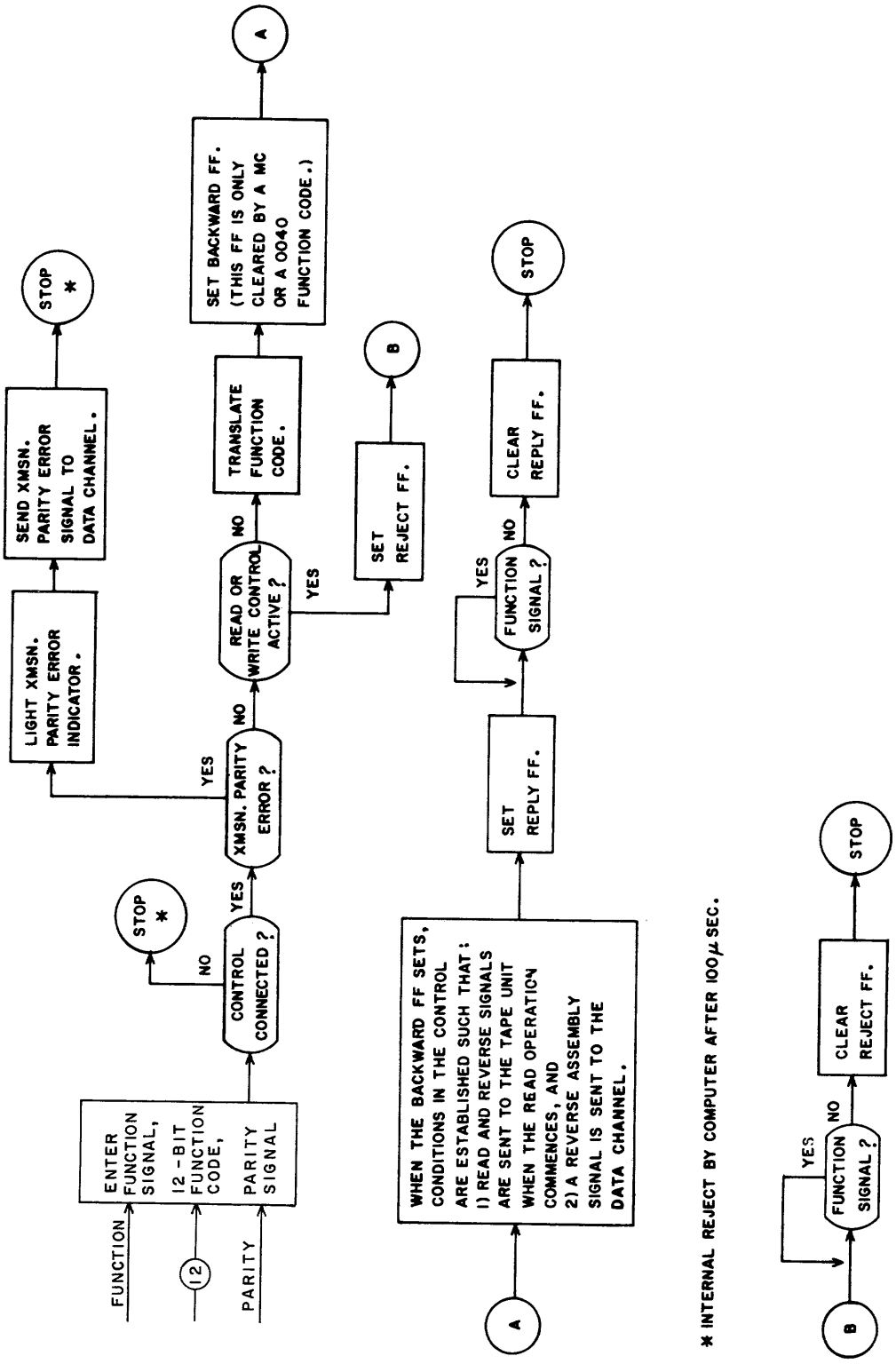


Figure 2-17. Reverse Operation

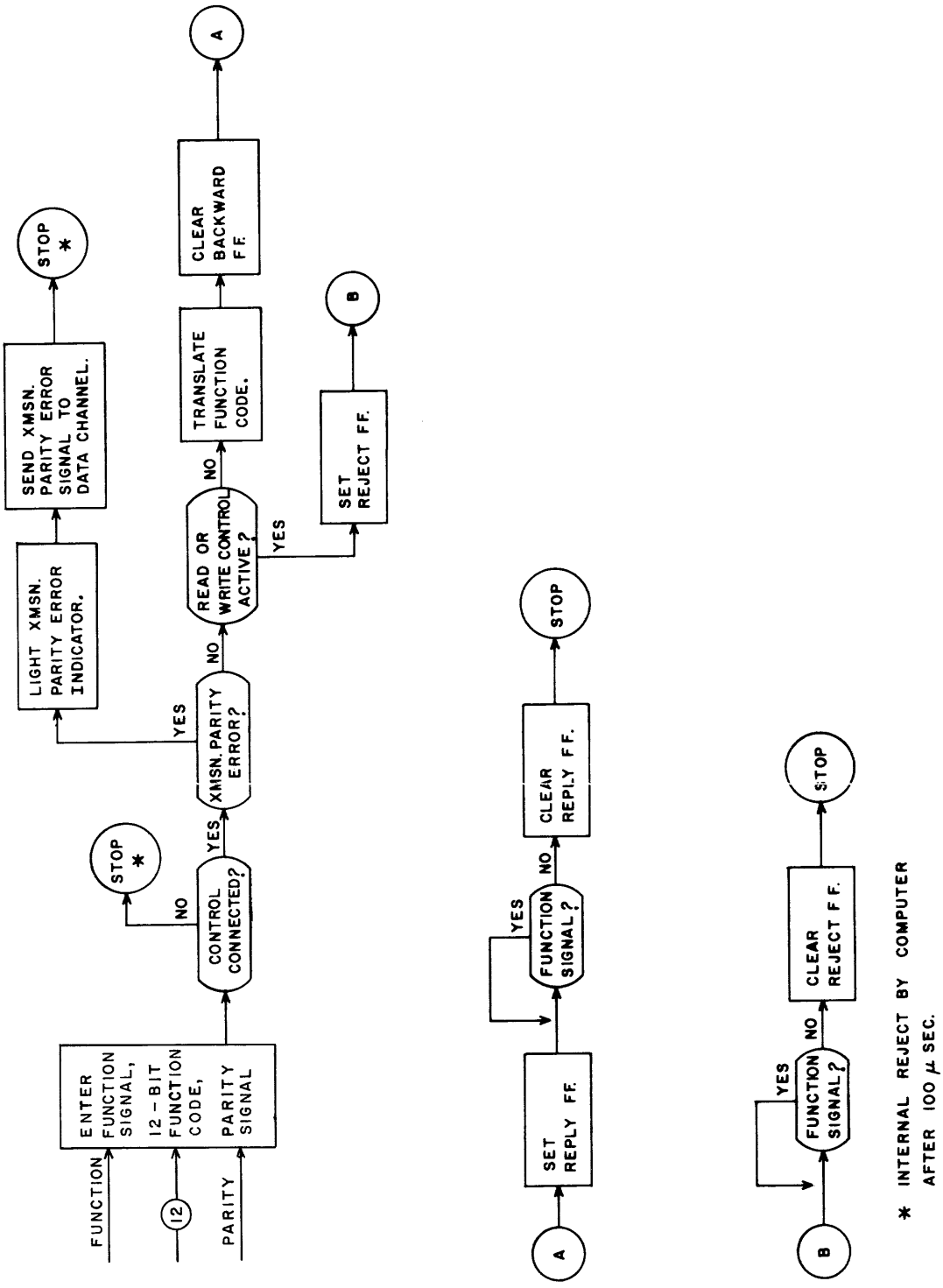


Figure 2-18. Clear Reverse Operation

SECTION 4. INFORMATION TRANSFER

The purpose of the Controller is to modify and synchronize data as it passes through to the Tape Handler or Data Channel. The data modification is performed by passing through certain registers in the Controller. Internal register transfers and synchronization are controlled by timing elements activated by exchange of signals between the Controller and the Data Channel and the Controller and the Tape Handler. The action of the signal exchange and the timing elements is shown later in this section in the command timing charts. (For simplicity, this section refers to certain timing elements as WT1, RT1, etc. These times are not always completely incremental as their names imply.)

REGISTER TRANSFERS DURING WRITE (Figure 2-19)

R to 0

This transfer accepts the output word from the Data Channel and checks the transmission parity. A new parity bit is generated for the 12 bits of data and compared with the transmitted parity bit (page 1). The transfer is gated by the R-to-0 FF set by the Data signal from the Data Channel if the Tape Handler and the Controller are ready to accept information (page 8).

0 to B_1

This transfer performs the disassembly function, converting the 12-bit output word into two 6-bit characters. The disassembly order is controlled by the disassembly counter (DK) shown in Figure 2-20. During a Suppress Assembly/Disassembly mode operation, this transfer discards bits 6 through 11 of the output word. Table 1-1 shows examples of disassembly.

B_1 to B_2

This automatic transfer performs the BCD conversion and the 0-to-12 conversion (Page 9). The BCD conversion changes internal BCD to external BCD; if a 1 appears in bit 4, bit 5 is complemented (bit 4 remains unchanged). The example shown in Figure 2-21 converts "31" to "71". If the Controller is selected to write in Binary format or if the Negate BCD Conversion signal is present, BCD conversion is blocked by inverter B042. The 0 to 12 conversion occurs if the Controller is selected to write in BCD. the Negate BCD signal is not present, and a frame contains all zeroes (Figure 2-22).

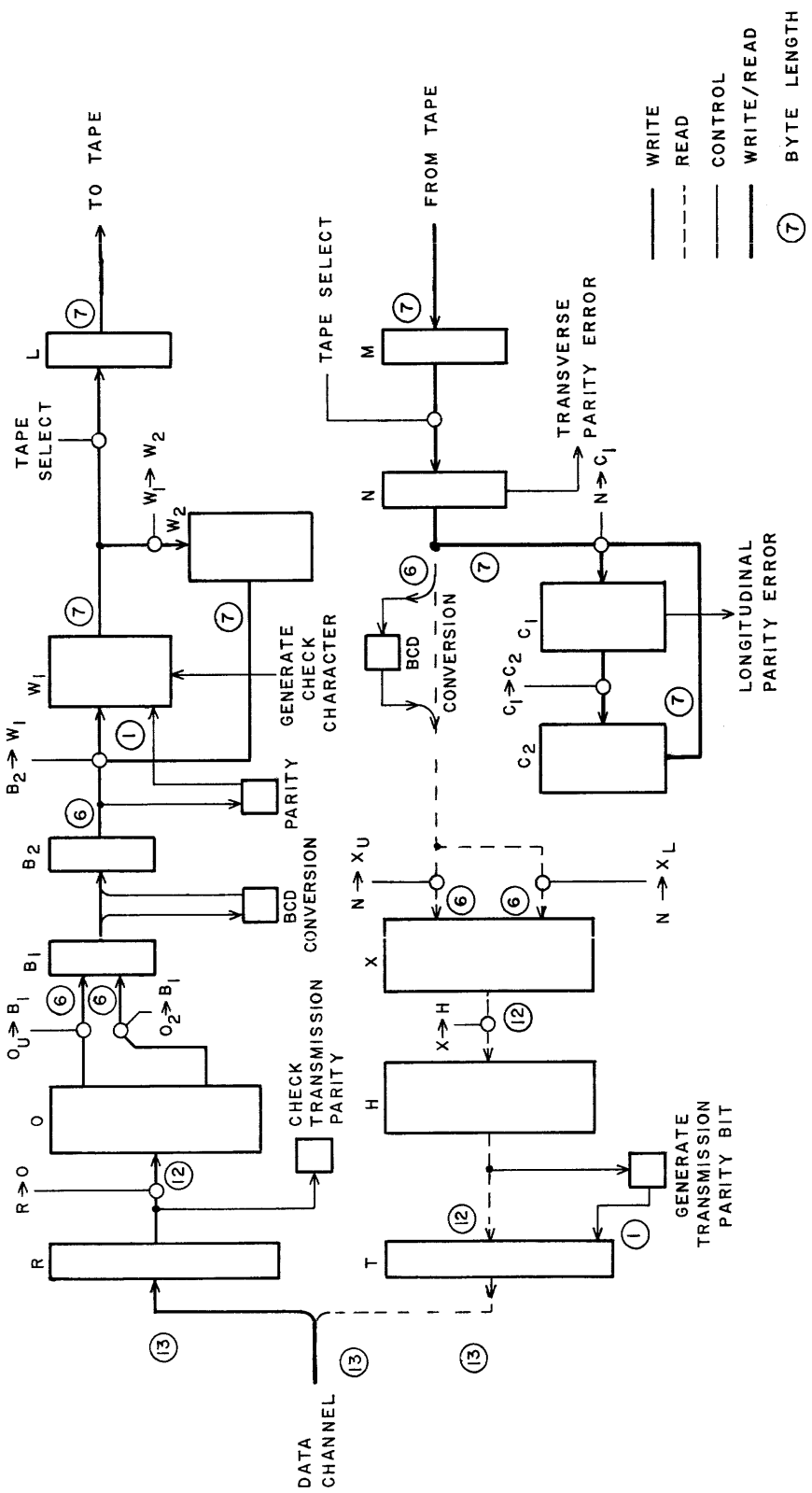
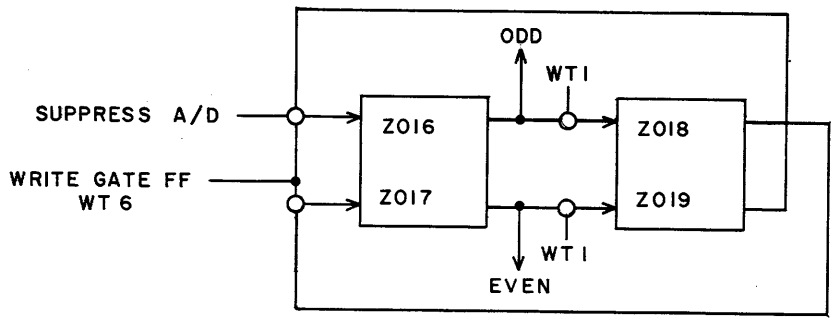


Figure 2-19. Data Transfer



$O_1 \rightarrow B = (\text{WRITE GATE FF})(\text{WT I})(6 - \text{BIT} + \text{ODD})$

$O_2 \rightarrow B = (\text{WRITE GATE FF})(\text{WT I})(\text{EVEN})(\overline{6 - \text{BIT}})$

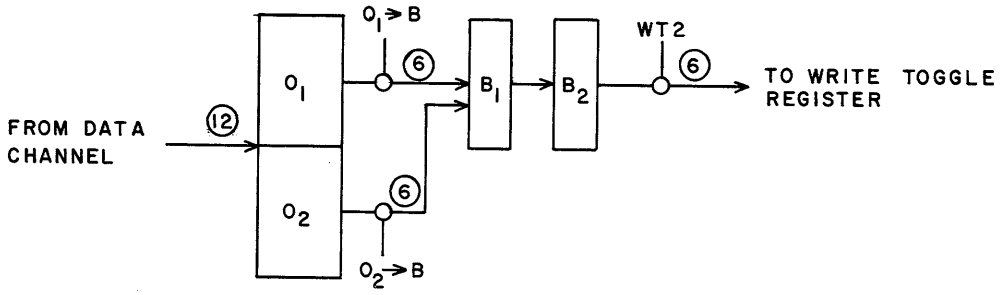


Figure 2-20. Disassembly Control

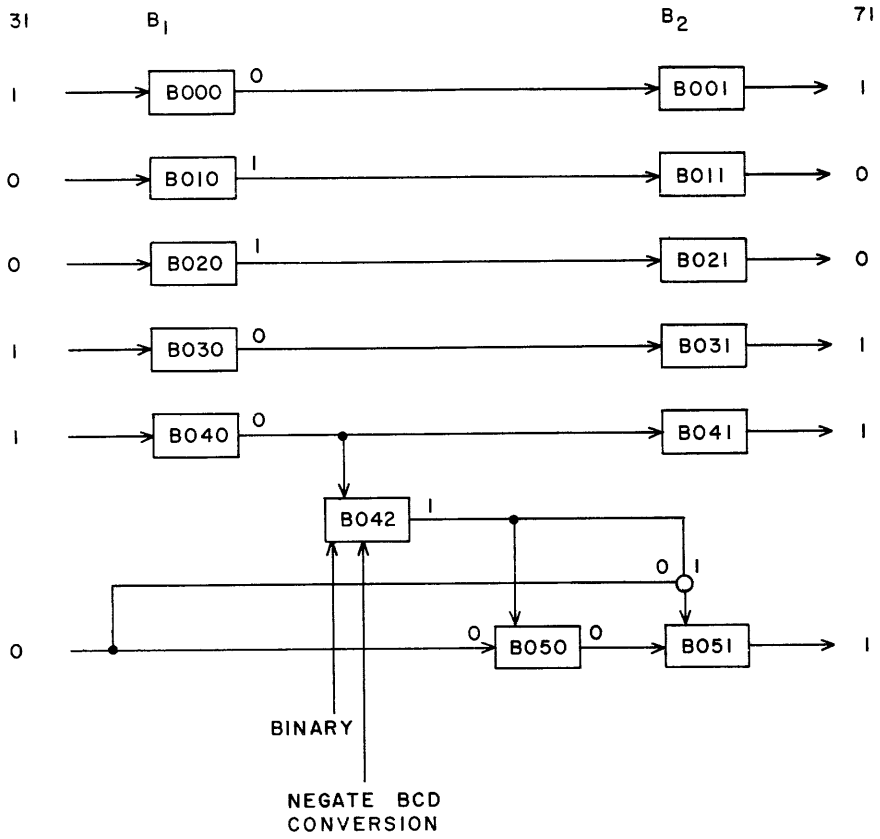


Figure 2-21. BCD Conversion

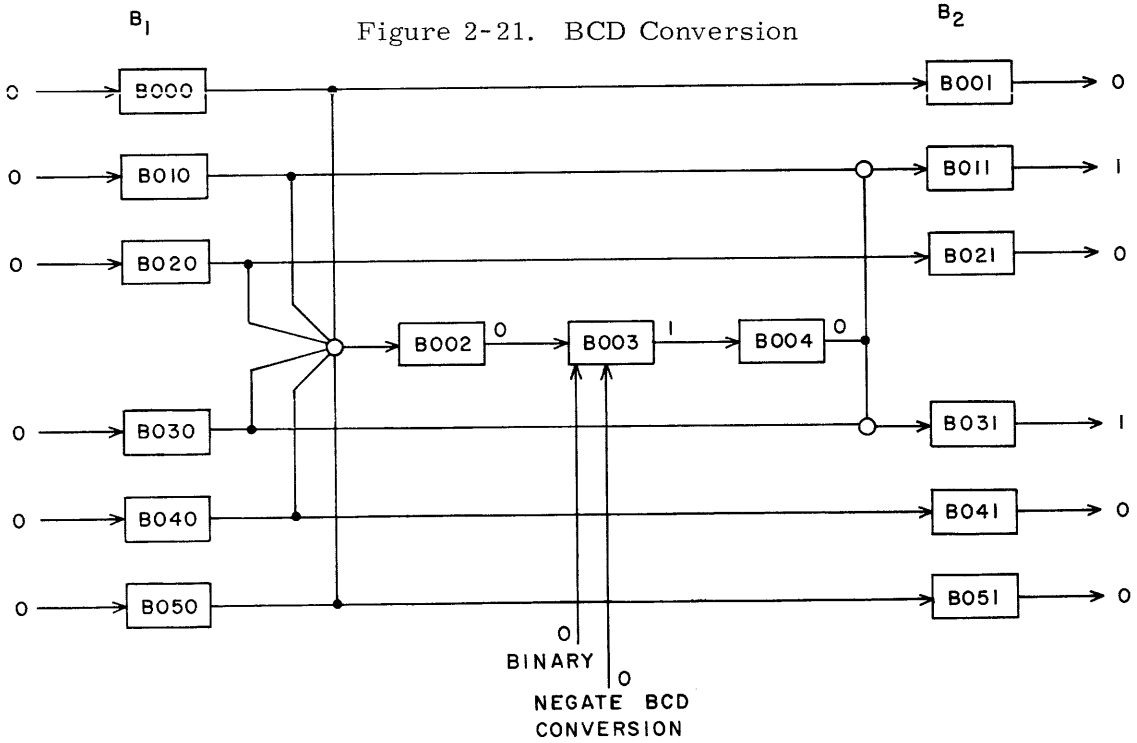
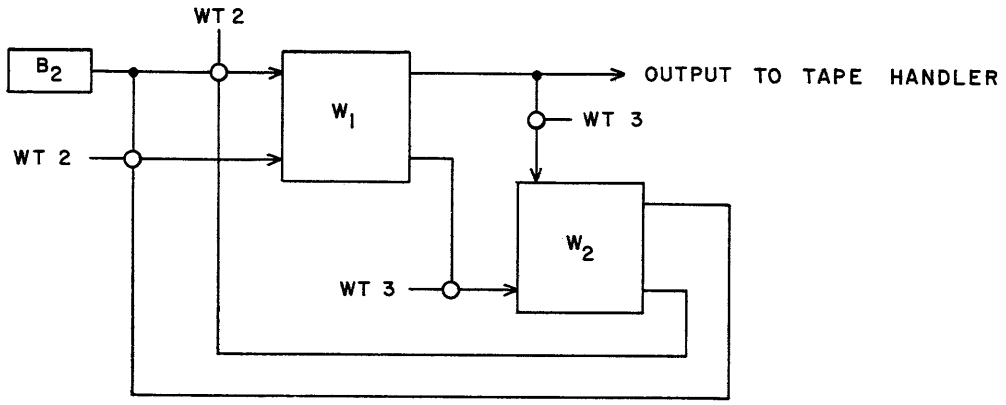


Figure 2-22. 0-to-12 Conversion



NEW INPUT (B_2)	PREVIOUS OUTPUT (W_2)	NEW OUTPUT (W_1)
1	1	0 (A CHANGE)
1	0	1 (A CHANGE)
0	1	1
0	0	0

Figure 2-23. Write Register (One Channel)

B_2 to W_1

This transfer performs the parity bit generation and the change-on-ones conversion. The parity generator determines whether an even or odd number of 1s exist. If an odd number exists and BCD is selected, a 1 is passed to the seventh channel of the W_1 register; if even and BCD, a 0. If an odd number exists and Binary is selected, a 0 is generated; if even and Binary, a 1.

