CONTROL DATA® 6000 SERIES COMPUTER SYSTEMS

Peripheral Equipment Reference Manual

RECORD of REVISIONS

REVISION	NOTES
01	Preliminary Edition
(9-23-65)	
02	Publications Change Order 12155 which did not advance the Product Designation. Pages 1 and 6
(12-15-65)	under Visual Recording Equipment, page 17 under Mass Storage Equipment, pages 1, 2, and 4 in
	the 6682 section, and pages 3, 4, 6, 7, 11, 13, 14, 15, 16, 20, 21 and 24 in the 6681 section under
	Interface Equipment revised.
03	Publication Change Order 13333 which did not advance the Product Designation. The following
(4-13-66)	pages are revised: Under Tab Magnetic Tape Equipment, Section 6622 pages 1, 4, 5, 6, 7, 11, 12,
	15, 16, 17, 18 and 25. Section 607-B, pages 2, 4, 5, 6, 9, 12, 17, 21, 22 and 25. Under Tab
	Card Equipment, Section 6600, pages 1 and 2 under Section A and pages 1 and 6 under Section B.
	Under Tab Visual Recording Equipment, Section 6602, pages 7 and 12. Section 1612, pages 1, 2,
	6, 13, 14 and 18. Under Tab Mass Storage Equipment, Section 6603, pages 5, 11, 12, 15 and 16.
	Under Tab Interface Equipment, Section 6681, pages 1, 3, 7, 8, 10, 11, 12, 24, 25, 26, and 27.
	Under Tabs Card Equipment, Section 3446/3644 page 9, Section 3447/3649 page 9.
04	Publication Change Order 14006 covers the revision of Part 1 Magnetic Tape Equipment (Sections A
(6-24-66)	and B), and the following pages: 18 (1612 Printer), 26 and 27 (6681 Data Channel Converter), and
	6 (6600 Card Punch).
A	Manual Released. Publications Change Order 14967. The manual was completely revised including
(10-14-66)	two title changes in Section II as follows: 6600 Card Reader to 405-B Card Reader, and 6600 Card
	Punch Controller to 170 Card Punch Controller. The 6612 Console Display and the 6683 Satellite
	Coupler were added to Sections III and V respectively. This printing obsoletes all previous editions
	and raises the manual from a preliminary to a final edition.
B	Publication Change Order CA 15872 adds 6639-A Disk File Controller information to Mass Storage
(3-3-67)	Equipment Section.
C	Publications Change Order 16411 adds 6673-A/6674-A Data Set Controller information to 6000
(5-10-67)	Series Interface Equipment section.
D	Publications Change Order 17972 adds 6671-A Data Set Controller information to 6000 Series
(1-19-68)	Interface Equipment section and revises page 9 of 6603-A/B/C Disk File Controller information
	in Section IV. Obsoletes the 6671 Multiplexer Reference Manual (Pub. No. 60212900).
E	Manual revised; includes Engineering Change Order 20367, publications change only. Pages
(11-20-68)	1, 5, 8, 9, 10, and 11 (6602/6612) (Section III) revised.
F	Manual revised; includes Engineering Change Order 20823, publication change only. Page iii
(11-20-68)	(General Contents) revised. Added 6684-A (Section V) and 6641-A (Section IV).
G	Manual revised, includes Engineering Change Order 21349, publication change only. Page 6 of
(1-6-69)	6681 (Section V) and page 9 of 362X (Section VI) revised.

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GENERAL CONTENTS

FOREWORD

This manual provides machine-language programming information for peripheral equipments that are used in 6000 Series Computer Systems.

The first half of the manual (blue tabs) describes the 6000 Series peripheral equipments. These devices have been specifically designed for use in 6000 Series Computer Systems.

The second half of the manual describes those 3000 Series peripheral equipments which are used in 6000 Series systems through the medium of the CONTROL DATA* 6681 Data Channel Converter.

This manual assumes that the reader is familiar with the input-output characteristics of the 6000 Series Peripheral Processor.

The octal digit used for status reply codes is formed by setting only the bit (in a few cases, those bits or no bits) necessary to specify that condition. The other bits of that octal digit are assumed to be clear. If any bit of another octal digit in the code is used to indicate status, that octal digit is called X . If no bit of another octal digit is presently used by that controller, that octal digit is specified by 0 . Special letters such as D have the significance assigned to them for the specific device being considered.

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6622-A/B MAGNETIC TAPE CONTROLLER

CONTENTS

FIGURES

TABLES

6622-A/B MAGNETIC TAPE CONTROLLER

The CONTROL DATA* 6622-A/B Magnetic Tape Controller facilitates high-speed transfer of data between CONTROL DATA 626 Magnetic Tape Transports (tape units) and standard 6000 Series Data Channels.

This section describes the processing of data received by the controller from both the Data Channels and the tape units. It also describes the function and status reply codes and provides pertinent programming information.

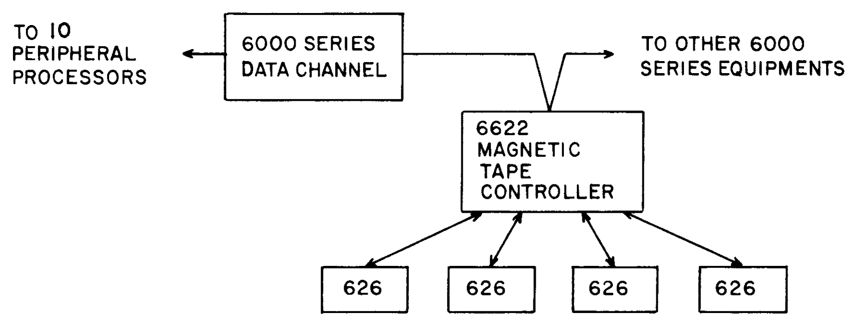

Figure 1. Typical Configuration

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FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 6622 Controller has one read/write control which controls from one to four 626 tape units that use 1-inch magnetic tape and have a 14-track recording format.

DATA TRANSMISSION

During a Write (output) operation, the controller receives data from the Data Channel in 12-bit bytes. It adds two parity bits, one for each 6-bit character, and sends these to the selected 626 tape unit.

During a Read (input) operation, the tape unit transmits 14 bits of information to the controller. After performing a parity check, the controller sends the 12 data bits via the Data Channel to the PPU.

Format

Data is written onto, or read from tape in binary format (just as it is represented in core storage). Each 6-bit character is accompanied by an odd parity bit. It is recorded on tape at 800 bits per inch density.

Transfer Rate

Data transfer rate is 125,000 12-bit words per second, or one word every 8 usec.

PROGRAMMING

CODES

All operations are controlled by 12-bit function codes. They are transmitted to the 6622 by FAN or FNC instructions. In all discussion of codes, bit 0 is in the rightmost position. All 6622 codes, listed in Table 1, are described separately in the following discussions. Applications of these codes are presented under Programming Considerations.

TABLE 1. 6622 MAGNETIC TAPE CONTROLLER CODES

Function Codes	
Select	300U*
Write Binary	301U
Read Binary	302U
Backspace	303U
Rewind	306U
Rewind Unload	307U
Status Request	310U
Write File Mark	361U
Status Reply Codes	
Ready	00X0
Not Ready	00X1
Parity Error	00X2
Load Point	00X4
End of Tape	001X
File Mark	002X
Write Lockout	004X

Function Codes

The 6622 Controller and a tape unit are selected each time a 3XXU (except 310U) function code is directed to the tape system. The 3 specifies the 6622 Controller and the U, a number from 0-7, specifies a particular tape unit. The selection of another tape unit automatically deselects the first unit. A nonexistent unit may be selected and return a status response of Write Lockout and Ready. If U specifies a nonexistent controller, the data channel must be disconnected prior to a new select attempt.

The Inactive signal signifying acceptance of a select or an operating function code is inhibited if the controller is Not Ready. The Backspace, Rewind Unload and Write File Mark operating function codes initiate tape motion. An Activate Channel (74) instruction initiates tape motion when it follows a Read Binary code. Thus, to avoid losing data, an appropriate input instruction should follow the Activate Channel within 42 ms if the tape is at load point or within 5.3 ms if the tape has stopped in a record gap.

*U = unit number of a specific tape unit (0 - 7).

The Status Request code enables the program to input the status reply word. The status reply word indicates conditions within the previously selected unit. Status should be sensed prior to using a tape unit to insure that all tape motion, except for rewinds, is stopped. Status should always be sensed prior to issuing operating function codes to insure conflict free operation. Status may be checked any time a unit has been selected.

Select (300U)

This code selects the 6222 Controller and one of its four associated tape units.

Write Binary (301U)

This code selects tape unit U for a Write Binary operation. A PPU output operation should follow immediately. To avoid loss of data, it is necessary to be in a Channel Empty condition before disconnecting the data channel at the end of the Write operation. The data is recorded in odd parity.

Read Binary (302U)

This code selects tape unit U for a Read Binary (input) operation.

Backspace (303U)

This code backspaces tape on tape unit U one record length.

Rewind (306U)

This code rewinds tape to load point on tape unit U at high speed (320 inches per second). The controller is released 15 ms after Rewind is initiated. It is then free to perform operations with other tape units. All further operations with this unit are locked out until the tape is at load point.

Rewind Unload (307U)

This code rewinds tape on tape unit U 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.

Status Request (310U)

This code enables the status response of the currently selected unit to the PPU channels. A one-word Input operation must follow to read the status word into the PPU.

Write File Mark (361U)

This code writes a one-word record of 17_8 in even parity and a corresponding checkword as an End of File mark. The file mark gap is 6 inches.

Status Reply Codes

Ready (00X0)—Bit 0

Bit 0 is clear if the unit is mechanically Ready to conduct a Read/Write operation or is nonexistent.

Not Ready (00X1)—Bit 0

Bit 0 is set if the unit is Not Ready; for example, the tape unit is still performing some operation such as a Rewind, power is not on, a tape is not mounted, or tape unit is in manual control.

Parity Error (00X2)—Bit 1

Bit 1 in the status reply word is set:

a) When a vertical (odd transverse) parity error is detected during a Read/Write operation. (The parity error could be for one or both characters in the 12-bit word.)

b) When a longitudinal parity error is detected during a Read/Write.

c) When writing or reading (sensing) a file mark. This is not an error condition.

Any function code, except Status Request (310U) or Select (300U) clears this bit.

Load Point (00X4)—Bit 2

Bit 2 in the status reply word is set when the tape is at load point.

End of Tape (001X)—Bit 3

Bit 3 in the status reply word is set when the tape unit senses the end of tape marker. A Rewind or a Backspace operation over the marker clears this condition.

File Mark (002X)—Bit 4

Bit 4 in the status reply word is set when the tape unit senses a file mark. This bit is cleared when a new operation is initiated.

Write Lockout (004X)—Bit 5

Bit 5 in the status reply word is set when the file protect ring is not on the tape reel. When this bit is set, it is impossible to write on tape; information may, however, be read from tape. Write Lockout is also returned as a status reply when checking status of a unit which does not have a tape reel mounted or when a nonexistent unit is selected.

PROGRAMMING CONSIDERATIONS

Data transfers or tape positioning operations are accomplished by PPU I/O instructions executed on the channel to which the 6622 is physically connected. The following general comments apply to the I/O instructions:

1) Function instructions (76 and 77) send a code that selects a device on channel d and places it in a mode of operation.

2) Activate (74) and Disconnect (75) instructions signal the status of channel d and the beginning or end of data flow.

3) Input instructions (70 and 71) and Output instructions (72 and 73) define and control the number of words to be transferred on channel d as well as the PPU location(s) of data to be transferred to or from the selected device.

4) Jump instructions (64, 65, 66 and 67) permit the PPU to sense the status of channel d (whether it is Active/Inactive or Full/Empty).

Several peripheral devices may be physically attached to each bidirectional data channel, but only one device can communicate with the PPU at one time. To accommodate this feature, each device has a unique function select code to connect it to the data channel. The code is contained in the upper 3 bits of the 12-bit function code sent out on the data channel by the function instruction. Only the selected device responds to this code.

The 6622 responds to 3XXU function codes. The lower 3 bits of the code select one of four tape units and must match the setting of the Unit Select switch on the transport on which an operation is desired. (Duplicate switch settings are not permitted.) The middle 6 bits of the code define a mode of operation for the selected transport (e.g., Read, Write, Rewind, etc.).

Data transfers, tape positioning and status checks are described briefly on the following pages.

Data Transfer

Data transfer involves writing a binary record of PPU data on tape or reading a binary tape record into the PPU. Records may be variable in length (not to exceed available PPU memory) and may be read or written in a nonstop mode, i.e., the tape does not stop between records.

Write: A Write (output) operation records a PPU word on tape every 8 usec. The PPU must supply output words at this rate; an interval exceeding 8 usec or a channel disconnect from the PPU indicates the end of the PPU record to the 6622. The 6622 then sends an end of record longitudinal parity check character to the tape and stops tape motion. The tape unit reads each word 2 ms after it is recorded and returns it to the 6622 for a parity check. A parity error sets the Parity Error status bit. The check character is not checked for vertical parity. The 6622 clears the Parity Error on receipt of any function code other than Status Request.

The Write operation involves several steps:

PPU Instruction	6622 Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75), and test A	310U	1)	Check status of previously selected tape U (Ready, Write Lockout, and End of Tape)
FAN(76) or FNC(77)	301U	2)	Select write binary function, tape U
ACN(74)		3)	Activate channel
OAN(72) or Load A and OAM(73)		4)	Output data (tape motion starts)
FJM(66)		5)	Test channel for successful transfer of the last word
DCN(75)		6)	Disconnect channel (indicates end of record to the 6622)
Delay Routine		7)	Wait 2 ms (spans read head gap of tape U to allow 6622 to parity check complete record)
FAN(76), ACN(74), IAN(70), DCN(75), and test A	310U	8)	Check status of tape U
		9)	Repeat 3-9 (steps 3-4 must be executed within 500 usec after step 8 for nonstop operation; otherwise tape stops in record gap)

Read: A Read (input) operation reads one record from tape into PPU memory beginning at the PPU location specified by the input instruction. Only forward reads are possible The 6622 checks each word in the record (except the check characters) for a vertical parity error and stores an error condition for sensing by the Status Request function code. Words are sent to the PPU at 8 usec intervals once tape U is started (in motion) and must be accepted at that rate to avoid missing data from the record. If no data is received from the unit for 32 usec, end of record is indicated and any further transfer of data from the tape handler to the controller is inhibited. The tape handler generates an End of Operation pulse 200 usec after the last character is read. This pulse causes the channel to disconnect. If end of operation is used to deactivate the channel instead of the Disconnect Channel instruction, a Channel Jump instruction can be used to sense Channel Inactive. As soon as the channel goes inactive, status can be checked. The programmer has 500 usec after end of operation deactivates the channel to initiate non-stop Read or Write.

If the PPU disconnects the channel, the 6622 stops sending data to the PPU and the tape moves to the record gap. If the PPU is reading one word at a time and fails to request a new word within 8 usec after receiving a word, the tape moves to the end of the record and stops in the record gap. Any information not already read from the record is lost.

A file mark record is read as a one word data record but the 6622 does not transfer the file mark to the PPU. The 6622 does set the File Mark and Parity Error status bits for sensing by the status function code.

The Read operation involves several steps:

PPU Instruction	6622 Code	Step	Event
FAN(76), ACN(74) IAN(70), DCN(75) and test A	310U	1)	Check status of previously selected tape U (Ready, $\overline{\text{End of Tape}}$)
FAN(76) or FNC(77)	302U	2)	Select read binary function tape U
ACN(74)		3)	Activate channel (informs the 6622 data is starting and starts tape motion)
IAN(70) or Load A and IAM(71)		4)	Input data (6622 starts input data transfer)
		5)	Disconnect channel (6622 disconnects channel at end of operation, see read description). This causes PPU to go on to the next instruction.
FAN(76), ACN(74), IAN(70), DCN(75) and test A		6)	Check status of tape U
		7)	Repeat steps 3-7 for next record. Steps 7, 3, 4 must be executed within 500 usec after step 6 to allow nonstop read of next record.

Write File Mark: This is a special Write operation executed by the 6622 upon receipt of a 361U function code from the PPU. The PPU need not execute instructions to activate the channel or establish an output data buffer.

The operation requires about 43.3 usec. The 6622 and tape unit are in a Not Ready condition during this time. Multiple file marks may be written in a nonstop mode if desired by issuing successive Write File Mark codes.

File marks are written as an octal 17 followed by an identical longitudinal check character. An odd parity bit is not added. Thus, reading or writing a file mark sets the Parity Error status bit. A file mark is written at least 6 inches after the last check character.

The Write File Mark operation involves the following steps:

PPU Instruction	6622 Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75) and test A	310U	1)	Check Ready status of previously selected tape U
FAN(76) or FNC(77)	361U	2)	Select write file mark tape U
		3)	In response to the Write File Mark code in step 2, the 6622 starts tape motion and after a 40 ms delay writes the file mark (17_8). The tape is stopped then in the record gap if no new Write code from the PPU is waiting to be executed. Note that the PPU is hung up during the 40 ms delay if it issues another non-status function code to the 6622 for any tape. The lockout allows the 6622 to complete the current operation before starting another.

A Search File Mark operation may be accomplished by successive Read operations by the PPU, followed by status checks. Once a file mark is sensed, the File Mark status bit is set. Sensing a file mark also forces a Parity Error condition.

Tape Positioning

Tape positioning operations move the tape in a reverse direction in the following ways:

1) Backspace over one record and stop (nonstop backspace over multiple records is possible).
2) Rewind to the load point (beginning of data on tape).
3) Rewind tape to unload position. (Tape may be changed at this time.)

No tape data is available to the PPU during these operations and the PPU does not execute activate channel or input data instructions.

Backspace: The Backspace operation moves tape backward to the beginning of the preceding record. The tape and 6622 are in a Not Ready condition while backspacing. If the peripheral processor issues a function code to the 6622 during the interval, the PPU is hung up until the Backspace operation is completed.

Backspacing over a file mark sets the File Mark and Parity Error status bits. These status bits remain set until cleared by the next non-status 6622 function code. Backspacing over a load point is possible.

The wait period during backspace is a function of the record length. Known record length waits may be computed using 8 usec/frame. The tape becomes Ready and the 6622 accepts another backspace command for nonstop operation 333 usec after the last frame is read. A backspace over a file mark introduces an additional 40 ms waiting period for nonstop Backspace operations.

If the next tape operation is a Read or Write function, the tape unit stays busy 5 ms after Stop Tape Motion is initiated. Note that the 6622 accepts Read or Write function (and disconnects the PPU channel) during the 5 ms stop period, but does not issue the Forward Motion signal to the tape until it is stopped.

A Backspace operation involves the following steps:

PPU Instruction	6622 Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75), and test A	310U	1)	Check Ready status of previously selected tape U
FAN(76) or FNC(77)	303U	2)	Select backspace tape U (start tape motion)
FAN(76), ACN(74), IAN(70) and test A	310U	3)	Wait and check tape U status (tape U Ready)
		4)	Repeat steps 2 and 3 for nonstop.

Rewind: The Rewind operation moves the tape to load point and places the tape in Not Ready status until it has stopped at load point.

The 6622 accepts the Rewind, disconnects the PPU from the channel, and starts the rewind on tape U. Tape U is Not Ready until load point is reached; however, the 6622 is Ready 15 usec after disconnecting the PPU channel and can accept a function code for one of the remaining tapes so that other tape operations may proceed during the rewind time. Thus, all tapes could be rewinding at once or one tape could be transferring data (read or write) while one or more tapes are rewinding.

A Rewind operation is as follows:

PPU Instruction	6622 Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75) and test A	310U	1)	Check selected tape U status (tape READY light on and Not Busy)
FAN(76) or FNC(77)	306U	2)	Rewind tape U (start tape motion - tape Not Ready until stopped at load point - 6622 Ready in 15 usec)

Rewind Unload: The Rewind Unload operation moves tape to unload position to change the tape. The tape is Not Ready until reloaded and again positioned at load point and under external control (READY light on).

The 6622 is Ready and will accept a function for an operation on another tape 15 usec after the Rewind Unload is accepted. Acceptance of a Rewind Unload by the 6622 starts tape motion and disconnects the PPU from the channel.

A Rewind Unload operation is as follows:

PPU Instruction	6622 Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75) and test A	310U	1)	Check selected tape U status (tape READY light on and Not Busy)
FAN(76) or FNC(77)	307U	2)	Select rewind unload tape U (starts tape motion - tape Not Ready until reloaded and at load point - 6622 ready in 15 usec)

Status Checks

The 6622 makes available certain status conditions of the tapes to the PPU so that the latter may monitor progress of tape operations. A status function is accepted by the 6622 at any time and the response returned to the PPU by an input instruction. Thus, a status response for a tape that is in motion is given for the conditions existing at that time. The lower 3 bits of a Status Request code are not decoded so a status reply is always from a previously selected tape unit.

The status reply word is returned to the PPU on the lines that carry tape read data to the PPU. The PPU must execute an Input to A instruction after the status function to read the status reply word into A for testing.

Status responses and their meanings have been described earlier in relation to tape operations such as Read and Write and summarized under Status Reply Codes.

A Status Request operation is accomplished in the following way:

PPU Instruction	6622 Code	Step	Event
FAN(76) or FNC(77)	310U	1)	Select status of the previously selected tape unit.
ACN(74), IAN(70)		2)	Read status reply word into PPU A register.
		3)	PPU tests status reply word to determine conditions.

TAPE UNIT DESIGNATION

Each tape unit may have either a numerical designation (0 - 7) or be in Standby condition. These are determined by the Unit Select switch located on the tape transport. The transport cannot be used when it is on STANDBY. When the numerical designation of a unit is changed, any operation currently in progress with the transport is stopped and the PPU may hang up.

TAPE FORMAT

Magnetic tape provides a high-speed, non-volatile storage medium for recording and retaining information. The tape has a mylar base and is coated on one side with minute particles of iron oxide mixed with a binding agent. It is upon this coating that information is recorded. Extreme care is taken in the manufacture of the tape in order to eliminate any imperfection that could cause errors. Each roll of Control Data magnetic tape is thoroughly tested before use to guarantee its recording characteristics and performance.

Information is read (detected) or written (stored) by passing the oxide side of the tape over read/write heads. Information may be written on any of 14 independent tracks on the tape. During a Read or Write operation, 14 recording heads are placed vertically across the tape; therefore, 14 bits may be simultaneously recorded, 1 bit on each track. (See Figure 2 for the tape recording format.)

A 14-track non-return-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 a "0". Thus, each track of the tape is fully magnetized and the polarity is reversed as each "1" bit is recorded.

