CONTROL DATA® 3228-A/B, 3229-A/B
magnetic tape controllers

Reference Manual

REVISION RECORD

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Control Data Corporation
Technical Publications Department
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PREFACE

This publication contains reference information for CONTROL DATA® 3228-A/B, 3229-A/B Magnetic Tape Controllers which may be used in conjunction with standard Control Data 3000 series data channels. The reader should be familiar with characteristics of the 3000 series data channels.

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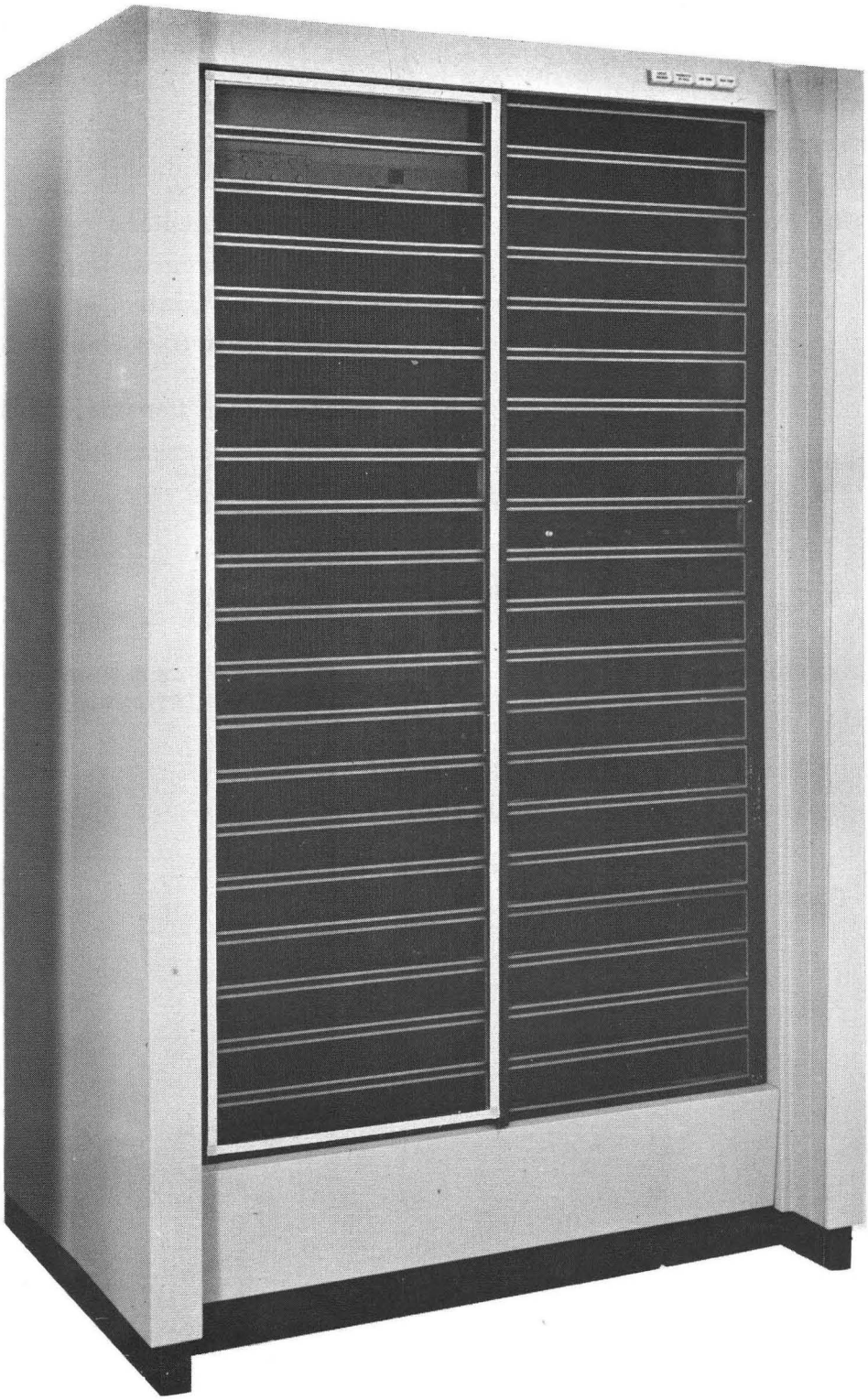

322X MAGNETIC TAPE CONTROLLER

3228-A/B, 3229-A/B MAGNETIC TAPE CONTROLLERS

The CONTROL DATA* 3228/3229 Magnetic Tape Controllers facilitate high-speed transfer of data between CONTROL DATA 603 and 604 or 606 and 607 Magnetic Tape Transports and a standard 3000 Series data channel. These controllers may be used in any 3000 Series system. (See Figure 1.)

This manual describes the disassembly of data received from the data channel and the assembly of data received from a tape unit. It also describes the Connect, Function, and Status codes and provides pertinent programming information.

FUNCTIONAL DESCRIPTION

The 322X Controller has one read/write control. The control may be physically attached to one 3000 Series data channel. This channel, through its control, can communicate with any attached tape unit.

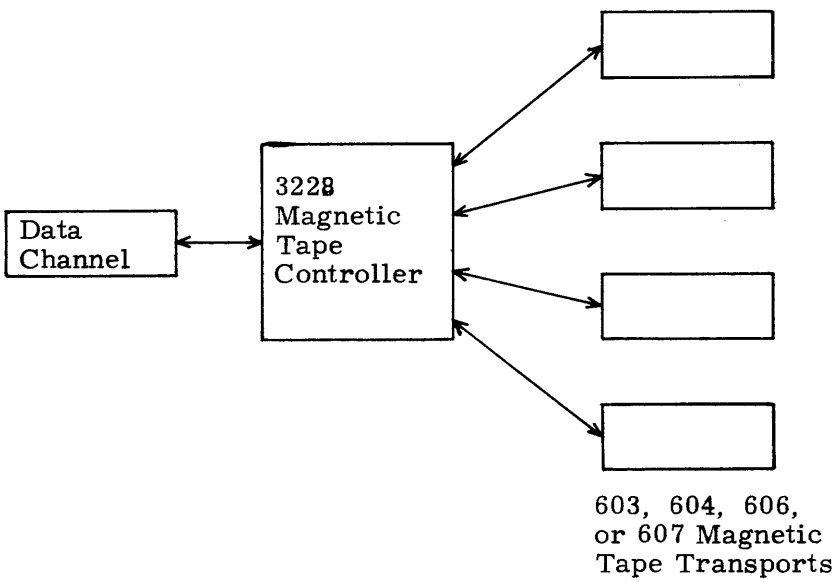

Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation

**The program must be adapted if 603 and 604 Tape Units are mixed or if 606 and 607 Tape Units are mixed. 603/604 Tape Units may not be mixed with 606/607 Tape Units.

The 3228 Controller can control one to four magnetic tape transports (tape units); the 3229 Controller can control one to eight tape units.

TAPE UNIT DESIGNATION

Each tape unit must have a unique numerical designation (0 - 7) that is determined by a Unit Select switch.* When the numerical designation of a unit is changed, any existing connection and/or reservation is cleared.

ASSEMBLY/DISASSEMBLY

During Write operations, each control receives data from its data channel in 12-bit bytes (i.e., 12 bits of data are received simultaneously on 12 data lines). A tape unit, however, can handle only one 6-bit character at a time. The control, therefore, must disassemble each byte into two characters. The character comprised of the upper 6 bits is transmitted to the tape unit first, followed by the lower 6 bits.