W_1 to W_2

The Write register (W_1 - W_2) performs the change-on-ones conversion; W_1 toggles each time a 1 is received (Figure 2-23 shows one channel of the Write register).

At the end of a record, three spaces remain blank and then a check character is written. The check character (longitudinal parity) is generated by clearing the Write register (W_1). Each FF that must be toggled to clear the register generates a 1. Therefore, the total number of bits in each channel (including the check character) equals an even number.

REGISTER TRANSFERS DURING WRITE REPLY (Figure 2-19)

After each 7-bit frame is recorded on tape, it is read back to the Controller by the Write Reply circuit. The Write Reply circuit checks the vertical and longitudinal parity. Vertical parity is checked during the M-to-N transfer, when a new parity bit is generated for each 6 bits of data and compared against the recorded parity bit. Any difference sets the Vertical Parity Error FF (page 12).

Each 7-bit frame received by the Write Reply circuit is sent to the Read Toggle register ($C_1 \rightarrow C_2$). Each 1 in the frame toggles its corresponding FF. After all the frames in the record (and the record check character) have been toggled, the C_1 register should be clear (indicating an even number of 1s in each channel). If C_1 is not clear, the Longitudinal Parity Error FF is set (page 14).

REGISTER TRANSFERS DURING READ

M to N

This transfer checks the vertical parity as the 7-bit frame is read from the tape. A new parity bit is generated for each 6 bits of data and compared against the recorded parity bit. Any difference sets the Vertical Parity Error FF (page 12).

N to X and N to C

This transfer checks the longitudinal parity, performs the external BCD to internal BCD conversion, performs the 12-to-0 conversion and assembles two 6-bit characters into one 12-bit input word.

As each 7-bit frame is gated out of the N register, it is passed to the Read Toggle register ($C_1 \rightarrow C_2$). Each 1 in the frame toggles its corresponding FF. After all the frames in the record (and the record check character) have been toggled, the C_1 register should be clear (indicating an even number of 1s in each channel). If C_1 is not clear, the Longitudinal Parity Error FF is set (page 14).

If the Controller is selected to Read in BCD format and the Negate BCD signal is not present, any time bit 4 is a 1, bit 5 is complemented (bit 4 remains 1). The example shown in Figure 4-6 shows the conversion of 71 to 31.

The 12-to-0 conversion occurs if the Controller is selected to Read in BCD, the Negate BCD signal is not present, and a frame is read as 12 (Figure 2-25).

The assemble function converts two 6-bit characters into one 12-bit input word. The assembly order is controlled by the assembly counter (AK) shown in Figure 2-26. During a Suppress Assembly/Disassembly mode operation, this transfer packs each 6-bit character into N_1, and N_1 - N_2 are transferred to the Data Channel with N_2 all zeros. Table 1-1 shows examples of assembly.

X to H

The H register (Holding register) temporarily stores the 12-bit input word to assure that the Data Channel has time to accept the word before new characters from the tape are assembled. The H register is cleared when the Data signal drops (indicating that the Data Channel has accepted the word.)

H to T

During this transfer, the transmission parity bit is generated. The 12 bits of data are inspected to determine whether an even or odd number of bits is present. The transmission parity uses odd parity, so if an even number of bits is sensed, a 1 is added as the 13th bit. If an odd number of bits exist, a 0 is added.

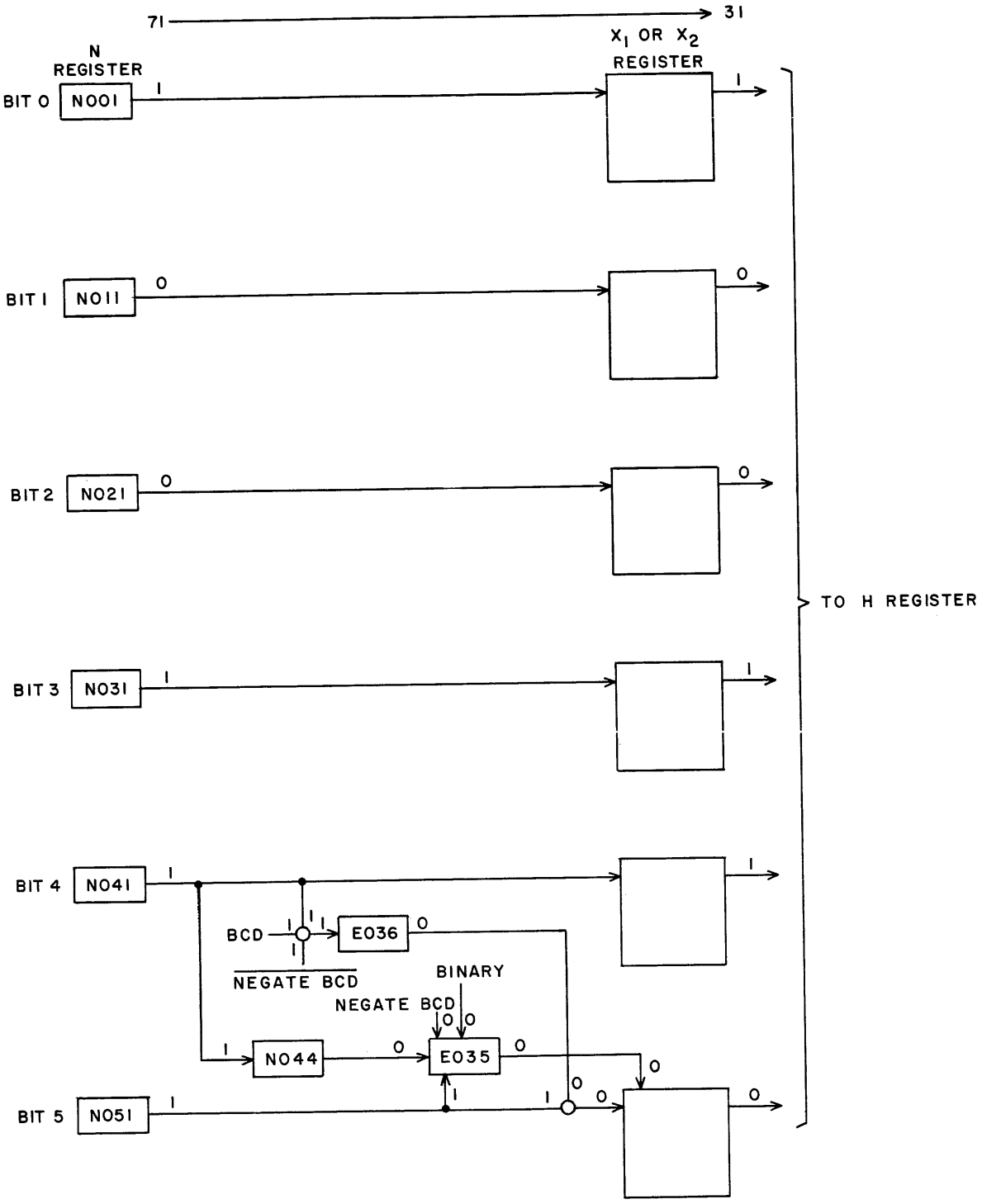


Figure 2-24. BCD Conversion

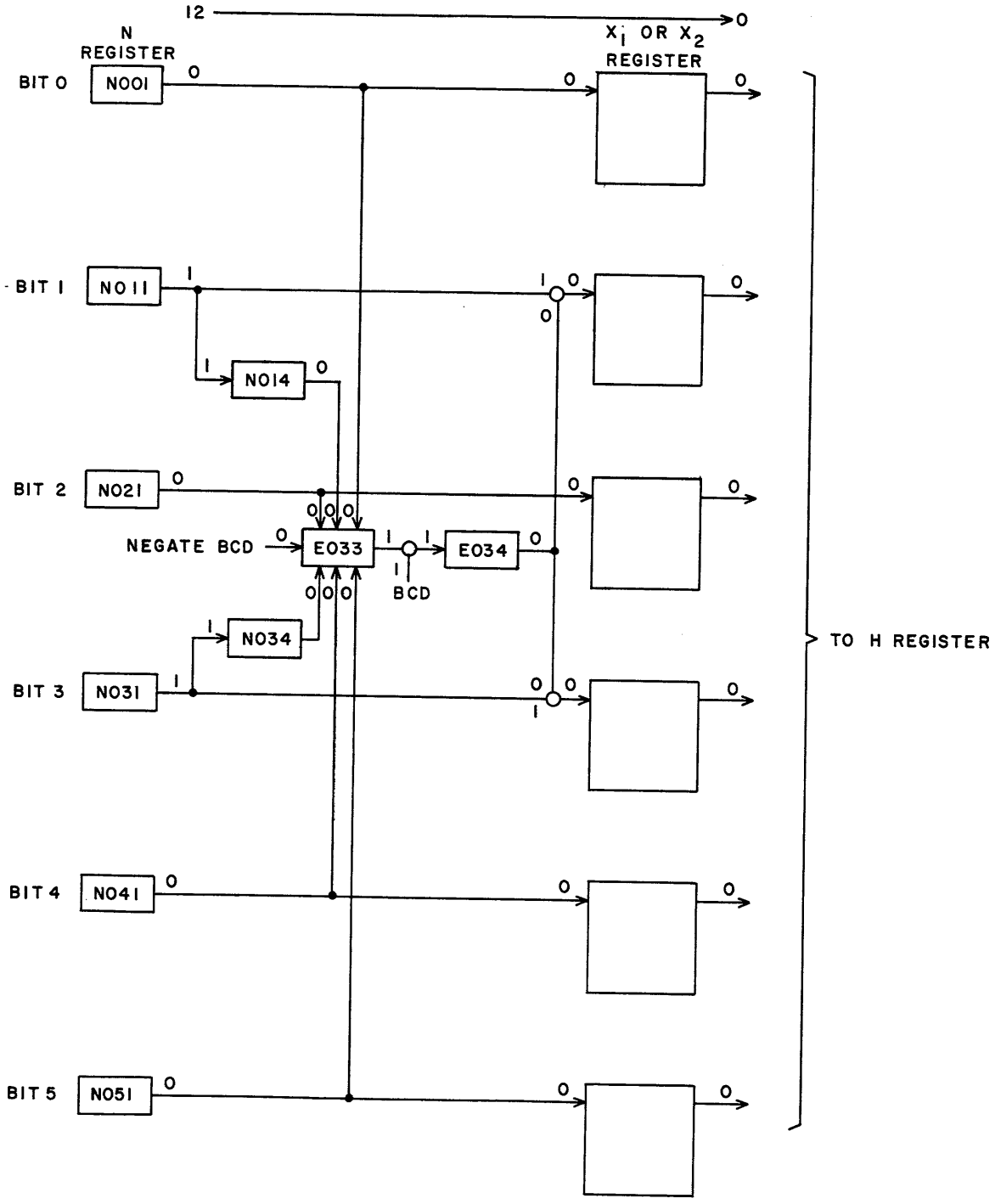


Figure 2-25. 12-to-0 Conversion

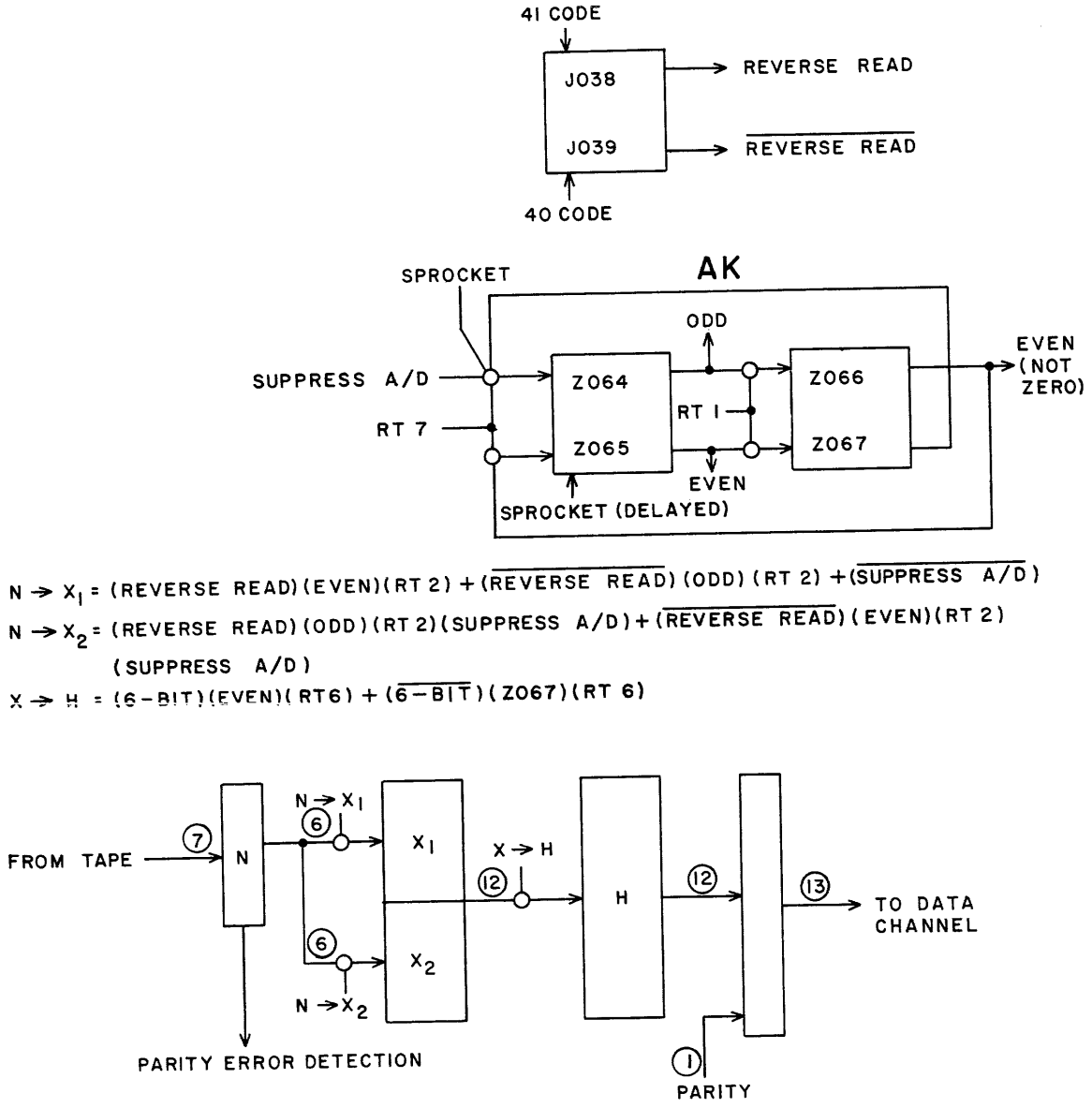


Figure 2-26. Assembly Control

WRITE OPERATION SEQUENCE (FIRST OUTPUT WORD)

STEP	EVENT	COMMENT
1	Write Signal	Set Write Motion FF Send Tape Handler Write and Forward signals Tape motion initiated Initiate delay path to set Write Control FF
2a	Write Control FF set	3.5 (4.5) ms delay path from Write Motion FF; 30 (70) ms if tape is at Load Point Write channel through the controller prepared for data transfer
2b	2 to 60 μsec after the Write Signal is present, the Data Signal occurs	Indicates a 12-bit word available
3	0.1 μsec after Write Control prepares the Write channel, R to 0 FF sets	Controller accepts 12-bit word Clear check character counter enable FF + 0.1 μsec Write Resync FF sets Reply signal sent to Data Channel, thereby permitting the Data Signal to drop and return later with a new 12-bit word R-to-0 FF cleared
4	First (T0) to come after Write Resync sets	(Timing Chain running continuously) Set Write Gate FF
5	Pass through Timing Chain	Upper 6 bits of data pass through the Write channel Write Sprocket FF set (signal passed to tape) Advance Disassembly Counter (set DK_1) Clear Write Sprocket FF + 0.1 μsec Clear Write Gate FF
6	Next WT 0	Set Write Gate FF
7	Pass through Timing Chain	Lower 6 bits of data pass through the Write channel Write Sprocket FF set (signal passed to tape) Advance Disassembly Counter (clear DK_1) Set check character counter Enable FF Clear Write Sprocket FF Clear Write Resync FF + 0.1 μsec Clear Write Gate FF

WRITE OPERATION SEQUENCE (NOT FIRST OR LAST OUTPUT WORD)

8	R-to-0 FF sets after the Write Resync FF clears from the previous output word	Same as step 3 above
9	Same as steps 4 through 7 above	

WRITE OPERATION SEQUENCE (LAST OUTPUT WORD)

STEP	EVENT	COMMENT
10	Data and Write signals not present when Write Resync FF clears	R-to-0 FF not reset Check Character Counter Enable FF not cleared Write Data Lockout FF sets
11	Pass through Timing Chain	Enable check character counter I
12	Pass through Timing Chain	Enable check character counter II
13	Pass through Timing Chain	Enable check character counter III
14	Pass through Timing Chain	Enable Check Character Counter IV Set Write Termination I FF Clear W_1 register (generates check character) Set Write Sprocket FF Send Sprocket signal to Tape Handler
15	+2.6̇ (6.2) ms	Set Write Termination II FF Clear Write Termination I FF Clear Write Motion FF Drop Forward signal Initiate End of Record Clear (F002=1) Clear Write Data Lockout FF Drop Write signal
16	+1.0 usec	Clear Write Termination II FF Clear Write Control FF
17	+0.1 usec	Enable New Write (Y043)

WRITE OPERATION SEQUENCE (WRITE REPLY)

During a Write operation, every frame written on the tape (including the check character) is read back to the controller to check the accuracy of the recording. The distance between the Write heads and the Read heads in the tape handler (0.3 inches) causes the Write reply to trail the Write output by 2 ms (4 ms).