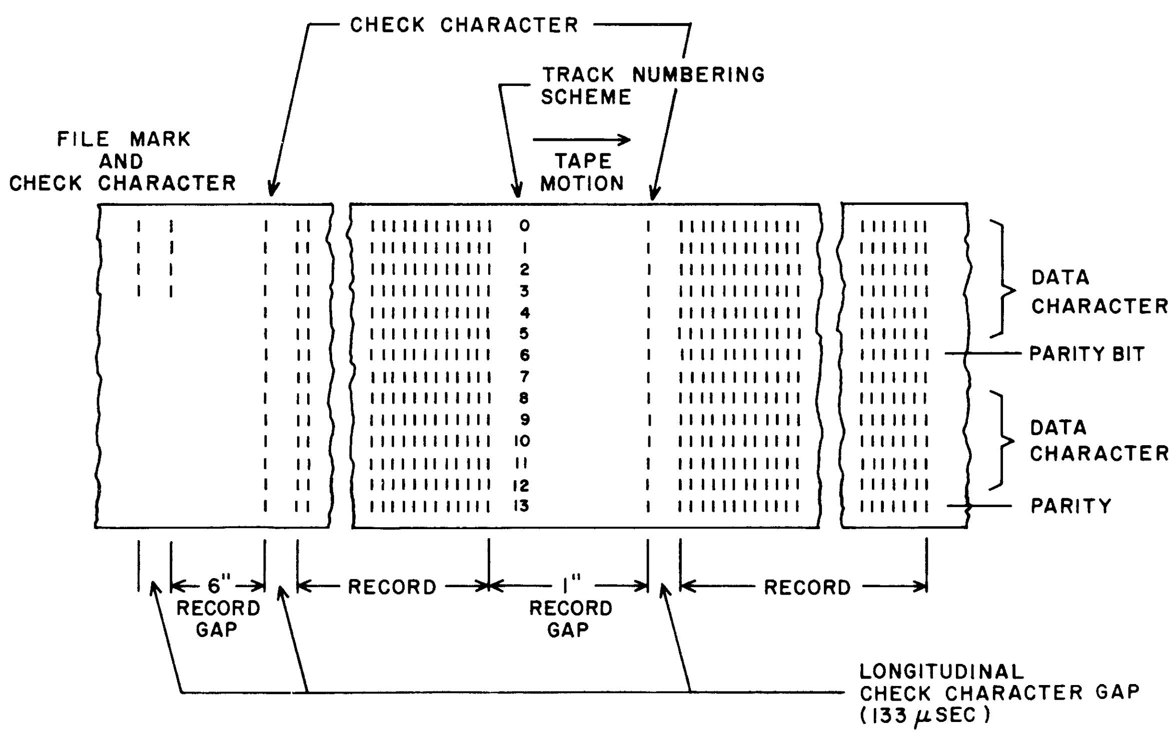
A frame of tape data consists of two 6-bit binary data characters and one parity (check) bit for each character. Tracks 0 through 5 and 7 through 12 specify the characters while tracks 6 and 13 hold the parity bits (Figure 2). The upper and lower characters in each frame correspond to one data word from the PPU. The 6622 adds the parity bit.

Data is recorded in binary format (just as they are represented in the memory). The parity bit is chosen so that the total number of "1" bits for each character in a line is odd. (Thus, the total number of "1" bits in a two-character line must be even.) The 6622 automatically adds the correct parity bit that accompanies each character.

The controller records data on the tape in groups called records and files. A minimum of one frame of information constitutes a record. Adjacent records are separated by a 1-inch unrecorded area (record gap). A longitudinal parity frame is recorded at the end of each record such that the number of "1's" in each record track is made even.

During input/output operations the 6622 checks each character for correct vertical parity and each record for proper longitudinal parity. If a parity error occurs, a Parity Error status bit is set.

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 (also an octal 17) in the four lower order bit positions. The upper bits are all zero.



NOTES :
1. WRITE FREQUENCY 125KC $\pm$ 1% = 8 μSEC/FRAME
2. AVERAGE STEADY STATE TAPE SPEED : 150 in./SEC $\pm$ 1 1/2 %

Figure 2. Tape Recording Format

REFLECTIVE SPOTS

Reflective spots are placed on the tape to enable the tape unit to sense the beginning and end of the usable portion of the magnetic tape. The reflective spots are plastic, 1 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 where they can be detected by photosensing circuits.

The load point marker must be placed at least 50 feet from the beginning of the tape on the supply reel (Figure 3). This marker is placed with its 1-inch dimension parallel to, and not more than 1/32 inch from, the edge of the tape nearer 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 take-up reel hub. This space includes approximately 10 feet of tape trailer and enough tape to hold a record of 96, 000 words after the end of tape marker is sensed. The marker is placed with its 1-inch dimension parallel to, and not more than 1/32 inch from, the edge of the tape nearer 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 accumulating on the tape while attaching markers.

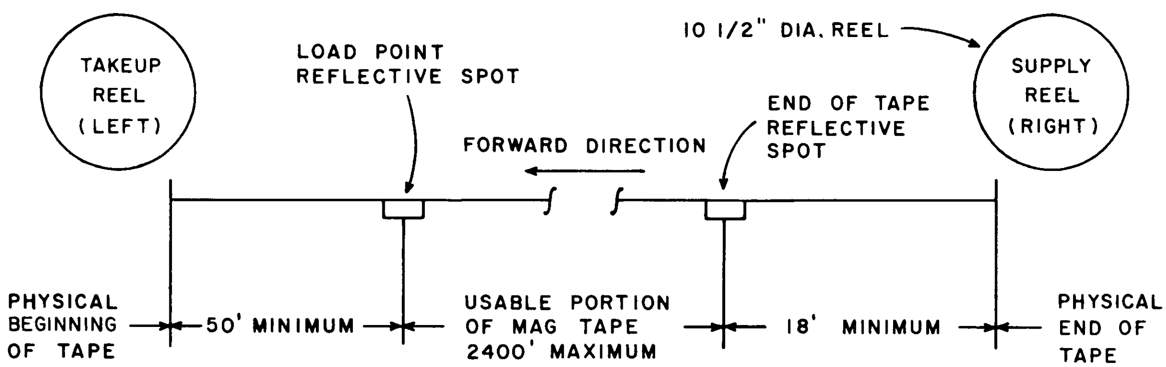


Figure 3. Physical Layout of Tape

FILE PROTECTION RINGS

The back of the tape reel has a slot near the hub which accepts a plastic file protection ring (Figure 4). Writing on a tape is possible only when the reel contains the file protection ring. If an attempt is made to write on a file protected tape, the channel hangs up the output operation. 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 unloaded. The ring should be removed from the file reel after writing is completed to avoid loss of valuable records through accidental rewriting.

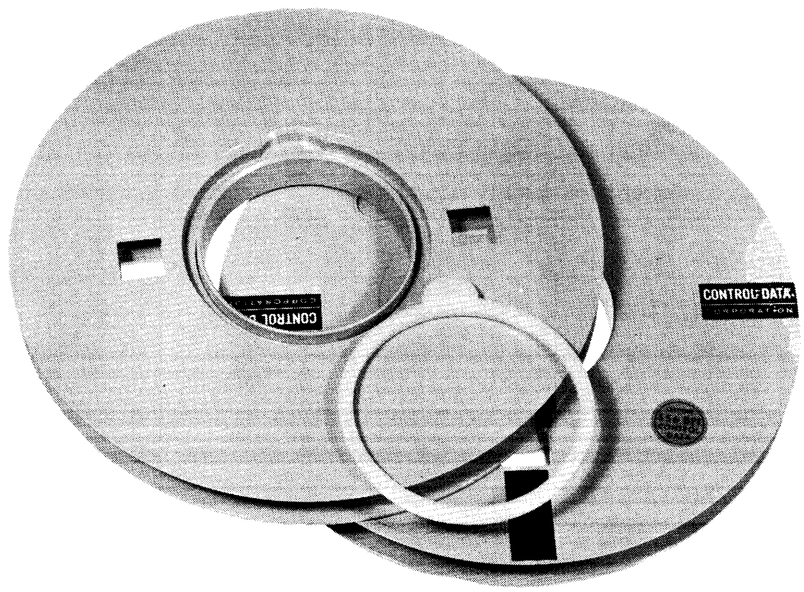


Figure 4. File Protection Ring

MANUAL OPERATION OF 626 TAPE TRANSPORT

Switches and Indicators

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

POWER	FORWARD	REVERSE	REWIND
UNLOAD	LOAD	READY	CLEAR

Figure 5. Manual Controls

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 therefore cannot be used by, the processor.

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.

REVERSE Switch/Indicator: This switch moves the tape backward. 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 at high speed. It is lighted during this operation.

UNLOAD Switch/Indicator: This switch moves all the tape to the supply reel at high speed. It is lighted when the tape unit is unloaded.

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 lights while depressed.

Operating Procedures

Application of Power:

1) Open doors at back of cabinet.
2) Place the main power circuit breaker (on power supply) in the up position. If the neon indicator fails to light, notify maintenance.
3) Place the remaining circuit breakers (on power supply) in the up position.
4) Hold the POWER switch on the maintenance panel in the ON position for about two seconds, then release.
5) The POWER indicator on the front panel should light. If not, repeat the procedure (notify maintenance if the indicator does not light).
6) Close the back doors.

The POWER switch on the front panel is used only to remove power from the unit. Once this switch is pressed, the above procedure must be repeated in order to apply power to the unit.

Tape Load Procedure:

1) Slide front glass door down to lowest position (Figure 6).
2) Check that supply reel has been file protected as necessary.
3) Mount reel on supply reel hub and tighten knob.

CAUTION

For proper alignment, push reel firmly against hub stop before tightening knob.

4) Make sure tape load arms are in up position.
5) Pull sufficient tape from supply reel to reach take-up reel. Thread tape on the outside of the supply tape load arm, under the head assembly, around the outside of the take-up load arm, and over the top of the take-up reel. Release tape and spin the take-up reel hub two or three times.
6) Slide tape under head assembly.

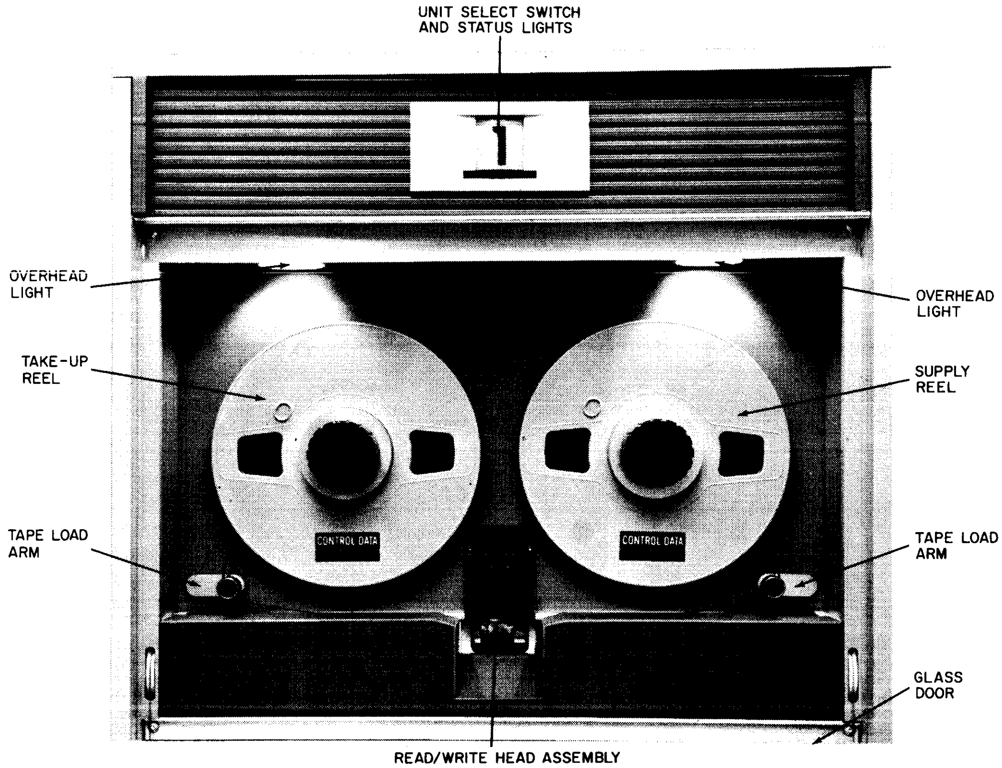


Figure 6. Tape Load and Unload Mechanics

7) Snap tape load arms down.

8) Set Unit Select switch to one of the numerical positions to assign a logical program selection number.

9) Press LOAD switch. Tape drops in columns, moves forward, and stops on load point marker. The LOAD indicator lights. (If the indicator does not light, notify maintenance.) If tape continues moving forward for more than 4 or 5 seconds, it indicates either no load point marker was placed on the tape or the operator manually wound the marker onto the take-up reel during step 5.

10) If the unit is to be externally controlled, press the READY switch. If it is to be manually operated and the READY switch has been pressed, press the CLEAR switch.

11) Slide the front door up.

If the supply reel contains a file protection ring, the overhead lights should be on, indicating that a Write operation may be performed. If the lights are not on, notify maintenance.

Tape Unload Procedure:

1) Press CLEAR switch.

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

3) Slide front door down to lowest position.

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: In order to simulate an Unload condition without removing all tape from the take-up reel, simultaneously press the CLEAR and UNLOAD switches. The Unload condition is simulated, but tape does not move. In order to place the unit in operational status, remove all tape from the vacuum columns by revolving the take-up reel clockwise and the supply reel counterclockwise. Snap the tape load arms down and press the LOAD switch. The tape moves forward and stops at the nearest load point marker and the LOAD indicator lights. If past the load point marker, clear the unit when motion starts forward.

If all tape is unwound from the supply reel:

1) Snap tape load arms up, if necessary.

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

3) Slide tape under head assembly.

4) Press the LOAD switch.

5) As soon as the FORWARD indicator lights, press the CLEAR switch and then the REWIND switch. The tape rewinds to 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.

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

2) To reverse from a reflective marker and stop at nearest load point marker, press the REVERSE and REWIND switches in that order.

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

607-B MAGNETIC TAPE CONTROLLER

CONTENTS

FIGURES

TABLES

607-B MAGNETIC TAPE CONTROLLER

The CONTROL DATA* Special Option 60028 607-B Magnetic Tape Controller facilitates high-speed transfer of data between CONTROL DATA 607 Magnetic Tape Transports (tape units) and standard 6000 Series Data Channels.

This section describes the processing of data received by the controller from both the Data Channels and the tape units. It also describes the function and status reply codes and provides pertinent programming information.

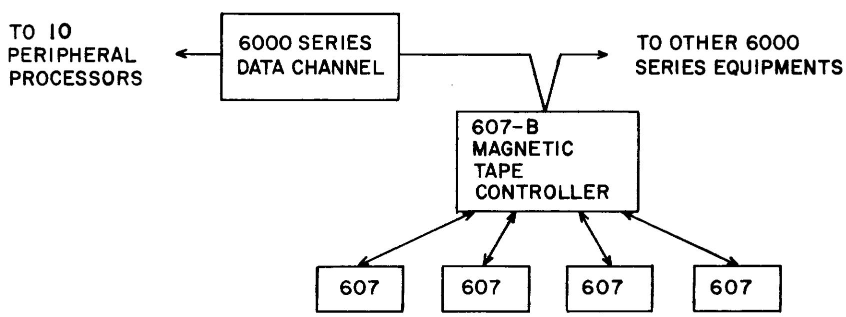


Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 607-B Controller has one read/write control which controls from one to four 607 tape units that use 1/2-inch magnetic tape and have a 7-track recording format.

DATA TRANSMISSION

During a Write (output) operation, the controller receives data from its Data Channel in 12-bit bytes. A tape unit, however, can handle only one 6-bit character at a time. The controller, therefore, must disassemble each 12-bit word into two characters. The character comprised of the upper 6 bits is transmitted to the tape unit first and is followed by the lower 6 bits.

During a Read (input) operation, the tape unit transmits 6-bit characters to the control. The control assembles two successive characters into a single 12-bit word for transmission to the Data Channel. The first character received comprises the upper 6 bits of the word, and the next character comprises the lower 6 bits.

Format

Data is written onto or read from tape in binary or BCD format (just as it is represented in core storage). It is recorded on tape at 200, 556 or 800 bits per inch density. Each frame is accompanied by a parity bit.

Transfer Rate

The data transfer rate depends upon recording density: 200 bits/inch, 32 ms/frame; 556 bits/inch, 12 ms/frame; 800 bits/inch, 8 ms/frame.

CODES

All operations are controlled by 12-bit function codes. They are transmitted to the 607-B by FAN or FNC instructions. In all discussion of codes, bit 0 is in the right-most position. All 607-B codes, listed in Table 1, are described separately in the following discussions. Applications of these codes are presented under Programming Considerations.

TABLE 1. 607-B MAGNETIC TAPE CONTROLLER CODES

Function Codes	
Select	200U*
Write Binary	201U
Read Binary	202U
Backspace	203U
Rewind	206U
Rewind Unload	207U
Status Request	210U
Write BCD	221U
Read BCD	222U
Write File Mark	261U
Status Reply Codes	
Ready	0DX0**
Not Ready	0DX1
Parity Error	0DX2
Load Point	0DX4
End of Tape	0D1X
File Mark	0D2X
Write Lockout	0D4X

*U = unit number of a specific tape unit (0 - 7)

**D = density: D = 0: 800 bpi
D = 1: 556 bpi
D = 2: 200 bpi

Function Codes

The 607-B Controller and a tape unit are selected each time a 2XXU (except 210U) function code is directed to the tape system. The 2 specifies the 607-B Controller and the U, a number from 0-7, specifies a particular tape unit. The selection of another tape unit automatically deselects the first unit. A nonexistent unit may be selected and return a status response of Write Lockout and Ready. If U specifies a nonexistent controller, the Data Channel must be disconnected prior to a new select attempt.

The Inactive signal signifying acceptance of a select or an operating function code is inhibited if the controller is Not Ready. The Backspace, Rewind, Rewind Unload and Write File Mark operating function codes initiate tape motion. An Activate Channel (74) instruction initiates tape motion when it follows a Read Binary code. Thus, to avoid losing data an appropriate input instruction should follow the Activate Channel within 42 ms if the tape is at load point or within 5.3 ms if the tape has stopped in a record gap.

The Status Request code enables the program to input the status reply word. The status reply word indicates conditions within the previously selected unit. Status should be sensed prior to using a unit to insure that all tape motion, except for rewinds, is stopped. Status should always be sensed prior to issuing operating function codes to insure conflict free operation. Status may be checked any time a unit has been selected.

Select (200U)

This code selects the 607-B Controller and one of its four associated tape units.

Write Binary (201U)

This code selects tape unit U for a Write Binary operation. A PPU output operation should follow immediately. To avoid loss of data, it is necessary to be in a Channel Empty condition before disconnecting the data channel at the end of the Write operation. The data is recorded in odd parity.

Read Binary (202U)

This code selects tape unit U for a Read Binary operation.

Backspace (203U)

This code backspaces tape on tape unit U one record length.

Rewind (206U)

This code rewinds tape to load point on tape unit U at high speed (320 inches per second). The controller is released 15 usec after the Rewind is initiated. It is then free to perform operations with other tape units. All further operations with this transport are locked out until the tape is at load point.

Rewind Unload (207U)

This code rewinds tape on tape unit U until all of the tape is on the supply reel. All further operations with this transport are locked out until the tape is manually reloaded.

Status Request (210U)

This code enables the status response of the currently selected unit to the PPU channels. A one-word Input operation must follow to read the status word into the PPU.

Write BCD (221U)

The Write BCD code selects tape unit U for a Write BCD operation. A PPU output operation should follow immediately. To avoid loss of data, it is necessary to be in a Channel Empty condition before disconnecting the data channel. The data is recorded in even parity.

Read BCD (222U)

This Read BCD code selects tape unit U for a Read BCD operation.

Write File Mark (261U)

This code writes a one-word record of 17_8 in even parity and a corresponding checkword as an End of File mark. The file mark gap is 6 inches.

Status Reply Codes

Density (0DXX)—Bits 6, 7, and 8

Bits 6, 7, and 8 are clear if recording density is 800 bpi.
Bit 6 is set; Bits 7 and 8 are clear if recording density is 556 bpi.
Bit 7 is set; Bits 6 and 8 are clear if recording density is 200 bpi.

Ready (0DX0)—Bit 0

Bit 0 is clear if the unit is mechanically Ready to conduct a Read/Write operation or is nonexistent.

Not Ready (0DX1)—Bit 0

Bit 0 is set if the unit is Not Ready; for example, the tape unit is still performing some operation such as Rewind, power is not on, a tape is not mounted, or the tape unit is in manual control.

Parity Error (0DX2)—Bit 1

Bit 1 in the status reply word is set:

a) When a vertical (odd transverse) parity error is detected during a Read/Write operation.

b) When writing or reading (sensing) a file mark. This is not an error condition.

Any function code, except Status Request (310U) or Select (300U), clears this bit.

Load Point (0DX4)—Bit 2

Bit 2 in the status reply word is set when the tape is at load point.

End of Tape (0D1X)—Bit 3

Bit 3 in the status reply word is set when the tape unit senses the end of tape marker. A Rewind or a Backspace operation over the marker clears the condition.

File Mark (0D2X)—Bit 4

Bit 4 in the status reply word is set when the tape unit senses a file mark. This bit is cleared when a new operation is initiated.

Write Lockout (0D4X)—Bit 5

Bit 5 in the status reply word is set when the file protect ring is not on the tape reel. When this bit is set, it is impossible to write on tape; information may, however, be read from tape. Write Lockout is also returned as a status reply when checking status of a unit which does not have a tape reel mounted or when a nonexistent unit is selected.

PROGRAMMING CONSIDERATIONS

Data transfers or tape positioning operations are accomplished by PPU I/O instructions executed on the channel to which the 607-B is physically connected. The following general comments apply to the I/O instructions:

1) Function instructions (76 and 77) send a code that selects a device on channel d and places it in a mode of operation.
2) Activate (74) and Disconnect (75) instructions signal the status of channel d and the beginning or end of data flow.
3) Input instructions (70 and 71) and Output instructions (72 and 73) define and control the number of words to be transferred on channel d as well as the PPU location(s) of data to be transferred to or from the selected device.