This disassembly is automatically suppressed when a 3100/3200 Character Output instruction (OUTC or OTAC) is executed. In this case, only the lower 6 bits of the data byte are transmitted to the tape unit. The controller ignores the upper 6 bits of the byte.

During Read operations, the tape unit transmits 6-bit characters to the control. The control assembles two successive characters into a single byte for transmission to the data channel. The first character received comprises the upper 6 bits of the byte, and the next character comprises the lower 6 bits.

This assembly is automatically suppressed when a 3100/3200 Character Input instruction (INPC or INAC) is executed. In this case, each character received from the tape unit is transmitted to the data channel as the lower 6 bits of the byte. The upper 6 bits are all zeros.

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*Located on the tape unit

BCD/Binary Modes

Data may be written on or read from tape in either BCD (binary coded decimal) or Binary mode. Data is processed in Binary mode following a clearing operation or the selection of Binary mode. It is processed as BCD following the selection of BCD mode. A code of all zeros is considered illegal if the controller is in BCD and the computer is operating in 1604 mode.

1604 Mode*

Normally, during a Write operation in BCD mode, the controller automatically changes any character of all "0's" and writes it as 12_8 on tape. When reading a 12_8 from tape in BCD mode, the controller changes it to a character of all "0's". If bit 4** is a 1, bit 5 is complemented during Read and Write operations (bit 4 remains unchanged). This process converts internal BCD codes to external BCD codes when writing and vice versa for reading.

If the computer is running in 1604 mode, the conversion from internal BCD to external BCD does not apply during a Write operation. Similarly, the conversion from external BCD to internal BCD does not apply during a Read operation.

Record/File Formats

The data written on tape as the result of a single Output instruction constitutes a record. If 3100/3200 Character Output instructions are used, a record may be as short as a single character. Adjacent records are separated by a record gap.

A file consists of one or more records. Its length is determined by the programmer. Adjacent files are separated by a file mark which a tape unit writes in response to a function code (Write File Mark).

*3600/3800 systems only

**Bit 0 is the right most bit of the character to be written on tape.

An End of Record signal is sent to the data channel during a Read operation when a tape unit detects a record gap or a file mark. This signal may be used to terminate a Read.* The Read operation also terminates when the specified number of words or characters has been read.

Transfer Rates

Read or Write operations may be performed with 607 Tape Units at any one of three densities: 200 characters/inch, 33 microseconds/frame; 556 characters/inch, 12 microseconds/frame; 800 characters/inch, 8 microseconds/frame. With 606 Tape Units only low density (200 characters/inch) and high density (556 characters/inch) are available.

The transfer rate of the 604 Tape Unit is one half that of the 607 Tape Unit, and the rate of the 603 Tape Unit is one half that of the 606 Tape Unit.

The programmer should determine or select density and binary or BCD formats prior to a Read or Write operation.

CONNECT

A control must be connected to its data channel before it can respond to either a Select/Function instruction or an Input/Output instruction. The connection is accomplished by the Connect instruction; the Connect code (N00U) is the lower 12 bits of this instruction. The N portion of the code must contain the equipment number of the controller. The U portion of the code designates one of the eight possible tape units. Each control examines every Connect code transmitted from its attached data channel. A Reply signal,** indicating a connect, is returned to the data channel from a control if:

1) The N portion of the Connect code matches the setting of the Equipment Number switch on the read/write control,
2) The U portion of the Connect code matches the setting of the Unit Select switch on an unreserved tape unit, and
3) A transmission parity error is not detected.

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*In 3100/3200 systems, the End of Record signal always terminates a Read. In 3400/3600/3800 systems, this use of the signal is optional.

**A Reply signal tells the central processor to process the next instruction.

If the N portion of the Connect code does not match the setting of the Equipment Number switch, neither a Reject nor a Reply is returned to the channel from the control. Equipment status is not made available to the channel. If the control is already connected, it automatically disconnects. If neither a Reply nor a Reject is returned to the data channel from any of its attached equipments within 100 microseconds, the central processor generates an Internal Reject.

If the U portion of the Connect code does not match the setting of any Unit Select switch a Reject signal* is returned to the data channel.

If a parity error is detected in a Connect code, the device does not connect** and neither a Reject nor a Reply is returned to the data channel. Instead, the Parity Error indicator of each equipment detecting the error lights. In this equipment, a red indicator in the Equipment Number switch lights. These parity error conditions must be cleared by either a Channel Clear or a Master Clear prior to a new connect attempt.

FUNCTION

Function codes are used to prepare a connected control and/or unit for an Input/Output operation. (They have no effect on unconnected controls or units.) They comprise the lower 12 bits of a Select/Function*** instruction and are transmitted to the control on the 12 data lines. Table C-1 is a complete list of function codes. A detailed description of each code follows the table.

There are three classifications of codes: operating,**** nonoperating, and interrupts. Operating codes cause tape motion. They include Rewind, Rewind Unload, Backspace, Search Forward/Backward to File Mark, Write File Mark, and Skip Bad Spot. Nonoperating codes include Release, Binary, Coded, Densities, Clear, and Set and Clear Reverse Read.

The control accepts operating codes only when the tape is completely at rest. Thus, operating codes are not accepted during a Read or a Write operation or while an operating code is being executed. Likewise, a new Read or Write operation cannot be initiated while an operating code is being executed.

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*A Reject signal tells the central processor to read the next instruction at the reject jump address contained in the Connect instruction.

**If the device is connected, it automatically disconnects.

***Select in 3100/3200 systems, Function in 3400/3600/3800 systems

****Operating codes cause the control to become Busy.

Nonoperating codes are accepted prior to a Read or Write operation, following the conclusion of a Write, and following the receipt of an End of Record signal during a Read. Thus, they are accepted even though an operating code is being executed.

Interrupt codes are never rejected.

A control examines only one code at a time. First, it checks for parity errors. If none are found, it returns a Reply if the requested function can be performed* or a Reject if it cannot be performed. Interrupt codes always cause a Reply to be returned to the channel.

If a parity error is detected, the requested function is not performed, a Parity Error signal is returned to the data channel, and a red indicator in the Equipment Number switch lights. Since neither a Reply nor a Reject is returned to the data channel, the central processor generates an Internal Reject after a wait of 100 microseconds.

These parity error indications must be cleared by either a Channel Clear or a Master Clear. The equipment must then be reconnected before a new function code is examined by the controller.

INTERRUPTS

Interrupts provide a means for attaining optimum utilization of a system's capabilities. Basically, the system interrupts (halts) the main program and initiates an interrupt processing program** when an Interrupt signal is detected by the processor.

The 322X Tape Unit can be programmed to send an Interrupt signal to the processor when any one of the conditions specified by the three Interrupts*** occurs.

A Select Interrupt code permits the controller to consider as a group**** several of the operating conditions which may occur in an attached unit. If a specific interrupt has been selected and if at least one of the conditions specified by it occurs in the connected unit, the controller sends an Interrupt signal to the processor. If the interrupt system

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*Certain illegal Function codes cause a Reply to be returned. However, in these cases no action follows.

**See the system reference manual for the addresses pertinent to interrupt processing.

***See explanation of function codes following Table 1 for a list of these conditions.

****See description of function codes following Table 1 for a breakdown of the three possible groups.

in the processor has been set to recognize the interrupt, the main program is interrupted and control is transferred to a specific program address. Status sensing and followup operations may follow. If desired, control may be returned to the main program by an appropriate Jump instruction located at the close of the interrupt processing program.