STEP	EVENT	COMMENT
A	Read Sprocket signal	Initiates Read timing chain Z054/055 sets C_1 to C_2 transfer (Read Toggle register)
B	+0.2 μsec	Set Z056/057 Set Write Reply Timing Chain Lockout FF Accept frame from tape handler in C_1 Check Vertical Parity (if parity error occurs. Vertical Parity Error Indicator lights and Status line (bit 10) is activated)
C	Repeat steps A and B for each frame written on tape (includes check character) When tape handler senses an End of Record, check C_1 -- it should be all zeros. If not, indicate a Longitudinal Parity Error (see Read Sequence)	

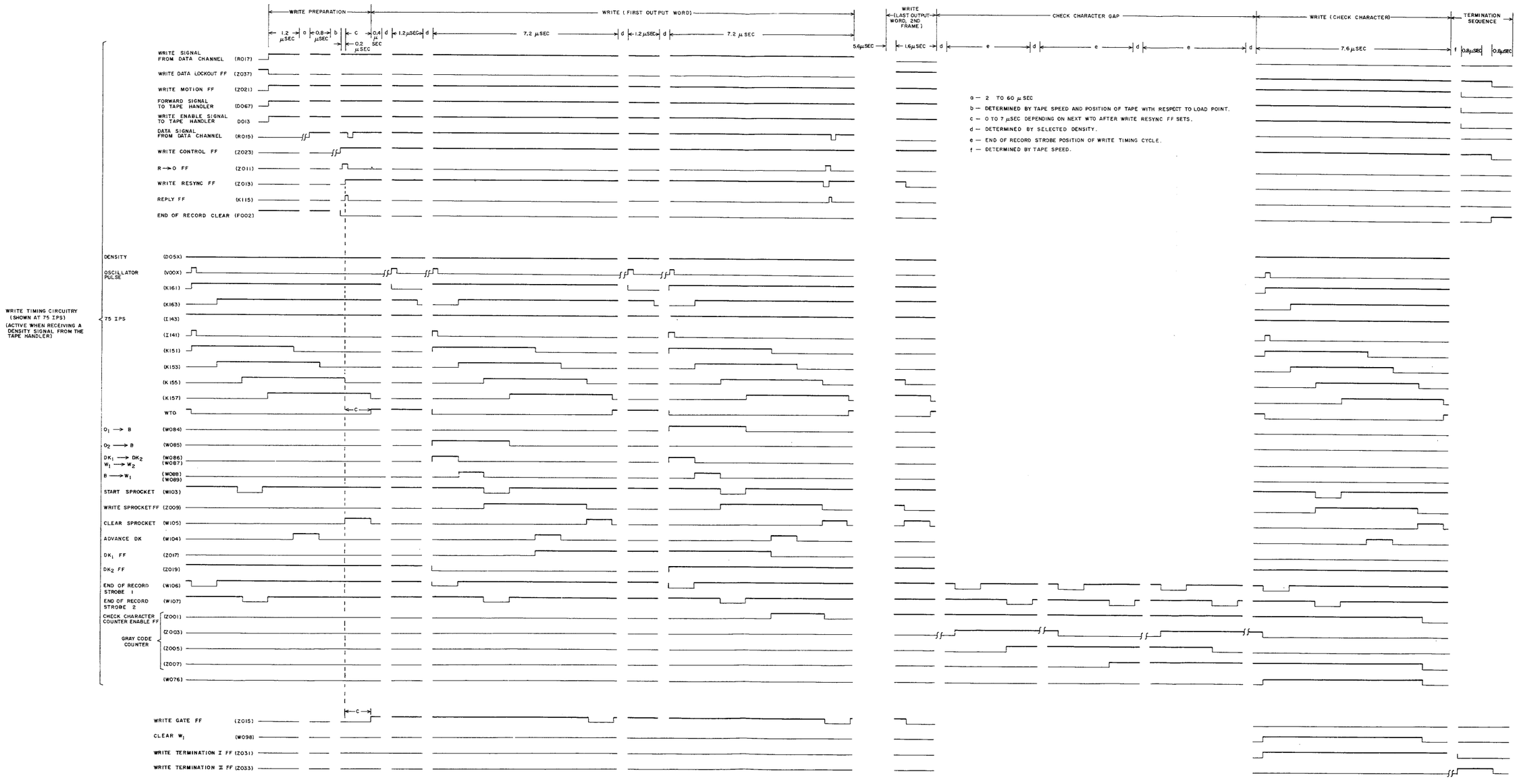
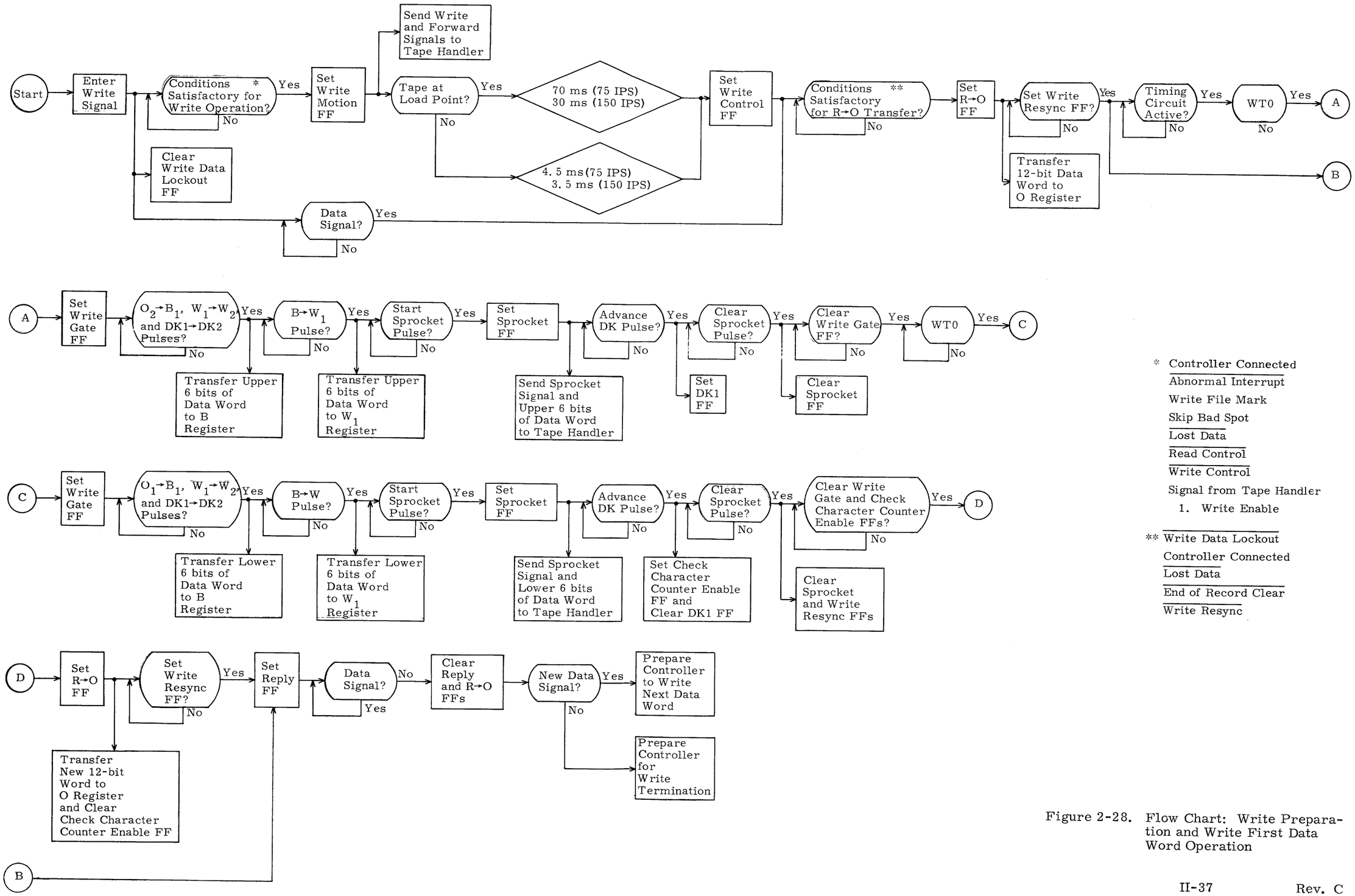


Figure 2-27. Write Timing



* Controller Connected
Abnormal Interrupt
Write File Mark
Skip Bad Spot
Lost Data
Read Control
Write Control
Signal from Tape Handler
1. Write Enable

** Write Data Lockout
Controller Connected
Lost Data
End of Record Clear
Write Resync

Figure 2-28. Flow Chart: Write Preparation and Write First Data Word Operation

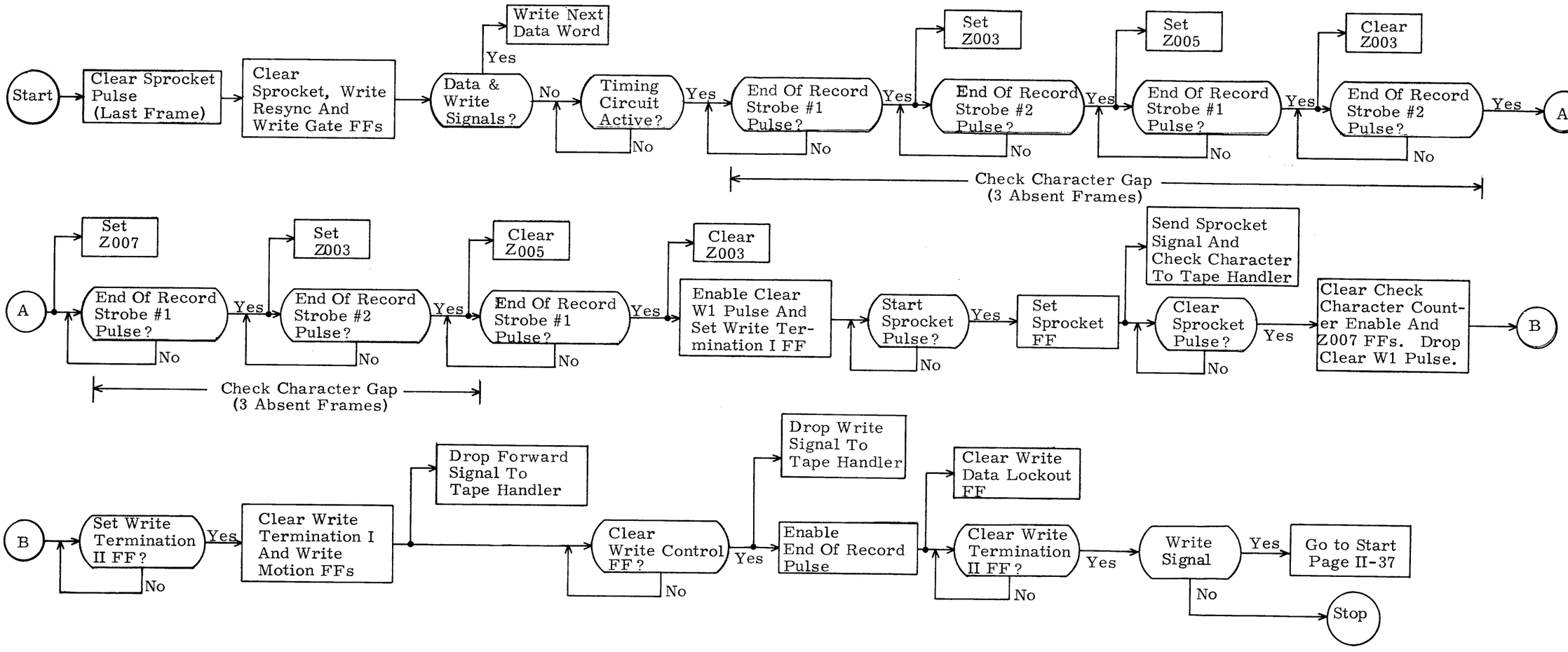


Figure 2-29. Flow Chart: Write Termination

READ OPERATION SEQUENCE (FIRST TWO FRAMES)

STEP	EVENT	COMMENT
1	Read signal	Set Read Motion FF Set Read FF Generate Forward and Read signals to tape handler Clear C_1 register Clear Assembly Counter (AK) Clear End of Record II FF
2	+1 μsec Data signal received	Data Channel ready to accept data
3	10 usec	Set Read Control FF Read/Write Active (E021)
4	First frame read	Sprocket pulse received
5	+0.2 μsec initiate timing (set Z054/055)	Read FF clears Forward and Read signals drop, but tape motion continues (motion stops only at End of Record) Clear X register C_1 to C_2 AK_1 to AK_2 Read Data Lockout FF clears
6	+0.2 μsec set Z056/057	Set Reply Timing Chain Lockout FF Set Begin Record I FF N to X_2 (6 bits of data to Assembly register) N to C_1 (7 bits to Read Toggle register to check parity)
7	+0.5 μsec set Z058/059	
8	+0.2 μsec set Z090/091	
9	+0.2 μsec clear Z054/055	
10	+0.2 μsec clear Z056/057	Set AK_1
11	Second frame read	Sprocket pulse received
12	+0.2 μsec set Z054/055	C_1 to C_2' AK_1 to AK_2 Set Begin Record II FF
13	+0.2 μsec set Z056/057	N to X_1 N to C_1
14	+0.2 μsec set Z058/059	
15	+0.2 μsec set Z090/091	
16	+0.2 μsec clear Z054/055	
17	+0.2 μsec clear Z056/057	Clear AK_1
18	+0.2 μsec clear Z058/059	Generate Reply signal to Data Channel Transfer 12-bit word

READ OPERATION SEQUENCE (NOT FIRST TWO FRAMES)

Same as steps 4 through 18 above, except that Begin Record I and Begin Record II FFs remain set.

READ OPERATION TERMINATION SEQUENCE (END OF RECORD)

STEP	EVENT	COMMENT
19A	Absence of sprocket pulse for 2 1/2 frames	Set End of Record I FF Set Assembly Counter Enable FF (this blocks further assembly counting and thus prevents any more data from being passed to the Data Channel)*
20A	Check Character read	Sprocket Pulse
21A	+0.2 usec initiate timing (set Z054/055)	C_1 to C_2
22A	+0.2 usec set Z056/057	N to C_1
23A	+0.2 usec set Z058/059	C_1 should now be all zeros. If it is not, longitudinal parity error is indicated.
24A	End of Record signal from Tape Handler	Set End of Record II FF (clear H) Set End of Record Disconnect FF Send Data Channel End of Record signal Clear Read Motion FF
25A	Read and Data signals drop	Set Read Data Lockout FF
26A	+1. usec clear Read Control FF	Clear Begin Record FFs Clear End of Record I FF

* The timing chain is enabled one more time so that if an odd number of frames were read, the AK counter will be stepped to the even state and thereby transfer one more word to the Data Channel. Bits 6 through 11 will be zeros in this last word.

READ OPERATION TERMINATION SEQUENCE (NOT AT END OF RECORD)

STEP	EVENT	COMMENT
19B	No Read or Data signals	Set Read Data Lockout FF Tape motion and data transfer to the controller continue until the end of the record. Data is not transferred to the Data Channel, but vertical and longitudinal parity is checked for any remaining frames.
20B	End of Record sensed by lack of sprocket	Set End of Record I FF
21B	Check Character read	Sprocket pulse
22B	+0.2 μsec initiate timing (set Z054/055)	C_1 to C_2
23B	+0.2 μsec set Z056/057	N to C_1
24B	+0.2 μsec set Z058/059	C_1 should now be all zeros. If it is not, longitudinal parity error is indicated.
25B	End of Record signal from Tape Handler	Set End of Record II FF
		Clear Read Motion FF
26B	+1. usec Clear Read Control FF	Clear Begin Record FFs Clear End of Record I FF

REVERSE READ OPERATION SEQUENCE

The sequence of events occurring during a Reverse Read is similar to those in a normal Read with the following exceptions:

1) The Reverse signal (rather than the Forward signal) is sent to the Tape Handler at step 1.

2) A Reverse Assembly signal is sent to the Data Channel during step 1.

3) If a blank space follows the first frame read, the first frame is recognized as a Check Character and is not passed to the Data Channel as if it were a frame of data. If no blank space follows the first frame read, the first frame is assembled and passed to the Data Channel. (This occurs if the Check Character was all zeros) If the first frame read was the Check Character, the Vertical Parity Error FF is cleared because the Check Character is written without regard to vertical parity and may have set the FF.

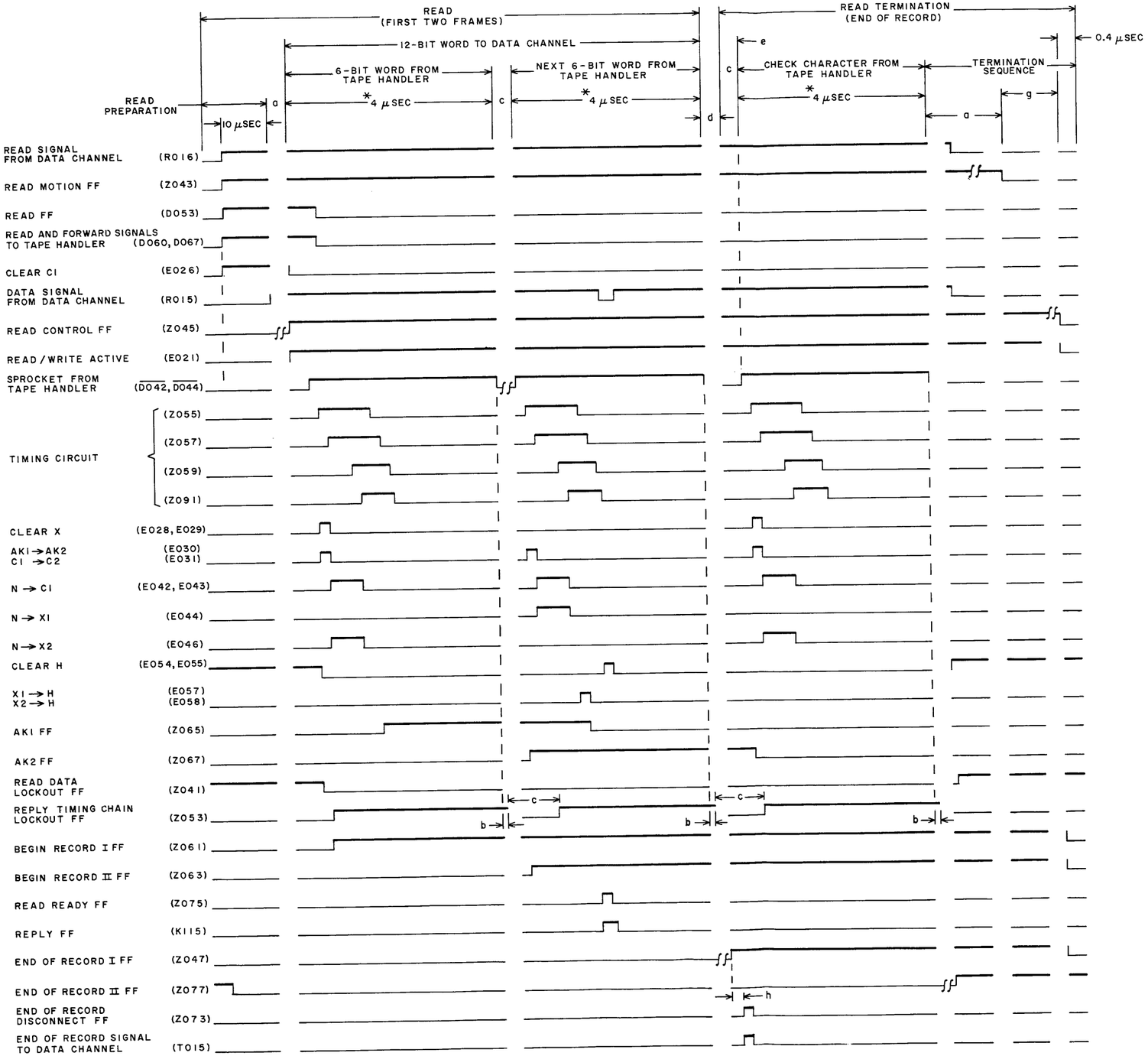
4) Steps 7 and 14 are reversed, thereby reversing the order of frame assembly.