The Write operation involves several steps:

PPU Instruction	607-B Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75) and test A	210U	1)	Check status of currently selected tape U (Ready, $\overline{\text{Write Lockout}}$, and $\overline{\text{End of Tape}}$)
FAN(76) or FNC(77)	201U	2)	Select Write Binary, tape U
ACN(74)		3)	Activate channel
OAN(72) or Load A and OAM(73)		4)	Output data (tape motion starts)
FJM(66)		5)	Test channel for successful transfer of the last word
DCN(75)		6)	Disconnect channel
Delay Routine		7)	Wait 2 ms (spans read head gap of tape U to allow 607-B to parity check complete record)
FAN(76), ACN(74), IAN(70), DCN(75) and test A	210U	8)	Check status of tape U
		9)	Repeat 3-9 (steps 3-4 must be executed within 500 usec after step 8 for nonstop operation; otherwise tape stops in record gap)

Read: A Read (input) operation reads one record from tape into PPU memory beginning at the PPU location specified by the input instruction. Only forward reads are possible. The 607-B checks each word in the record (except the check characters) for a vertical parity error and stores an error condition for sensing by the status function code. Words are sent to the PPU at 16, 24, or 64 usec intervals for 800, 556, and 200 bpi respectively once tape U is started (in motion) and must be accepted at that rate to avoid missing data from the record. If no data is received from the unit for 32 usec, end of record is indicated and any further transfer of data from the tape handler to the controller is inhibited. The tape handler generates an End of Operation pulse 200 usec after the last character is read. This pulse causes the channel to disconnect. If end of operation is used to deactivate the channel instead of the Disconnect instruction (DCN, 75), a Channel Jump instruction can be used to sense Channel Inactive. As soon as the channel goes inactive, status can be checked. The programmer has 500 usec after end of operation deactivates the channel to initiate nonstop Read or Write.

If the PPU disconnects the channel, the 607-B stops sending data to the PPU and the tape moves to the record gap. If the PPU is reading one word at a time and fails to request a new word within 8 usec after receiving a word, the tape moves to the end of the record and stops in the record gap. Any information not already read from the record is lost.

A file mark record is read as a one word data record but the 607-B does not transfer the file mark to the PPU. The 607-B does set the File Mark and Parity Error status bits for sensing by the status function code.

The Read operation involves several steps:

PPU Instruction	607-B Code	Step	Event
FAN(76), ACN(74) IAN(70), DCN(75), and test A	210U	1)	Check status of previously selected tape U (Ready, $\overline{\text{End of Tape}}$)
FAN(76) or FNC(77)	202U	2)	Select read binary, tape U
ACN(74)		3)	Activate channel (informs the 607-B data is starting and starts tape motion)
IAN(70) or Load A and IAM(71)		4)	Input data (607-B starts input data transfer)
		5)	Disconnect channel (607-B disconnects channel at end of operation, see read description). This causes PP to go on to the next instruction.
FAN(76), ACN(74), IAN(70), DCN(75), and test A		6)	Check status of tape U
		7)	Repeat steps 3-7 for next record. Steps 7, 3, 4 must be executed within 500 usec after step 6 to allow nonstop read of next record.

Write File Mark: This is a special Write operation executed by the 607-B upon receipt of a 261U function code from the PPU. The PPU need not execute instructions to activate the channel or establish an output data buffer.

The operation requires about 43.3 usec. The 607-B and tape unit are in a Not Ready condition during this time. Multiple file marks may be written in a nonstop mode if desired by issuing successive Write File Mark codes.

File marks are written as an octal 17 followed by an identical longitudinal check character. An odd parity bit is not added. Thus, reading or writing a file mark sets the Parity Error status bit. A file mark is written at least 6 inches after the last check character.

The Write File Mark operation involves the following steps:

PPU Instruction	607-B Code	Step	Event
FAN(76), ACN(74) IAN(70), DCN(75) and test A	210U	1)	Check ready status of previously selected tape U
FAN(76) or FNC(77)	261U	2)	Select write file mark tape U
		3)	In response to the Write File Mark code in step 2, the 607-B starts tape motion and after a 40 ms delay writes the file mark (17_8). The tape is stopped then in the record gap if no new Write code from the PPU is waiting to be executed. Note that the PPU is hung up during the 40 ms delay if it issues another non-status function code to the 607-B for any tape. The lockout allows the 607-B to complete the current operation before starting another.

A Search File Mark operation may be accomplished by successive Read operations by the PPU, followed by status checks. Once a file mark is sensed, the File Mark status bit is set. Sensing a file mark also forces a Parity Error condition.

Tape Positioning

Tape Positioning operations move the tape in a reverse direction in the following ways:

1) Backspace over one record and stop (nonstop backspace over multiple records is possible).
2) Rewind to the load point (beginning of data on tape).
3) Rewind tape to unload positions. (Tape may be changed at this time.)

No tape data is available to the PPU during these operations and the PPU does not execute activate channel or input data instructions.

Backspace: The Backspace operation moves tape backward to the beginning of the preceding record. The tape and 607-B are in a Not Ready condition while backspacing. If the Peripheral Processor issues a function code to the 607-B during the interval, the PPU is hung up until the Backspace operation is completed.

Backspacing over a file mark produces a File Mark and Parity Error Status condition. These status bits remain set until cleared by the next non-status 607-B function code. Backspacing over a load point is possible.

The wait period during backspace is a function of the record length. Known record length waits may be computed using 16, 24, or 64 usec/frame. The tape becomes Ready and the 607-B accepts another backspace command for nonstop operation 333 usec after the last frame is read. A backspace over a file mark introduces an additional 40 ms wait period for nonstop Backspace operations.

If the next tape operation is a read or write function, the tape unit stays busy for 5 ms after Stop Tape Motion is initiated. Note that the 607-B can accept a read or write function (and disconnect the PPU channel) during the 5 ms stop period, but does not issue the Forward Motion signal to the tape until it is stopped.

A Backspace operation involves the following steps:

PPU Instruction	607-B Code	Step	Event
FAN(76), ACN(74) IAN(70), DCN(75) and test A	210U	1)	Check Ready status of previously selected tape U
FAN(76) or FNC(77)	203U	2)	Select backspace tape U (start tape motion)
FAN(76), ACN(74), IAN(70), and test A	210U	3)	Wait and check tape U status (tape U Ready)
		4)	Repeat steps 2 and 3 for nonstop.

Rewind: The Rewind operation moves the tape to load point and places the tape in Not Ready status until it has stopped at load point.

The 607-B accepts the rewind function, disconnects the PPU from the channel, and starts the rewind on tape U. Tape U is Not Ready until load point is reached; however, the 607-B is Ready 15 usec after disconnecting the PPU channel and can accept a function code for one of the remaining tapes sothat other tape operations may proceed during the rewind time. Thus, all tapes could be rewinding at once or one tape could be transferring data (read or write) while one or more tapes are rewinding.

A Rewind operation is as follows:

PPU Instruction	607-B Code	Step	Event
FAN(76), ACN(74) IAN(70), DCN(75) and test A	210U	1)	Check selected tape U status (tape READY light on and Not Busy)
FAN(76) or FNC(77)	206U	2)	Rewind tape U (start tape motion - tape Not Ready until stopped at load point - 607-B ready in 15 usec)

Rewind Unload: The Rewind Unload operation moves tape to unload position to change the tape. The tape is Not Ready until reloaded and again positioned at load point and under external control (READY light on).

The 607-B is Ready and will accept a function for an operation on another tape 15 usec after the Rewind Unload is accepted. Acceptance of a Rewind Unload by the 607-B starts tape motion and disconnects the PPU from the channel.

A Rewind Unload operation is as follows:

PPU Instruction	607-B Code	Step	Event
FAN(76), ACN(74), IAN(70), DCN(75), and test A	210U	1)	Check selected tape U status (tape READY light on and Not Busy)
FAN(76) or FNC(77)	207U	2)	Select rewind unload tape U (starts tape motion - tape Not Ready until reloaded and at load point - 607-B ready in 15 usec)

Status Checks

The 607-B makes available certain status conditions of the tapes to the PPU so that the latter may monitor progress of tape operations. A status function is accepted by the 607-B at any time and the response returned to the PPU by an input instruction. Thus, a status response for a tape that is in motion will be given for the conditions existing at that time. The lower 3 bits of a status request are not decoded so status response is always from a previously selected tape unit.

The status word is returned to the PPU on the lines that carry tape read data to the PPU. The PPU must execute an Input to A instruction after the status function to read the status word into A for testing.

Status replies and their meanings have been described earlier in relation to tape operations such as read and write and summarized under Status Reply Codes.

A status function is accomplished in the following way:

PPU Instruction	607-B Code	Step	Event
FAN(76) or FNC(77)	210U	1)	Select status of the previously selected tape unit.
ACN(74), IAN(70)		2)	Read status word into PPU A register.
		3)	PPU tests status word to determine conditions.

607 MAGNETIC TAPE TRANSPORTS

TAPE UNIT DESIGNATION

Each tape unit may have either a numerical designation (0 - 7) or be in Standby condition. These are determined by the Unit Select switch located on the tape transport. The transport cannot be used when it is on STANDBY. When the numerical designation of a unit is changed, any operation currently in progress with the transport is stopped and the PPU may hang up.

TAPE FORMAT

Magnetic tape provides a high-speed, non-volatile storage medium for recording and retaining information. The tape has a mylar base and is coated on one side with minute particles of iron oxide mixed with a binding agent. It is upon this coating that information is recorded. Extreme care is taken in the manufacture of the tape in order to eliminate any imperfection that could cause errors. Each roll of Control Data magnetic tape is therefore thoroughly tested before being used to guarantee its recording characteristics and performance.

Information is read (detected) or written (stored) by passing the oxide side of the tape over read/write heads. Information may be written on any of seven independent tracks on the tape. During a Read or Write operation, seven recording heads are placed vertically across the tape; therefore, 7 bits may be simultaneously recorded, one bit on each track. (See Figure 2 for the tape recording format.)

A seven-track non-return-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 a "0". Thus, each track of the tape is fully magnetized and the polarity is reversed as each "1" bit is recorded.

A frame of tape data consists of one 6-bit data character and one parity (check) bit for each character. Tracks 0 through 5 specify the characters while track 6 holds the parity bits (Figure 2). Two frames correspond to one data word from the PPU.

Data is recorded in binary or BCD format (just as they are represented in the memory). 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 in any line is even. The 607-B automatically adds the correct parity bit that accompanies each character.

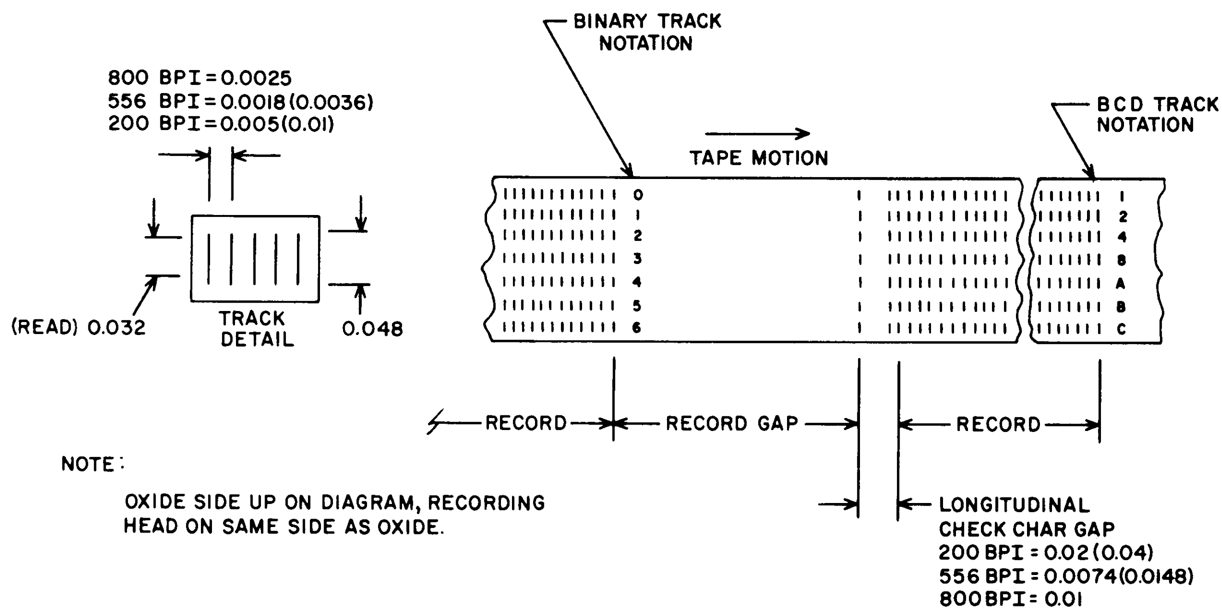


Figure 2. Bit Assignments on Tape

The controller records data on the tape in groups called records and files. A minimum of two frames of information constitutes a record. Adjacent records are separated by a 1-inch unrecorded area (record gap). A longitudinal parity frame is recorded at the end of each record such that the number of "1's" in each record track is made even.

During input/output operations the 607-B checks each character for correct vertical parity. If a parity error occurs a Parity Error status bit is set.

A file consists of a group of records. Adjacent files are separated by recording an end of file mark about 6 inches from the last record in the file. The file mark consists of an octal 17 (BCD) and its check character (also an octal 17) in the lower order bit positions. The upper bits are all zero.

REFLECTIVE SPOTS

Reflective spots are placed on the tape to enable the tape unit to sense the beginning and end of the usable portion of the magnetic tape. The reflective spots are plastic, 1 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 where they can be detected by photosensing circuits.

The load point marker must be placed at least 10 feet from the beginning of the tape on the supply reel (Figure 3). This marker is placed with its 1-inch dimension parallel to, and not more than 1/32 inch from, the edge of the tape nearer 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 take-up reel hub. This space includes approximately 10 feet of tape trailer and enough tape to hold a record of 96, 000 words after the end of tape marker is sensed. The marker is placed with its 1-inch dimension parallel to, and not more than 1/32 inch from the edge of the tape nearer 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 accumulating on the tape while attaching markers.

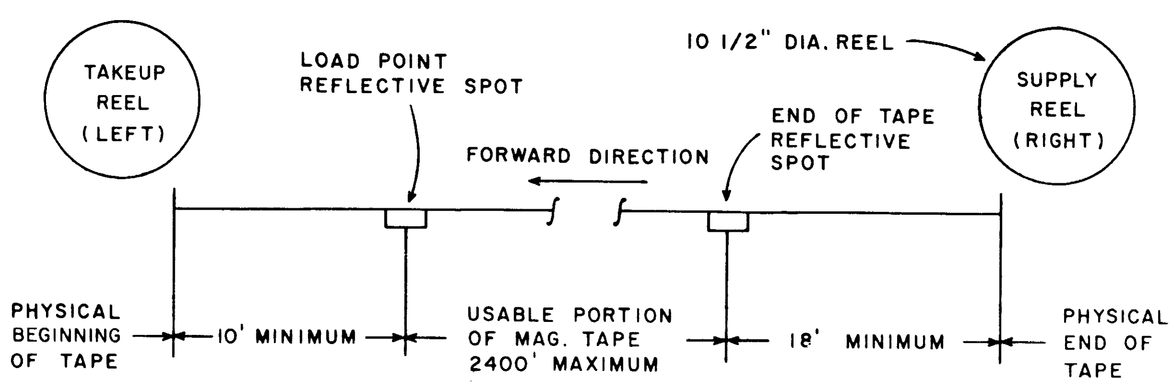


Figure 3. Physical Layout of Tape

FILE PROTECTION RINGS

The back of the tape reel has a slot near the hub which accepts a plastic file protection ring (Figure 4). Writing on a tape is possible only when the reel contains the file protection ring. If an attempt is made to write on a file protected tape, the channel hangs up on the output instruction. 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 unloaded. The ring should be removed from the file reel after writing is completed to avoid loss of valuable records through accidental rewriting.

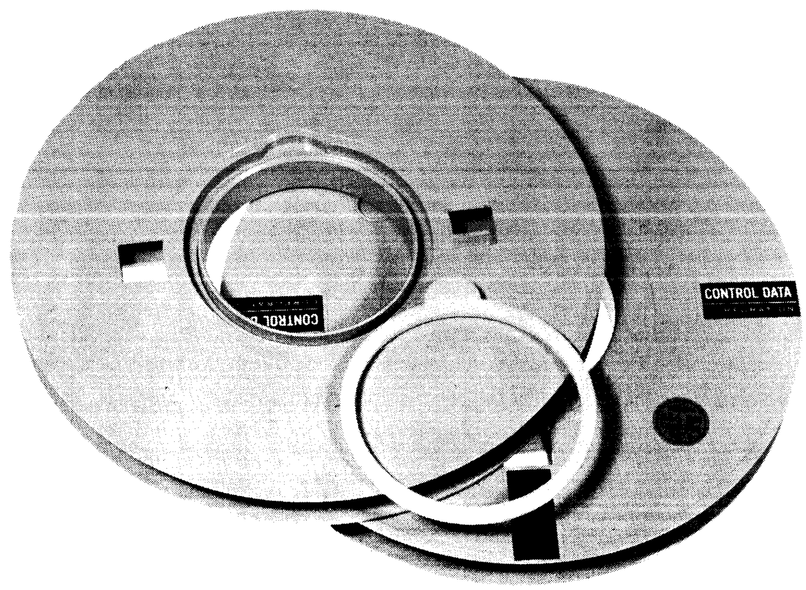


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Figure 4. File Protection Ring

MANUAL OPERATION OF 607 TAPE TRANSPORT

Switches and Indicators

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

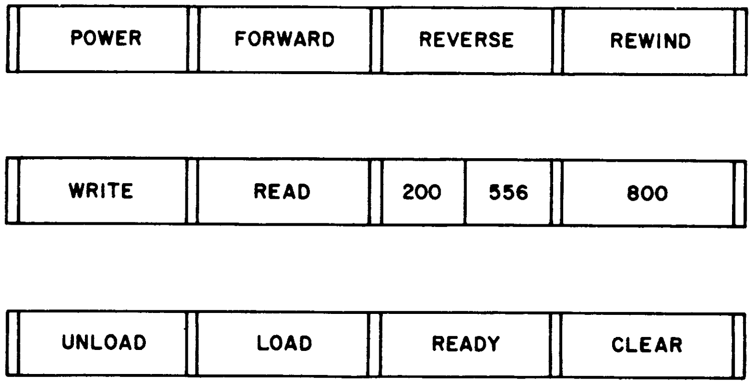

Figure 5. Manual Controls

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 therefore cannot be used by the processor.

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.

REVERSE Switch/Indicator: This switch moves the tape backward. 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 at high speed. It is lighted during this operation.

WRITE Indicator: The WRITE indicator is lighted while a Write operation is in progress.

READ Indicator: The READ indicator is lighted while a Read operation is in progress (not on during Read while Write operation).

200/556 Switch/Indicator: The 200/556 switch/indicator selects a density rate of 200 or 556 bpi and indicates the density selected.

800 Switch/Indicator: The 800 switch/indicator selects a density rate of 800 bpi. It is lighted when 800 bpi is selected.

UNLOAD Switch/Indicator: This switch moves all the tape to the supply reel at high speed. It is lighted when the tape unit is unloaded.

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 while depressed.

Operating Procedures

Application of Power:

1) Open doors at back of cabinet.
2) Place the main power circuit breaker (on power supply) in the up position. If the neon indicator fails to light, notify maintenance.
3) Place the remaining circuit breakers (on power supply) in the up position.
4) Hold the POWER switch on the maintenance panel ON for about 2 seconds, then release.

5) The POWER indicator on the front panel should light. If not, repeat the procedure (notify maintenance if the indicator does not light).

6) Close the back doors.

The POWER switch on the front panel is used only to remove power from the unit. Once this switch is pressed, the above procedure must be repeated in order to apply power to the unit.

Tape Load Procedure:

1) Slide front glass door down to lowest position (Figure 6).

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

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

CAUTION

For proper alignment, push reel firmly against hub stop before tightening knob.

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

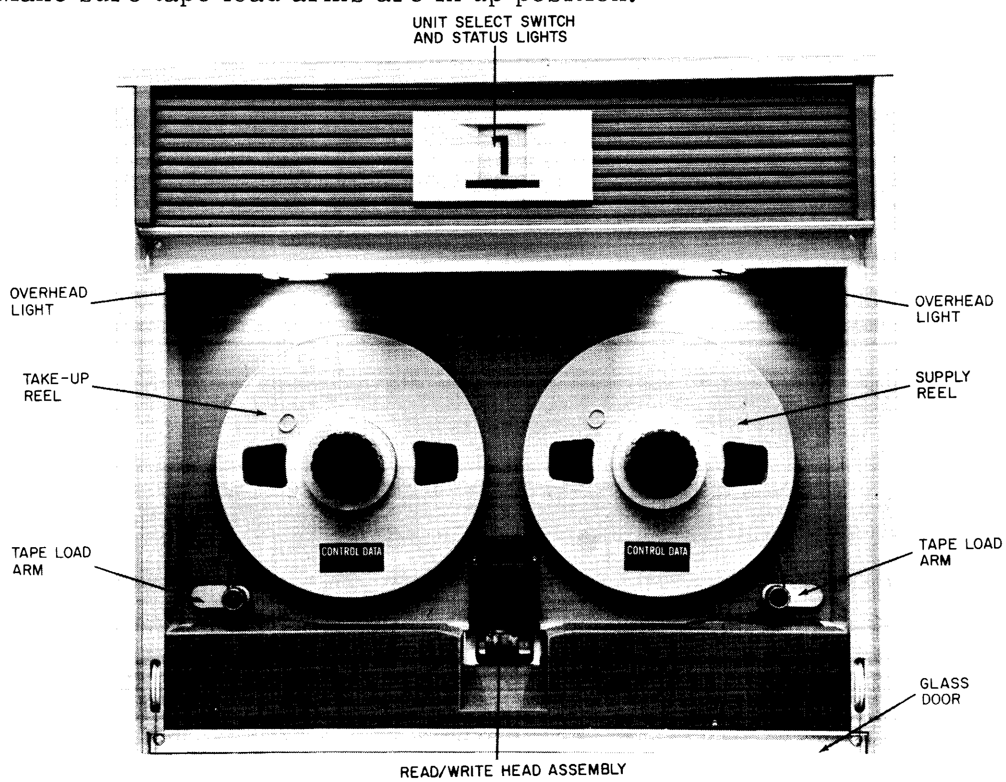

Figure 6. Tape Load and Unload Mechanics

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

6) Slide tape under head assembly.

7) Snap tape load arms down.

8) Set Unit Select switch to one of the numerical positions (0-7) to assign a logical program selection number.

9) Press LOAD switch. Tape drops in columns, moves forward, and stops on load point marker. The LOAD indicator lights. (If the indicator does not light, notify maintenance.) If tape continues moving forward for more than 4 or 5 seconds, it indicates either no load point marker was placed on the tape, or the operator manually wound the marker onto the take-up reel during step 5.