If the processor's interrupt system has not been enabled, it is still possible to sense for these conditions via Sense Status and Copy Status instructions written into the main program.

Regardless of which of the above actions is followed, the Interrupt signal remains up until cleared by reselecting the interrupt, selecting release, or master clearing the system. The Interrupt signal is transmitted on the equipment's interrupt line via the data channel, whether or not the channel is currently serving the equipment.

The eight-position (0-7) Equipment Number switch determines the number of the line on which the Interrupt signal is transmitted. For example, if the Equipment Number switch is set at 5, all Interrupt signals coming from this control are transmitted on interrupt line 5. Since each equipment attached to a data channel has a unique equipment number, each uses a different interrupt line. A Channel Product Register Jump instruction* or a Copy Status instruction** can identify the equipment sending the Interrupt signal by inspecting the interrupt lines.

STATUS

Status codes permit the monitoring of several control/unit operating conditions. These codes are made available to the data channel over 12 status lines following a connect or a rejected connect attempt. Sense Status and Copy Status instructions make these codes available to the central processor.

See Table 1 for a complete list of these codes. If two or more conditions exist simultaneously, the Status Response code is the sum of the individual codes. A detailed description of each code follows the table.

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*3600/3800 systems

**3100/3200/3400 systems

PARITY CHECKING

Transmission Parity Checking

Connect codes, function codes, and data are transmitted between the data channel and the controller in odd parity (i.e., the number of "1" bits transmitted must be odd). If the number of "1" bits in a data byte is even, a "1" is transmitted on the parity line to make the total number of "1" bits odd.* If the number of "1" bits in the data byte is odd, the "1" is not transmitted on the parity line.

A transmission parity error exists if the total number of "1" bits transmitted on the 12 data lines plus the parity line is even, indicating that a bit has been lost or picked up.

Parity Error in a Connect Code: If a parity error is detected in a Connect code, the device does not connect** and neither a Reject nor a Reply is returned to the data channel. Instead, the red indicator in its Equipment Number switch of each equipment detecting the error lights. These parity error conditions must be cleared by either a Channel Clear or a Master Clear prior to a new connect attempt.

Parity Error in a Function Code: If a parity error is detected, the requested function is not performed, a Parity Error signal is returned to the data channel, and a red indicator in the Equipment Number switch lights. Since neither a Reject nor a Reply is returned to the data channel, the central processor generates an Internal Reject after a wait of 100 microseconds. These parity error indications must be cleared by a Channel Clear or a Master Clear.*** The equipment must then be reconnected before a new function code can be examined by the controller.

Parity Error in Output Data: If a transmission parity error is detected during a Write operation, the control lights a red indicator in its Equipment Number switch and sends both a Reply and a Parity Error signal to the data channel. The data is written on tape. All operations continue**** unless appropriate programming steps have been taken to

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*Do not confuse this line with the parity error line.

**If the device is connected, it automatically disconnects.

***Though operations may continue normally, the validity of a new function code and/or data prior to a Master Clear or Channel Clear is questionable.

****The validity of the data received from this point until a Channel Clear or Master Clear is questionable.

sense for a Parity Error signal and rewrite the data. These parity error indications must be cleared by either a Channel Clear or a Master Clear. The equipment must then be reconnected and the appropriate functions reselected prior to the new output.

Parity Errors in Input Data: Transmission parity errors may be detected by the data channel on data received from the equipment. If a parity error is detected, a parity error bit in the data channel is set and a Parity Error indicator on either the channel or console lights. The faulty data is entered into either core storage or the A register. All operations continue* unless appropriate programming steps have been taken to sense for the set bit and reread the data. These parity error indications may be cleared by a Channel Clear or a Master Clear issued by any 3000 Series system and by a new Read or Write from a 3100/3200 system. Following a Channel Clear or a Master Clear, the equipment must be reconnected and the appropriate functions reselected prior to a new input.

Input/Output Parity Error Bit in the Data Channel: The input/output parity error bit is set whenever a transmission parity error is detected. If the error is detected by the external equipment, the bit is set by the Parity Error signal.

In 3400/3600/3800 systems, if the interrupt system is active, an Interrupt signal is generated when this bit sets. If the interrupt system has not been set to detect the setting of this bit, the bit may be sensed to detect parity error conditions.

In 3100/3200 systems, the bit must be sensed if transmission parity error conditions are to be detected by the central processor.

Refer to the appropriate system reference manual for more information on the input/output parity error bit.

Equipment Parity Checking

Each character, whether BCD or Binary, transmitted between a control and a unit is checked for correct parity. For BCD characters, correct parity is even, and for Binary characters, it is odd. During a Write operation, the control adds the correct

*The validity of the data received from this point until the indicators are cleared is questionable.

parity bit to each character and relays it to the tape unit. Approximately 2 or 3 milliseconds* after writing, a vertical parity error check is made. This time interval is used to check-read the tape and transmit the data back to the control. At the conclusion of a record, a record check character is written.

This character is used for longitudinal parity checking. During a Read, vertical and longitudinal parity checks are made by the control when the appropriate data is received.

Both vertical and longitudinal parity errors are considered equipment parity errors.

Vertical Parity Error Checking: A vertical (transverse) parity error exists when the number of "1" bits on the six data lines plus the parity line is not correct. The number of "1" bits must be odd for binary data and even for BCD data.

If a vertical parity error is detected, the Vertical Parity Error indicator on the control lights and a Parity Error signal is placed on the appropriate status line. These parity error indications may be cleared by a new Read, Write, Channel Clear, or Master Clear. If desired, this condition may cause an Abnormal End of Operation interrupt.

Longitudinal Parity Error Checking: Longitudinally (lengthwise), the tape is divided into seven tracks. Six of these are used to store data, and the seventh holds the vertical parity bits. When a record is written on or read from tape, the total number of "1" bits in each track must be even. If the number of "1" bits in any track of a record is odd, a "1" is written in that track as a part of the record check character. During a Read operation, a longitudinal parity error exists if the record check character is not as anticipated.

If a longitudinal parity error is detected, the appropriate Longitudinal Parity Error indicator(s) remains lighted,** and a Parity Error signal is placed on the appropriate status line. These parity error indications may be cleared by a new Read, Write, Channel Clear, or Master Clear. If desired, this condition may cause an Abnormal End of Operation interrupt.

*Two milliseconds for 606/607 Tape Units, 3 milliseconds for 603/604 Tape Units

**These indicators may flash on and off during normal operations. Such flashings are to be ignored.

CODES

All connections and operations are controlled by 12-bit Connect and function codes in conjunction with the appropriate Connect or Select/Function instruction. Status codes are constantly available while the equipment is connected. In all discussions of codes, bit 0 is in the rightmost position (see Table 1).