5) If an odd number of frames are recorded on the tape (often the case if the data had been recorded in Suppress Assembly/Disassembly mode), and the Assembly mode of Reverse Read is attempted, the inverted assembly will be one frame out of order and bits 0 through 5 of the last Data Channel word will be filled in with zeros. The zeros are inserted and the Data Channel word passed by having the timing chain make one additional pass. This advances the Assembly counter to the even position, thereby permitting the transfer.

SUPPRESS ASSEMBLY/DISASSEMBLY OPERATION SEQUENCE

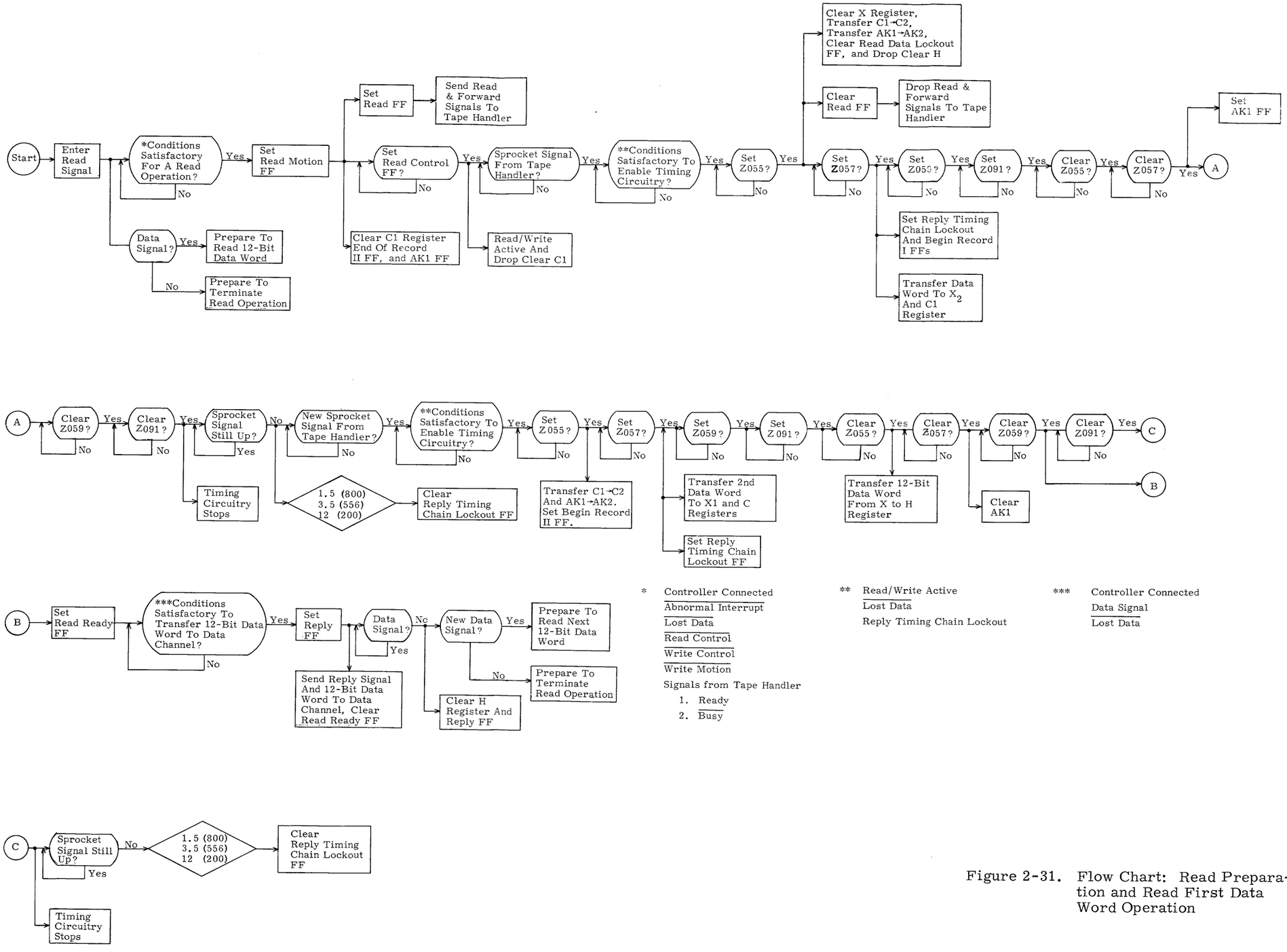
When the Suppress Assembly/Disassembly signal is present, the AK and DK counters are disabled. This forces only bits 0 through 5 of each Data Channel word to be written before a new Data Channel word is accepted. During Read and Reverse Read, each frame is inserted in bits 0 through 5 of the Data Channel word (bits 6 through 11 are all zeros).

During a Suppress Assembly/Disassembly Reverse Read, there is not enough time to determine if the first frame read is the Check Character or not. Therefore, the first frame is always treated as if it were a true data frame and passed to the Data Channel. This is a programming consideration.



a — DETERMINED BY TAPE SPEED
b — DETERMINED BY DENSITY
c — DETERMINED BY TAPE SPEED AND DENSITY
d — DETERMINED BY TAPE SPEED AND DENSITY WHEN $\overline{\text{SPROCKET}}$
e — DETERMINED BY TAPE SPEED TO CHECK CHARACTER
f — DETERMINED BY LENGTH OF REMAINING RECORD, TAPE SPEED, AND DENSITY WHEN $\overline{\text{SPROCKET}}$
g — 1 μSEC
h — 10 μSEC
* — 2 μSEC FOR 606, 607

Figure 2-30. Read Timing

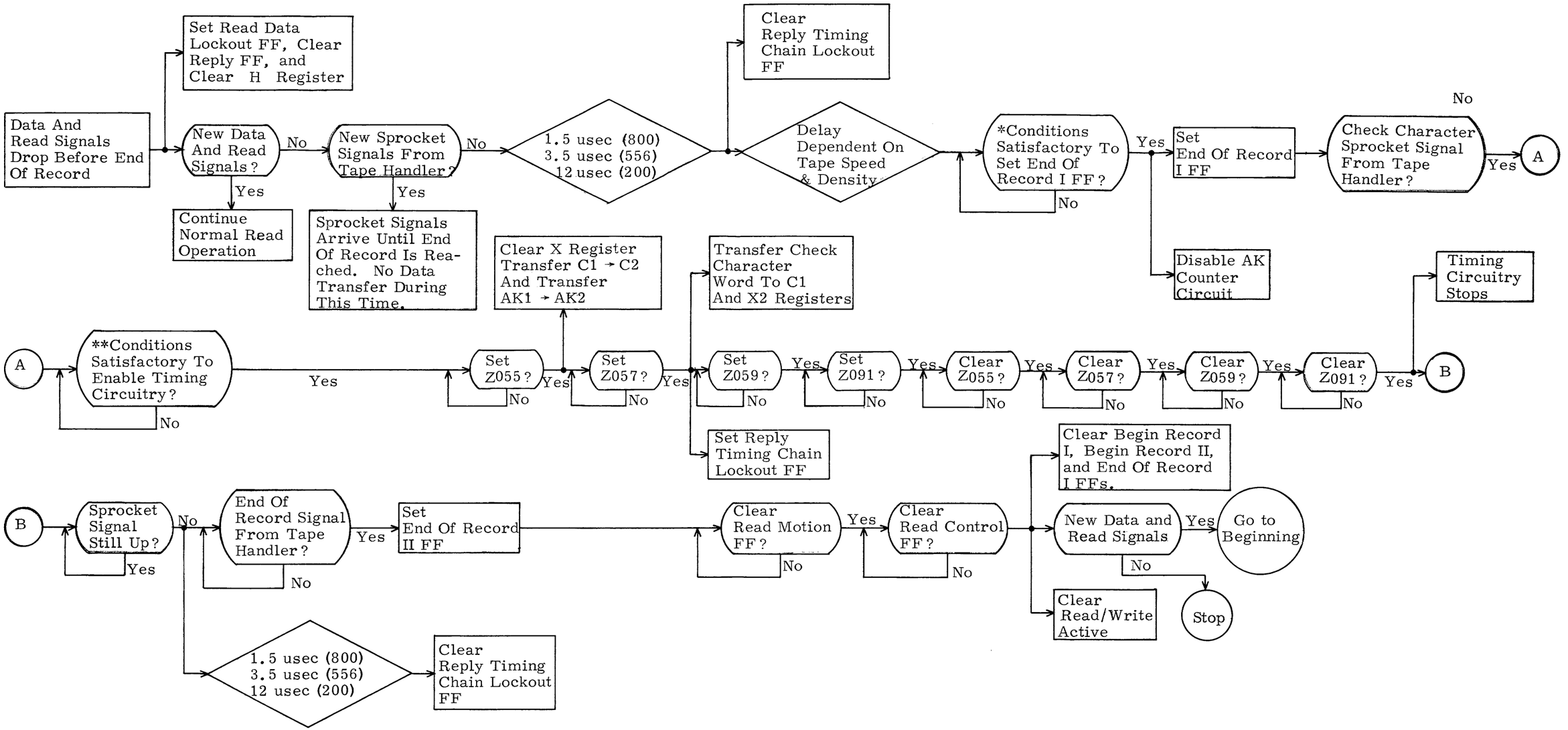


* Controller Connected
Abnormal Interrupt
Lost Data
Read Control
Write Control
Write Motion
Signals from Tape Handler
1. Ready
2. Busy

** Read/Write Active
Lost Data
Reply Timing Chain Lockout

*** Controller Connected
Data Signal
Lost Data

Figure 2-31. Flow Chart: Read Preparation and Read First Data Word Operation

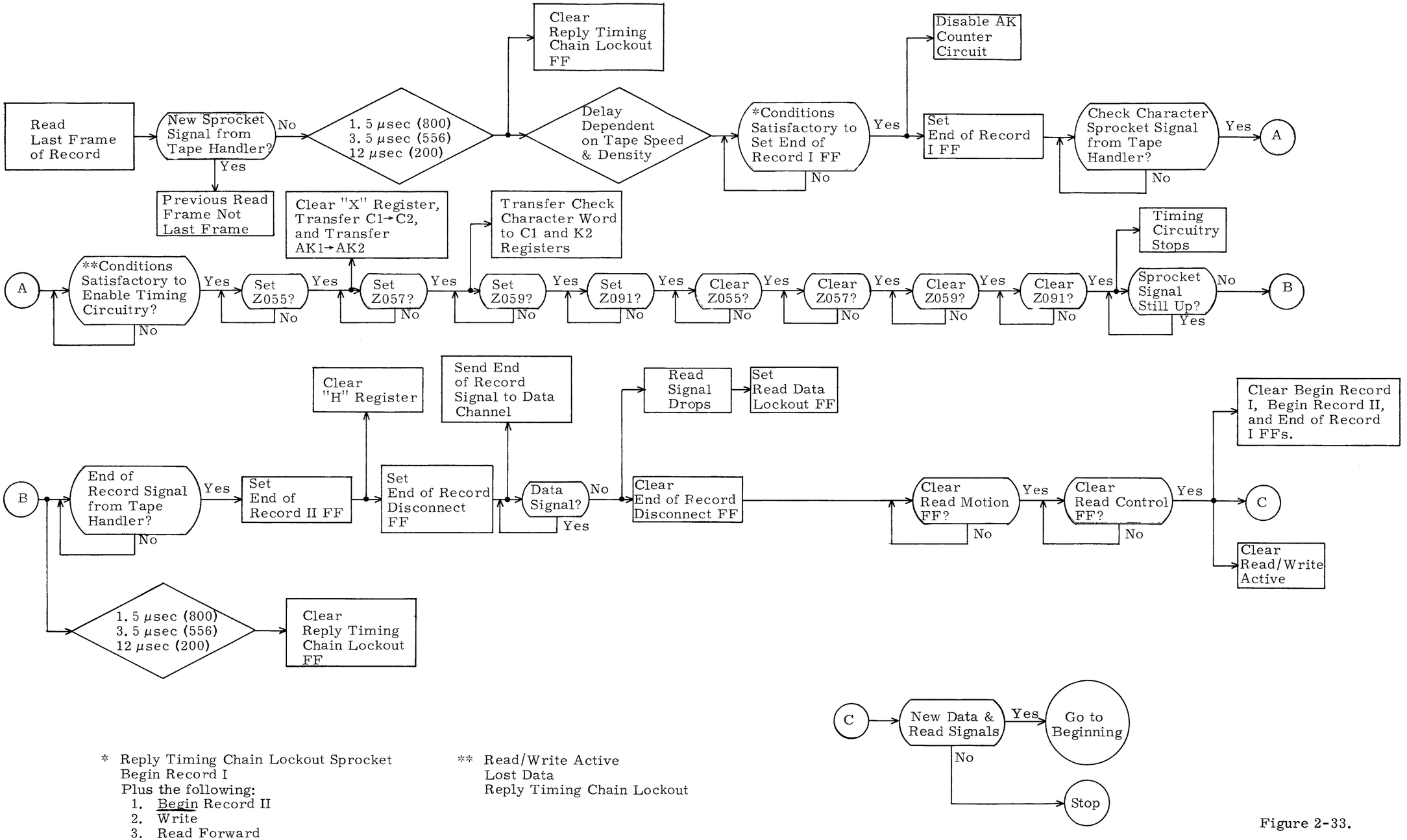


* Reply Timing Chain Lockout
Sprocket
Begin Record I
Plus the following:

1. Begin Record II
2. $\overline{\text{Write}}$
3. Read forward

** Read/Write active
Lost Data
Reply Timing Chain Lockout

Figure 2-32. Flow Chart: Read Termination (Not End of Record) and Read Nonstop Operation



* Reply Timing Chain Lockout Sprocket
Begin Record I
Plus the following:
1. Begin Record II
2. Write
3. Read Forward

** Read/Write Active
Lost Data
Reply Timing Chain Lockout

Figure 2-33.

Flow Chart: Read Termination (End of Record)

SECTION 5. FUNCTION OPERATION MOTION DIRECTIVES

SKIP BAD SPOT

The Skip Bad Spot FFs (Figure 2-34 and Page 3) simulate a partial Write operation. The Write Motion FF (Page 8) is set as if the Write signal were present (Figure 2-34). The 30 ms (70 ms) delay path to set the Write Control FF is initiated (this allows time for the tape to move 6 inches). When the Write Control FF is set, Write Termination I FF sets and a Write termination procedure ensues.

WRITE FILE MARK

The Write File Mark FFs (Figure 2-35 and Page 3) simulate a Write operation which automatically writes one frame (17 BCD) and its check character on the tape. The Write Motion FF (Page 8) is set as if the Write signal were present (Figure 2-35). The 30 ms (70 ms) delay path to set the Write Control FF is initiated (this allows time for the tape to move 6 inches). When the Write Control FF is set, the R-to-0 FF is set as if the Data signal were present. The File Mark is then sent to the W_1 register as if it were a frame of data. The normal End of Record procedure (leaving 3 blank frames and then writing the check character) then follows.

SEARCH FORWARD TO FILE MARK

The Search Forward To File Mark FF (Figure 2-36 and Page 3) simulates a partial Read operation. The Read FF (Page 5) is set as if the Read Motion FF were set by the Read signal (Figure 2-36). The Forward signal, the Read signal, and the Search signal are sent to the Tape Handler. The Search signal modifies the End of Record circuit in the Tape Handler so that the End of Record signal is returned to the Controller only when a File Mark is sensed. This permits tape motion to continue over any End of Record gaps.

SEARCH BACKWARD TO FILE MARK

This operation is identical to Search Forward except that the Search Backward to File Mark FF (Figure 2-37 and Page 3) initiates reverse, rather than forward, tape motion (Figure 2-37).

BACKSPACE

The Backspace FF (Figure 2-38 and Page 3) simulates a partial Reverse Read operation. The Read FF (Page 5) is set as if the Read Motion FF were set by the Read signal

(Figure 2-38). The Reverse signal and the Read signal are sent to the Tape Handler. Tape Motion continues until the Tape Handler senses an End of Record.

REWIND

The Rewind FF (Figure 2-39 and Page 3) sends the connected Tape Handler the Rewind signal (Figure 2-39). This signal instructs the Tape Handler to rewind at high speed to the nearest Load Point. The Controller is free to assume some other operation with a different Tape Handler. When the Tape Handler that is rewinding senses the Load Point and terminates tape motion, it signals the Controller that it is Ready and at Load Point. New operation is then possible.

REWIND UNLOAD

The Rewind Unload FF (Figure 2-40 and Page 3) sends the connected Tape Handler the Rewind Unload signal (Figure 2-40). This signal instructs the Tape Handler to rewind at high speed until the tape is completely off the reel. The Controller is free to assume some other operation with a different Tape Handler. Operation with the Tape Handler that is selected to Rewind Unload is impossible until the tape is manually reloaded.