10) If the unit is to be externally controlled, press the READY switch. If it is to be manually operated and the READY switch has been pressed, press the CLEAR switch.

11) Slide the front door up.

If the supply reel contains a file protection ring, the overhead lights should be on, indicating that a Write operation may be performed. If the lights are not on, notify maintenance.

Tape Unload Procedure:

1) Press CLEAR switch.

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

3) Slide front door down to lowest position.

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: In order to simulate an Unload condition without removing all tape from the take-up reel, simultaneously press the CLEAR and UNLOAD switches. The Unload condition is simulated, but tape does not move. In order to place the unit in operational status, remove all tape from the vacuum columns by revolving the take-up reel clockwise and the supply reel counterclockwise. Snap the tape load arms down and press the LOAD switch. The tape moves forward and stops at the nearest load point marker and the LOAD indicator lights. If past the load point marker, clear the unit when motion starts forward.

If all tape is unwound from the supply reel:

1) Snap tape load arms up, if necessary.
2) Guide tape around the tape load arms, over the head assembly, and wrap approximately ten turns around the supply reel.
3) Slide tape under head assembly.
4) Press the LOAD switch.
5) As soon as the FORWARD indicator lights, press the CLEAR switch and then the REWIND switch. The tape rewinds to 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.

1) To move forward off a reflective marker and stop at nearest load point or end of tape marker, press the FORWARD switch. LOAD indicator lights if motion stops at load point marker.
2) To reverse from a reflective marker and stop at nearest load point marker, press the REVERSE and REWIND switches in that order.

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

405-B CARD READER CONTROLLER

CONTENTS

FIGURES

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405-B CARD READER CONTROLLER

This section describes the 6600 Card Reader system consisting of a CONTROL DATA* Special Option 60029 405-B Card Reader Controller and a CONTROL DATA 405-B Card Reader. This system operates with standard 6000 Series Data Channels. Figure 1 shows a typical configuration. Table 1 gives the system specifications.

This section describes data formats, the function of the controller, programming information, and operating instructions.

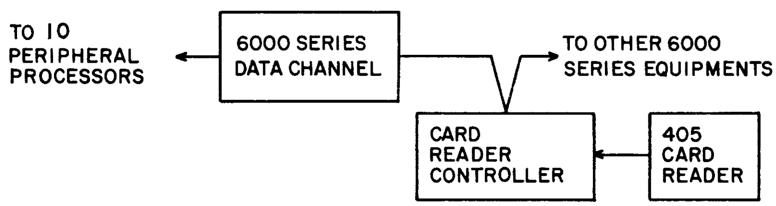

Figure 1. Typical Configuration

TABLE 1. SYSTEM SPECIFICATIONS

Reading Rate	1,200 80-column cards per minute 1,600 51-column cards per minute
Input Tray	4,000-card capacity tray
Receiving Trays	4,000-card capacity primary tray 240-card capacity secondary tray

*Registered trademark of Control Data Corporation

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

Peripheral and Control Processors communicate with the 405-B Card Reader via a Data Channel and the card reader controller. In addition to controlling the reading of cards, the card reader controller accepts data and control bits from the Data Channel register and one minor cycle later relays these bits to the next equipment on the channel. It must also accept data and control bits from the next equipment and relay these back to the Data Channel.

READ OPERATION

Reading is performed column-by-column, 12 bits at a time, with the bit from row 9 in the least significant position as shown in Figure 2. Card motion is initiated by the Read (0702) function code, and the card then proceeds without stopping completely through the reader. The Peripheral Processor must input 80 words (one for each column) to obtain the entire contents of a card.

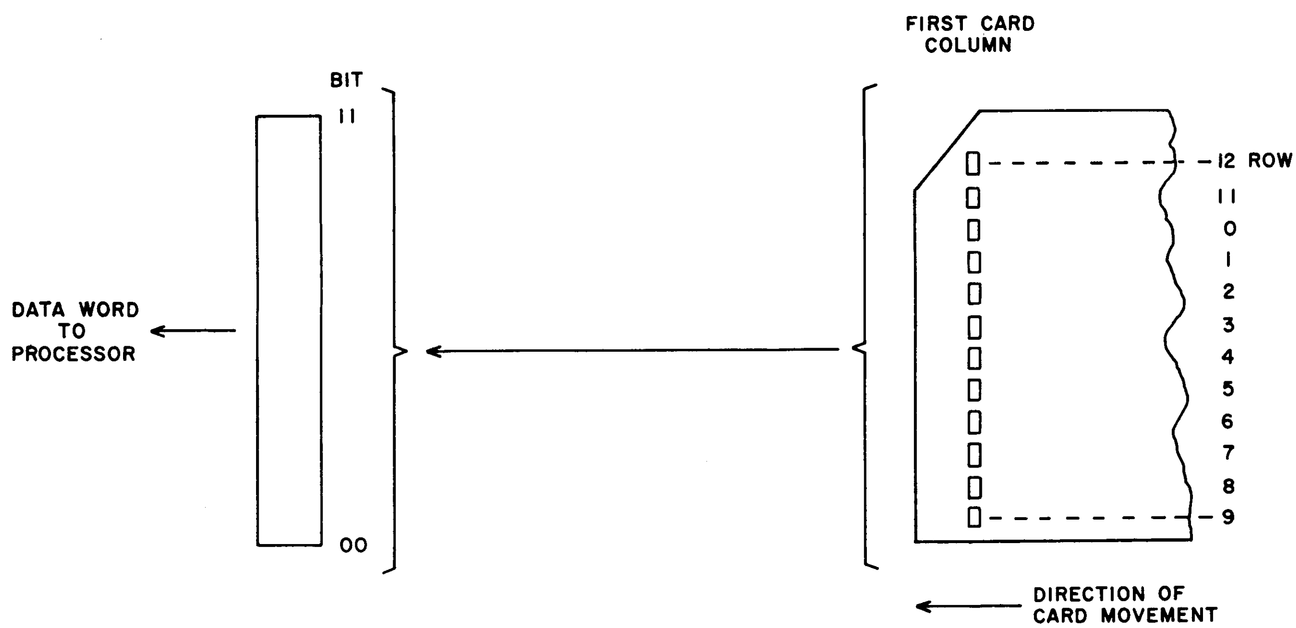

Figure 2. Bit Positions

CARD FORMAT

Card format information is given in Part VII, 3000 Series Card Equipment, Supplementary Information section.

ERROR CHECKING

The 405-B performs error checking by reading each column twice and comparing the data. If the two are not identical, the Compare Error status response (bit 2 = "1") is generated. This status response bit remains set until the operator manually presses the READY switch on the card reader (or until a Master Clear is transmitted during dead start). This type of error may be caused by a mutilated card. To use this error checking facility, the program must examine status after reading the last card column to determine if a Compare Error has occurred during the reading of the card. If so, the Gate Card to Secondary Tray (0701) function code may be transmitted to gate the faulty card to the secondary bin. This code must be transmitted within 1.5 ms after reading the last column.

NOTE

The card reader becomes Not Ready (status bit 0 = "1") if a Compare Error occurs. No further cards can be read until the operator restores the Ready condition by pressing the READY switch on the reader. The card should be reread.

PROGRAMMING

The basic philosophy of programming the 405-B Card Reader Controller is that cards are read one at a time and the status of the reader checked for Ready before each card is read. The Ready status bit is set if there is a card in position and the system is able to proceed. A card jam, input tray empty, or receiving tray full are some of the conditions which can cause a Not Ready status.

CODES

Table 2 lists the codes that apply to the 6600 card reader system.

TABLE 2. READER CODES

Function Codes	
Deselect Reader	0700
Gate Card to Secondary Tray	0701
Read	0702
Status Request	0704
Status Request Codes	
Ready	0000
Not Ready	0001
End of File	0002
Compare Error	0004

Function Codes

Deselect Reader (0700)

This code deselects the reader so that other equipment on the same channel can be selected. This prevents data intended for another equipment from being sent to the reader. This code should always be used at the end of a read program.

Gate Card to Secondary Tray (0701)

This code, if issued within 1.5 ms after the last card column is read, directs the card to the secondary receiving tray.

Read (0702)

This code starts a card through the card reader. For nonstop operation the 0702 code must be issued within 1.5 ms after the last column of the preceding card is read.

Status Request (0704)

This code makes the card reader status response word available to the Peripheral Processor. The processor must then execute a one-word data input to read in the status word.

Status Reply Codes

The lower 3 bits of the status reply word each indicate a separate condition. Any combination of the 3 bits can be present in the status word. The upper 9 bits are always zero.

Not Ready (0001) – Bit 0

Bit 0 is set whenever the reader cannot proceed with a Read operation due to the following conditions:

1) Stacker Full or Jammed
2) Input Tray Empty
3) Feed Failure
4) Compare Error
5) Power Off

The abnormal condition must be corrected and the READY switch pressed to return the reader to the Ready state.

End of File (0002) – Bit 1

Bit 1 is set after the last card in the input tray is read if the END OF FILE switch has previously been pressed.

Compare Error (0004) – Bit 2

Bit 2 is set if the reader incorrectly reads a card. This condition makes the reader Not Ready. No further cards can be read until the READY switch is pressed, however, the current card continues through the reader.

Programming Caution

An input instruction used to read a card must not specify a word count greater than the number of columns on the card. If the word count maintained in the A register is not reduced to zero when the last card column is read, the input instruction cannot be completed. This prevents the Peripheral Processor from executing the next instruction.

Timing

Receipt of the Read (0702) function code when a card cycle is not in progress initiates a card cycle in the 405-B. The card then proceeds through the reader as shown in Figure 3 and data is read column by column.

For the first card in a stack the first column of data is available 40 ms after the Read operation is initiated. For subsequent cards read from the same stack on a start-stop basis* the first column is available 20 ms after the Read function code is received. During nonstop reading, the first column on subsequent cards is read 18 ms after column 80 of the preceding card.

Using 80-column cards, the time required for a complete card cycle during nonstop operation is 50 ms. The 80 columns of data are read at a rate of 392 usec per column, giving 32 ms total.

For nonstop operation, the Read operation for the next card must be initiated with a Read (0702) function code within 1.5 ms after column 80 of the previous card is read.

It is necessary for the Peripheral Processor to input each column of data as it is read off the card. Normally this requires only a few usec, leaving time available for other operations. If it is desired to do I/O operations with other equipment on the same channel as the reader, the Deselect Reader (0700) function code should be transmitted after the column is received. This code prevents the controller from sending any of the other equipment's data to the card reader. At a later time, the card reader must be re-selected using the Read (0702) function code to receive the next column of data. (A Read (0702) function code received while a card cycle is in progress does not initiate additional card motion.)

*The new Read function code is not received within 1.5 ms after column 80 of a card has been read.

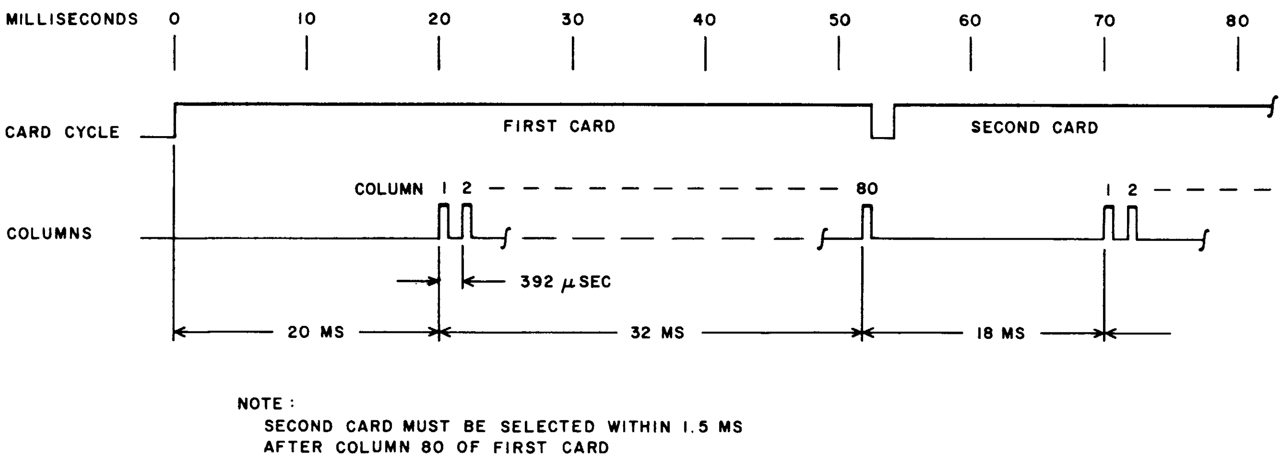

Figure 3. Timing

Programming Example for Continuous Reading

START	FNC	0704B, CHANNEL	Function to request status
	ACN	CHANNEL	Activate channel
	IAN	CHANNEL	Input status response to A
	DCN	CHANNEL	Disconnect channel
	LPN	01	Compare the status response with 0001 using the logical product
	NJN	START	Repeat if Not Ready
LOOP	FNC	0702B, CHANNEL	Start reading of card

16 ms available here; processor may not use this channel.

	ACN	CHANNEL	Activate channel
	LDC	80	Load word count in A
	IAM	BUFFER,CHANNEL	Input 80 words to memory starting at address BUFFER
	DCN	CHANNEL	Disconnect channel
	FNC	0704B, CHANNEL	Function to request status
	ACN	CHANNEL	Activate channel
	IAN	CHANNEL	Input status response to A
	DCN	CHANNEL	Disconnect channel
	LPN	04	Compare the status response with 0004 using logical product
	NJN	ERROR	Jump to address ERROR if Compare Error has occurred

1.5 ms available here; processor may use this channel.

	UJN	LOOP	Return to LOOP for next card

ERROR	FNC	0701B, CHANNEL	Function to gate erroneous card to secondary bin
	LJM	LOOP	Jump back to LOOP

NOTE

A compare error makes the card reader Not Ready. Thus, on the next iteration of the read program after a Compare Error the program hangs up on the input instructions until the operator presses the READY switch.

SWITCHES AND INDICATORS ON 405-B CARD READER

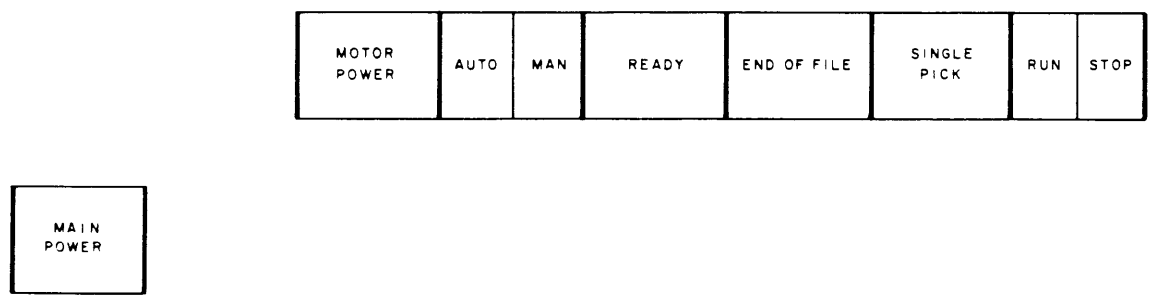

Figure 4. Card Reader Switches and Indicators

MAIN POWER Switch/Indicator

This switch, which is lighted when power is on, controls all primary power and turns on the photocell light source.

MOTOR POWER Switch/Indicator

This switch, which is lighted when power is on, controls power to the drive motors, the vacuum-pressure system, and the hopper-stacker vibrators.

AUTO/MAN Switch/Indicator

This two-position switch, which lights for the selected side, selects program- or manual-controlled modes of operation. Changing switch position to MAN drops the Ready status bit. The switch must be in the AUTO position when the reader system is used for computer I/O operations.

READY Switch/Indicator

This switch activates the reader if:

1) Input tray contains cards,
2) No error conditions exist in the unit, and
3) Primary and secondary stackers are not full.

The reader operates under program control only when the indicator lights to indicate the Ready condition.

END OF FILE Switch/Indicator

Pressing this switch, which lights when set, enables the reader system to generate an End of File status bit after the last card in the input tray is read.

SINGLE PICK Switch

This switch, which does not light, allows a single card to be cycled through the reader when the AUTO/MAN switch is in the MAN position.

RUN/STOP Switch/Indicator

This switch, which lights for the selected side, allows manual control of card feed when the AUTO/MAN switch is in the MAN position.

170 CARD PUNCH CONTROLLER

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FIGURES

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170 CARD PUNCH CONTROLLER

This section describes the 170 Card punch system consisting of a CONTROL DATA* 170 Card Punch Controller and a CONTROL DATA 415 Card Punch. This system operates with standard 6000 Series Data Channels. Figure 1 shows a typical configuration. Table 1 gives the system specifications.

This section describes data formats, the function of the controller, programming information, and operating instructions.

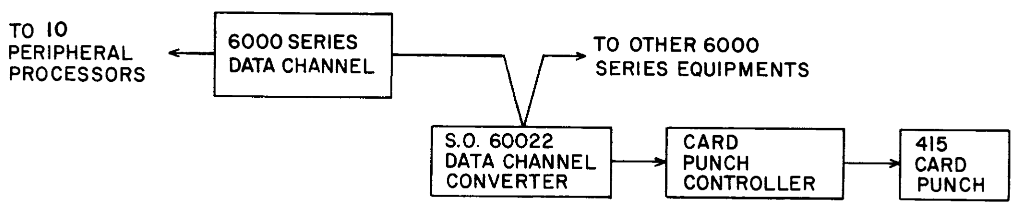

Figure 1. Typical Configuration

TABLE 1. SYSTEM SPECIFICATIONS

Punching Rate	250 80-column cards per minute
Input Hopper	1, 200-card capacity
Output Stacker	1, 500-card capacity

*Registered trademark of Control Data Corporation

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

Peripheral and Control Processors communicate with the 415-B Card Punch via a Data Channel, a Special Option 60022 Data Channel Converter, and a 170 Card Punch Controller. The Data Channel Converter accepts data and control bits from the Data Channel register and one minor cycle later relays these bits to the next equipment on that channel. It must also accept data and control bits from the next equipment and relay these back to the Data Channel.

When used with the 6600 in this configuration, the MANUAL SELECT switch on the 170 Card Punch Controller must always be in the 160 position.

PUNCH OPERATION

Punching is performed row-by-row, requiring 80 bits of data for each row. The 170 Card Punch Controller receives seven 12-bit data words and assembles them end-to-end to form a row pattern as shown in Figure 2. On a request from the punch, the leftmost 80 bits are transmitted to the punch and punched into one row of the card. This operation of assembling seven words and transmitting them to the punch must be repeated 12 times (once for each row) as a card moves through the punch head.

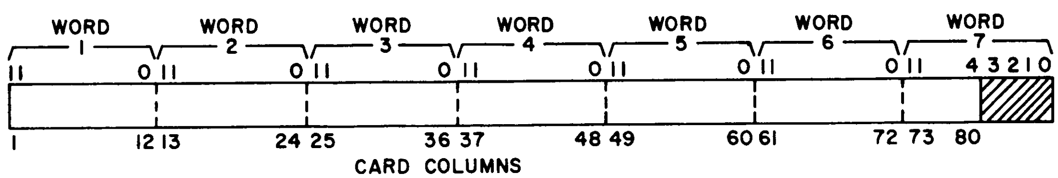

Figure 2. Punch Register in the 170 Controller

CARD FORMAT

Card format information is given in Part VII, 3000 Series Card Equipment Supplementary Information section.

OFFSET CARD

The Offset Card (3001) function code offsets a card slightly as it enters the output stacker. This feature permits the 415 card punch to do a limited sorting operation. The following limitations are imposed when using this feature:

1) The function code is not accepted until the controller becomes Ready near the end of a card card cycle.

2) The function code must be issued within 54 ms after the controller becomes Ready at the end of a card cycle if it is to be effective. If issued later than this, the card may not be offset or only partially offset, and the edge of the card may be damaged by the offsetting mechanism.

3) The function is automatically cleared at the start of a new card cycle.

PROGRAMMING

CODES

Table 2 lists the codes applicable to the 170 card punch system. The Offset Card (3001) and Status Request (3040) function codes should not be issued during that portion of a card cycle indicated by Not Ready in Figure 3. The punch does not respond to these function codes during this period and thus will not automatically disconnect the Data Channel after receiving a function code.

TABLE 2. PUNCH CODES

Function Codes	
Deselect Punch	3000
Offset Card	3001
Punch	3002
Status Request	3040
Status Reply Codes	
Ready	0X00
Not Ready	2X00
Incorrect Manual Switch Position	X200

Function Codes

Deselect Punch (3000)

This code deselects the punch so that other equipment on the same Data Channel can be selected. This prevents the other equipment's data from also being sent to the punch. This code should always be used at the end of a punch program.

Offset Card (3001)

The next card punched after this code is issued will be offset 1/4 inch by the stacker mechanism.

Punch (3002)

This code starts a card through the punch. It must be issued for each card to be punched.

Status Request (3040)

This code makes the punch system status reply word available to the Peripheral Processor. The processor must then execute a one-word data input to read in the status word.

Status Reply Codes

The 12-bit status reply word contains an Incorrect Manual Switch Position bit (bit 7) and a Not Ready bit (bit 10). All other bits are always zero.

Incorrect Manual Switch Position (X200)—Bit 7

Bit 7 is set whenever the MANUAL SELECT switch on the 170 Controller is in the 1604 position. This is incorrect for the 6600 application. The switch must be in 160 position.

Not Ready (2X00)—Bit 10

Bit 10 is set whenever a punch cycle is in progress or if punch is inoperative due to an abnormal condition such as:

1) Card jam, or
2) Chip box full.

PROGRAMMING CONSIDERATIONS

Timing

Selecting a Punch operation with a Punch (3002) function code causes the 170 Card Punch Controller to start a card cycle in the punch. The first row (row 9) reaches punching position 30 ms later. The remaining rows reach punching position at 15 ms intervals, as shown in Figure 3.

It is necessary for the Peripheral Processorto send seven words to the 170 Controller for each row punched into the card. Normally, this requires only a few usec, leaving several ms available for the execution of other programs. If it is desired to do I/O operations with other equipment on the same channel with the punch, the deselect (3000) function code should be transmitted after the seven words have been loaded. This code prevents the Data Channel Converter from sending any of the other equipment's data to the 170 Controller. At a later time, the punch and controller will have to be reselected using the Punch (3002) function code to load data for the next row.