TABLE 1. CONNECT, FUNCTION AND STATUS CODES

Connect	
Connect Tape Unit	N00U*
Function	
Release	0000
Binary	0001
Coded	0002
556 BPI	0003
200 BPI	0004
Clear	0005
800 BPI**	0006
Rewind	0010
Rewind Unload	0011
Backspace	0012
Search Forward to File Mark	0013
Search Backward to File Mark	0014
Write File Mark	0015
Skip Bad Spot	0016
Clear Reverse Read**	0040
Set Reverse Read***	0041
Select Interrupt on Ready and Not Busy	0020
Release Interrupt on Ready and Not Busy	0021
Select Interrupt on End of Operation	0022
Release Interrupt on End of Operation	0023
Select Interrupt on Abnormal End of Operation	0024
Release Interrupt on Abnormal End of Operation	0025

*N=equipment number of read/write control, U=unit number of a specific tape unit

**604 and 607 Tape Units only

***If a Backspace operation is executed when Reverse Read is set, tape is moved in a forward direction. 604 and 607 Tape Units only

TABLE 1. CONNECT, FUNCTION, AND STATUS CODES (Cont'd)

Status	
Ready	XXX1
Channel and/or Read/Write Control and/or Unit Busy	XXX2
Write Enable	XXX4
File Mark	XX1X
Load Point	XX2X
End of Tape	XX4X
Density ("1" in bit 6 indicates 556 BPI, "0" in bits 6 and 7 indicates 200 BPI)	X1XX
Density ("1" in bit 7 indicates 800 BPI)	X2XX
Lost Data	X4XX
End of Operation	1XXX
Vertical or Longitudinal Parity Error	2XXX

CONNECT CODE

Connect Tape Unit (N00U)

This code connects the desired unit. N is the equipment number of the read/write control. U is the unit number of a specific tape unit.

FUNCTION CODES

Release (0000)

This code clears the existing unit connection.

Binary (0001)

This code causes all data to be written/read in binary notation.

Coded (0002)

This code causes all data to be written/read in BCD notation.

556 BPI (0003)

This code causes all data to be written/read at 556 bits per inch density.

200 BPI (0004)

This code causes all data to be written/read at 200 bits per inch density.

Clear (0005)

This code clears the existing unit connection.

*800 BPI (0006)**

This code causes all information to be written/read at 800 bits per inch density.

Rewind (0010)

This code rewinds tape at high speed (400 inches per second) to load point. It has no effect when the tape is at load point.

Rewind Unload (0011)

This code rewinds tape at high speed to load point. It then rewinds tape slowly until all of the tape is on the supply reel. All further operations with this tape unit are locked out until the tape is manually reloaded.

Backspace (0012)

This code backspaces the tape one record or until load point is detected. If the tape is at load point and if fewer than two records precede the load point, it unloads the tape. If Reverse Read is selected,* a Backspace selection initiates forward tape motion.

Search Forward to File Mark (0013)

This code advances the tape until a file mark is detected. If no file marks are detected, tape motion continues until all the tape is on the takeup reel.

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*604 and 607 Tape Units only

Search Backward to File Mark (0014)

This code backspaces tape until a file mark or load point is detected. If the tape is at load point, it backspaces the tape until either a file mark is detected or the tape is unloaded.

Write File Mark (0015)

This code advances the tape at least 6 inches, then writes a 17_8 file mark followed by a 17_8 check character. Both are written in even vertical parity. This file mark is used with both BCD and Binary modes. Writing a file mark does not affect the selected format.

Skip Bad Spot (0016)

This code erases at least 4 inches of tape. Vertical and longitudinal parity checks are made to insure complete erasure.

*Clear Reverse Read (0040)**

This code clears the condition set by the Set Reverse Read code.

*Set Reverse Read (0041)**

This code must precede a Reverse Read operation (see Reverse Read section).

Select Interrupt on Ready and Not Busy (0020)

This code causes the controller to send an Interrupt signal to the processor when the tape unit is in a Ready and Not Busy condition (i.e., when power is applied, the unit is under computer control, and all tape motion has ceased). Once up, the Interrupt signal can be cleared by selecting release (0021) or by clearing the control.

Release Interrupt on Ready and Not Busy (0021)

This code clears an Interrupt on Ready and Not Busy selection and the Ready and Not Busy Interrupt signal if it is up.

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*604 and 607 Tape Units only

Select Interrupt on End of Operation (0022)

This code causes the controller to send the Interrupt signal to the processor when the data channel terminates a Read or Write operation, when a tape unit senses the end of a record during a Read operation, or upon completion of an operating function. Once up, the Interrupt signal remains up until cleared by reselecting the interrupt (0022), selecting release (0023), or clearing the control.

During a chaining operation, * interrupt does not occur until the data channel is Not Busy (i.e., until the last record has been written/read in the chaining operation).

Release Interrupt on End of Operation (0023)

This code clears an Interrupt on End of Operation selection and the End of Operation Interrupt signal if it is up.

Select Interrupt on Abnormal End of Operation (0024)

This code causes the controller to send an Interrupt signal to the processor after an abnormal condition occurs. These abnormal conditions are End of Tape, File Mark, ** Load Point,** Vertical Parity Error, Longitudinal Parity Error, Lost Data, parity error during a Skip Bad Spot operation, and connected tape unit becoming Not Ready.

In all but the last case, the interrupt occurs when one or more of these conditions are encountered and when an end of record check character is written/read by the tape unit. In the case of interrupt on connected tape unit becoming Not Ready, interrupt occurs immediately when the connected tape unit goes from a Ready to a Not Ready condition (e.g., if the power is turned off on the tape unit). Interrupt on connected tape unit becoming Not Ready does not occur during a Connect operation or when a Release code (0000) is executed.

A new Read/Write operation cannot start until the Interrupt signal is cleared. Once up, the Interrupt signal can be cleared by reselecting the interrupt (0024), selecting release (0025), or a Master Clear.

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*3400/3600/3800 systems only

**Common to Interrupt on End of Operation and Interrupt on Abnormal End of Operation

Release Interrupt on Abnormal End of Operation (0025)

This code clears an Interrupt on Abnormal End of Operation selection and the Abnormal End of Operation Interrupt signal if it is up.

STATUS CODES

Ready (XXX1)

Bit 0 is set when the tape unit is in a Ready condition (i.e., power is applied and the ready switch is lighted). (The tape controller can operate the unit.)

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

If the tape unit is Ready, bit 1 is set when the channel is transmitting or receiving data during an Input/Output operation. It is also set if the unit is Ready and tape motion is initiated by an operating function code. In these two cases, it remains set until 5 milliseconds after tape motion stops. Bit 1 is cleared approximately 5 milliseconds after either detection of lost data or an Abnormal End of Operation Interrupt signal and cannot be reset until these conditions cease to exist. Bit 1 cannot be set if bit 0 is clear.

Write Enable (XXX4)

Bit 2 is set when the file protection ring is on the tape reel. When this ring is present, it is possible to read from and write on the tape. When this ring is absent, it is possible to read from but not write on the tape.

File Mark (XX1X)

Bit 3 is set whenever a file mark is read.* It remains set until a new operating function, a Read/Write operation, or a clearing operation is initiated or until a new unit is connected or the same unit is reconnected.

Load Point (XX2X)

Bit 4 is set when the tape is at load point. It is cleared when the tape moves off the load point.

*If a file mark is detected during a Search Backward to File Mark and this is followed by a Read forward, the file mark is the first record read.

End of Tape (*XX4X*)

Bit 5 is set when the end of tape marker is detected. It is cleared when the end of tape marker is sensed during Rewind or Reverse Read.*

Density (*X1XX*)

Density (*X2XX*)

	Bit 7	Bit 6
200 BPI	0	0
556 BPI	0	1
800 BPI	1	0

Lost Data (*X4XX*)

Bit 8 is set when the control determines that data may have been lost in transmission. Tape motion stops when bit 8 is set and cannot be restarted until this bit has been cleared by a new Connect or function code or Master Clear (see Programming Considerations).