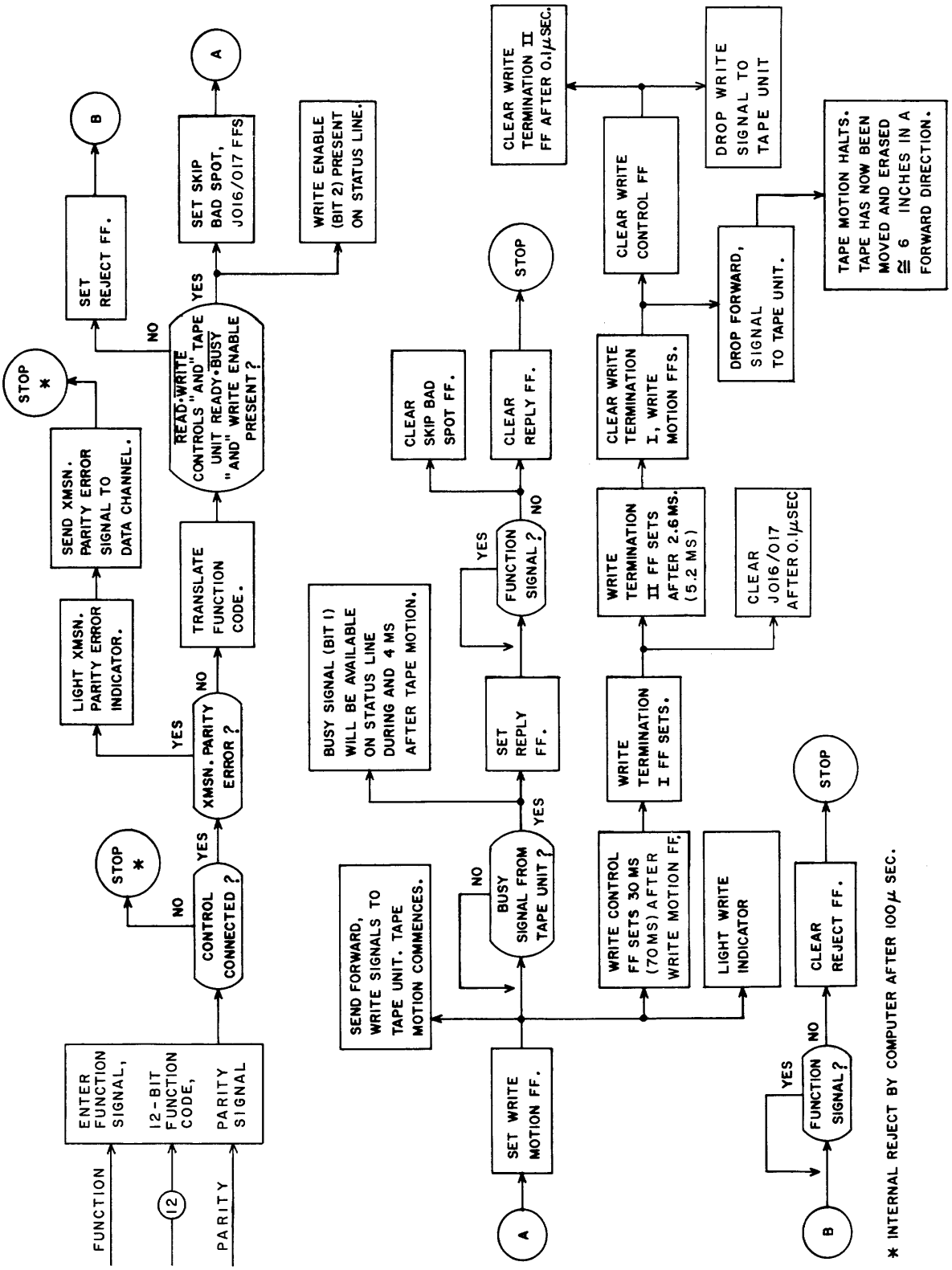


Figure 2-34. Skip Bad Spot

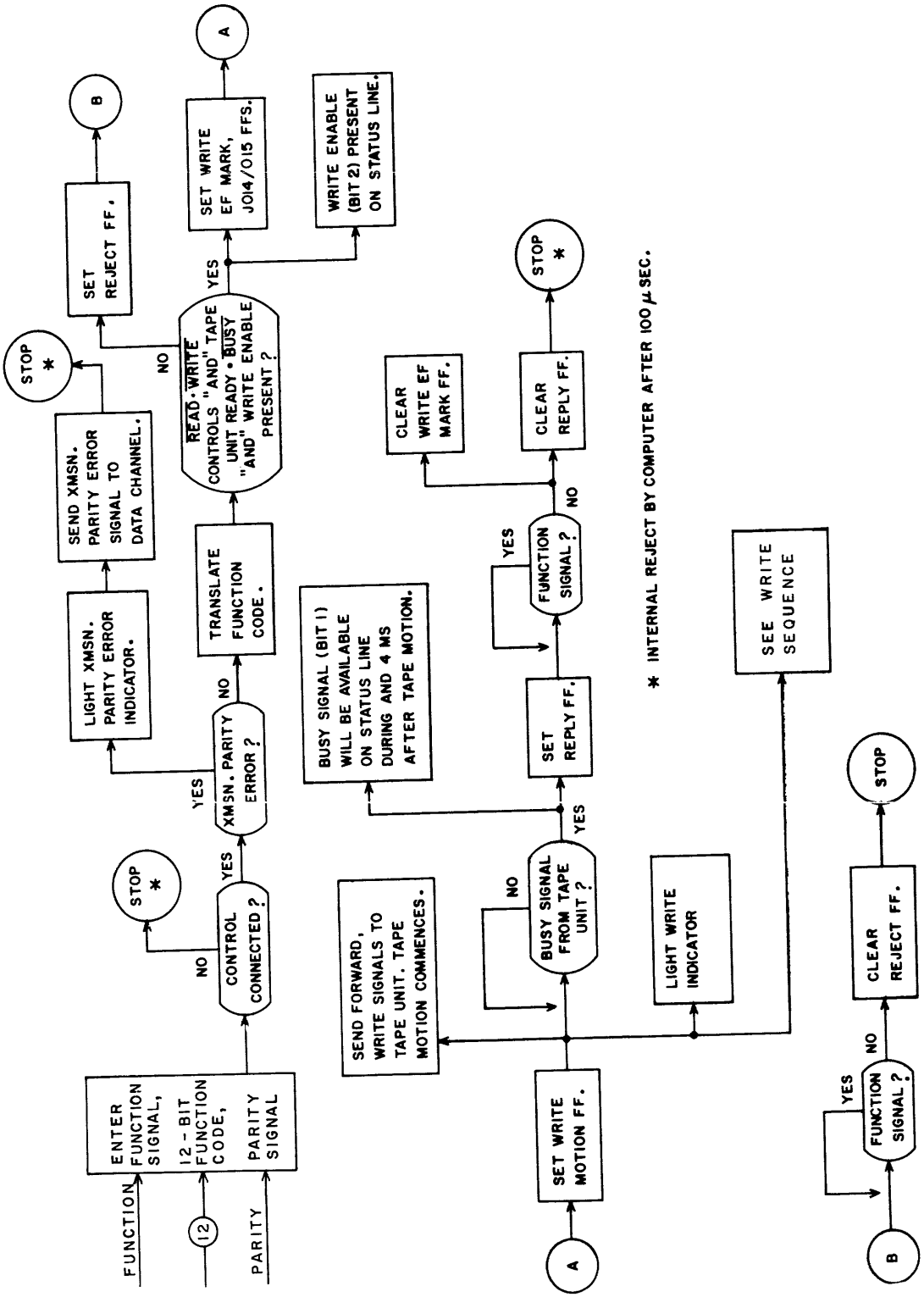


Figure 2-35. Write File Mark

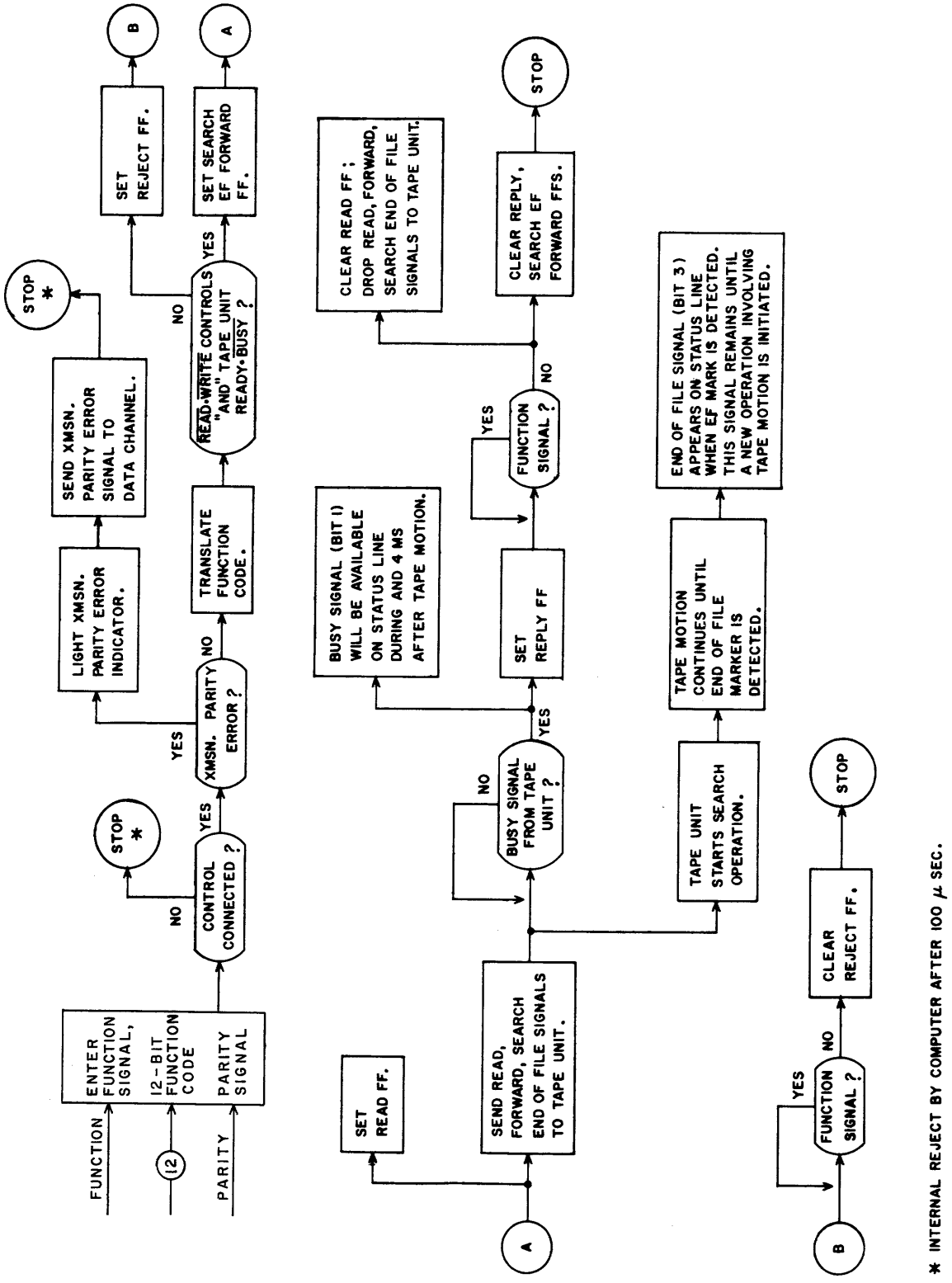


Figure 2-36. Search Forward to File Mark

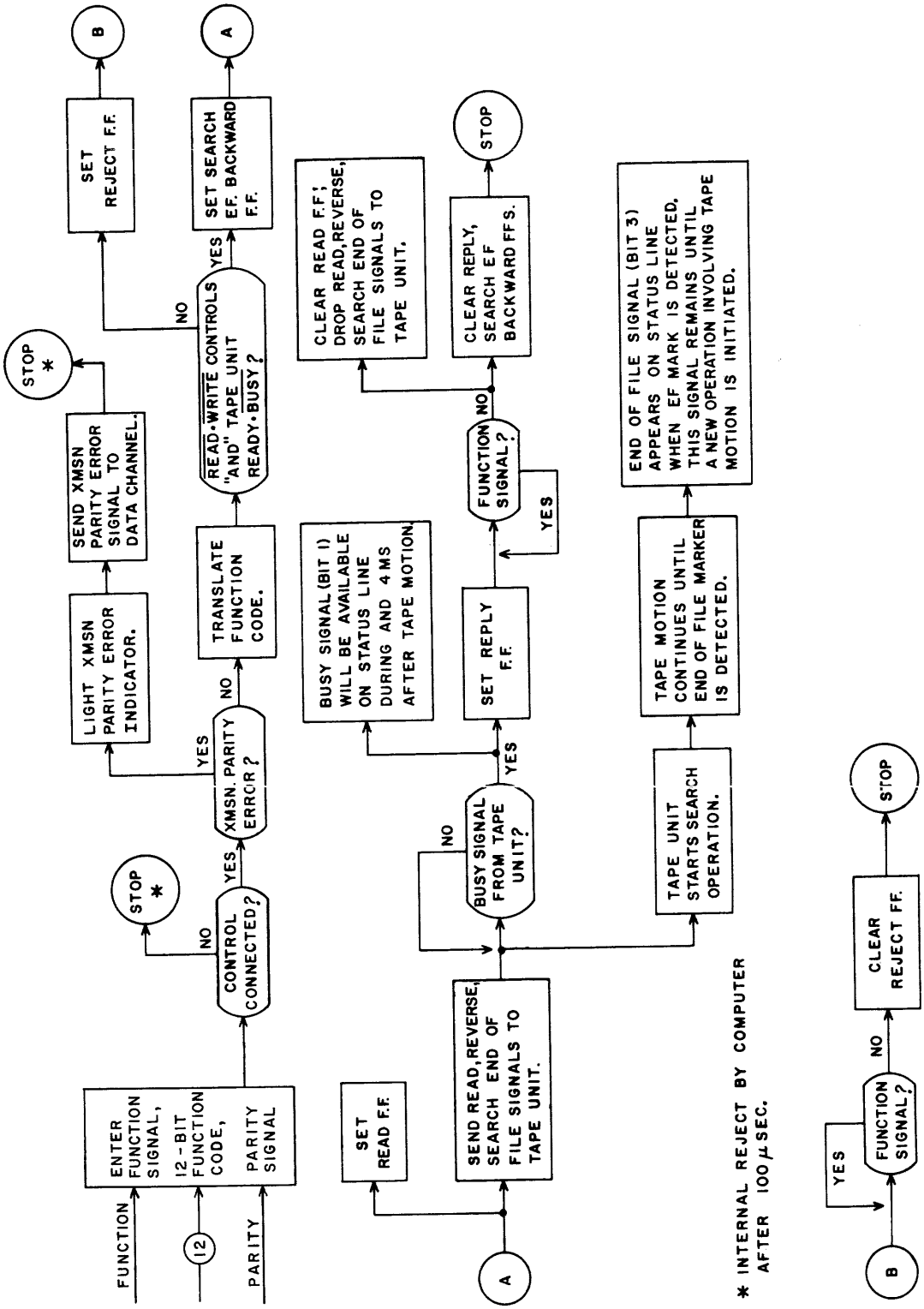
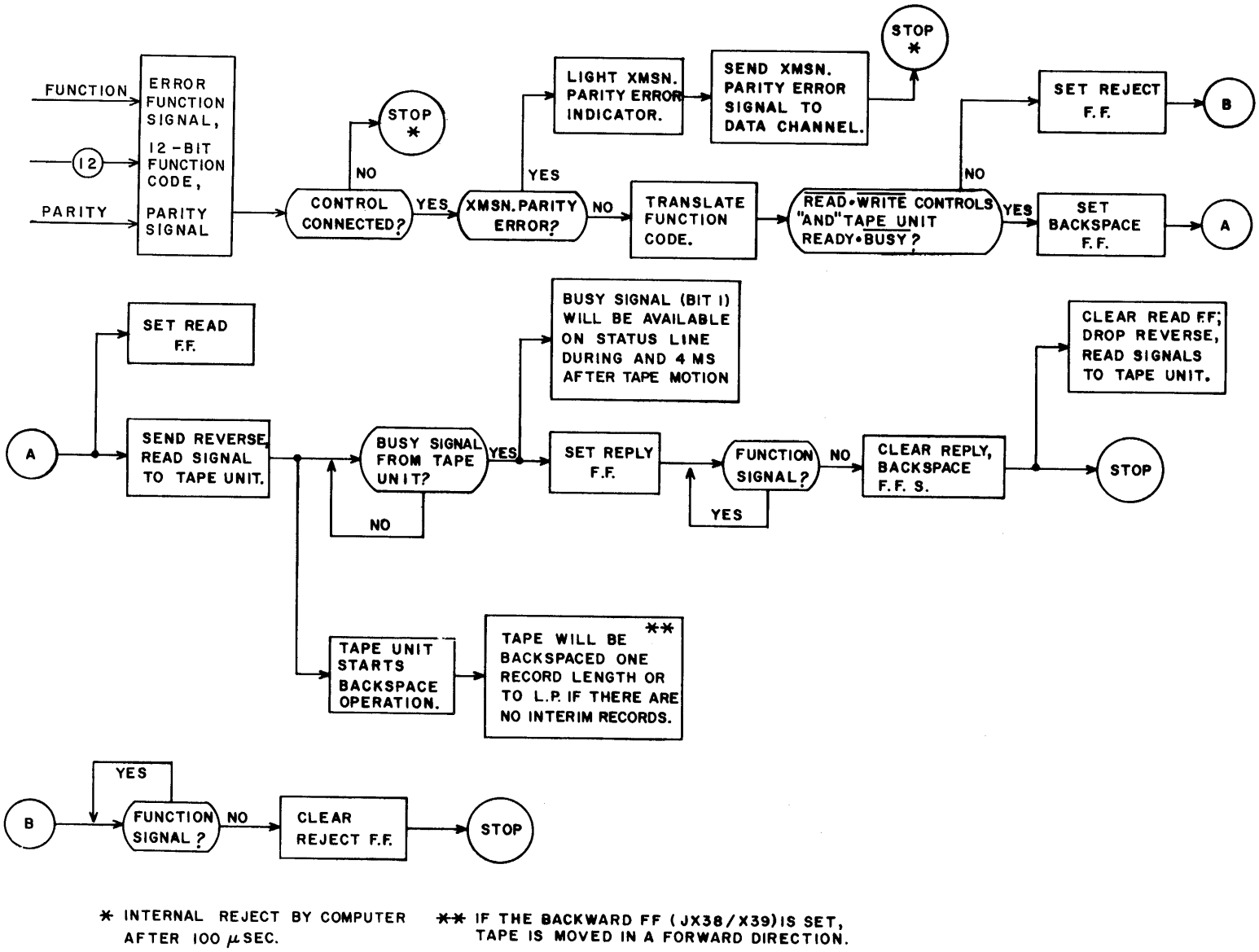


Figure 2-37. Search Backward to File Mark



* INTERNAL REJECT BY COMPUTER AFTER 100 μSEC.