A time of 45 ms elapses between the last row (row 12) and the end of the card cycle; thus the total time required for a card to pass through the punch head is 240 ms. However, the punch again becomes Ready (status reply 0000) approximately 5 ms after row 12 is punched. For continuous operation, the punch and controller should be re-selected, with another 3002 code, within 55 ms after becoming Ready.

NOTE

The controller does not recognize either the Status Request (3040) or the Offset Card (3001) function codes during the Not Ready portion of a card cycle. If either code is issued during this period the punch system will not disconnect the Data Channel.

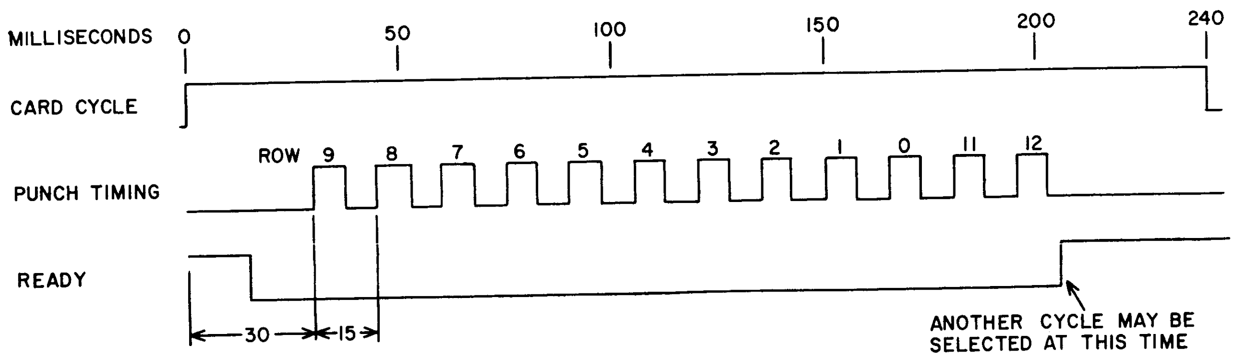

Figure 3 Timing

Programming Example

Card image must already be rotated to row-by-row in peripheral processor memory addresses BUFFER to BUFFER+83.

```
START   FNC   3040B, CHANNEL     Function to request status
        ACN   CHANNEL            Activate channel
        IAN   CHANNEL            Input status response to A
        DCN   CHANNEL            Disconnect channel
        LPC   2000B              Compare the status response with
                                 2000 using the logical product
        NJN   START              Repeat if not ready
        FNC   3002B, CHANNEL     Function to start punch cycle
        ACN   CHANNEL            Activate channel
        LDC   BUFFER             Load starting address in A
        STM   0, OUT+1           Store starting address in location
                                 OUT+1
    30 ms available here before row 9
ROW     LDN   07                 Load word count in A
OUT     OAM   BUFFER, CHANNEL    Output 7 words for one card row
        FJM   *, CHANNEL         Wait until all seven are sent
    15 ms available here between each row
        LDN   07                 Load number of words transmit-
                                 ted in A
        RAM   0, OUT+1           Add 7 to address and replace
        LMC   BUFFER+84          Test if new address equals
                                 BUFFER+84
        NJN   ROW                If not - recycle
        DCN   CHANNEL            If so - disconnect channel
```

6602-A/B/C/D/E/6612-B/C/D/E
CONSOLE DISPLAY

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FIGURES

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6602-A/B/C/D/E/6612-B/C/D/E/F/G CONSOLE DISPLAY

The CONTROL DATA® 6602-A/B/C/D/E 6612-B/C/D/E/F/G Console Display permits the visual display of information from the 6000 Series system processors as well as modification of register contents and Central Processor programs. The 6602/6612 Console Display consists of one controller and either one or two consoles (see Figure 1). The 6612-F/G is limited to one console.

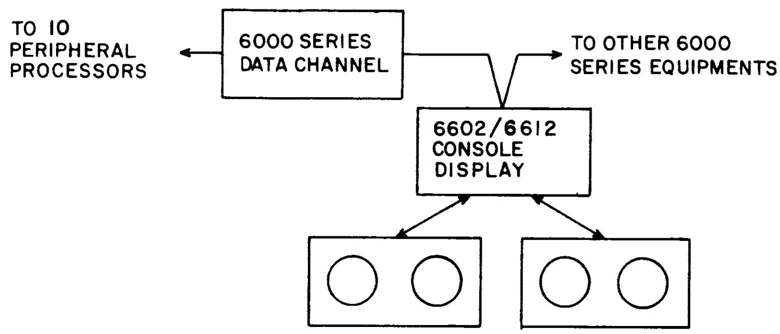


Figure 1. Typical Configuration

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The controller is mounted in either the central computer cabinet or in a peripheral controller cabinet. The console (DD60-A/B/C) is a self-contained, on line, direct reading cathode ray tube (CRT) display unit. Each console contains two 12-inch CRT's and a manual keyboard.

The CRT's provide program monitoring during 6000 Series computer operations. Several simultaneous operations may be displayed at the same time.

Data may be visually displayed within a 10-inch square raster on each CRT. This display can be either alphanumeric (Character mode) or graphic (Dot mode). The 262,144 dot locations in the display area are arranged in a 512 by 512 array. Each array location is uniquely defined by an X and a Y coordinate. An address of (000, 000) is located in the lower left corner of the display area. (777, 777) is located in the upper right corner.

The controller must be reselected each time an output is intended for a different CRT. Due to the persistence of the CRTs, however, up to four independent displays may be viewed simultaneously. Displays should be regenerated at least 25 times a second to avoid flicker.

There is no status response available from the console, which is always ready to receive data when the power is switched on. The controller accepts data at the maximum rate that it can be painted: 3 usec intervals for coordinate words (Dot mode) and 6 usec intervals for character words (Character mode). (Each character word contains two characters.) If the power to the console is switched off, the controller operates normally. Nothing will be painted and a keyboard input request will return code 00 (no data).

DISPLAY MODES

Dot Mode

Dot mode permits tailoring the display to meet the needs of the programmer. A dot is painted in response to each Y coordinate received at the location specified by it and the last X coordinate received.

Character Mode

Character mode permits painting (display) of controller generated characters in any one of three different sizes: large, medium or small. Sixteen large characters, each painted within a 32 by 32 array, may be displayed on a line. A line may also contain up to 32 medium sized (16 by 16) character locations or 64 small sized (8 by 8) character locations. Once the initial character location has been specified and the Write operation has begun, spacing of successive characters on the line is regulated by the controller. At the end of a line, a new initial character location must be sent to the controller. It is also necessary to specify a new initial location for successive writes on a line unless normal controller generated spacing is desired. The console interprets a 6--- code as specifying X coordinate --- and a 7--- code as specifying Y coordinate ---, where --- = 000 - 777. These codes may appear at any place in the Write that follows Character mode selection and should be considered in the message length count.

CRT ALLOCATION

Typical operation of the 6602/6612 Console Display allocates one screen for presentation of operator directives, and another for status information on the current problem or information on other problems being run. Although none of the central computer or PPU registers or memory locations are displayed automatically, a Peripheral Processor control program can extract this information and send it to the console for viewing. In addition, a control program can change the contents of the registers or Central Memory locations and can interrupt, step, or terminate a Central Processor program with manual inputs from the console keyboard. The use of several consoles minimizes idle-time in the system and permits simultaneous debugging and monitoring of many unrelated problems.

CONSOLE KEYBOARD

The console keyboard has 48 alphanumeric and special characters (see Table 1). When the console receives a Keyboard Input Request function code from the PPU it permits the PPU to input a Character code in the lower 6 bits of an input word. A Character code is always available from the keyboard. It will be either 00 (no data) or the code representing the last key pressed by the operator.

TABLE 1. 6602/6612 CONSOLE DISPLAY AND KEYBOARD* CHARACTER CODES

Character	Code	Character	Code	Character	Code
(Space)	00	P	20	5	40
A	01	Q	21	6	41
B	02	R	22	7	42
C	03	S	23	8	43
D	04	T	24	9	44
E	05	U	25	+	45
F	06	V	26	-	46
G	07	W	27	*	47
H	10	X	30	/	50
I	11	Y	31	(	51
J	12	Z	32	)	52
K	13	0	33	Blank	53
L	14	1	34	=	54
M	15	2	35	Blank	55
N	16	3	36	,	56
O	17	4	37	.	57

*Keyboard codes are identical to character codes with the following additions and one exception (space):

No Data	00	Backspace	61
Carriage Return	60	Space	62

PROGRAMMING

CODES

The 6602/6612 function code addends are listed in Table 2. In the discussion of these codes, bit 0 is the rightmost bit.

A function code is the sum of the Equipment Select addend and one addend from each of the remaining three groups.

EXAMPLE:

Equipment select	7---
Console 1, left screen	-2--
Dot mode	--1-
64 characters/line	---0
Function code	7210

TABLE 2. FUNCTION CODES

Equipment Select	7---	Select Console Display
Console/Tube	-0--	Console 0, Left Screen
	-1--	Console 0, Right Screen
	-2--	Console 1, Left Screen *
	-3--	Console 1, Right Screen *
Mode	--0-	Character Mode
	--1-	Dot Mode
	--2-	Keyboard Input Request
Character Size	---0	64 Characters/Line (Small)
	---1	32 Characters/Line (Medium)
	---2	16 Characters/Line (Large)
NOTE For Dot mode and Keyboard Input Request bits 0-2 are ignored and generally are 000.		
* Console 1 Screen selection is not applicable on a 6612-F/G		

DATA TRANSFER

Data Output

There are two basic data word formats, one for each of the two modes of operation in the 6602 Console Display (Figure 2).

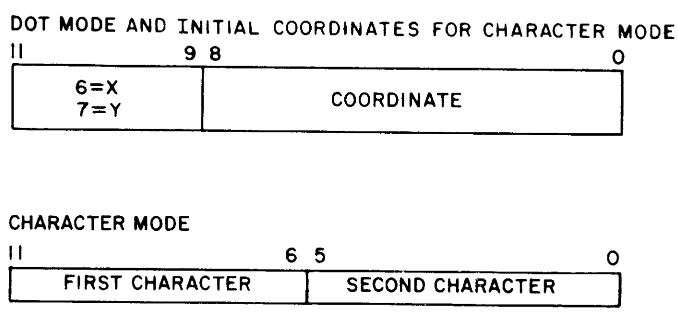


Figure 2. Data Word Formats

Dot Mode: In Dot mode, a 6--- data word represents a 9-bit X coordinate, and 7--- represents a 9-bit Y coordinate. Receipt of an X coordinate word designates the X coordinate only. Receipt of a Y coordinate word, however, both designates the Y coordinate and forces a period (.) into the character translators. This causes a dot to be painted at the intersection of the new Y coordinate and the last X coordinate received.

Character Mode: In Character mode, a 12-bit data word contains two 6-bit character codes. These codes are translated serially in the controller and sent to the character generator where various control signals are formed.

Data Input

The 6602/1612 Console Display, like any other piece of peripheral equipment, can input data only when requested. After being selected by a keyboard input function (7-20), the controller senses Channel Active condition and inputs a 6-bit Character code to the computer. Only one code is available to the PPU during the time a key is pressed. The 00 (no data) code is available to the PPU at all other times.

PROGRAMMING CONSIDERATIONS

Timing

Because of console timing considerations, a 1 usec pause (minimum) must be allowed between disconnecting a channel after an output and the execution of an input function. This time is the same as the execution time for a 00 PSN instruction. Below is a coded example of this use of the Pass instruction.

74d	Activate channel d
73d	Output (A) words
75d	Disconnect channel d
00	Pass
77d	Function on channel d
7020	Select Keyboard Input
74d	Activate channel d
70d	Input to A from channel d
75d	Disconnect channel d

Programming Example

The following program requests an input of one line of data from the console and displays this data on the console's left CRT as it is being typed in. Figure 3 is the flow chart for this program.

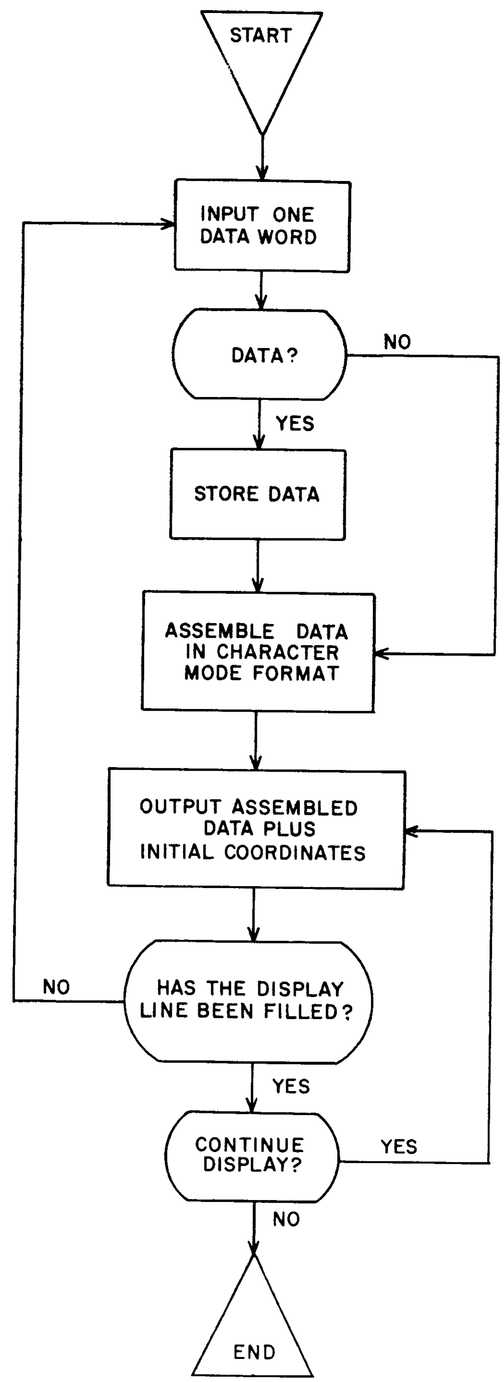


Figure 3. Flow Chart of Program to Input Data From Console and Display on CRT

```
START      LDN    00
           STD    DELTA               Set input address incremen-
                                      ter to zero

LOOP       AJM    LOOP, CHANNEL       Test for channel inactive
           FNC    7020B, CHANNEL      Select console 0, keyboard
                                      input
           ACN    CHANNEL             Activate channel
           IAN    CHANNEL             Input one word
           DCN    CHANNEL             Disconnect channel
           ZJN    GENERATE            Exit on No Data
           STM    INPUT, DELTA        Store data word
           LMN    62B                 Sense Space
           NJN    ADVANCE             Exit on Space
           STM    INPUT, DELTA        Store character code = 00

ADVANCE    AOD    DELTA               Advance input address in-
                                      crementer

GENERATE   LDN    00
           STD    ECHO                Set message address incre-
                                      menter to zero
           STD    FOX                 Set output address incremen-
                                      ter to zero

NEXT       LDM    INPUT, ECHO         Load first character
           SHN    6                   Left Shift six
           STD    MEMORY              Store temporarily
           AOD    ECHO                Advance message address
                                      incrementer
           LDM    INPUT, ECHO         Load second character
           ADD    MEMORY              Assemble output word
           STM    OUTPUT, FOX         Store output word
           LDD    FOX
           SBN    16
           ZJN    DISPLAY             Exit on a full line
           AOD    FOX                 Advance output address
                                      incrementer
           AOD    ECHO                Advance message address
                                      incrementer
           LJM    NEXT                Exit to assemble next out-
                                      put word

DISPLAY    AJM    DISPLAY, CHANNEL    Test for channel inactive
           FNC    7001B, CHANNEL      Select console 0, left CRT,
                                      medium character
           LDN    18                  Word count plus two
           ACN    CHANNEL             Activate channel
           OAM    MESSAGE, CHANNEL    Output message
           DCN    CHANNEL             Disconnect channel
           LJM    LOOP                Jump to beginning

MESSAGE    CON    6000B, 7757B        Initial coordinates, upper
                                      left corner

OUTPUT     BSS    16                  Output addresses

INPUT      BSS    32                  Input Addresses
           ORG

DELTA                                 Input address incrementer

ECHO                                  Message address incremen-
                                      ter
```

FOX			Output address incrementer
MEMORY			Temporary storage
CHANNEL	EQU	11	Define data channel

MANUAL OPERATION

CONSOLE CONTROLS

Operator controls on the DD60A/B/C Console are located in two areas:

1) The POWER ON/OFF switch is located under the right side of the desk top, and

2) The display adjustments DEAD START switch, and EMERGENCY OFF switch are directly below the two CRT's (Figure 4). Three of these controls, INTENSITY, FOCUS, and ASTIGMATISM are separate for each CRT. The remaining controls affect both CRT's equally.

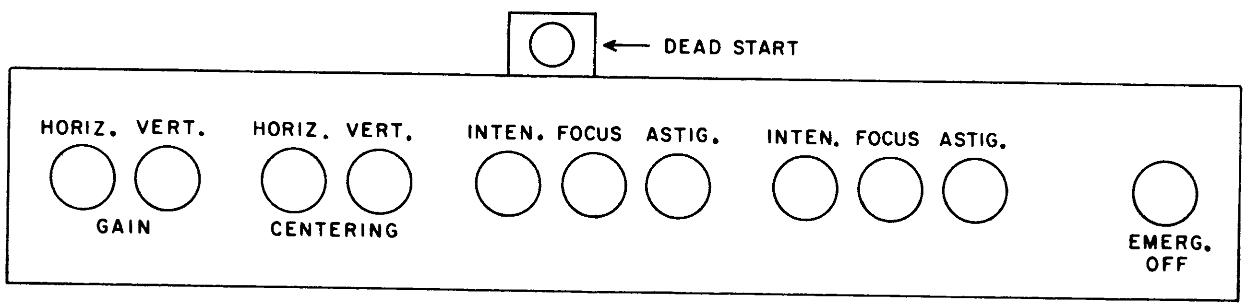


Figure 4. Operator Control Panel

POWER ON/OFF Switch

This switch applies or disconnects the ac voltages to the DD60A/B/C.

HORIZONTAL GAIN Control

This control varies the width of the CRT rasters.

VERTICAL GAIN Control

This control varies the height of the CRT rasters.

HORIZONTAL CENTERING Control

This control varies the horizontal location of the CRT displays.

VERTICAL CENTERING Control

This control varies the vertical location of the CRT displays.

HORIZONTAL CHARACTER SIZE Control (DD60-A only)

This control varies the width of the characters about their centers.

VERTICAL CHARACTER SIZE Control (DD60-A only)

This control varies the height of the characters about their centers.

INTENSITY Controls

These two controls vary the brightness of the CRT displays.

FOCUS Controls

These two controls are used to obtain optimum image clarity in the center areas of the CRT displays.

ASTIGMATISM Controls

These two controls are used to obtain optimum image clarity at the edges of the CRT displays.

DEAD START Switch (DD60-B/C only)

This pushbutton switch dead starts the computer system in a particular operating sequence.

EMERGENCY OFF Switch (DD60-B/C only)

NOTE

Do not press EMERGENCY OFF unless absolutely necessary because it turns off power to the entire computer system.

This pushbutton switch disconnects ac voltages to the display console and the entire computer system after an incorporated delay.

OPERATING PROCEDURES

CAUTION

Failure to rotate INTENSITY controls fully counterclockwise prior to warm-up may result in irreparable damage to the CRT's.

To turn the DD60A/B/C on, rotate both INTENSITY controls fully counterclockwise and press the POWER ON/OFF switch to the ON position.

After the 40- to 80-second incorporated time delay has passed, rotate the INTENSITY controls clockwise to obtain proper intensity of the symbols. Further manipulation of the other controls (GAIN, CENTERING, FOCUS, etc.) may or may not be necessary.

In the event it is necessary to turn the DD60A/B/C off, rotate both INTENSITY controls fully counterclockwise and press the bottom POWER ON/OFF switch.

1612 LINE PRINTER CONTROLLER

CONTENTS

FIGURES

TABLES

1612 LINE PRINTER CONTROLLER

The CONTROL DATA* 1612 Line Printer Controller and Special Option 60022 Data Channel Converter facilitate high speed printout of data received from standard 6000 Series Data Channels. Figure 1 shows a typical configuration.

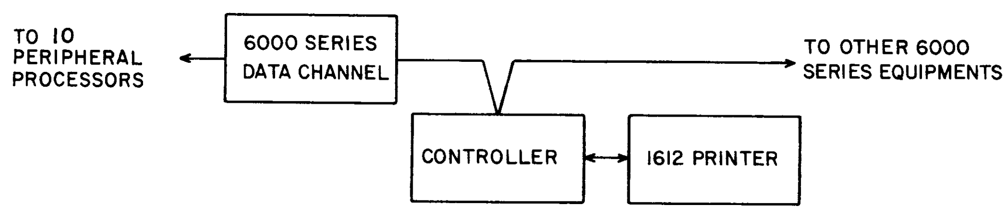


Figure 1. Typical Configuration

FUNCTIONAL DESCRIPTION

BUFFER MEMORY

These controllers store one line of data (up to 120 characters) in a magnetic core memory until the data is printed. This feature permits the Data Channel to load one line of characters into the memory at high speed. The Data Channel can then disconnect to service another device while the slower printing operation is being performed.

*Registered trademark of Control Data Corporation

PRINT OPERATION

The printer system (controller plus basic printer) accepts the lower 6 bits of the 12-bit words from the Data Channel and prints one character for each word. The upper 6 bits in each word are not used. Each line of print contains up to 120 characters; thus, 120 words are required to form a full line. If more than 120 words are transmitted to the system in a single output, words are lost or an erroneous printout occurs.

The controller forms each line of print in a buffer memory. After the line of print has been formed, the print (0605) function code must be sent to the printer. This code initiates printout of the line in buffer memory. Actual printing begins when the print head has rotated to the proper position.

PAPER ADVANCE

The printer system has a very flexible paper advancing system that is controlled by function codes. Certain function codes, such as Single Space and Double Space, cause spacing operations to occur directly. Other codes turn spacing control over to the printer's format tape reader. If no spacing operations are programmed by means of the function codes, the printer automatically single spaces after each line is printed. The eight-level format tape can be used to provide any page format desired. A loop of punched tape is the controlling medium. Loops of various lengths can be used to provide different page lengths.

A tape loop contains one frame for each line on the page format. During any spacing operation, the format tape advances one frame each time the paper advances one line. Paper spacing can be programmed to begin automatically after a line is printed or upon receipt of certain function codes. Once a spacing operation begins, the paper (and the tape loop) advances until a hole is detected in a preselected position on the tape.

There are two main types of spacing codes:

1) Advance format codes, and
2) Select format codes.