When operating from a 160/160-A Computer via a 3681 Data Channel Converter, lost data is also detected if the read or write selection in the 3681 Converter is not cleared immediately after a Read or Write operation is completed. As long as a Write signal is present and the Data signal is not present at the required time, the controller assumes that a data transmission loss has occurred and a Lost Data signal is sent. If the Read signal is present but data is not being accepted by the channel, lost data also occurs. It is, therefore, necessary to clear the read or write selection in the 3681 Converter immediately after a Read or Write operation is completed to prevent the Lost Data signal from being sent abnormally. If the Lost Data signal is present, it must be cleared if Read or Write operations are to continue.

End of Operation (*1XXX*)

Bit 9 is set when the data terminates a Read or Write operation, when a tape unit senses the end of a record during a Read operation, or upon completion of an operating function. It remains up until a new Read/Write operation, operating function, or clearing operation is initiated.

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*Reverse Read is possible with 604 and 607 Tape Units only.

Vertical or Longitudinal Parity Error (2XXX)

Bit 10 is set following detection of either a vertical or longitudinal parity error or reading a file mark while in Binary mode. It is cleared by initiating a new Read, Write, or clearing operation. If this bit is set during a chaining operation* due to detection of a vertical parity error or due to detection of a longitudinal parity error, it cannot be cleared until the chaining operation terminates.

SWITCHES AND INDICATORS

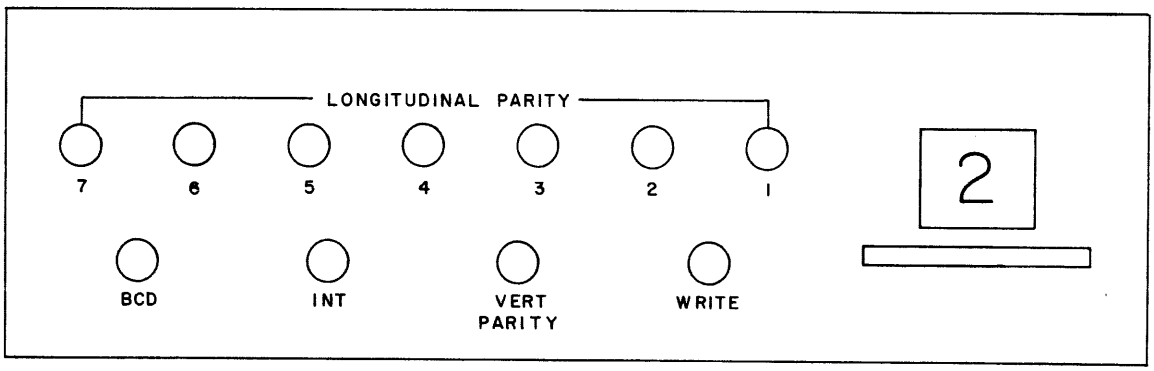

Figure 2. 322X Equipment Number Switch and Indicator Panel**

EQUIPMENT NUMBER SWITCH

An eight-position Equipment Number switch is associated with each read/write control. The setting of this switch (0 - 7) designates the control and corresponds to the N portion of the Connect code. It also determines the number of the interrupt transmission line that the equipment uses.

When a control is connected to a tape unit, a white indicator in the switch lights.

If a transmission parity error is detected during a Connect, Function, Read, or Write operation, a red indicator in the Equipment Number switch lights.

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*3400/3600/3800 systems only

**Located on the 322X Controller logic chassis

LONGITUDINAL PARITY INDICATORS

Seven LOGITUDINAL PARITY indicators are associated with each control. At the end of an operation involving longitudinal parity checking, none of these indicators should remain lighted. If one or more remains lighted, a longitudinal parity error has occurred. The indicators remain lighted until a new record is begun.

WRITE INDICATOR

The WRITE indicator lights during Write and Write File Mark operations. The WRITE indicator is cleared on termination of the Write operation.

VERT (VERTICAL) PARITY INDICATOR

A Vertical Parity Error indicator lights if a vertical parity error is detected during a Read or Write operation. This indicator remains lighted until cleared by a new Read, Write, Channel Clear, or Master Clear.

INT (INTERRUPT) INDICATOR

This indicator lights when an interrupt occurs. This indicator remains lighted until the Interrupt signal drops.

BCD INDICATOR

This indicator lights when BCD mode is selected or a file mark is being written on tape.

OPERATION AND PROGRAMMING

CLEARING THE CONTROLLER

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

1) Clear Channel* (100 microseconds)
   This instruction:
   a) Clears all activity in the data channel.

*See the individual processor instructions

b) Clears the present connection control N may have with a tape unit.

c) Performs a Master Clear on control N read, write, and function logic. No status signals are available to the data channel after executing this instruction.

2) Clear (0005) (2 microseconds)
This function code clears the present connection control N may have with a tape unit. Control N remains connected in the sense that status signals are still available for the data channel.

3) Release (0000)
This function code clears the connection for the connected tape unit.

4) Power On Master Clear
When power is applied to the 322X Controller, all tape units are cleared. Logic in all controls is also cleared. No status signals are available to the data channel after power is applied.

5) External Master Clear
This clears all tape units. It also clears the logic in all controls. No status signals are available to the data channel after executing this operation.

The Clear and Release codes can only be used after a control is connected to a tape unit.

All clear operations (except the Release code) place the 322X Controller in binary format.

REVERSE READ (604 AND 607 TAPE UNITS ONLY)

The 322X Controller can read information in a reverse direction from tape. Six-bit frames are read from tape, 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, etc, have already been selected and all tape motion has stopped), a 322X Controller must first receive Function code 0041 (Set Reverse Read). When the Read instruction is executed in the processor, the Reverse Read operation begins (i.e., data is available to the data channel). A Reverse Assembly signal is sent to the data channel from the 322X Controller to indicate that the 12-bit bytes should be assembled into a word in reverse order.

*This assembly may be suppressed. See Assembly/Disassembly.

Data transfer continues until the word count in the control word equals zero* or until $m^1 = m^2$.** Tape motion continues in a reverse direction and stops at the gap between the current record and the record check character of the next record (unless chaining or nonstop read has been selected).

Vertical and longitudinal parity checking occur as in a normal Read operation, except 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 the remaining frames.

If a Reverse Read is attempted from load point, there is no tape motion. The Read operation hangs up.

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. Chaining and nonstop Read operations are also handled as if the operation were a normal Read.

Function code 0040 (Clear Reverse Read) should be issued when the Reverse Read operation terminates.

PROGRAMMING CONSIDERATIONS

Suppress Assembly/Disassembly

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 automatically fills in bits 0 through 5 of the last input byte with "0's". If an odd number of frames are written and a Reverse Read is attempted, the inverted assembly is one frame out of order, and bits 6 through 11 of the last data channel word are filled in with "0's".

*3400/3600/3800 systems

**3100/3200 systems

Lost Data

The Lost Data condition occurs in two cases:

1) When the data channel cannot supply or accept data at the rate required by the tape unit due to competition from other devices for access to storage.

2) When certain malfunctions occur in the data channel.