** IF THE BACKWARD FF (JX38/X39) IS SET, TAPE IS MOVED IN A FORWARD DIRECTION.

Figure 2-38. Backspace

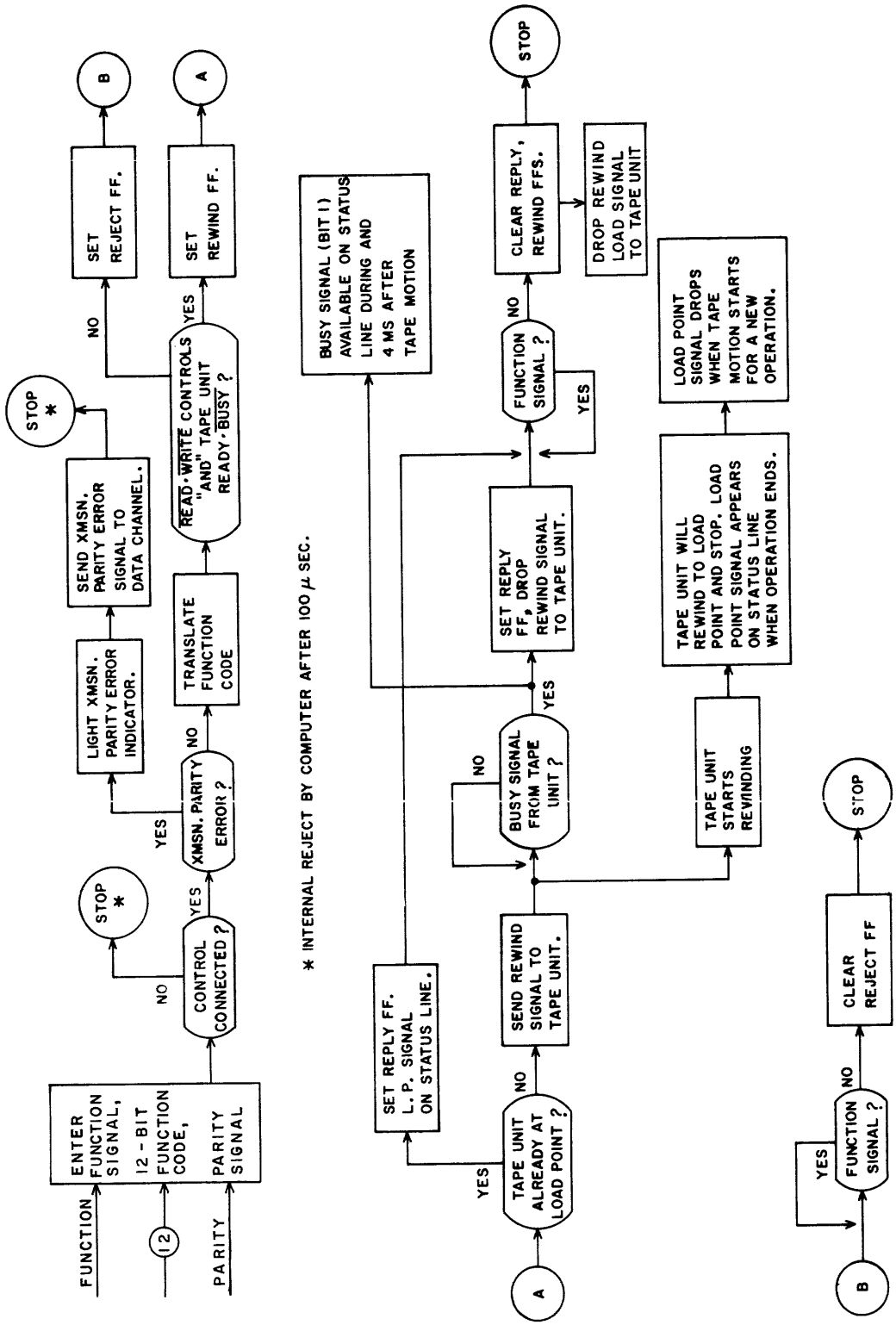


Figure 2-39. Rewind

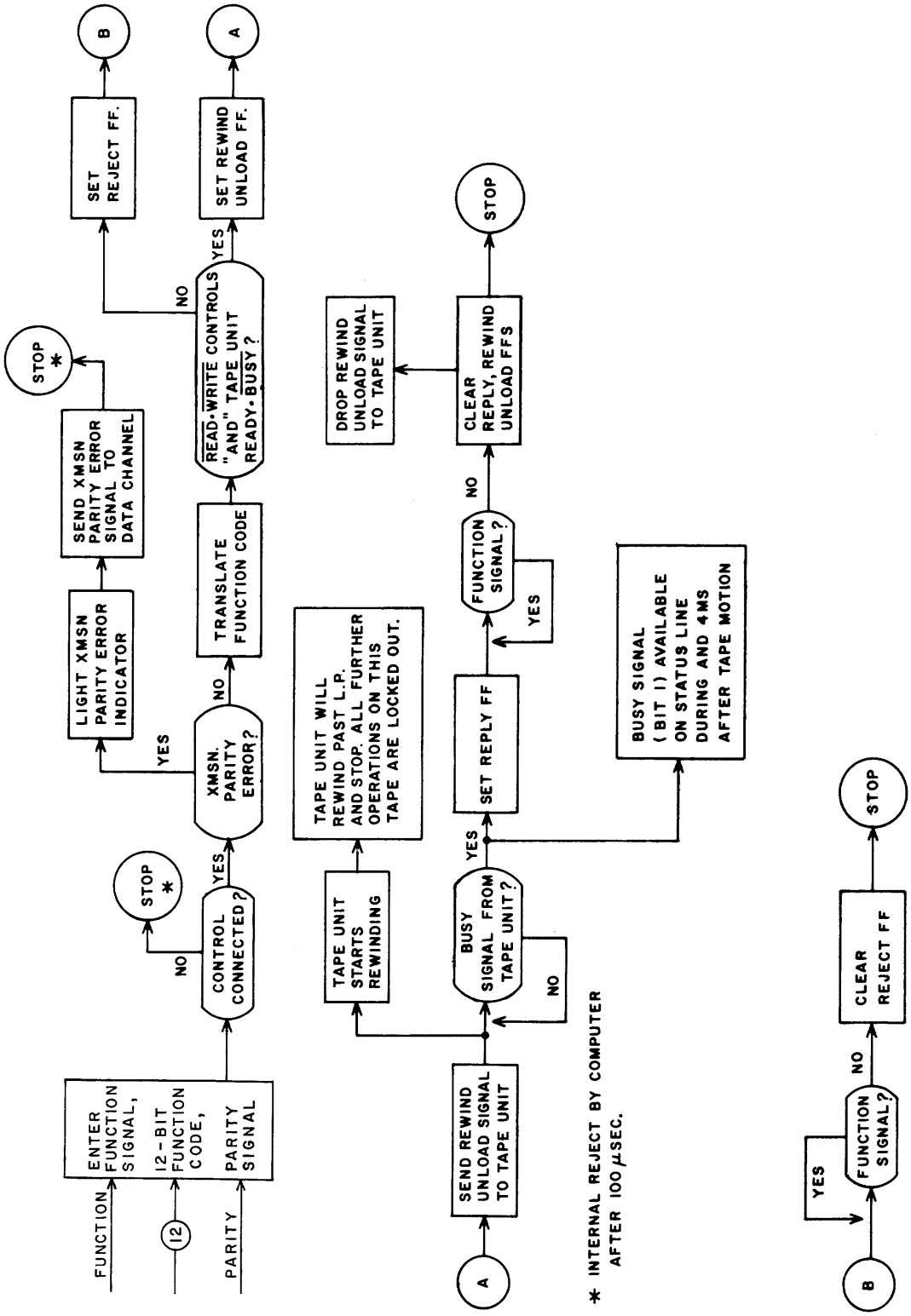


Figure 2-40. Rewind Unload

SECTION 6. PROGRAM CONVENIENCES

INTERRUPT FUNCTION

Three sets of conditions in the tape handler or controller may generate an Interrupt signal to the data channel. Function codes set or clear the Interrupt Condition FFs which determine what conditions are to generate the Interrupt. The three Interrupt Condition FFs are: Interrupt on Ready, Interrupt on End of Operation, and Interrupt on Abnormal End of Operation. Figure 2-41 shows how they are set and cleared.

Interrupt on Ready

If the Interrupt on Ready FF is set, the Interrupt FF is set if a Ready signal and a Not Busy signal are received from the tape handler (Figure 2-42). The Interrupt FF sends the Interrupt signal to the data channel and lights the Interrupt indicator on the controller. The Interrupt FF remains set until a new 2X Function code is received by the controller or if all Interrupt Condition FFs are cleared.

Interrupt on End of Operation

If the Interrupt on End of Operation FF is set, the Interrupt FF is set when the controller receives the End of Record signal from the tape handler while J040/041 is set (Figure 2-43). J040/041 is set by a pulse generated when the Channel Busy signal goes not busy.

Interrupt on Abnormal End of Operation

If the Interrupt on Abnormal End of Operation FF is set, the Interrupt FF will be set by any of the following conditions sensed at the End of Record (Figure 2-44):

Lost data
Longitudinal parity error
Vertical parity error
Tape at Load Point
End of File detected during a Search
End of Tape

If the Interrupt FF is set by any of the above conditions, no new tape motion can be initiated until this FF is cleared.

The Interrupt FF can also be set by the Interrupt on Abnormal End of Operation FF if the tape handler Ready signal drops at an improper time.

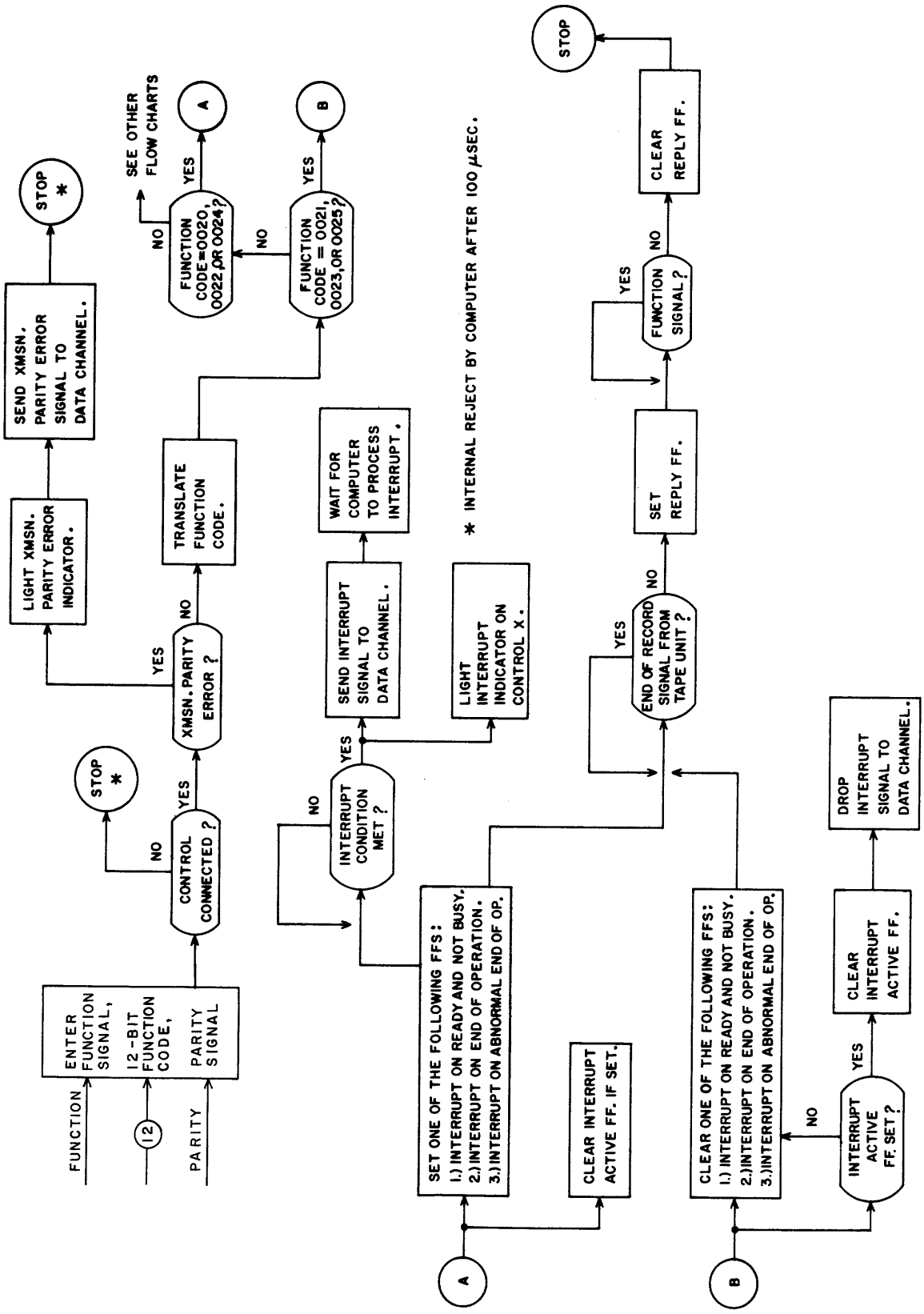


Figure 2-41. Interrupt and Select

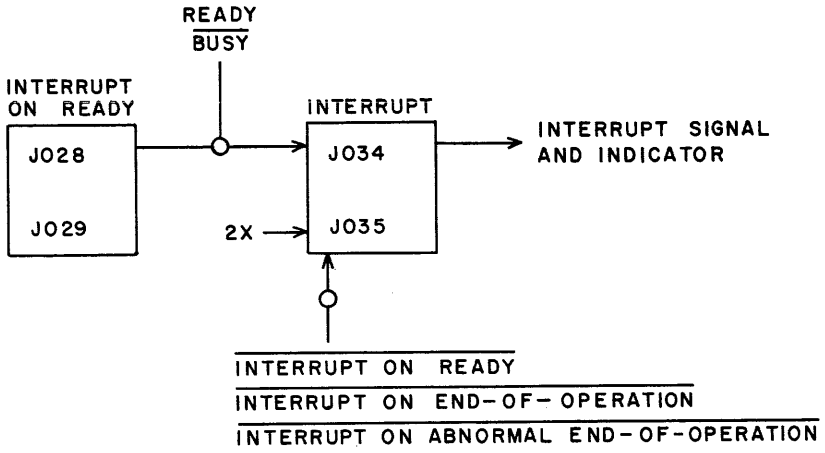


Figure 6-2. Interrupt on Ready

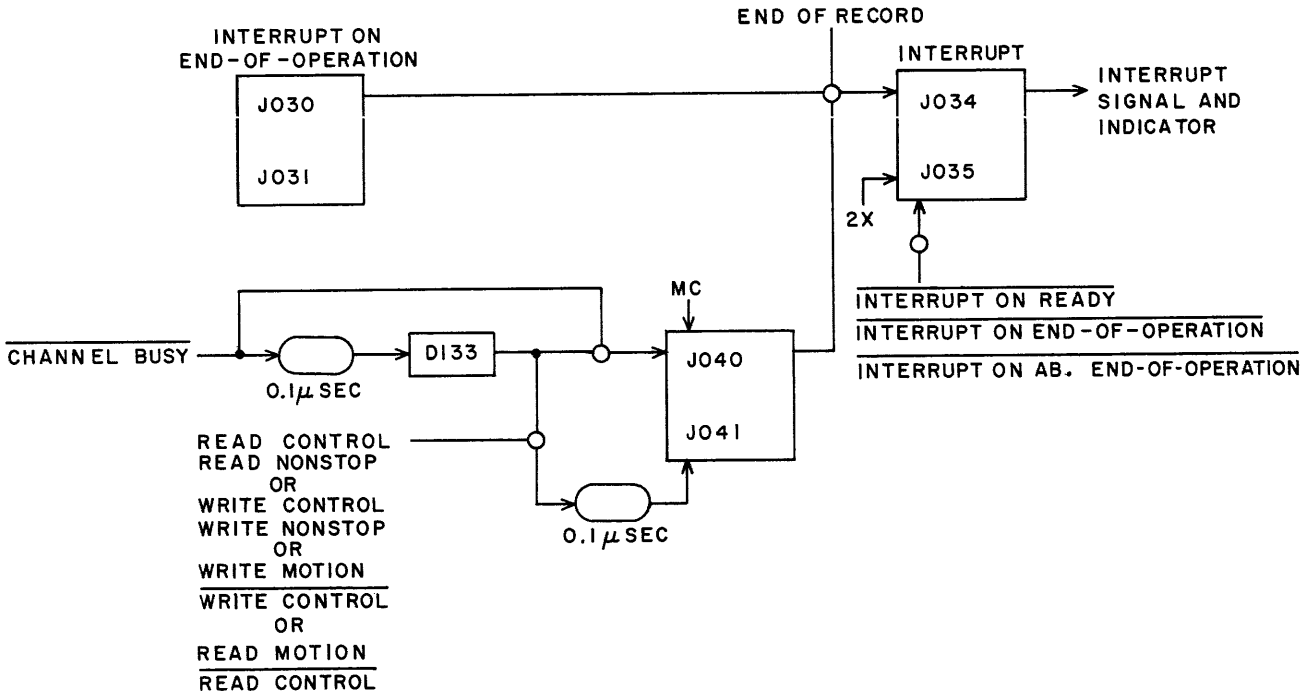


Figure 2-43. Interrupt on End of Operation

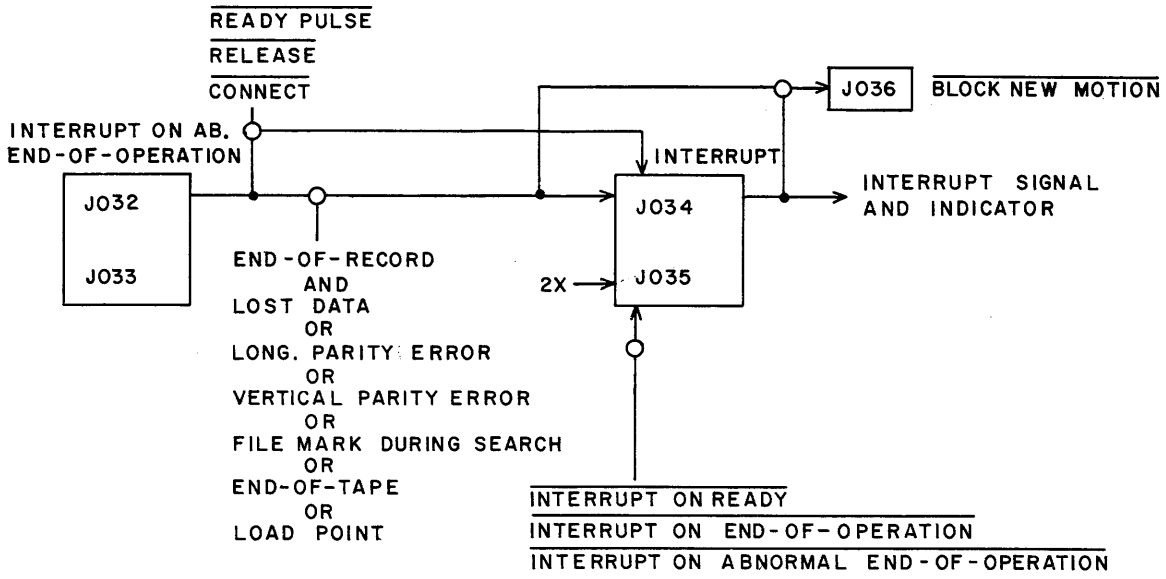


Figure 2-44. Interrupt on Abnormal End of Operation

STATUS

Various conditions existing in the Controller and the Tape Handler may be sensed by the computer by using the eleven status lines. A status inspection may occur at any time during a program.

The status lines are enabled when the Controller is connected to the Data Channel (Page 1). If any of the predetermined conditions exist, the corresponding line is activated. For example, if the Controller is connected and the connected Tape Handler is at Load Point, bit 4 status line (Tape Handler at Load Point) is activated.

Bit 0	Tape Handler Ready
Bit 1	Tape Handler Ready and Busy
Bit 1	Tape Handler Ready and Controller Write Control
Bit 1	Tape Handler Ready and Controller Read Control
Bit 1	Tape Handler Ready and Controller Write Motion
Bit 1	Tape Handler Ready and Channel Busy and $\overline{\text{Lost Data}}$ and $\overline{\text{Channel Interrupt}}$
Bit 2	Tape Handler Write Enable
Bit 3	Tape Handler at File Mark
Bit 4	Tape Handler at Load Point
Bit 5	Tape Handler at End of Tape

Bit 6	Tape Handler at 556 BPI
Bit 7	Tape Handler at 800 BPI
$\overline{\text{Bit 6}}$ and $\overline{\text{Bit 7}}$	Tape Handler at 200 BPI
Bit 8	Controller Lost Data
Bit 9	End of Operation
Bit 10	Vertical Parity Error
Bit 10	Longitudinal Parity Error

Any number of these responses may be active at the same time.

LOST DATA CONDITION DURING WRITE

If at any time during a Write operation (Write signal present), the Data signal does not appear for the length of time required to write two frames, the Lost Data FF sets (Page 8). This condition will cause an Interrupt on Abnormal End of Operation (if selected) and activate Bit 8 on the Status lines. No other Write operation is possible until the Lost Data FF is cleared by a new Function, a new Connect, or a Master Clear.

LOST DATA DURING READ

The input word to the computer is held in the H register until the Data signal drops, indicating that the input word has been accepted by the computer. If the Data signal does not appear (operation being normal in other respects), the Lost Data FF will be set at the time the next frame would have to be transferred to the X register. A Lost Data signal (bit 8) appears on a status line. (An Interrupt occurs 5 μsec after the End of Record signal is received from the tape unit if Interrupt on Abnormal End of Operation is selected.)

The Lost Data FF also sets the End of Record Disconnect FF if the Read control is set. This sends an End of Record signal back to the data channel. Tape motion continues to the End of Record check character before stopping.

Further Read operations are impossible until the Lost Data FF is clear. A new Function, a new Connect, or a Master Clear signal clears the Lost Data FF.

PART III. MAINTENANCE

SECTION 1. ENVIRONMENTAL CARE

The Controller is constructed of standard Control Data components with properties identical to those of the 3000 series computers. Normal dust-free, air-conditioned computer environment is required.