Advance Format Codes

An advance format code initiates a one-time spacing operation. An example of these codes is Move Paper to Top of Form (0604). This code causes the paper to advance until a hole is detected in the eighth level (channel) of the format tape loop.

Advance format codes take precedence over suppress space and select format codes. If two advance format codes are received, the paper advances to the farthest position specified.

Select Format Codes

Select format spacing codes set up automatic spacing operations which occur after each line is printed. These codes remain in effect until cleared. An example of these codes is Select Format Tape Level (channel) 5 (code 0615). When this code is in effect, a spacing operation begins after each line is printed. The paper advances until a hole is detected in the fifth level of the tape loop.

Tape levels one through six are used to control postprint spacing operations. Thus, the printer can be programmed to advance paper until the reader senses a hole in any level one through six.

The section on function codes following Table 1 describes each of the paper spacing codes. Preparation of the format tape is discussed in the Manual Operation section.

PRINTING RATE

A printer system using the 1612 Printer can operate at a maximum rate of 1, 000 lines per minute. To maintain maximum printing rates, certain programming considerations must be observed. These restrictions are outlined under Programming Considerations.

CODES

Tables 1 and 2 list the codes applicable to the printer system. Function and status reply codes are defined following Table 1. In all discussion of codes, bit 0 is the rightmost bit.

TABLE 1. 1612 PRINTER CONTROLLER CODES

Function Codes	
Select Printer	0600
Single Space	0601
Double Space	0602
Advance Paper to Format Level 7	0603
Top of Form	0604
Print	0605
Suppress Postprint Space	0606
Status Request	0607
Clear Format Selection	0610
Select Format Tape Level 1 for Postprint Spacing	0611
Select Format Tape Level 2	0612
Select Format Tape Level 3	0613
Select Format Tape Level 4	0614
Select Format Tape Level 5	0615
Select Format Tape Level 6	0616
Status Reply Codes	
Not Ready	0000
Ready	4000

Function Codes

Function codes are used to select and to prepare the printer for an output operation. A FAN or FNC instruction is used to transport function codes to the controller over the 12 data lines. See Table 1 for a complete list of function codes.

There are three classifications of function codes:

1) Operating*,
2) Print initiate, and
3) Nonoperating.

Operating Codes: There are two groups of operating codes; both cause paper motion.

1) Advance format codes (Single Space, Double Space, Advance to Format Level 7 and Top of Form) initiate paper motion, cause the control to become Busy and are self-clearing.

2) Select format codes (postprint) do not initiate paper motion. Instead, paper motion is initiated automatically following the printing of a line of data. The Postprint codes are Select Format Tape Level L for Postprint Spacing. They may be cleared by the Clear Format Selection code or a Dead Start Master Clear.

Print Initiate Code: This code (Print) permits printing to commence after the print head has rotated into position.

Nonoperating Codes: These codes (Select Printer, Suppress Postprint Space, Status Request, and Clear Format Selection) are not accepted during a printing operation, but are accepted while an operating function is being executed.

A control examines only one code at a time. A Reply is returned provided the function code is legal and the request can be performed. If the code is illegal or if it cannot be performed, a Reject is returned to the Data Channel.

*Operating codes cause the control to become Busy.

Select Printer (0600)

This code selects the 1612 Printer.

Single Space (0601)

This code selects the printer and advances paper one line. It is self-clearing.

Double Space (0602)

This code selects the printer and advances paper two lines. It is self-clearing.

Advance Paper to Format Level 7 (0603)

This code selects the printer and advances paper until a hole is detected in Format Tape Level 7. It is self-clearing.

Top of Form (0604)

This code selects the 1612 and advances paper until a hole is detected in Format Tape Level 8. The first line of the new form should then be in position for printing. It is self-clearing.

Print (0605)

This code selects the 1612 and initiates printout of a line from the buffer memory.

Suppress Postprint Space (0606)

This code suppresses the next Postprint Spacing operation. It is self-clearing.

Status Request (0607)

This code prepares the system for transmission of the status reply word to the Peripheral Processor. An Input to A operation must follow to read the status word into the processor.

Clear Format Selection (0610)

This code clears all format selections. Following issue of this code, paper automatically spaces one line after each Print operation.

Select Format Tape Level L for Postprint Spacing (061L)

These codes cause automatic advancement of paper following each Print operation. Advancement continues until a hole is detected in tape level (L), where L designates the tape level that is to control the postprint spacing operation. Tape levels 1 through 6 may be used for postprint spacing. The selections are cleared by Clear Format Selection (0610) and the Dead Start Master Clear only.

Status Reply Codes

The Status Reply codes permit the program to determine whether the printer is Ready or Not Ready. It is Ready if it is able to receive and print data. The Status Reply code is available by sending a status request to the printer and then inputting one word into A. See Table 1 for a list of the codes.

Not Ready (0000)—Bit 11

Bit 11 is clear if the printer system is Not Ready.

Ready (4000)—Bit 11

Bit 11 is set when the printer system is Ready.

Character Codes

Table 2 lists the printer character set and the corresponding codes. Internal and external BCD* codes are shown for each character.

Table 3 shows the printer characters in the order they appear on the printer drum. To maintain the maximum printing rate, successive characters must fall within the first 48 consecutive rows on the drum. Table 3 aids the programmer in selecting this section of the drum.

* BCD refers to binary coded decimal codes.

TABLE 2. CHARACTERS ARRANGED BY INTERNAL BCD CODES

Internal BCD	External BCD	Character Printed	Internal BCD	External BCD	Character Printed
00	12	0	40	40	- (minus)
01	01	1	41	41	J
02	02	2	42	42	K
03	03	3	43	43	L
04	04	4	44	44	M
05	05	5	45	45	N
06	06	6	46	46	O
07	07	7	47	47	P
10	10	8	50	50	Q
11	11	9	51	51	R
12	00	: (colon)	52	52	∨ (OR)
13	13	= (equals)	53	53	$ (dollar sign)
14	14	≠ (not equal)	54	54	* (asterisk)
15	15	≤ (less than or equal)	55	55	↑ (arrow up)
16	16	% (percent)	56	56	↓ (arrow down)
17	17	[(open bracket)	57	57	> (greater than)
20	60	+ (plus)	60	20	blank
21	61	A	61	21	/ (slash)
22	62	B	62	22	S
23	63	C	63	23	T
24	64	D	64	24	U
25	65	E	65	25	V
26	66	F	66	26	W
27	67	G	67	27	X
30	70	H	70	30	Y
31	71	I	71	31	Z
32	72	< (less than)	72	32	] (closed bracket)
33	73	. (period)	73	33	, (comma)
34	74	) (closed parenthesis)	74	34	((open parenthesis)
35	75	≥ (greater than or equal)	75	35	→ (right arrow)
36	76	⌉ (NOT)	76	36	≡ (identity)
37	77	; (semicolon)	77	37	∧ (AND)

TABLE 3. CHARACTERS ARRANGED BY CHARACTER ROWS

Character Row	Character Printed	Internal BCD	External BCD
1	0	00	12
2	1	01	01
3	2	02	02
4	3	03	03
5	4	04	04
6	5	05	05
7	6	06	06
8	7	07	07
9	8	10	10
10	9	11	11
11	A	21	61
12	B	22	62
13	C	23	63
14	D	24	64
15	E	25	65
16	F	26	66
17	G	27	67
18	H	30	70
20	J	41	41
21	K	42	42
22	L	43	43
23	M	44	44
24	N	45	45
25	O	46	46
26	P	47	47
27	Q	50	50
28	R	51	51
29	S	62	22
30	T	63	23
31	U	64	24
32	V	65	25
33	W	66	26
34	X	67	27
35	Y	70	30
36	Z	71	31
37	. (period)	33	73
38	- (minus)	40	40
39	+ (plus)	20	60
40	= (equals)	13	13
41	((open parenthesis)	74	34
42	) (closed parenthesis)	34	74
43	/ (slash)	61	21
44	* (asterisk)	54	54
45	, (comma)	73	33
46	≠ (not equal)	14	14
47	$ (dollar sign)	53	53
48	: (colon)	12	00
49	≤ (less than or equal)	15	15
50	% (percent)	16	16
51	[(open bracket)	17	17
52	] (closed bracket)	72	32
53	→ (right arrow)	75	35
54	≡ (identity)	76	36
55	∧ (AND)	77	37
56	∨ (OR)	52	52
57	¬ (NOT)	36	76
58	↑ (arrow up)	55	55
59	↓ (arrow down)	56	56
60	> (greater than)	57	57
61	< (less than)	32	72
62	≥ (greater than or equal)	35	75
63	; (semicolon)	37	77
64	blank (no character)	60	20

PROGRAMMING CONSIDERATIONS

Printing Rate (1612 Printer)

A 1,000 line per minute printing rate (up to 120 characters per line) can be maintained on the 1612 Printer if:

1) The character set is confined to the first 48 consecutive rows on the printer drum (see Table 3),
2) Single spacing is maintained between lines, and
3) The data channel begins to load a new line of data into the buffer memory within 11 ms after the printer becomes Ready.

Table 3 shows the order of characters on the printer drum and aids the programmer in selecting a 48-row character set. If all 64 characters are used, the printing rate is reduced to 500 lines per minute with single spacing.

If additional characters are used or if other spacing codes are used, optimum printing rates may be obtained by using 667 lines per minute motor speed.

Timing for Data Transfers

The printer system determines the transfer rate. The nominal transfer rate is 40 usec per 12-bit word or 2.4 ms per 120 character line.

Programming Example

This program prints one line.

```
START   FNC   0607B, CHANNEL    Request status
        ACN   CHANNEL           Activate channel
        IAN   CHANNEL           Input status reply
        DCN   CHANNEL           Disconnect channel
        ZJN   START             If status response zero, printer
                                Not Ready - Repeat status check
                                until Ready
        FNC   0600B, CHANNEL    Select printer
```

ANC	CHANNEL	Activate channel
LDC	120	Load word count for line into A register, 60 words (120 characters) to the line.
OAM	BUFFER, CHANNEL	Output characters
FJM	*, CHANNEL	Wait for last character to be accepted.
DCN	CHANNEL	Disconnect channel
FNC	0605B, CHANNEL	Print the line

MANUAL OPERATION

CONTROLS, SWITCHES AND INDICATORS ON 1612 PRINTER

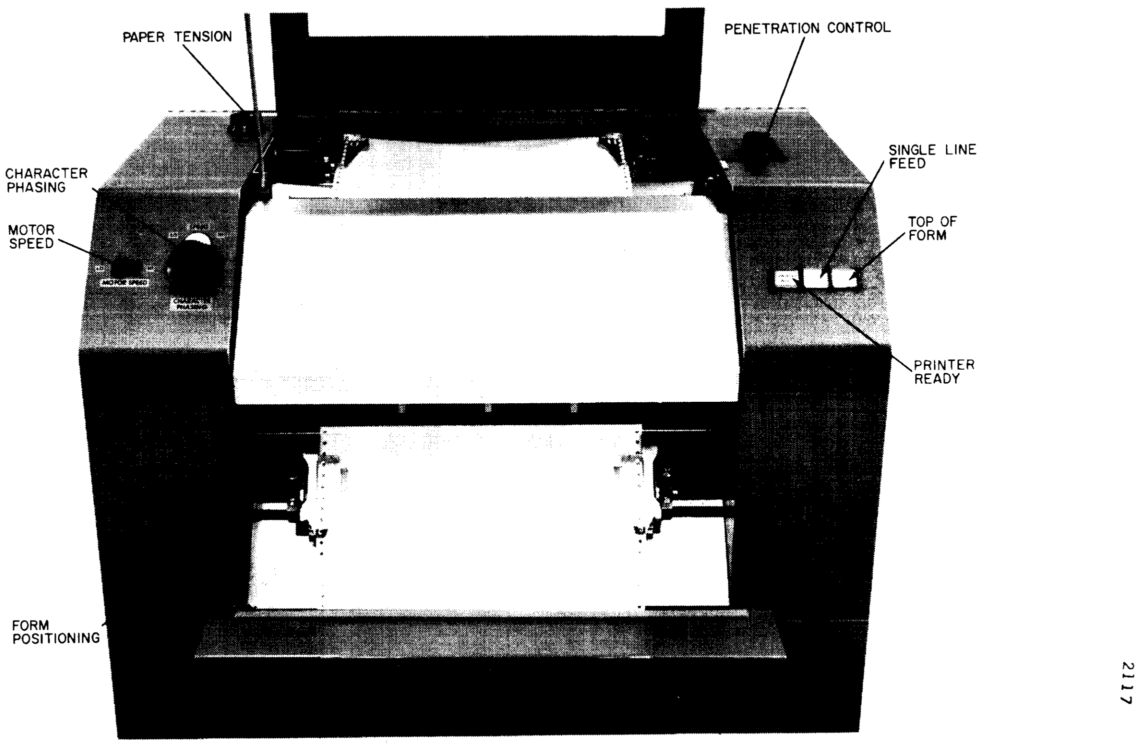


Figure 2. 1612 Printer

MOTOR SPEED Switch

This switch selects either 1000 or 667 lines per minute print rate.

CHARACTER PHASING Control

This control makes five adjustments of print quality after changing motor speed.

PENETRATION Control

This crank-actuated control adjusts the hammer-print head gap to accommodate various weights of paper. It includes a mechanical stop to prevent hammer damage to the print cylinder.

FORM POSITIONING Control

This control raises and lowers the paper during positioning.

PAPER TENSION Control

This control increases or decreases the paper tension to accommodate various weights of paper.

TOP OF FORM Switch

This switch advances the paper until a hole is detected in Format Tape Level 8. The first line of the new form to be printed on should then be in position for printing.

SINGLE LINE Switch

This switch advances the paper one space.

PRINTER READY Switch

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

MAIN POWER Switch

This switch applies power to the printer and is located in the printer control unit.

1604/160 Switch

This switch, located in the lower left hand cabinet of the printer control unit, must be in the 160 position.

OPERATING PROCEDURES

Preparation of Format Tape

The 8-level format tape is of punched mylar, approximately 13 inches long, joined in a continuous loop. This tape contains a number of frames equal to, or a multiple of, the number of lines on the printed page. If short forms are to be printed, duplicate hole patterns for several forms can be punched in the tape. Because of the physical characteristics of the reader mechanism, the tape must have a minimum length of 6-1/2 inches. During any spacing operation, the format tape is advanced one frame each time the paper advances one line.

As shown in Figure 3, the format tape includes a row of feed holes which engage cogs on a metal drum and drive the tape. Tape levels 1 through 8 are monitored by a photocell assembly, and paper is stopped when the selected level is sensed. Levels are selected by issuing the desired function codes. Selecting any level 1 through 6 for postprint spacing provides a means of extending the automatic single space feature to include more than one line. For example, if function code 0614 is selected, paper starts moving after each line is printed and continues to move until the photocells sense a hole in level 4 of the tape.

Level 8 must always contain only one hole* punched in the first frame. This level may be selected by function code 0604 or by pressing the PAGE EJECT switch on the control panel. When selected, level 8 moves paper to the top of the form.

---

*If the number of frames on the tape is a multiple of the number of lines on the printed page, the tape may contain in levels 7 and 8 one hole for each duplicate hole pattern.

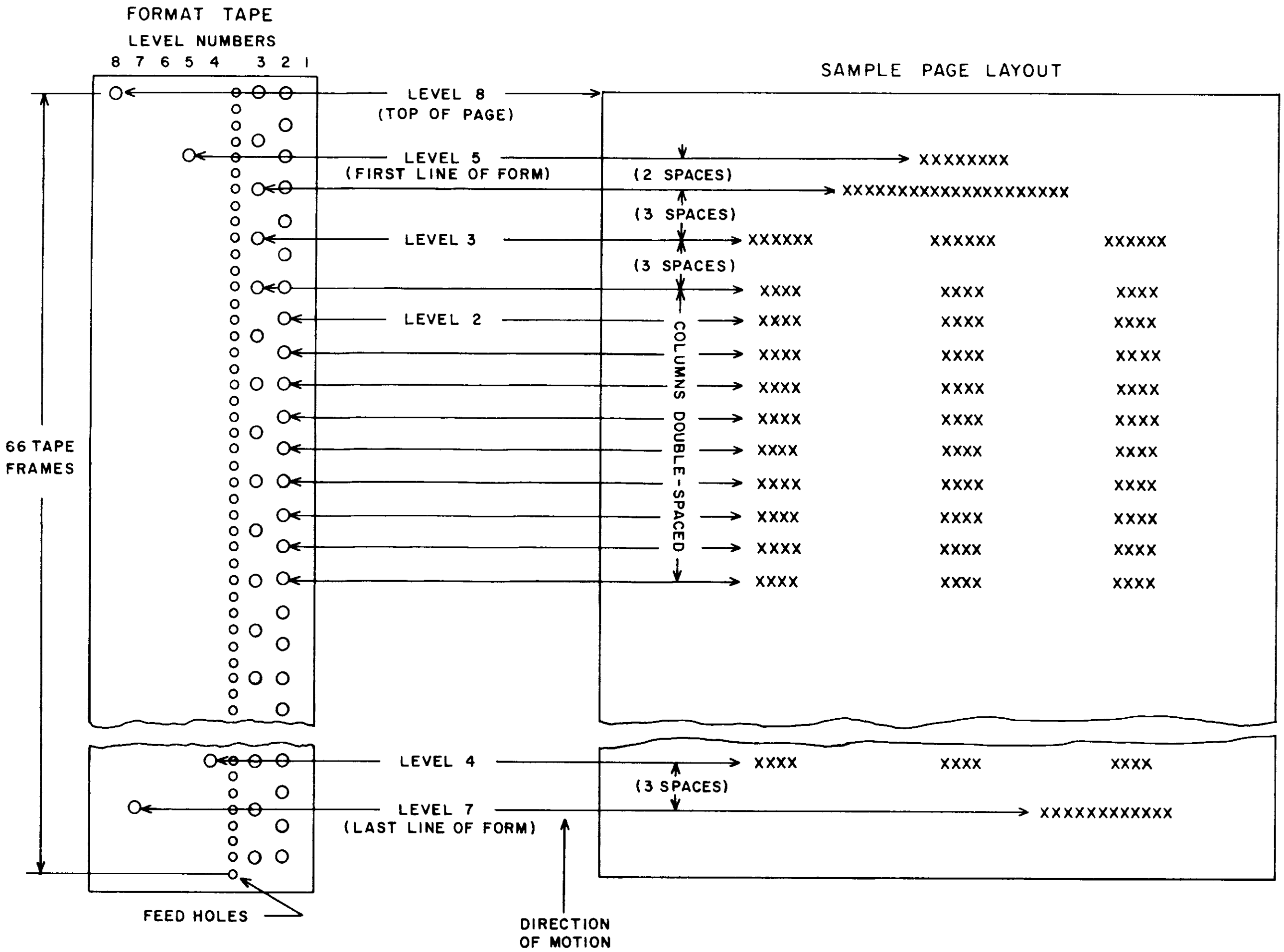


Figure 3. Spacing Example

Level 7 must also contain only one hole*. This hole may be punched in any frame according to the desired format. In the example shown, the hole in level 7 is in frame 62, consequently, the last line was printed on line 62 of the paper.

In the example (Figure 3), level 3 contains holes in every third frame, and level 2 contains holes in every second frame. This is a convenient arrangement because the sample form contains a number of triple spaces and double spaces. Selecting level 3 allows printing in lines 7, 10, and 13, double spacing the main heading and triple spacing to the column headings and the first tabulated figures.

Referring again to the sample page, note that a line is to be printed eight lines from the bottom of the page. To do this, punch a hole in frame 59 of level 4. Also, the double space function used in the preceding lines of print must be cleared and level 4 selected.

*If the number of frames on the tape is a multiple of the number of lines on the printed page, the tape may contain in levels 7 and 8 one hole for each duplicate hold pattern.

The last line to be printed is three spaces below the preceding line, and as mentioned above, is controlled by level 7 of the tape.

After the last line has been printed, level 8 must be selected to move paper to the top of the form.

Preparation for Operation

Installing Format Tape: Raise the brush assembly by turning the block-raising knob. This knob is located on the format tape assembly. This assembly is located on the left side of the print head. Install the format tape so the brushes fall between the first and last line of holes. Lower the brush assembly.

Loading Paper: Thread paper over the lower paper feed tractors, through the paper feed guide, and over the upper paper feed tractors. It may be necessary to use the penetration control crank to lower the print hammer module assembly. Return this assembly to the proper position after the paper is loaded. Position the paper feed tractors. The paper should press firmly against the platten, but should not be so taut as to cause elongation of the perforations.

Setting Manual Controls:

1) Set the 160/1604 switch to the 160 position.
2) Turn on the MAIN POWER and MOTOR POWER switches.
3) Select printer speed. If it is changed, adjust the CHARACTER PHASING control.
4) Put the format tape into position.
5) Press TOP OF FORM switch. If necessary reposition paper to conform to this setting.
6) Adjust PENETRATION control if paper weight has changed.
7) Press PRINTER READY switch.

The printer is now under processor control.

6603-A/B/C DISK FILE CONTROLLER

CONTENTS

FIGURES

TABLES

6603-A/B/C DISK FILE CONTROLLER

The CONTROL DATA* 6603-A/B/C Disk System consists of the 6603 Disk File Controller and a Bryant Series 4000 Disk File. The system may be used with the 6000 Series Computer Systems.

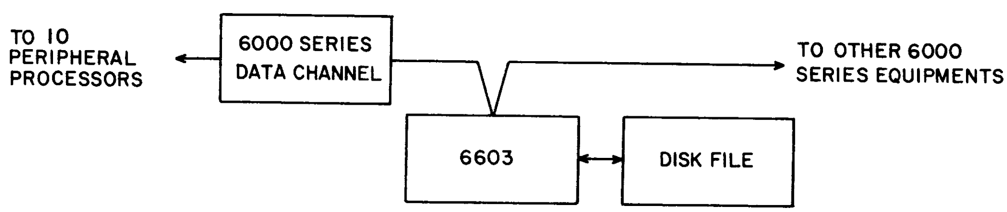


Figure 1. Typical System Configuration

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 6603 Disk System provides nonvolatile random access storage for 37, 355, 520 12-bit words. Data is written on, or read from the disk file (in parallel), i.e., each of the 12 bits is written on, or read from a separate disk surface.

Data transfer rate for sequential words is:

1.4 usec per word for the two outer disk zones
1.8 usec per word for the two inner disk zones

---

*Registered trademark of Control Data Corporation

DISK ORGANIZATION

The disk surface organization is illustrated in Figure 2 and is described as follows:

Zones	Tracks	Sectors	Bit-Positions Per Track†
1 (outer)	128	128	45,056
2 (outer)	128	128	45,056
3 (inner)	128	100	35,200
4 (inner)	128	100	35,200

Sector count is initiated at the reference mark. There is a group switch gap between the end of the last sector and the reference mark. This area is ordinarily not used for data storage.