A Lost Data condition causes data transfer to stop, stops tape motion (at the next record gap), and sets the lost data status bit. A new Read or Write operation cannot begin until the Lost Data condition is cleared by a Master Clear, Clear Channel instruction, or new Connect or Function operation. In most cases, the Lost Data condition leaves the data channel active (i. e., the Read or Write operation remains uncompleted). Thus, a new Connect or Function operation cannot be initiated until the channel active condition is cleared by a Master Clear, Clear Channel instruction, or Stop Channel Activity function code. *

* 3600/3800 systems only

SUPPLEMENTARY INFORMATION A
MAGNETIC TAPE EQUIPMENT

The section contains information common to several Control Data magnetic tape units. It includes:

1) Tape format.
2) Operating instructions for CONTROL DATA 603, 604, 606, and 607 Tape Units.
3) Manual controls for 603, 604, 606, and 607 Tape Units.

TAPE RECORDING CHARACTERISTICS

TAPE FORMAT

Magnetic tape provides a high-speed, nonvolatile storage medium for recording information. The tape has a plastic base, coated on one side with a magnetic oxide which consists of minute particles of iron oxide mixed with a binding agent.

Information is read (detected) or written (stored) by passing oxide side of the tape over read/write heads. Information is written on or read from independent tracks on the tape by seven recording heads placed vertically across the tape.

A nonreturn-to-zero (change-on-ones) recording scheme is used. In this system, magnetic particles on the tape are aligned in either the positive or negative direction. A binary "1" is recorded by reversing the alignment (polarity); no polarity reversal results in recording a "0". Thus, each track of the tape is fully magnetized, and the polarity is reversed as each "1" bit is recorded.

A line of tape data consists of a 6-bit character and a parity (check) bit. Tracks 0 through 5 specify the character; track 6 holds the parity bit (Figure A-1).

In Control Data systems, data is recorded in binary or binary coded decimal (BCD) format. Tape is binary if data is recorded as it is represented in core storage. In BCD format, digits, characters, and special symbols are represented in core storage by 6-bit binary numbers.

The formats also differ in selection of parity bits. In binary format, the parity bit is chosen so that the total number of "1" bits in any line is odd. In BCD format, the total number of "1" bits is even. The format is selected by the controller.

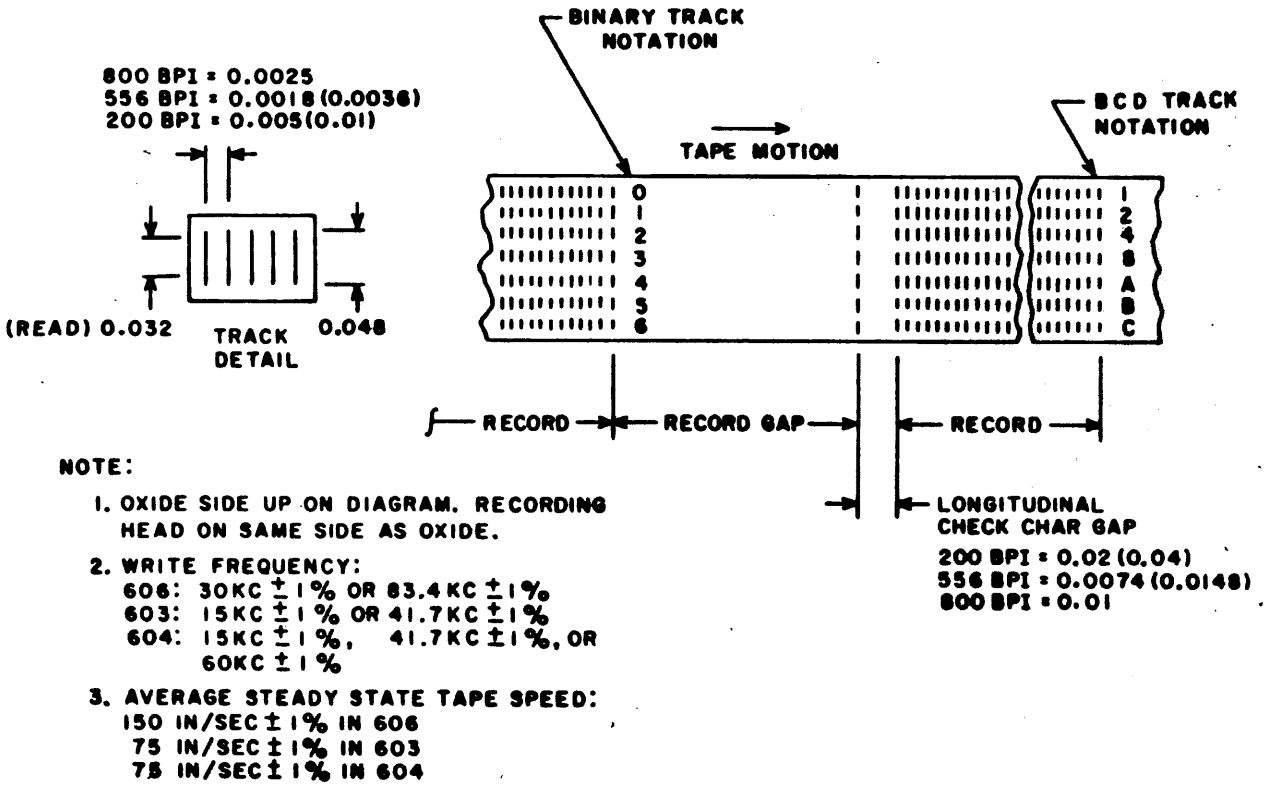

Figure A-1. Bit Assignments on Tape

Recorded data on the tape is arranged in groups called records and files. A minimum of one line of information constitutes a record. Adjacent records are separated by a 3/4-inch unrecorded area (record gap). A longitudinal parity bit is recorded in coded* format at the end of each record; the number of "1's" in each record track is made even.

A file consists of a group of records. Adjacent files are separated by recording an end of file mark 6 inches from the last record in the file. The file mark consists of an octal 17 (BCD) and its check character.

REFLECTIVE SPOTS

Reflective spots are placed on the tape to determine the beginning and end of the usable portion of the magnetic tape. The reflective spots are plastic, one inch long by 3/16 inch wide, coated on one side with adhesive strips and on the other with vaporized aluminum. They are placed on the base or uncoated side of the tape and detected by photosensing circuits.

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* The word "coded" is often used instead of BCD.

The load point marker must be placed at least 10 feet from the beginning of the tape on the supply reel (Figure A-2). This marker is placed with its one-inch dimension parallel to and not more than 1/32 inch from the edge of the tape nearest the operator when the file reel is mounted.

The end of tape marker should be placed not less than 18 feet from the end of the tape attached to the takeup reel hub. The marker is placed with its one-inch dimension parallel to and not more than 1/32 inch from the edge of the tape nearest the tape unit (when reel is mounted).

Markers are applied while the reel is removed from the tape unit and must be properly aligned and firmly attached to the tape. Use care to avoid dust accumulation on the tape while attaching markers.

FILE PROTECTION RINGS

The back of the file reel has a slot near the hub which accepts a plastic file protection ring (Figure A-3). Writing on a tape is possible only when the reel contains this ring, but the tape may be read with or without the ring. Presence of a ring on a reel of tape is signaled by the overhead lights which turn on immediately after the tape load procedure is executed. The lights remain on until the ring is removed or the tape unit is placed in the unload status. The ring should be removed from the file reel after writing to avoid loss of records through accidental rewriting.