Blowers cool the Controller by drawing air through reuseable filters at the bottom of the cabinet. These filters should be cleaned weekly. Power and cooling requirements can be determined from tables in the 3200 Installation Manual or from Engineering Specification No. 118102. The 3228/3229 uses Power Type C power control wiring.

SECTION 2. LOGIC CABLING

Cables are connected to the cable connector panel at the bottom rear of the chassis. Tables 3-1 and 3-2 give the pin numbers associated with signals in the two cables to each Tape Handler. Table 3-3 gives a brief description of each of these signals.

The four connectors at the bottom of the connector panel are used to fasten cables from the Data Channel. Connector 1A1 attaches to a Data Channel I/O cable (data). Connector 1A2 is either terminated or attached to another I/O cable (data) going to some other external equipment. Connector 1B1 is attached to a Data Channel I/O cable (control). Connector 1B2 is either terminated or attached to another I/O cable (control) going to some other external equipment.

Tables 3-4 and 3-5 list signal and pin assignments for the Data Channel I/O cables. Table 3-6 gives a brief description of each of these signals.

TABLE 3-1. SIGNAL AND PIN ASSIGNMENTS

Output cable from 322X to 60X, Connector #J208

Note: Terms in parentheses give signal nomenclature used in 60X manuals and specifications.

Pin	Signal
*A	2^0 Write
*B	2^1 Write
*C	2^2 Write
*D	2^3 Write
*E	2^4 Write
*F	2^5 Write
*H	Parity Write
*J	Write Sprocket
**K	Address 6
**L	Address 7
*M	Forward
*N	Reverse
*P	Search End of File (Stop On File Mark)
*R	Set 556 BPI Density (Select Hi Density)
*S	Set 200 BPI Density (Select Lo Density)
*T	Write (Write Select)
*U	Read (Read Start)
*V	MC (Master Clear)
*W	Rewind Unload
*X	Rewind
**Y	Address 5
*Z	Turn On Connect Light (Unit Select Light #1)
*a	Turn On Reserve Light (Unit Select Light #2)
b	Ground

* From 322X to 60X
** From 60X to 322X

TABLE 3-2. SIGNAL AND PIN ASSIGNMENTS

Input cable to 322X from 60X, Connector #J209

Note: Terms in parentheses give signal nomenclature used in 60X manuals and specifications.

Pin	Signal
**A	2^0 Read
**B	2^1 Read
**C	2^2 Read
**D	2^3 Read
**E	2^4 Read
**F	2^5 Read
**H	Parity Read
**J	Read Sprocket
**K	Write Enable (Write Ready)
**L	Address 4
**M	End of Record (End of Operation)
**N	File Mark
**P	Address 0
**R	Address 1
**S	Address 2
**T	Address 3
**U	Busy
**V	Density (1 = 556 BPI)
**W	Load Point
**X	End of Tape
**Y	Ready
Z	Density (1 = 800 BPI)
a	Not Used
b	Ground

* From 322X to 60X
** From 60X to 322X

TABLE 3-3. SIGNAL DEFINITIONS

Signal Definitions: Output cable from 322X to 60X	
7 Write Information	These seven lines carry information from the Write register in the 322X control. Six lines carry data, one line carries a parity bit.
Write Sprocket	A 4 (6) usec pulse which gates the information on the seven data lines into the 60X Write circuitry.
Address 5, 6, and 7	These three address lines (eight total) correspond to a setting on the 60X Unit Select switch. A static 1 signal appears on the address line corresponding to the Unit Select setting. When the switch is rotated, all address lines have a momentary 0 output.
Forward	A 1 signal which initiates forward tape motion at 150/75 ips.
Reverse	A 1 signal which initiates reverse tape motion at 150/75 ips.
Search End of File	A 1 signal which initiates tape motion forward/backward. Tape motion stops when an End of File character is detected.
Set 556 BPI Density	A 1 signal which selects 556 BPI density Operating mode (556 lines per inch)
Set 200 BPI Density	A 1 signal which selects 200 BPI density Operating mode (200 lines per inch)
Write	A 1 signal which enables Write and Read verify operations.
Read	A 1 signal which enables a Read operation.
MC	A 1 signal which establishes initial operating conditions by clearing all Select conditions. Immediately stops tape motion.
Rewind Unload	A 1 signal which initiates tape motion in a reverse direction at 350 ips to a Tape Unload condition (all tape on supply reel) and Stop.
Rewind	A 1 signal which initiates tape motion at 350 ips to the nearest Load Point marker.
Signal Definitions: Output cable to 322X from 60X	
Turn On Connect Light	A 1 signal which turns on Unit Select light #1. This light indicates a particular tape handler is connected to a data channel.
Turn On Reserve Light	A 1 signal which turns on Unit Select light #2. This light indicates a particular tape handler is reserved by a data channel. (Not used when connected to 3206.)
Ground	

TABLE 3-3. SIGNAL DEFINITIONS (Cont'd)

Signal Definitions: Input Cable to 322X from 60X	
7 Read Information	These seven lines carry information from the 60X to the 322X. Six lines carry data, one line carries a parity bit.
Read Sprocket	A 1 pulse which signals the 322X to sample the 7 bits of Read information from the 60X.
Write Enable	A 1 signal which indicates that the file protection ring is in and tape has been loaded. Write and Read Verify operations may now be performed.
Address 0, 1, 2, 3, 4	See address 5, 6, and 7.
End of Record	A 1 signal which indicates an End of Record check character, File Mark, or Load Point has been detected.
File Mark	A 1 signal which indicates a File Mark has been detected.
Busy	A 1 signal which indicates that tape is in motion. Signal drops 4 ms after tape motion stops.
Density (556 BPI)	A 1 signal which indicates that 556 BPI density is selected. If this signal is absent, 200 or 800 BPI density is selected.
Load Point	A 1 signal which indicates tape is at Load Point.
End of Tape	A 1 signal which indicates the End of Tape marker has been sensed.
Ready	A 1 signal which indicates the 60X is under 322X control and is prepared for the next operation. The tape handler is always ready when its Ready indicator is illuminated. The tape handler is Not Ready when power is off or when the tape handler is being manipulated from its control panel.
Density (800 BPI)	A 1 signal which indicates 800 BPI density is selected. If this signal is absent, 200 BPI or 556 BPI density is selected.
Ground	

TABLE 3-4. SIGNAL AND PIN ASSIGNMENTS

Data I/O Cable

(Mates a 322X Control and a 3206 or a 3681 Converter)

Pin (two used)	Signal
A1-2	Data Bit 00
A3-4	Data Bit 01
A5-6	Data Bit 02
A7-8	Data Bit 03
A9-10	Data Bit 04
B1-2	Data Bit 05
B3-4	Data Bit 06
B5-6	Data Bit 07
B7-8	Data Bit 08
B9-10	Data Bit 09
C1-2	Data Bit 10
C3-4	Data Bit 11
C5-6	Parity Bit
C7-8	Channel Busy
C9-10	Reverse Assembly
D1-2	Read
D3-4	Write
D5-6	Connect
D7-8	Function
D9-10	Data Signal
E1-2	Reply
E3-4	Reject
E5-6	End of Record
E7-8	Parity Error
E9-10	(Unused)
F1-2	
F3-4	Master Clear
F5-6	(Used Internally)
F7-8	(Used Internally)
(Not in cable. See note). F9-10	Termination Power

TABLE 3-5. SIGNAL AND PIN ASSIGNMENTS

Control I/O Cable

(Mates a 322X Control and a 3206)

Pin (two used)	Signal
A1-2	Status Bit 00 Ready
A3-4	Status Bit 01 R/W Control (and/or) Bus
A5-6	Status Bit 02 Density (1 = 556 BPI)
A7-8	Status Bit 03 File Mark
A9-10	Status Bit 04 Load Point
B1-2	Status Bit 05 End of Tape
B3-4	Status Bit 06 Write Enable
B5-6	Status Bit 07 Density (1 = 800 BPI)
B7-8	Status Bit 08 Lost Data
B9-10	Status Bit 09 Longitudinal Parity Error
C1-2	Status Bit 10 Vertical Parity Error
C3-4	Status Bit 11 Tape Handler Reserved for Other Control (Unused)
C5-6	Computer Running (Unused)
C7-8	Negate BCD Conversion (1604 Mode)
C9-10	Suppress Assembly/Disassembly
D1-2	Interrupt Line 0
D3-4	Interrupt Line 1
D5-6	Interrupt Line 2
D7-8	Interrupt Line 3
D9-10	Interrupt Line 4
E1-2	Interrupt Line 5
E3-4	Interrupt Line 6
E5-6	Interrupt Line 7
E7-8	(Unused)
E9-10	(Unused)
F1-2	(Unused)
F3-4	(Unused)
F5-6	(Unused)
F7-8	(Unused)
(Not in cable. See note) F9-10	Termination Power

NOTE: The 29-pair cables terminate in 61-pin connectors. Pins F9-10 of each connector are used to provide power to the terminal assembly and do not connect to lines in the I/O cable.

TABLE 3-7. DATA CHANNEL SIGNALS

**Data Signal	Static 1 signal received by the 322X during both Read and Write operations. Signal drops when 322X returns a Reply to the 3206. 1) In a Read operation, Data Signal indicates that 322X may begin reading information and transmitting it to the data channel. 2) In a Write operation, Data Signal indicates that information is available on the data lines and the Write operation may begin.
***Reply	Static 1 signal produced by the 322X in response to a Connect, Function, or Data Signal. Signal drops when Connect, Function, or Data Signal drops. 1) If connection can be made when Connect signal is received, the 322X connects the desired tape unit and returns a Reply. 2) If a specified function can be performed when the Function signal is received, the 322X executes the function and returns a Reply. 3) In a Read operation, the 322X sends a Reply as soon as it has placed a 12-bit word on the data lines in response to the Data Signal. In a Write operation, the 322X sends a Reply as soon as it samples the data lines in response to the Data Signal.
***Reject	Static 1 signal produced by the 322X in response to a Connect or Function signal, if the connection cannot be made or the Function cannot be performed at the time that the 322X receives the respective signal.
***End of Record	Static 1 signal produced by the 322X during a Read operation. This signal is produced in response to the Data Signal, if the end of the specified block of data has been reached.
*Data Bits	The 12 lines which carry data are bidirectional, and perform as follows: 1) In a Read (input) operation, data is read from tape in 6-bit frames, and assembled into 12-bit bytes. These 12-bit bytes are sent to the 3206 data channel. 2) In a Write (output operation), data is received from the 3206 in 12-bit bytes. The 322X disassembles these 12-bit bytes into 6-bit frames and writes them on tape. 3) The Connect code and Function code are received by the 322X via the 12 data lines.
**Channel Busy	Static 1 signal which indicates the data channel is performing a Read/Write operation.

TABLE 3-7. DATA CHANNEL SIGNALS (Cont'd)

*Parity Bit	A parity bit accompanies each 12 bits of data transmitted between the 322X and the 3206 data channel. Odd parity is used, so the total number of 1s transmitted is always an odd number.
**Read	Static 1 signal received by the 322X from the 3206 during a Read operation.
**Write	Static 1 signal received by the 322X from the 3206 during a Write operation.
**Connect	Static 1 signal received by the 322X when a 12-bit Connect code is available on data lines. The signal drops when the 322X returns a Reply or Reject.
**Function	Static 1 signal received by 322X when a 12-bit Function code is available on data lines. The signal drops when the 322X returns a Reply or Reject.
***Parity Error	Static 1 signal produced if the total number of 1s in the 12 data bits plus the parity bit is not an odd number. This signal will be returned to the 3206 only if the 322X is connected to some tape handler.
**Master Clear	A 1 signal from the computer which returns channel and 322X to zero initial conditions and clears all connections to tape handlers.
***Reverse Assembly	This signal directs the data channel to reverse the byte positions while receiving a computer word from the 322X.
***Status Bits	The 322X uses eleven status lines to indicate its condition.
***Negate BCD Conversion	Static 1 received by the 322X. This signal disables the automatic internal-to-external BCD conversion during a Write operation in BCD mode. It also disables the automatic external-to-internal BCD conversion during a Read operation in BCD mode. (Used only when the 322X is used by a 3400 or 3600 computer.)
**Suppress Assembly/ Disassembly	Static 1 signal received by the 322X. This signal disables the assembly/disassembly in the 322X. Each word received by the 322X from the data channel writes one 6-bit frame on the tape (upper 6 bits of the data channel word). During Read, the upper 6 bits of the data channel word are all zeros.
***Interrupt Lines	A 1 signal on an Interrupt line indicates a tape handler connected to the 322X has reached a predetermined condition. Each 322X has an Interrupt line corresponding to the setting of the Equipment Number switch.

*Bidirectional signal flow
**Signal flow from the 3206 to the 322X
***Signal flow from the 322X to the 3206

SECTION 3. GENERAL MAINTENANCE PROCEDURE

In the 322X system, which includes the 322X and associated tape handlers, the problem may be in the Read/Write control, the logic matrix which gates information to the tape handler, or the tape handler itself. The following steps may be used to localize the problem:

1) Check the tape handler

   a) Change the switch setting on the tape handler and use a new Connect code. Try several positions and Connect codes. If the unit now works, the problem is in the switch logic.

   b) Cable another tape handler that is known to be working in place of the suspect tape handler. Remove power from the tape handlers when recabling. If the program runs using the new tape handler, the problem is in the original tape handler.

   c) If the problem still exists, recable the tape handlers to their original positions and continue with step 2.

2) Check the logic matrix

   a) Recable the tape handler to the next higher or lower cable connectors. If the program runs, the problem is in the L and M cards and associated logic that feed the tape unit. If the problem still exists, recable the tape handler and continue with step 3.

3) Check the control logic

   a) If the control won't connect the tape handler, check out the connect logic as shown in the flow chart on page II-3 (Figure 2-2) of this manual.

   b) If the control won't execute a function, check out the function logic as shown in the flow charts on pages II-55 through II-65.

   c) If the control won't Write, check out the Write logic using the sequence of events listed in Section 4 and the timing diagrams on pages II-35, II-37 and II-39.

   d) If the control won't Read, check out the Read logic using the sequence of events listed in Section 4 and the timing diagrams on pages II-45, II-47, II-49 and II-51.

The following table will be helpful in adjusting certain critical delays:

TABLE 3-7. CRITICAL DELAY TABLE

TERM	TITLE	PAGE	DELAY	TAPE SPEED
Y024 Y057	Write ($\overline{LP}$)	8(F24A) 8(G22A)	3.5 ms 7 ms	150 ips 75 ips
Y045	Write Stop	8(F29A)	5 ms	both
Y041 Y058	Write Term. I to II	8(F41A) 8(K08A)	2.6 ms 5.2 ms	150 ips 75 ips
Y064	From Sprocket	11(G23A)	0.2 μsec	both
Y027	Reply Timing	11(K16A)	0.2 μsec	both
Y028	Reply Timing	11(E32A)	0.5 μsec	both
Y067	Reply Timing	11(G28A)	0.2 μsec	both
Y033	Reply Timing	11(E28A)	0.2 μsec	both
Y029	Reply Timing	11(I40A)	0.2 μsec	both
Y031	Reply Timing	11(I38A)	0.2 μsec	both
Y068	Reply Timing	11(E33A)	0.1 μsec	both
Y034	Reply Timing Lockout (800 BPI)	11(E38A)	1.5 μsec	both
Y070	Reply Timing Lockout (556 BPI)	11(L05A)	3.5 μsec	both
Y071	Reply Timing Lockout (200 BPI)	11(L06A)	12 μsec	both
Y038 Y060	200 BPI	11(D21A) 11(K12A)	28 μsec 50 μsec	150 ips 75 ips
Y039 Y061	556 BPI	11(D22A) 11(K13A)	72 μsec 140 μsec	150 ips 75 ips
Y040 Y062	800 BPI	11(D23A) 11(K14A)	20 μsec 40 μsec	150 ips 75 ips
Y037	End of Record	11(D17A)	400 μsec	both
Y009	End of Record signal	7(I33A)	5 μsec	both
Y023 Y056	Write (LP)	8(F23A) 8(G21A)	30 ms 70 ms	150 ips 75 ips
Y042 Y059	Non-Stop Write	8(F23A) 8(K04A)	3 ms 6 ms	150 ips 75 ips
Y047	Read	11(D33A)	1 ms	both
Y046	Read Stop	11(D32A)	3.5 ms	both
Y036	Non-Stop Read	11(E36A)	2 μsec	both
Y044	Lost Data	8(F37A)	1 ms	both

APPENDIX A

TAPE SYNCHRONIZER/CONTROLLER GLOSSARY

Applicable to the synchronizers that control the 603, 604, 606, and 607 tape handlers. It is intended to benefit people who are not completely familiar with these systems as well as to aid in the standardization of synchronizer nomenclature.

Acceleration Time	The time required for the tape handler to reach full tape speed. The 606 requires 3 ms. Preferred Term: Start Time
Assembly	The function of the synchronizer that packs characters from the tape into words to be passed to the computer.
Backspace	One of the motion directive functions of the tape handler. Tape is moved one record length in the reverse direction.
Backward	See Reverse Read.
BCD	See Binary Coded Decimal format.
BCD Conversion	The change from internal BCD format to external BCD format or from external to internal. Internal-to-external converts a character of all zeros to twelve and any time bit 4 equals 1, bit 5 is complemented (bit 4 remains 1). External-to-internal operates conversely. (See Internal BCD.)
Binary Format	One of two format representations used on tape (opposed to BCD). This format is often used when numerical data is being stored. Binary format employs odd parity so that the number "zero" can be recorded on the tape. If even parity were used, the tape handler could not recognize the frame (no sprocket pulse would be generated).
Binary Coded Decimal Format (BCD)	One of two format representations used on tape (opposed to Binary). This format is used when alphanumeric data is being stored. BCD format employs even parity because it is not necessary to write "zero". (Also referred to as Coded format.)
Bit	The binary equivalent of a decimal digit.

Bit Density	Commonly-used term for the number of tape frames per inch (BPI). It does not really mean the total number of bits per inch, but rather the number of bits on one of the tracks. Preferred Term: Frames Per Inch
Block	One group or record of data. Preferred Term: Record
Buffer	A register to hold information temporarily while it is in transit between pieces of equipment that operate at different transfer rates or word lengths.
Busy	The state of the tape handler and a corresponding signal when tape is in motion.
Byte	A group of bits, usually part of a larger word. Usually refers to a bi-octal character (6 bits) in tape nomenclature.
Change-On-Ones	Method of representing information on tape. The magnetic polarity of each channel is changed if a 1 is to be written. If a 0 is to be written, the polarity remains unchanged.
Channel	See Track
Character Density	The number of 6-bit characters written on one inch of tape (Commonly termed bits per inch)
Character Mode	The method of writing one tape frame from each computer output word regardless of the length of the computer word. During a Read, an input word is sent to the computer for each frame (other characters in the input word are packed with zeros). Suppress Assembly/Disassembly is the term used to describe character mode in 3000 Series operation.

Check Character	A frame written on the tape at the end of a record to make an even number of bits in each channel. In effect, a longitudinal parity frame using even parity.
Check Character Counter	A counter used to space the check character gap.
Check Character Gap	The three blank frames between the end of a record and the check character.
Coded	See Binary Coded Decimal format.
Connect	The selection of the synchronizer and the tape handler as the equipment to be used by the computer.
Control	Used to name one of the independent bi-direction controllers (synchronizers) in a multi-controller device such as in the 342X or 362X. (The 342X Controller has two independent controls.)
Controller	The interface between the computer (or data channel) and the tape handler. It provides the following functions: (1) selection circuits, (2) tape motion control, (3) Assembly/Disassembly, (4) timing control, (5) format control, and (6) parity checking. (Often referred to as a synchronizer.)
Deceleration Time	The time required for the tape handler to stop tape motion. The 605 requires 2 ms. Preferred Term: Stop Time
Density	The rate of characters per inch of tape (200, 556, or 800).
Direct Transfer	The 926 and 1615 synchronizers have satellite capabilities which permit two computers to communicate directly.