There are two separate banks of 12 parallel disk surfaces (Figure 3). However, data can be transferred to or from only one bank at a time. The head groups shown in Figure 3 each serve one disk zone.

A Read or Write operation can be programmed to start at any location by function codes which specify track, sector, and head group.

RECORD FORMAT

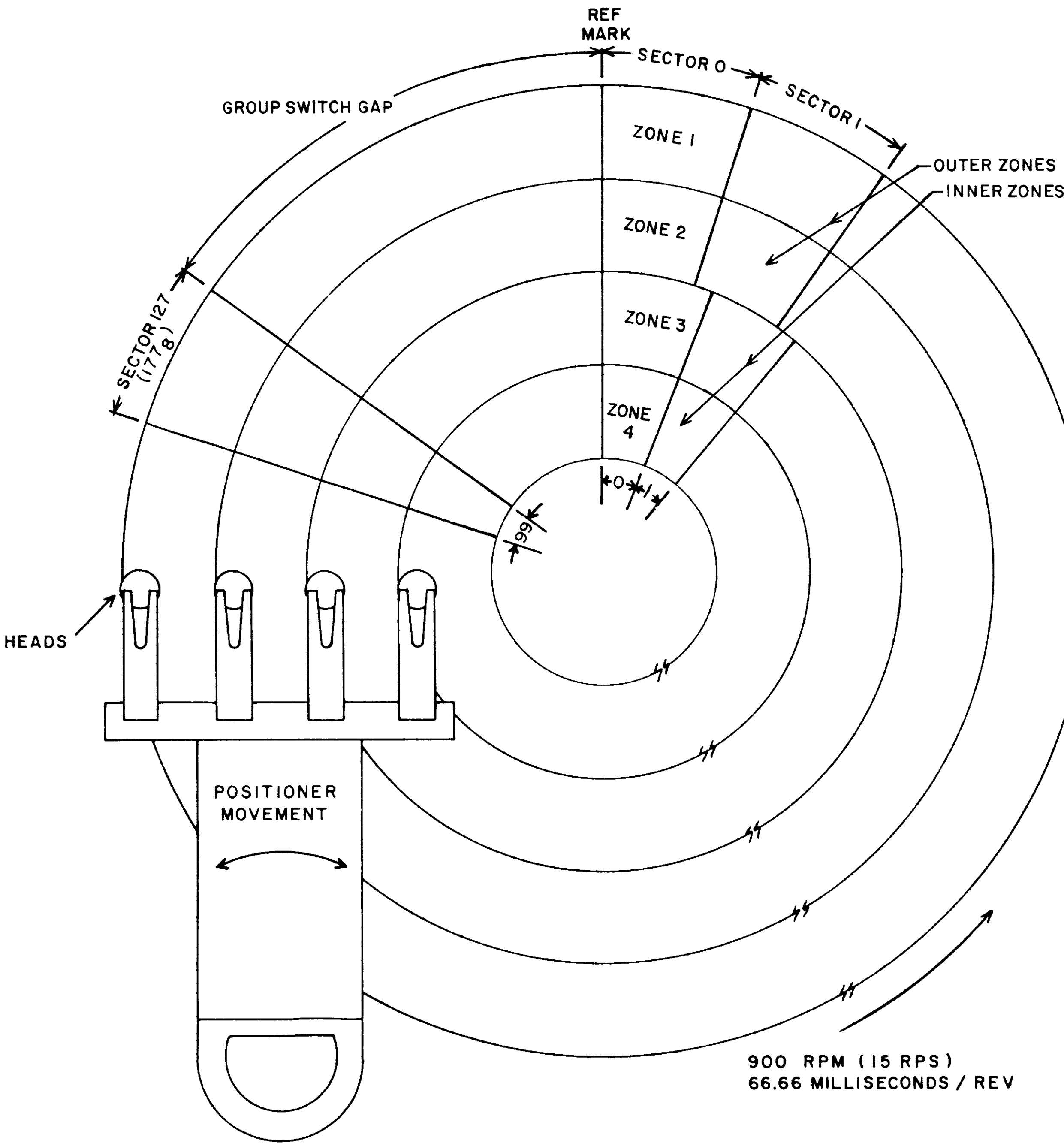
A record is a series of sequential data words sent from the Peripheral Processor by a single output operation. It always starts at the beginning of a sector.

A record consists of four words of all zeros, a series of data words, and a check word. Figure 4 shows various record formats. The minimum record length of six words (6-bit positions per surface) occurs when only one data word is written. The four words of all zeros that designate the start of a record and the check word are written automatically by the disk system.

A maximum of 45,051 data words* can be stored on each track in each of the two outer zones. The maximum is 35,195 data words per track in each of the two inner tracks.

†There are 352 bit positions available on each track in a sector.

*Some additional data may be stored in the group switch gap but this practice is not recommended.



EACH ZONE CONTAINS 128 TRACKS
(TRACK 127 OUTERMOST WITHIN EACH ZONE)

2 OUTER ZONES DIVIDED INTO
128 SECTORS

2 INNER ZONES DIVIDED INTO
100 SECTORS

EACH SECTOR CONTAINS 352_{10}
BIT POSITIONS

GROUP SWITCH GAP APPROXIMATELY
3 SECTORS WIDE

Figure 2. Disk Surface

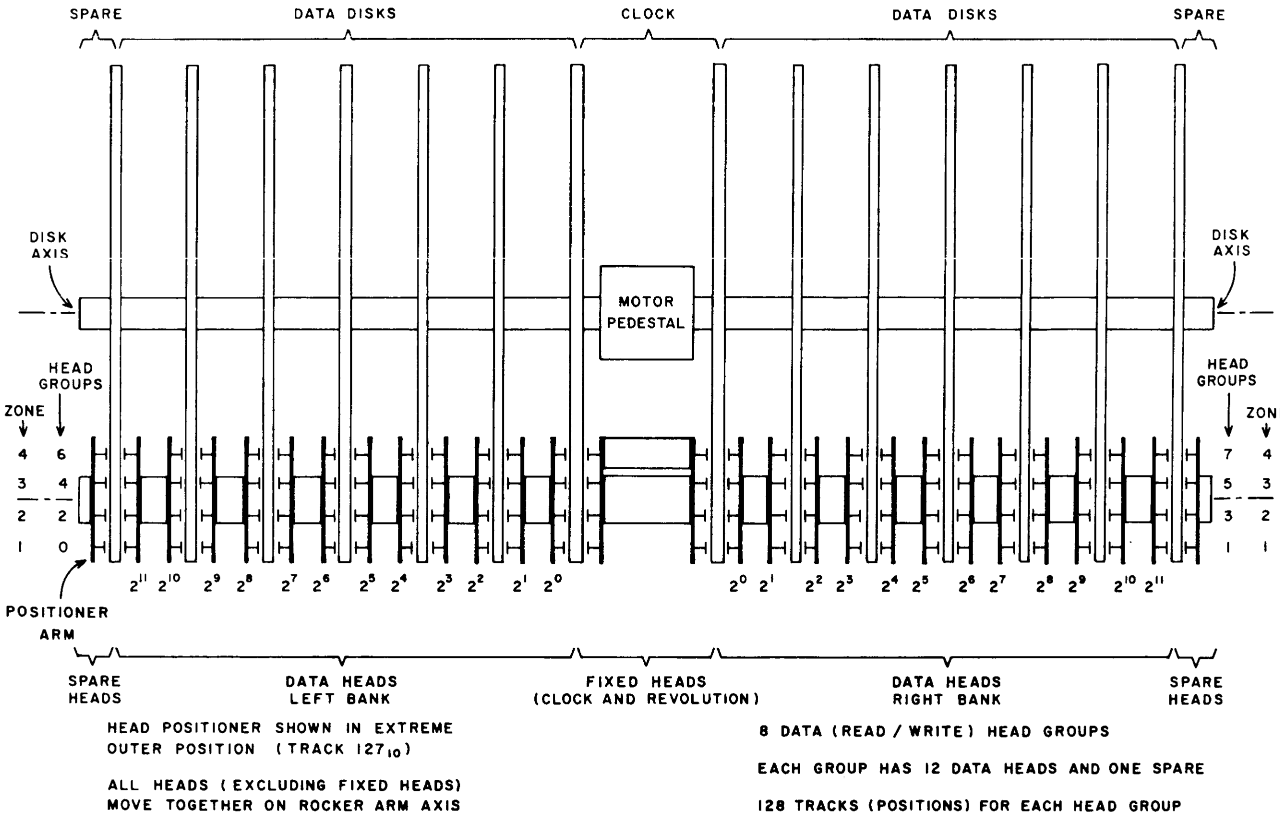


Figure 3. Disk Organization

If the record length is longer than can be accommodated in a single track, it must be segmented and written on more than one track.

Record length may vary as shown in Figure 4. A record can be shorter or longer than a sector. If a record only partially fills a sector, the remaining portion of the sector cannot be used since a new record can start only at the beginning of a sector.

During a Read operation the input instruction must specify the exact number of data words in the record (exclusive of the four zero words and the check word). The disk system does not signal the Peripheral Processor to terminate an input operation when it reaches the end of a record. Thus, if the word count specified in the input instruction is too large the disk will read the check word and data beyond the record of interest.

CHECK WORD

The disk system automatically writes a check word at the end of each record written on the disk (see Figure 4). This check word is used to verify the accuracy of the record when it is read from the disk. During a Read operation the disk system again generates the check word and automatically compares it with the original. If the two check words are not identical, an error occurred when the record was written or during the Read operation.

If there is a check word error the parity error status bit (bit 7) is set. Each input operation should be followed by a status check to sense for a parity error.

If an input instruction does not specify the exact number of data words in the record the check word comparison will be meaningless and the parity error status bit will be set. During a Write operation the parity error status bit will always be set, but is not significant. Status should be checked for a parity error only after a Read operation.

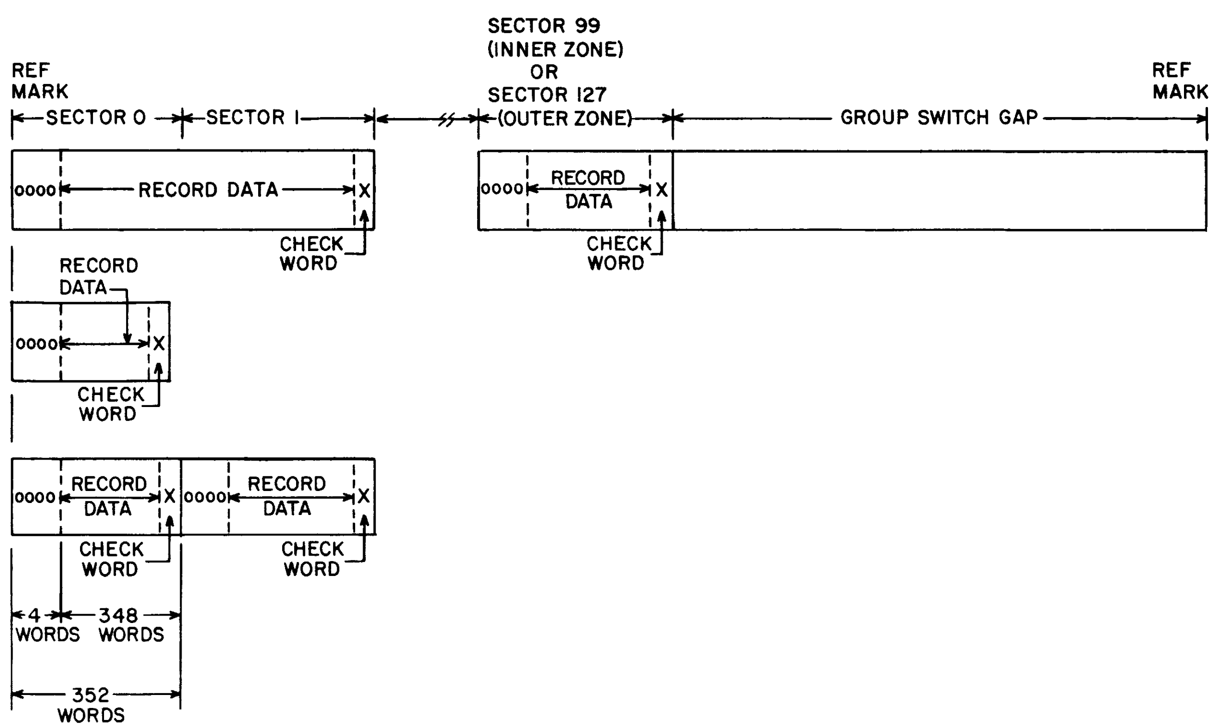


Figure 4. Record Formats

CODES

TABLE 1. 6603 DISK CODES

Function Codes	
Read Sector sSS*	1oosSS†
Write Sector sSS	1o1sSS
Select Track tTT**	11otTT
Select Head Group H***	160H
Request Status	1700
Status Reply Codes	
Ready	0opsSS
Not Ready	01psSS
No Parity Error	0rosSS
Parity Error	0r1sSS

*sSS = 000-177
**tTT = 000-177
***H = 0-7
†Small characters binary digits; large characters octal digits.

Function Codes

Read Sector *sSS (100sSS)*

This code prepares the disk system to read beginning at sector sSS. It must be issued prior to each Read operation.

Write Sector *sSS (101sSS)*

This code prepares the disk system to write beginning at sector sSS. It must be issued prior to each Write operation.

Select Track *tTT (110t TT)*

This code positions the heads over track tTT. The Peripheral Processor exits to the next instruction immediately after issuing this code. However, the disk will be Not Ready for a period of 201-267 ms while the heads reposition.

Select Head Group H (160H)

This code selects head group H. Bits 3-5 are normally clear, however, this value may be different for a particular installation. In any case bits 3-5 will be a constant for operational programming. The site customer engineer will have the correct value.

Status Request (1700)

This code selects the disk system for an input of the status reply word. An input instruction must follow to read in the status reply word.

Status Reply Codes

The disk status word consists of the current sector (sSS), a Parity Error bit (p) and a Not Ready bit (r).

Ready (0oPSSS) – Bit 8

Bit 8 is clear when the disk system is not engaged in a track selection (head repositioning) operation. The sector currently under the read/write heads is indicated by sSS.

Not Ready (01PSSS) – Bit 8

Bit 8 is set when the disk system is engaged in a track selection (head repositioning) operation. The sector currently under the read/write heads is indicated by sSS.

No Parity Error (0ROSSS) – Bit 7

Bit 7 is clear if a parity error is not detected during a Read operation.

Parity Error (0RISSS) – Bit 7

Bit 7 is set if a parity error is detected during a Read operation or if an input instruction does not specify the exact number of data words in the record. This bit will always remain set after a Write operation, but is not significant. It is intended for use only after a Read operation.

PROGRAMMING CONSIDERATIONS

Timing

Sector Selection: The Read or Write function codes select a specific sector for a Read or Write operation. When one of these codes is issued the disk does not respond until the designated sector reaches the heads. At this time the disk returns an inactive signal that permits the Peripheral Processor to execute the next instruction.

A Read or Write instruction must follow within 9.1 usec on the two outer zones and within 11.9 usec on the two inner zones. This period allows enough time to load the A register with the word count and activate the Data Channel. If a Read or Write instruction does not follow within this period the Read or Write operation will not start at the beginning of the sector.

Track Selection (Head Repositioning): The time required to reposition the read/write heads depends on the angular position of the disk with respect to the heads when the function code is issued. It is not dependent on the distance the heads must travel.

The minimum repositioning time of approximately 201 ms (3 disk revolutions) occurs if the function code is issued when the group switch gap is under the heads (just prior to revolution mark). The maximum repositioning time of about 268 ms (4 revolutions) results if the function code is issued when sector zero is under the heads (just after revolution mark).

If the Peripheral Processor issues either the Read or Write function code to the disk during the repositioning period, the disk does not respond. Thus, the Data Channel remains active until head repositioning is complete. The disk then accepts the Read or Write code and returns an Inactive signal to the Data Channel.

The Not Ready status bit (bit 8) is available to indicate if a head positioning operation is in progress.

Head Group Selection: Head group selection can be accomplished within the group switch period* if the group-select function code is issued at least one ms before the revolution mark passes under the heads. If the code is issued later than this, switching will not take place until the group switch gap again passes under the heads. The maximum delay is one revolution (67 ms).

The disk cannot respond to either a Read or Write function code during the group switching time. If either of these codes is issued during this period, the disk neither accepts the code nor inactivates the Data Channel until head selection is complete.

There is no status condition to indicate that a group switch operation is in progress.

Programming Techniques

Some of the techniques developed here are listed as aids to the programmer.

*Group switch period is the period of time the group switch gap passes under the read/write heads.

Half Track Technique: One way to organize data on the disk is the half-track idea where the programmer considers alternate sectors to be numbered consecutively around the track (the sector count is incremented by two). The skipped sectors are numbered in the same fashion. In this sense each track contains two half-tracks. The advantage of this method is that an entire sector time is available for programming between reading or writing consecutive sectors. This time is needed to load or unload the peripheral memory, and set up parameters for the next sector.

Parameter Storage: The programmer allows several words per sector for parameter storage. One way to use them is as follows:

1) Let word 501_8 contain the number of the next sector in which there is a continuation of the current record.

2) Let word 502_8 contain the number of words in the sector which are occupied by the current record. This scheme enables the processing of variable length records.

Programming Example

This program writes one record on the disk and reads one record from the disk.

100	6500	Jump to 0103 if
1	0103	channel is inactive
2	7500	Disconnect (deactivate) channel
3	7700	Function -
4	1700	Request Status
5	7400	Activate Channel
6	7000	Input Status Reply to A
7	7500	Disconnect Channel
110	2200	Check Status
1	0400	for Ready
2	0402	Jump if Ready
3	0300	Stop if disk is Not Ready
4	7700	Function -
5	1 10t TT	Select Track tTT (7 bits)
6	7700	Function -
7	160H	Select Head group H (3 bits)
120	7700	Function -
1	1 01s SS	Select Write Sector sSS (7 bits)
2	2000	Set A = 100 for
3	0100	100 word output
4	7400	Activate channel
5	7300	Output from
6	0200	0200
7	7500	Disconnect Channel

130	7700	Function -
1	1 oos SS	Select Read Sector sSS (7 bits)
2	2000	Set A = 100 for 100 word input
3	010X	Set to 101 if Check Word is also desired
4	7400	Activate Channel
5	7100	Input to
6	0300	0300
7	7500	Disconnect Channel
140	7700	Function -
1	1700	Request status
2	7400	Activate Channel
3	7000	Input Status Reply to A
4	7500	Disconnect Channel
5	2200	Check Status
6	0200	for Check Word error
7	05EE	Jump to error routine if error is detected
150	NI	Continue on in program

MANUAL OPERATION

SWITCHES AND INDICATORS

AUTOMATIC ON Switch/Indicator

This switch/indicator starts the disk file. It is dimly lighted during start up and brightly lighted when the file is ready for use. All other switches except AUTOMATIC OFF are disabled.

AUTOMATIC OFF Switch/Indicator

This switch/indicator turns off the file when the AUTOMATIC ON switch is lighted.

MANUAL ON Switch/Indicator

This switch/indicator permits use of all other switches except AUTOMATIC ON and AUTOMATIC OFF.

NOTE

The following switches are effective only when the MANUAL ON switch is lighted.

MANUAL OFF Switch/Indicator

This switch/indicator turns off the file when the MANUAL ON switch is lighted.

DISK MOTOR ON Switch/Indicator

This switch/indicator starts the disk drive motor. It is lighted when power is applied.

DISK MOTOR OFF Switch/Indicator

This switch/indicator turns off the disk drive motor.

HYDRAULIC MOTOR ON Switch/Indicator

This switch/indicator starts the hydraulic motor and applies power to the positioner control circuits. It is lighted when power is applied.

HYDRAULIC MOTOR OFF Switch/Indicator

This switch/indicator turns off the hydraulic motor and removes power from the positioner control circuits.

ELECTRONICS ON Switch/Indicator

This switch/indicator applies power to the electronic circuits.

ELECTRONICS OFF Switch/Indicator

This switch/indicator removes power from the electronic circuits.

HEADS ON Switch/Indicator

This switch/indicator places the heads in a working attitude.

HEADS OFF Switch/Indicator

This switch/indicator moves the heads away from the disk faces.

OPERATING PROCEDURES

The operator is also referred to Control Data 6603 A-C Disk System Service Handbook (Pub. No. 60127000).

Automatic Mode

To start automatic operation, press AUTOMATIC ON pushbutton. Indicator lights within the AUTOMATIC ON and DISK MOTOR ON pushbuttons light when the disk drive motor starts. The AUTOMATIC ON light is dimly lighted at this time.

After approximately a 60-second delay, indicator lamps within the HYDRAULIC MOTOR ON, HEADS ON, and ELECTRONICS ON pushbuttons light simultaneously with the starting of the hydraulic motor.

When the hydraulic system becomes operative and the head pads are prepared to begin Read/Write operations, the AUTOMATIC ON indicator lamp is brightly lighted, indicating the file is ready for use.

The stop automatic operation, simply press the AUTOMATIC OFF pushbutton. The data heads move immediately away from the disk faces, the hydraulic and disk motor is de-energized, and the storage disks coast to a stop.

Manual Mode

To start manual operation press MANUAL ON. Next press DISK MOTOR ON and HYDRAULIC MOTOR ON. After waiting approximately 60 seconds, press HEADS ON. It is possible to place heads in a flying altitude with the disk motor off by pushing MANUAL ON, HYDRAULIC MOTOR ON and, after 60 seconds, HEADS ON.

6639-A DISK FILE CONTROLLER

CONTENTS

FIGURES

TABLES

6639-A DISK FILE CONTROLLER

The CONTROL DATA* 6638-A Disk File System consists of one 6639 Disk File Controller, one disk file, and one hydraulic cabinet assembly. An expanded system consists of two 6639 Disk File Controllers, one disk file, and one hydraulic cabinet assembly. An expanded system incorporates CONTROL DATA Standard Option 10037-A which provides an additional controller to increase system capability. A basic system maintains operations with up to two 6000 Series Data Channels, one at a time. An expanded system maintains operations with up to four 6000 Series Data Channels, two at a time.