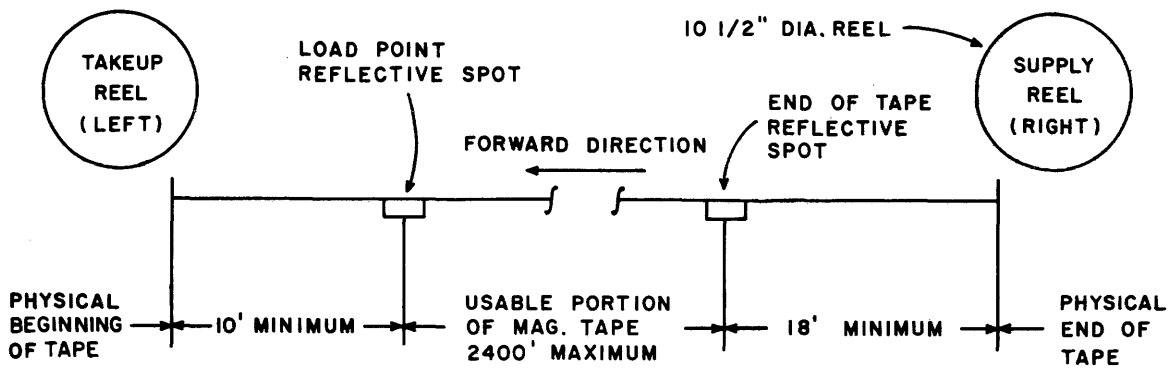

Figure A-2. Physical Layout of Tape

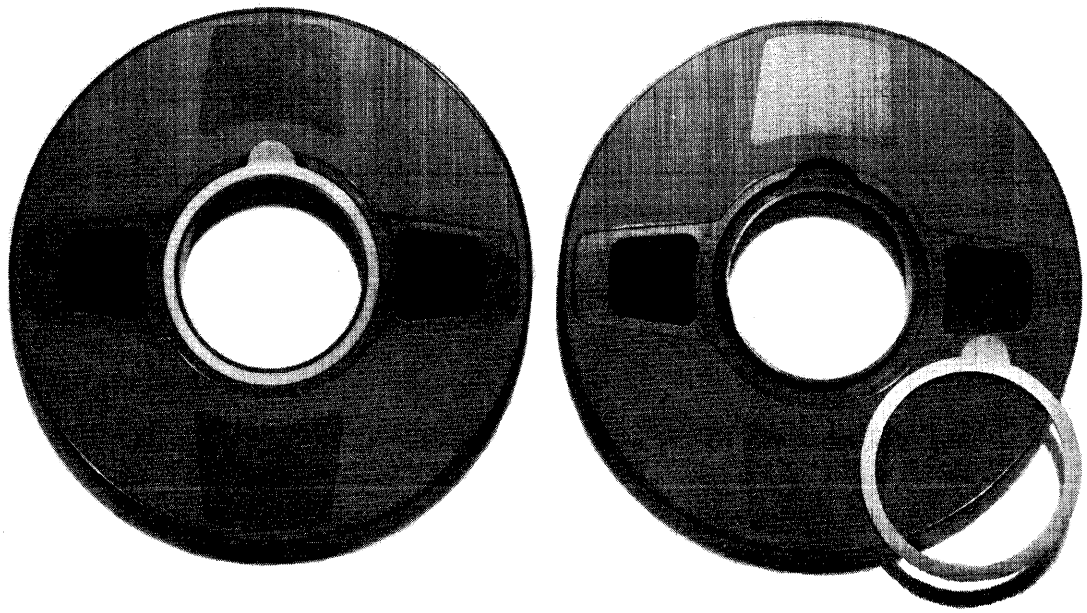

Figure A-3. File Protection Ring

603/604/606/607 OPERATING INSTRUCTIONS

APPLICATION OF POWER

To initially energize the tape unit:

1) Open doors at back of cabinet.
2) Push the two-line circuit breakers (on power supply) to the up position. The neon indicator should light.
3) Push the two-reel power circuit breakers (on power supply) to the up position.
4) Hold the Power On switch on the maintenance panel for about 2 seconds. The pump motor should start.
5) The POWER indicator on the operator's control panel should light. If not, repeat the procedure.
6) Close the back doors.

The POWER switch on the operator's control panel is used only to remove power from the unit. Once this switch is pushed, the above procedure must be repeated in order to apply power to the unit.

TAPE LOAD PROCEDURE

1) Slide front door down to lowest position (Figure A-4).

2) Check that supply reel has been file-protected as necessary.

3) Mount reel on supply reel hub and tighten hub knob.

4) Make sure that tape load arms are in up position.

5) Pull tape from supply reel to reach takeup reel. Thread tape on the outside of the supply tape load arm, over the head assembly, around the outside of the takeup load arm, and over the top of the takeup reel. Release tape and spin the takeup reel hub two or three times.

6) Slide tape under head assembly.

7) Snap tape load arms down.

8) Set Unit Select switch (0-7 or STANDBY) to desired program selection number.

9) Press CLEAR switch.

10) Press LOAD switch. Tape drops in columns, moves forward, and stops on load point marker. LOAD indicator lights. If tape continues moving forward for more than 3 or 4 seconds, either no load point marker was placed on the tape or the operator manually wound the marker onto the takeup reel during step 5.

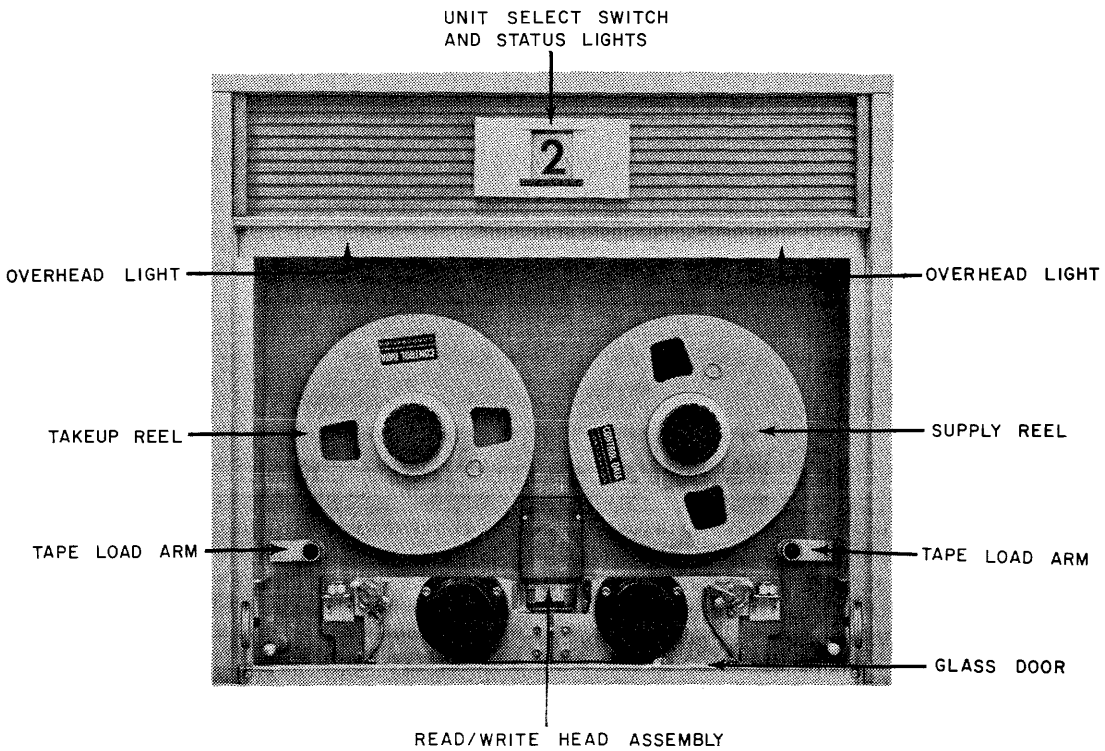

Figure A-4. Tape Load and Unload Mechanics

11) If the unit is to be controlled by the controller, press the READY switch. If it is to be namually operated and the READY switch has been pushed, push the CLEAR switch.