Disassembly	The function of the synchronizer that converts a computer output word into 6-bit characters to be written on tape.
Electronic Switch	Term used in the 362X to describe the control and tape handler selection circuits.
End-Of-File Mark	A one-character record (including its check character) of "17" written with even parity used to aid in addressing areas on tape. Usually, various records between two file marks are considered one file. Six inches of blank tape (file mark gap) precede the file mark.
End-Of-File Mark Gap	The blank six inches of tape between a file mark and the check character from the previous record.
End Of Operation	The state that exists in the synchronizer when the tape handler has signalled an End of Record while the computer is still requesting input.
End Of Record	The state that exists when the Read circuits sense a blank gap on the tape following a record of data.
End Of Tape	A marker on the tape indicating the end of useable recording area. The marker is sensed by photocells.
Equipment Selection Switch	A switch on the tape handlers and some of the synchronizers which is manually set to determine the address that will select the unit.
Erase Head	A tape head that physically precedes the Write head on the tape handler. It is used to erase any previous recording in preparation for a new Write.
Error Detection	The combination of checking transverse and longitudinal parity.

External BCD	See Internal BCD.
File	The various records between File Markers or between the Load Point and the first File Mark or between the last File Mark and the End of Tape.
File Protection Ring	A plastic ring inserted in the supply reel of the tape handler that must be present for the Write circuit to operate. When the ring is not inserted, the recorded data cannot be erased.
Flag	A programming convenience employed by the synchronizers that have the Satellite feature. It permits the computers to operate together more efficiently by being able to signal each other.
Format	In general, the selectable difference in recording modes (Parity, Density, Assembly/Disassembly). Sometimes used to designate Parity mode only.
Function Code	Computer I/O codes used to activate selection and operation of the tape system.
Function Lockout	A lockout that prevents a new function code or the I/O line from being recognized by the synchronizer until the present selection no longer requires synchronizer control.
Holding Register	A buffer register that temporarily stores the input word to the computer. It permits better synchronization between the tape handler and the computer.
Horizontal Parity	See Check Character. Preferred Term: Longitudinal Parity
Input	The Read word delivered to the computer.

Internal BCD	The method of alphanumeric representation used internally in the computer. It is an easier representation for the computer to use than external BCD, since the numeric equivalents of the alphabet go in ascending order and are therefore easier to sort (A = 21, J = 41 rather than A = 61, J = 41). See BCD conversion. The 3000 Series synchronizers can perform the conversion automatically.
Interrupt	A system that permits the synchronizer to signal the computer if a predetermined condition occurs.
Least Significant Byte (Character)	In a 12-bit word (0 through 11), bits 0 through 5 are the least significant.
Length Error	A condition in the 925, 926 and 1615 synchronizers which occurs if the number of frames on tape is not a multiple of characters in the computer word.
Load Point	A marker placed on the tape to indicate the beginning of the usable portion. It is sensed by photo circuits in the tape handler.
Longitudinal Parity	See check character.
Lost Data	A condition that can exist in the 3000 Series synchronizers during Write if the Write signal is present, but the Data signal does not appear for the length of time required to write two frames. During Read, the condition exists if the Read signal is present but the Data signal does not appear at the time to send the data channel the Reply signal.
Most Significant Byte (Character)	In the 12-bit word (0 through 11), bits 6 through 11 are the most significant.
Motion Directives	The Function codes which move tape but do not transfer data. They are used to position tape.

Negate BCD Conversion	A signal from the 3000 Series data channel instructing the synchronizer not to perform the internal-to-external BCD conversion or vice versa.
Non Return To Zero	See Change-On-Ones.
Nonstop	The mode of operation in which repetitive Read or Write functions are received by the synchronizer so soon after the previous function that tape motion does not stop between functions.
Off-Line	The mode of operation in which some piece of equipment other than a computer furnishes the synchronizer control.
On-Line	Opposed to Off-Line. Control of the synchronizer by a computer I/O channel.
160 Mode	The mode of operation in a 926 or 1615 synchronizer in which control is furnished by 160- Type I/O signals.
Output	The data the computer writes on tape.
Parity Bit	The bit generated by the synchronizer so that each Write frame consists of an even or odd number of bits (depending on the Parity mode). In I/O transfers in the 3000 Series, a parity bit is generated by each of the transmitting equipments to check transmission accuracy.
Parity Check	The synchronizer generates a new parity bit for each frame and compares it with the recorded parity bit during a Read and Write Reply. Longitudinal parity is checked at the end of each Record Read. The 3000 Series equipment also checks the transmission parity bit for each word received from the data channel.

Program Control	One of three modes of operation of the 926 and 1615 synchronizers (160 mode and 1604 mode are the others). This mode permits the 1604 mode computer to control the tape operation of the 160 mode computer and to perform the Satellite direct transfer.
Program Error	Certain program errors will generate this condition in the 160, 924 and 1604-type synchronizers. In the 3000 Series synchronizers, the Internal Reject feature eliminates the need for this condition.
Pseudo Code	The code the synchronizer receives during an off-line operation. It is not a true computer I/O code, but a code the controlling piece of equipment generates to simulate a computer I/O code.
Read	The transfer of data from the tape to the I/O channel via the tape handler and synchronizer.
Read Control	The circuits in the synchronizer that control a Read operation. Specifically, the Read Control FF.
Read Head	The tape head that senses data recorded on tape.
Read Motion	The circuits in the synchronizer that control tape motion during a Read.
Read Reply	See Write Reply.
Read Sprocket	The signal to the synchronizer from the tape handler indicating that a frame of data has been read and is on the input line. The signal is generated by the tape handler after sensing at least one bit of data in a frame.

Record	A group or burst of frames recorded continuously. A record is terminated by leaving three frames blank followed by a check character. A record is started by moving tape approximately 3/4" from the previous check character before writing the new record.
Reflective Spot	A marker fastened on tape to indicate the Load Point and the End of Tape. The tape handler senses these spots with photo cells. It is possible to have more than one Load Point on the tape.
Release	A mode of operation in the 3000 Series synchronizers which clears the connection to a particular tape handler, but reserves it for later use (a different control cannot connect to that tape handler).
Reserve	See Release.
Reverse Read	A mode of operation of a 604 or 607 tape handler in which a record can be read backward. The synchronizer assembles the character from the tape in reverse order.
Rewind	A method of operation in which tape is moved backward at a high rate of speed to its Load Point.
Rewind Unload	A method of operation in which tape is moved backward at a high rate of speed until all of the tape is off the takeup reel. New tape operation is possible only after tape is reloaded manually.
Satellite	A feature of the 926 and 1615 synchronizers which permits data transfer between two computers.
Search Backward	A motion directive function which moves tape backward to the nearest File Mark. If no File Mark is present, tape will not stop until completely off the takeup reel.

Search Forward	A motion directive function which moves tape forward to the nearest File Mark. If no File Mark is present, tape will not stop until completely off the supply reel.
Select	The operation that connects the synchronizer and tape handler to the computer and sets up the control necessary for the desired operation.
Sense	The method employed by the 924 and 1604 to determine the conditions in the synchronizer and tape handler. A predetermined Function code is sent to the synchronizer. If the particular condition this code is asking about is present, the synchronizer sends the computer a Sense Response signal.
Simultaneous Off-Line	A feature of the 162 and 925 synchronizers which permits a 166-2 Line Printer to control one tape handler at the same time the other tape handlers in the system are available for use on-line by the computer.
1604 Mode	One of the three modes of operation (160 mode and Program Control mode are the others) in a 926 or 1615 synchronizer in which control is furnished by 1604-type I/O signals.
Skew	The tape handler problem of the bits in a frame not being in a straight line perpendicular to the tape.
Skip Bad Spot	A motion directive function which moves tape approximately 3.5 inches.
Start Time	The time required for the tape handler to reach full tape speed. The 606 requires 3 ms.
Stop Time	The time required for the tape handler to stop tape motion. The 606 requires 2 ms.

Status Lines	The method employed by the 3000 Series computers to determine the conditions that exist in the synchronizer and tape handler. Each of the twelve status lines generates a signal that the computer may sense whenever the condition inherent to that line is present.
Status Request/Response	The method employed by the 160 computers to determine the conditions that exist in the synchronizer and tape handler. Whenever the computer issues a Status Request code, the synchronizer inputs a Status Response code. The computer then interprets the code for the predetermined conditions.
Supply Reel	The right-hand reel of tape when facing the tape handler. This reel initially holds the tape which is wound off during forward tape motion.
Suppress Assembly/Disassembly	See Character Mode.
Synchronizer	The interface between the computer (or data channel) and the tape handler. See Controller.
Take-up Reel	The left-hand reel when facing the tape handler. This reel accepts the tape during a forward tape operation.
Tape Handler	A device that uses magnetic tape. The 603, 604, 606 and 607 are tape handlers.
Tape Speed	The speed at which tape moves past the recording heads. The tape speed of the 603 and 604 is 75 inches per second; the 606 and 607 is 150 inches per second.
Tape System	The synchronizer and the various tape handlers which it controls.
Tape Transport	See Tape Handler.

Tape Unit	See Tape Handler.
Track	One of the discrete areas on tape on which corresponding bits of each frame are written. (Bit 4 of each frame is written on the same track). Often referred to as Channel.
Transfer Rate	See Character Rate.
Transmission Parity Checker	The circuit in the 3000 Series synchronizers that checks the accuracy of the parity bit received with each output word.
Transverse Parity	The parity bit (even or odd) which is included with each 6 bits of data recorded in a 7-bit frame.
12 → 0	See BCD Conversion.
Vertical Parity	See Transverse Parity.
Word	In I/O use, the data received by or transmitted to the computer or the data channel by the synchronizer.
Write	The transfer of data from the computer or data channel to the synchronizer, tape handler and tape.
Write Control	The circuits in the synchronizer which control a Write operation. Specifically, the Write Control FF.
Write Enable	The signal which permits a Write operation. The signal is generated by the presence of the file protection ring.
Write Head	The tape head which writes on the tape.
Write Register	The register in the synchronizer that converts binary characters to Change-On-Ones representation. See Change-On-Ones.

Write Reply	Each frame that is written on tape is read back to the synchronizer. The synchronizer then checks the parity to insure that the frame was written correctly.
Write Sprocket	The signal the synchronizer sends the tape handler with each frame of data to be written on tape. This signal allows the synchronizer to control the density of tape recording.
Write Termination	The cycle of operation that insures when output from the computer ceases. It consists of the following steps: (1) Check character gap, (2) Write check character, (3) Reception of End of Record from Write Reply.
0 → 12	See BCD Conversion.

APPENDIX B

3228/3229 OPERATION IN A 3400 OR 3600 SYSTEM

The 3228/3229 Controller is compatible with a 3400 or 3600 system. To achieve this compatibility, an external/internal BCD conversion feature is included in the controller.

If writing in BCD mode is selected: any time a 1 appears in the 5th bit, the 6th bit is complemented and the 5th bit remains unchanged. This changes internal BCD to external BCD.

If reading in BCD mode is selected: any time a 1 appears in the 5th bit, the 6th bit is complemented and the 5th bit remains unchanged. This changes external BCD to internal BCD.

If the controller receives the Negate BCD signal from the data channel, the above conversion does not take place.

APPENDIX C

3228/3229 PARTS LIST

INTRODUCTION

This parts list provides the identification and ordering data necessary for the replacement of electrical and mechanical parts for the CONTROL DATA 3228/3229 Magnetic Tape Controller.

Electrical Contents: All chassis items are included except jumper wires and wire.

Hardware Contents: All chassis and Fire Protection Kit items are included except standard hardware such as screws, nuts, bolts, washers and raw material.

The chassis and Fire Protection Kit assemblies are broken down into individual parts (with the exception of printed circuit card assemblies) but are listed in alphabetical rather than disassembly order.

The 3228/3229 is placed in the C-Type cabinet and uses different power supplies depending on the application. Listed below are the manuals in which the cabinet and power supplies are parts-listed.

Control Data Peripheral Controller Cabinets Customer Engineering Instruction Manual	Pub. No. 60097300
Cabinet Parts Lists	Appendix A
Power Supply Assembly Parts List (Control Data power supplies and all Control Data modifications to Vendor power supplies)	Appendix B
Ault Power Supply Parts List	Pub. No. 60107300

ORDERING OF PARTS

When ordering Control Data parts, include the following information: Control Data drawing number, description, quantity needed, equipment used on.

When ordering vendor parts, use the procedure indicated by that vendor.

3228/3229 Magnetic Tape Controller
CDC Dwg. No. 25150501, 25150502
(Items and quantities are common to the 3228 or 3229)

PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
30010600	Bar, mounting, connector	
30507200	Bar, mounting, switch panel	
00857102	Bearing, sleeve, flanged, nylon	
30008700	Bracket, angle, chassis frame	
30116600	Bracket, mounting shield, connector panel	
30506500	Bushing, sleeve, control-switch	
30002201	Capacitor, fixed, electrolytic; 10-10 MFD, 50 WVDC	
31631101	Card placement (for 3228)	
31631102	Card placement (for 3229)	
24530205	Clamp, cable	
30093502	Clip, spring tension	
24530101	Connector, plug, 5 socket	
30000400	Connector, plug, 61 pin	
30094406	Connector, receptacle, 10 socket, blue	
30094402	Connector, receptacle, 10 socket, red	
30092710	Connector, receptacle, 20 socket	
24512001	Connector, receptacle, 24 socket	
30000100	Connector, receptacle, 30 socket	
30000901	Connector, receptacle, 61 socket	
25176801	Connector, receptacle, wired, 24 socket, 1A1	
25176802	Connector, receptacle, wired, 24 socket, 1B1	
25176803	Connector, receptacle, wired, 24 socket, 1C1	
25176804	Connector, receptacle, wired, 24 socket, 1D1	
25176805	Connector, receptacle, wired, 24 socket, 1E1	
25176806	Connector, receptacle, wired, 24 socket, 1F1	
25176807	Connector, receptacle, wired, 24 socket, 1G1	
25176808	Connector, receptacle, wired, 24 socket, 1H1	
25176809	Connector, receptacle, wired, 24 socket, 1A2	
25176810	Connector, receptacle, wired, 24 socket, 1B2	
25176811	Connector, receptacle, wired, 24 socket, 1C2	
25176812	Connector, receptacle, wired, 24 socket, 1D2	
25176813	Connector, receptacle, wired, 24 socket, 1E2	
25176814	Connector, receptacle, wired, 24 socket, 1F2	
25176815	Connector, receptacle, wired, 24 socket, 1G2	

PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
25176816	Connector, receptacle, wired, 24 socket, 1H2	
25176701	Connector, receptacle, wired, 61 pin, 1J1	
25176702	Connector, receptacle, wired, 61 socket, 1J2	
25176703	Connector, receptacle, wired, 61 socket, 1K1	
25176704	Connector, receptacle, wired, 61 socket, 1K2	
30506901	Control-switch assembly	
30503501	Control-switch, wired	
30093614	Cover, terminal board, 14 holes	
24554902	Enclosure, terminator assembly	
30603101	Frame, member, chassis, bottom	
30602900	Frame, member, chassis, side	
30603102	Frame, member, chassis, top	
00839607	Grommet, rubber, 9/16 ID	
30104300	Guide, thumbscrew, connector panel	
30104800	Hinge, Input/Output, connector panel	
00856101	Knob, black	
00854100	Knob, terminator assembly	
30507000	Knob, control-switch	
24510201	Lamp, incandescent, clear, 28v, 10 amp	
24510202	Lamp, incandescent, 28v, 10 amp, red	
30002409	Light, indicator, incandescent, white	
00838200	Nut, "U" type, sheet spring	
25166400	Overlay, control panel	
25166301	Panel, control	
30104400	Pin, straight, threaded, connector panel	
25164803	Plate, chassis filler	
30010101	Plate, designation, narrow (01-23)	
30010900	Plate, designation, narrow (24-44)	
30008401	Plate, designation, wide (01-23)	
30008300	Plate, designation, wide (24-44)	
24548101	Plate, identification	
30506200	Plate, mounting, control-switch	
30506100	Plate, mounting, lampholder	
30001400	Plate, mounting, terminator assembly	
30103800	Plate, retaining, cable	

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PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
25170300	Plate, retaining, 8 connector	
25166501	Plate, retaining, 16 connector	
00843513	Ring, retaining, .207" ID	
30004600	Rubber, chassis seal, special section	
30001900	Shield, connector, terminator assembly	
25166600	Shield, connector	
30113702	Shield, terminator assembly	
24510100	Socket, bayonet, clip mounted	
30013801	Spacer	
30010700	Spacer card, module (01-44)	
30104200	Spring, helical, compression, connector panel	
25167000	Strip, chassis filler	
30103900	Stud, extension	
30506300	Stud, extension, control-switch assembly	
30104600	Support, connector panel	
24526700	Terminal Block, 20 contact	
30001202	Terminator assembly, resistor	
30095400	Termination strip	
00856604	Thumbscrew, 1/4 x .245 #6-32NC	
30001400	Washer, flat, terminator assembly	
31630201	Wire Tabulation, cable	
31631301	Wire Tabulation, chassis	
31631000	Wire Tabulation, switch and switch panel	

Printed circuit card assemblies
3228/3229

PARTS LIST

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
30908201	Printed circuit card assembly, Type CA21	
30911001	Printed circuit card assembly, Type CA28	
30921801	Printed circuit card assembly, Type CA55	
30924201	Printed circuit card assembly, Type CA61	
30924601	Printed circuit card assembly, Type CA62	
30929001	Printed circuit card assembly, Type CA73	
30929801	Printed circuit card assembly, Type CA75	
30930201	Printed circuit card assembly, Type CA76	
30931801	Printed circuit card assembly, Type CA80	
30932201	Printed circuit card assembly, Type CA81	
30932601	Printed circuit card assembly, Type CA82	
30933001	Printed circuit card assembly, Type CA83	
30935401	Printed circuit card assembly, Type CA89	
30942601	Printed circuit card assembly, Type HA06	
30943001	Printed circuit card assembly, Type HA07	
30948201	Printed circuit card assembly, Type HA20	
31700201	Printed circuit card assembly, Type K11	
31700601	Printed circuit card assembly, Type K12	
31701001	Printed circuit card assembly, Type K13	
31701401	Printed circuit card assembly, Type K14	
31701801	Printed circuit card assembly, Type K16	
31702201	Printed circuit card assembly, Type K17	
31702601	Printed circuit card assembly, Type K22	
31703001	Printed circuit card assembly, Type K24	
31703401	Printed circuit card assembly, Type K25	
31703801	Printed circuit card assembly, Type K26	
31704201	Printed circuit card assembly, Type K27	
31704601	Printed circuit card assembly, Type K29	
31709401	Printed circuit card assembly, Type K31	
31705001	Printed circuit card assembly, Type K32	
31709801	Printed circuit card assembly, Type K33	
31710201	Printed circuit card assembly, Type K35	
31706601	Printed circuit card assembly, Type K51	

Printed Circuit Card Assemblies
3228/3229

PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
31707001	Printed circuit card assembly, Type K58	
31708601	Printed circuit card assembly, Type K67	
31710601	Printed circuit card assembly, Type K68	
31711001	Printed circuit card assembly, Type K69	
31709001	Printed circuit card assembly, Type K71	
31707401	Printed circuit card assembly, Type K72	
31707801	Printed circuit card assembly, Type K92	
31708201	Printed circuit card assembly, Type K93	
	Fire Protection Kit CDC Dwg. No. 30119601	
30119601	Fire Protection Kit	
30119501	Cover, Screen, Upper Front Trim	
30119400	Retainer, Screen, Top	
30119300	Screen, Cover, Cabinet, Top	

FORM CA 108

CUT ALONG LINE

COMMENT SHEET

CONTROL DATA 3228-A/3229-A MAGNETIC TAPE CONTROLLER
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