12) Push up door.

If the supply reel contains a file protection ring, the overhead lights should be on, indicating that a Write operation may be performed.

TAPE UNLOAD PROCEDURE

1) Press CLEAR switch.

2) Press UNLOAD switch. All tape is automatically drawn from the takeup reel and wound on the supply reel. The UNLOAD indicator lights.

3) Slide down front door.

4) Loosen supply reel hub knob and remove supply reel.

5) Check if reel needs to be file-protected and if it is labeled adequately prior to storage.

SPECIAL INSTRUCTIONS

To simulate an Unload condition without removing all tape from the takeup reel, simultaneously push the CLEAR and UNLOAD switches. The Unload condition is simulated, but tape does not move. To place the unit in operational status, remove all tape from the vacuum columns by revolving the takeup reel clockwise and the supply reel counterclockwise. Snap the tape load arms down and push the LOAD switch. The tape moves forward and stops on the nearest load point marker. The LOAD indicator lights.

If all tape is unwound from the supply reel:

1) Snap the tape load arms up, if necessary.

2) Guide tape around the tape load arms, over the head assembly, and wrap approximately 10 turns around the supply reel.

3) Slide tape under head assembly.

4) Push the LOAD switch.

5) As soon as the FORWARD indicator lights, push the CLEAR switch and then the REVERSE switch. Tape will rewind on the nearest load point marker.

The following information is applicable when a number of load point or end of tape markers are used on a single tape:

To move forward from a reflective marker and stop at nearest end of tape marker, push the FORWARD switch.

To move forward off a reflective marker and stop at nearest load point or end of tape marker, push the FORWARD and then the LOAD switch. The LOAD indicator lights if motion stops at load point marker.

To reverse from a reflective marker and stop at nearest load point marker, push the UNLOAD, CLEAR, and REVERSE switches in that order.

Tape motion may be stopped at any time by pushing the CLEAR switch. An Unload operation may be performed by pushing the UNLOAD switch.

MANUAL CONTROLS

The manual controls (Figures A-5 and A-6) are effective when the CLEAR switch is lighted. The indicators, however, reflect both manual- and processor-imposed operating conditions.

UNIT SELECT SWITCH

A 10-position switch is mounted on each tape unit. The setting of this switch (0-7 or STANDBY) either designates the control or places it in a Standby condition. Units in a Standby condition cannot be connected to and, hence, used by the processor.

A white indicator in this switch is lighted while the unit is connected to a data channel. A red indicator is lighted while the unit is reserved by a data channel.

POWER SWITCH/INDICATOR

This switch turns off tape unit power. It is lighted when power is on.

FORWARD SWITCH/INDICATOR

This switch moves the tape forward. Motion stops when the end of tape marker is sensed or the CLEAR switch is pushed. It is lighted during this operation.

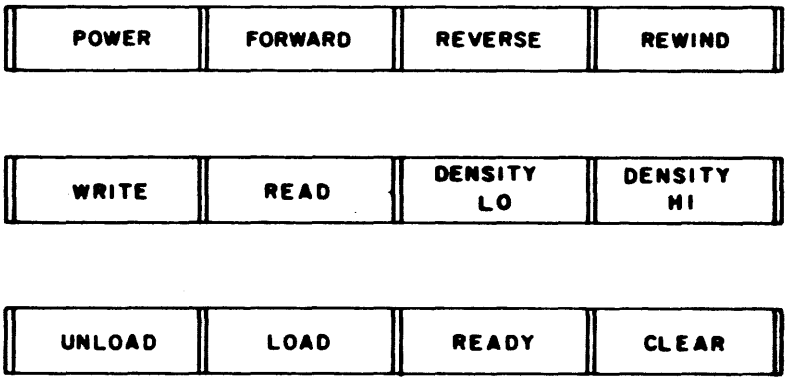

Figure A-5. 603/606 Operator's Control Panel

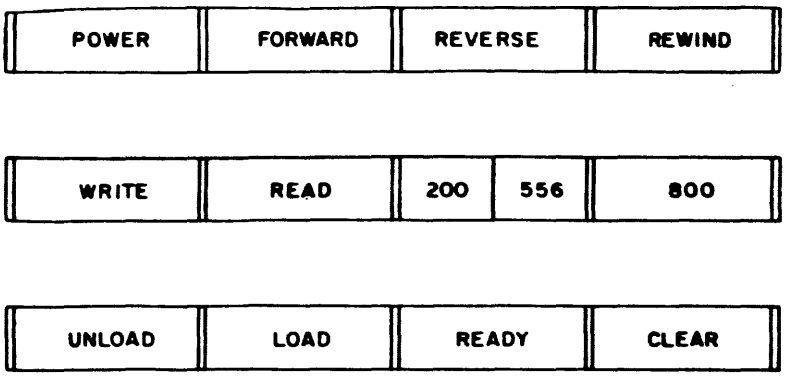

Figure A-6. 604/607 Operator's Control Panel

REVERSE SWITCH/INDICATOR

This switch rewinds the tape. Motion stops when the load point marker is sensed or the CLEAR switch is pushed. It is lighted during this operation.

REWIND SWITCH/INDICATOR

This switch rewinds the tape to load point. It is lighted during this operation.

WRITE INDICATOR

This indicator is lighted during a Write or Write File Mark operation.

READ INDICATOR

This indicator is lighted during a Read operation.

DENSITY LO* SWITCH/INDICATOR

This switch selects low density. It is lighted if low density is selected.

DENSITY HI* SWITCH/INDICATOR

This switch selects high density. It is lighted if high density is selected.

200/556** SWITCH/INDICATOR

This alternate-action switch selects either 200 or 556 bits per inch density. The selected side is lighted.

800** SWITCH/INDICATOR

This switch selects 800 bits per inch density. It is lighted if 800 bits per inch is selected.

UNLOAD SWITCH/INDICATOR

This switch moves all the tape to the supply reel. It is lighted when the tape unit is in unload status.

LOAD SWITCH/INDICATOR

This switch moves tape forward to load point. It is lighted when the tape is at load point.

READY SWITCH/INDICATOR

This switch places the unit under processor control. It is lighted while the unit is under processor control.

CLEAR SWITCH/INDICATOR

This switch master clears the tape unit. It places the unit under manual control. It is lighted when the unit is under manual control.

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* 603/606 Tape units

** 604/607 Tape units

COMMENT SHEET

MANUAL TITLE 3228-A/B, 3229-A/B MAGNETIC TAPE CONTROLLERS

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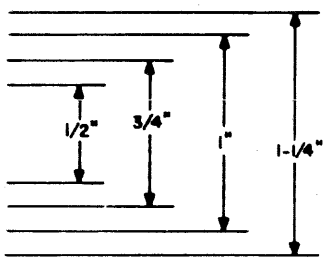

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CORPORATE HEADQUARTERS, 8100 34th AVE. SO., MINNEAPOLIS, MINN. 55440
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