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The basic system shown in Figure 1 consists of one controller, physically attached between the two Data Channels and one disk file. This allows the 10 Peripheral Processors in one or more 6000 Series computers to access the two Data Channels and the one disk file. The Data Channels may simultaneously sample the conditions in the disk file through the controller, but they can operate the controller and disk file on a time-shared basis only. The disk file is divided into two sections, unit 0 and unit 1, which are mechanically and electrically independent of each other. A Data Channel can communicate with either unit 0 or unit 1, but both Data Channels cannot communicate simultaneously with their selected disk file units. For example, if Data Channel A is operating with unit 0, Data Channel B must wait until Data Channel A relinquishes operations with unit 0 before it can resume operations with unit 0 or 1.

The expanded system (Figure 1) consists of two controllers** physically attached between four Data Channels and one disk file. Since a disk file contains two units, each connected to a controller and each capable of independent operation, it allows one or more 6000 Series computers, each controlling up to ten Peripheral Processors, to perform simultaneous operations on both disk file units.

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*Registered trademark of Control Data Corporation

**The second controller is a standard option. Each of the controllers is slightly modified to permit the expanded mode of operation.

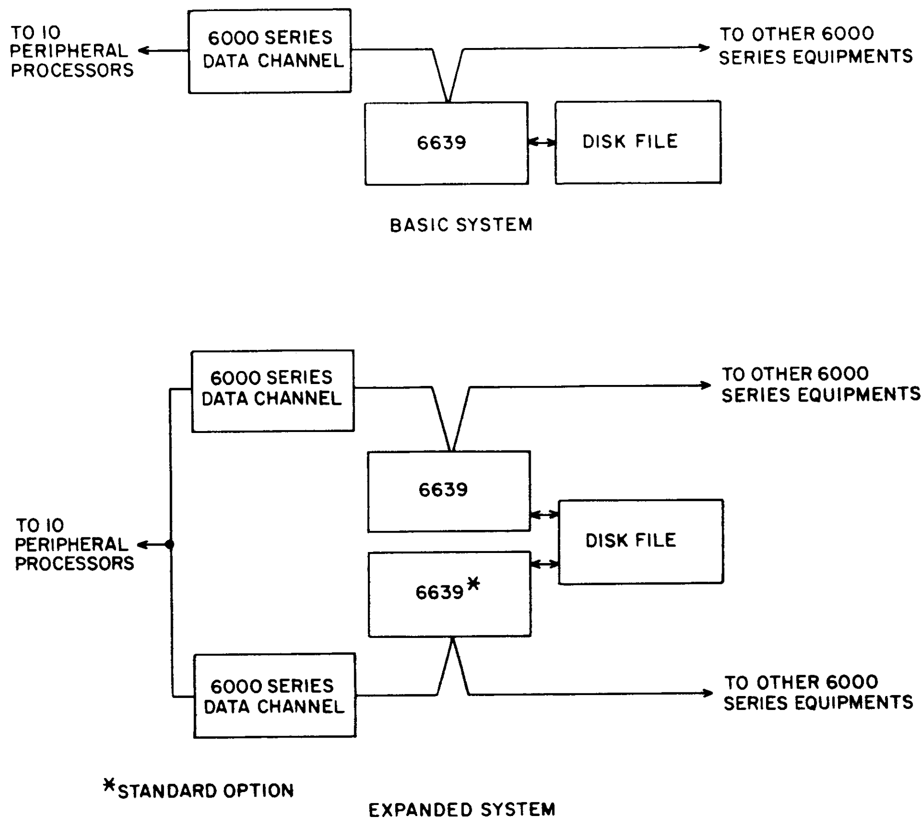


Figure 1. Typical System Configuration

CONTROLLER CHARACTERISTICS

The controller operates as an interface between the computer and the disk file. It buffers data in a 12-bit, parallel format between the computer and disk file via the Data Channel. The controller translates function codes sent by the computer program to control operations in the disk file. These codes condition the controller to connect between the proper Data Channel and disk file and to check the status of conditions within the disk file. The function codes determine from which area in the selected disk file unit the data is to be transferred. Finally, they select the operations that control the transfer of data. The controller provides timing and comparison circuits, registers, and the necessary logic to control and sequence the data handling operations.

The Data Channel issues a Function signal and output word to the controller. The Function signal causes the controller to sample the word and to define it as a function code. When the controller accepts a function word, it returns an Inactive signal to the Data Channel. Normally, functions are issued in the following sequence:

1) Connect and Status

2) Position Select

3) Head Group Select

4) Read

5) Write

If the function code is a Read, the Active signal (sent after the Read was replied to) signals the controller to start sending data. The controller then sends a data word together with a Full signal. When the Data Channel accepts the word, it sends an Empty signal, causing the controller to send the next word. The operations continue in this manner until the end of the read buffer. If the function code is a Write, the Active signal (sent after the Write) signals the controller that the Data Channel is ready to start sending data. The Data Channel sends a data word together with a Full signal. The controller accepts the word and returns an Empty signal, causing the Data Channel to send the next data word. The operation continues in this manner until the end of the write buffer.

The Data Channels connect to the controller on a first-come, first-served basis. The controller contains two interfaces, A and B, to accommodate the two Data Channels. If one Data Channel is connected, the other Data Channel cannot complete a connect. If both Data Channels attempt to connect to the controller at the same time, the channel wired to interface A is allowed to connect. To disconnect a connected controller, the Disconnect code (1740 or 1540) should be issued. The disconnect takes effect approximately 100 microseconds after the code is issued.

When the controller receives a Position Select function, it causes the disk file positioner to seek a new position. When the positioner reaches a null, the disk file sends an On-Point signal to the controller. The controller verifies the position address by comparing it with a Position code which has been prerecorded in serial form on one of the disk surfaces. One surface holds 32 position-codes for one 18-disk group. If the position code recorded on the track is equal to the position address specified by the function word, the read/write heads are correctly positioned. This, together with On-Point and File Ready signals, causes the controller to become Ready. A Ready condition must be present before a Read or Write operation can take place. If a Not Ready comes up during a Read or Write operation, the controller returns an Inactive signal to the Data Channel. A Status or Head Group Select function can be performed when the controller is Not Ready. A Position Select function is not accepted until an On-Point signal is received.

The disk file provides recording surfaces for mass data storage. Each disk file contains 72 disks divided into two units (designated unit 0 and unit 1) containing 36 disks each. Each 36-disk unit is divided into two 18-disk groups. The four 18-disk groups are mounted on two shafts so that an 18-disk group from each unit is mounted on the same shaft. Two 18-disk groups mounted on one shaft are a "stack". The disk file consists of stacks 0 and 1 (as shown in Figure 2). Each shaft turns independently so that separate reference and timing signals are provided for each half (stack) of a disk file unit. The disks, the hydraulic positioner assemblies, the disk file logic, and the power supplies are contained in the disk file. The hydraulic cabinet assembly contains the hydraulic system, the air compressor, and the associated hardware.

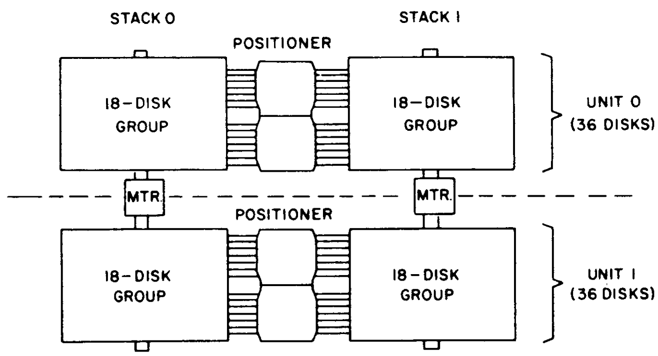


Figure 2. Disk File Disk Groupings

Surfaces

Each of the two 18-disk groups within a disk file unit is divided into two 9-disk groups. Each disk file unit, therefore, contains four 9-disk groups. Each 9-disk group contains 18 disk surfaces of which 16 are used for data storage. The remaining two surfaces in each group are either used for data synchronization or are not used. An entire disk file contains 144 disk surfaces (eight 9-disk groups times 18 disk surfaces) consisting of 128 data storage surfaces (eight 9-disk groups times 16 data storage surfaces). The remaining 16 surfaces (eight 9-disk groups times two non-data surfaces) consist of ten surfaces that are not used and six surfaces that are used to time Data Transfer operations. Four of the six surfaces are used for position verification. The remaining two surfaces contain write clock and sector marks for the two stacks.

Accessing

Each data storage surface is accessed by six read/write heads, three of which are selected at any one time. Since one head group contains 12 read/write heads, it accesses a total of 12 tracks on four disk surfaces at any one time. The two head arm assemblies, thus provide the capability of transferring 12 bits (1 byte) simultaneously to and from the disk file. Thirty-two head groups are used to access one disk file unit. These 32 head groups are mounted on a movable assembly (positioner). For the entire disk file, two positioners are used containing a total of 64 head groups. There are 768 read/write heads (12 read/write heads times 64 head groups) in the entire disk file. In addition, there are two fixed heads accessing the two disk surfaces which contain write clock and sector marks as shown in Figure 3.

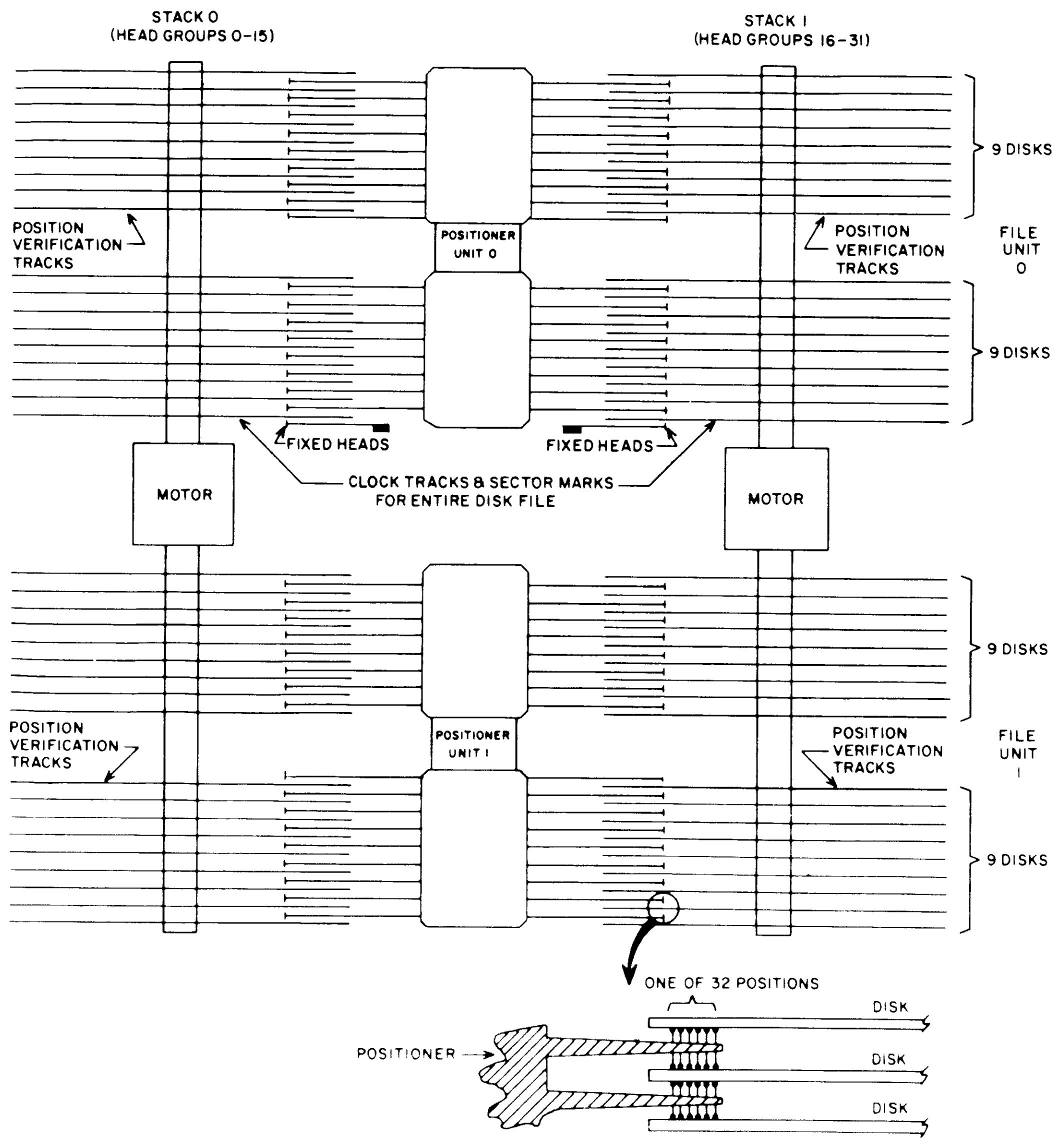


Figure 3. Disk File Disks and Positioners

Clock Track

Each data storage surface contains 192 tracks in which data can be recorded. The placement of data on each track is synchronized with pulses that have been permanently recorded on one track (clock track) of a non-data surface. The clock track contains 43,000 Write Clock pulses and 100 evenly spaced Sector Mark pulses. Each sector thus contains 430 Clock pulses. Refer to Figure 4. In addition, there are 24 extra pulses which provide for closure and index mark jitter. Separate clock tracks are provided for each of two stacks. Each clock track is accessed by a fixed head. Since the permanently recorded pulses on the clock track determine data placement, each track on a data surface is divided into 100 sectors and holds a maximum of 43,000 bits minus preamble and postamble bits.

Records

A record refers to a quantity of data which is written continuously over one or more sectors. Writing starts at a selected sector mark and stops at the end of the buffer. Since the capacity of each Peripheral Processor memory is approximately 4000 words (4096 words minus the computer program), the practical record size is restricted to a maximum of 10 sectors. Each record written on a track contains a preamble of 80 bits and a postamble of at least 28 bits. Preamble and postamble bits are provided as gaps between records (refer to Figure 4). A record always begins with a selected sector mark as a reference point. The preamble contains alternating "0" and "1" bits. Two "1" bits in succession signify the beginning of data. Since each record requires at least 108 preamble and postamble bits, the transfer of larger records allows the utilization of more track surface for the recording of data (greater track efficiency). Refer to Table 1 for information on record sizes and their relationship to track and sector efficiency.

Data Capacity

Each track has a maximum practical capacity of 42,892 data bits (one record or 43,000 bits minus the 108-bit preamble and postamble). One disk surface, therefore, can contain a maximum of 8,235,264 data bits (192 tracks times 42,892 data bits). An entire disk file can contain 1,054,113,792 data bits (128 data storage surfaces times 8,235,264 data bits) or 175,685,632 6-bit characters.

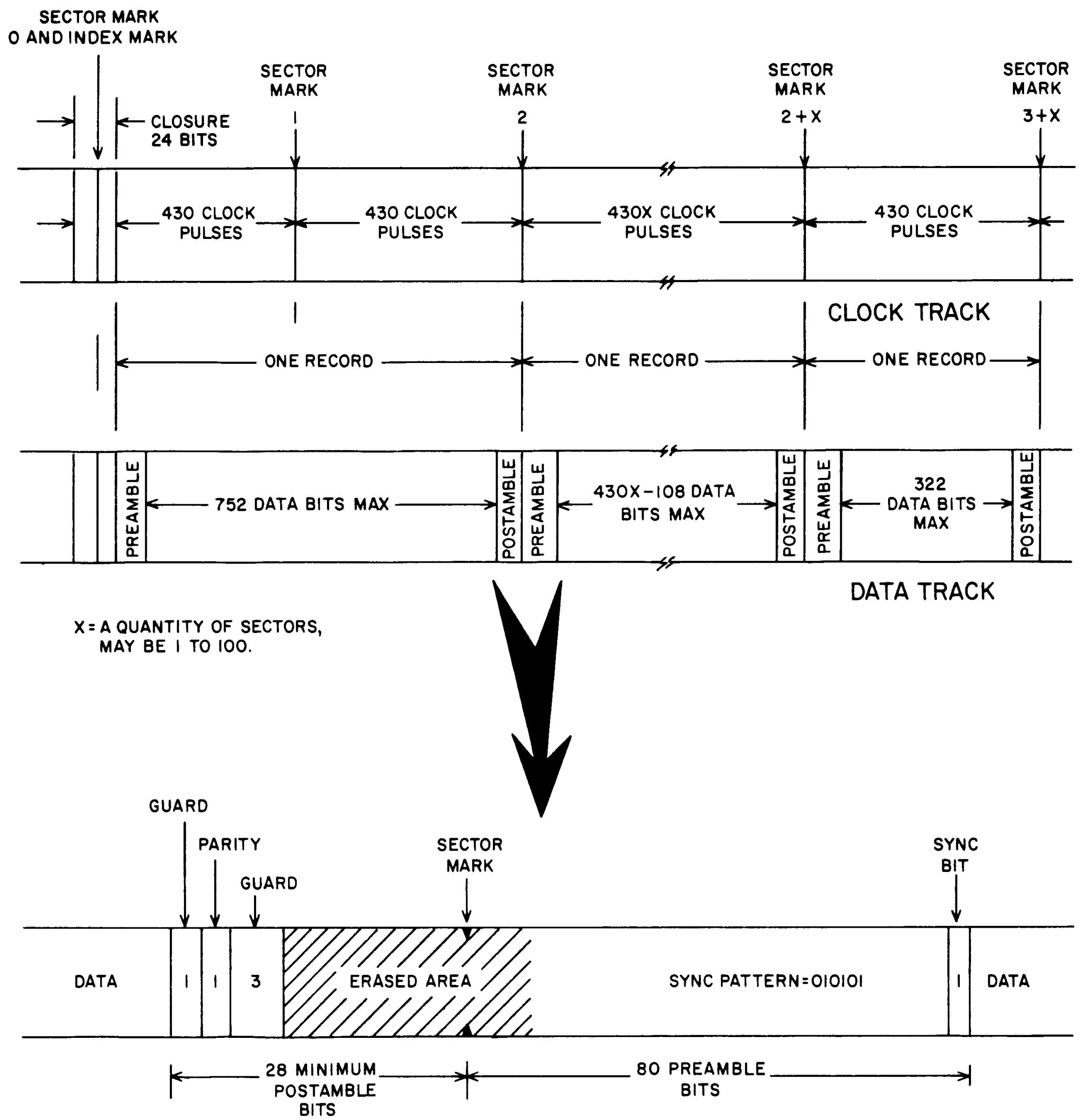


Figure 4. Track Formats

TABLE 1. TRACK AND SECTOR EFFICIENCY INFORMATION

NUMBER OF RECORDS	NUMBER OF SECTORS IN EACH RECORD	SIZE OF EACH RECORD (BITS OF DATA)	TRACK EFFICIENCY*	SECTOR EFFICIENCY**
100	1	1 to 322	0 to 75	100
50	2	323 to 752	38 to 87	100
33	3	753 to 1182	58 to 91	99
25	4	1183 to 1612	69 to 94	100
20	5	1613 to 2042	75 to 95	100
16	6	2043 to 2472	76 to 92	96
14	7	2473 to 2902	81 to 95	98
12	8	2903 to 3332	81 to 93	96
11	9	3333 to 3762	85 to 96	99
10	10	3763 to 4192	87 to 97	100

*Percentage of track used for recording data
**Percentage of available sectors in a track being utilized

Head Groups

Each disk file unit contains 32 head groups selectable by function. Each head group contains 12 read/write heads. Since the 32 head groups are mounted on one positioner, internal electronic switching is provided to allow 384 tracks to be accessed at one position (32 head groups times 12 read/write heads). Each stack in the disk file contains 16 head groups. The head groups in stack 0 are designated 0 through 15_{10} and the head groups in stack 1 are designated 16_{10} through 31_{10}. The head groups are designated identically in both disk file units.

Positions

The positioner in each disk file unit can move to 32 positions which are selectable by function. The positioner in each disk file unit is capable of accessing 12,288 data tracks (32 positions times 384 data tracks). Also, each positioner can move to a non-data or retract position, selectable by function.

PROGRAMMING

CODES

TABLE 2. 6639 DISK CODES

FUNCTION CODES	
Connect and Status	15XX or 17XX
Position Select	14XX
Head Group Select	16XX
Write	12XX or 13XX
Read	10XX or 11XX
Disconnect	154X or 174X
STATUS WORDS	
First Status Word	XXXX
Second Status Word	XXXX

<u>Function Codes</u>

Connect and Status (15XX or 17XX)

This code interconnects the Data Channel, controller, and disk file. It also causes the controller to return one of two status words to the Data Channel. The code bit assignment is shown in Figure 5.

11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	X	1	0	0	0	0	0	X
EQUIPMENT (CONTROLLER)			CONNECT AND STATUS FUNCTION								UNIT

Figure 5. Connect and Status Function Code

<u>Bits 9-11:</u> These bits designate the equipment code number (controller) to which two Data Channels are wired. If desired, the equipment code number can be altered by a small wiring change.

Bits 6-8: This bit combination attempts to connect the controller to the Data Channel and it designates one of two formats of a status word to be returned by the controller. If bit 7 (17XX) is a "1", the controller responds with the first status word. If bit 7 (15XX) is a "0", the controller responds with the second status word. Either bit combination attempts to connect the controller to the Data Channel. Whether or not a connect is made, the controller responds with the status word designated by bit 7. If a connect is not made, any functions other than status hang up the channel.

Bits 1-5: These bits are not used.

Bit 0: (Not applicable if Standard Option 10037 is used.) This bit designates one of two disk file units to be selected. All further operations are performed on the selected unit.

Position Select (14XX)

This code causes the access mechanism to seek one of 32 positions in the disk file (refer to Figure 6).

11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	0	0	R	X	X	X	X	X
EQUIPMENT (CONTROLLER)			POSITION SELECT FUNCTION			RETRACT	POSITION ADDRESS				

Figure 6. Position Select Function Code

Bits 9-11: These bits designate the controller to which the Data Channels are wired.

Bits 6-8: These bits designate the Position Select function.

Bit 5: When this bit is a "1", it causes the positioner to withdraw the read/write heads from the data zone to a non-data zone. This withdrawn position is provided as a standby location in which the read/write heads may reside with a low risk of data loss in the event of hardware failure.

Bits 0-4: These bits designate one of 32 positions in the disk file which are available to the access mechanism.

Head Group Select (16XX)

This code causes the selection of one of 32 head groups in the disk file (refer to Figure 7).

11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	1	0	0	X	X	X	X	X
EQUIPMENT (CONTROLLER)			HEAD GROUP SELECT FUNCTION			NOT USED	HEAD GROUP				

Figure 7. Head Group Select Function Code

Bits 9-11: These bits designate the controller to which the Data Channel is wired.

Bits 6-8: These bits designate the Head Group Select function.

Bit 5: This bit is not used.

Bits 0-4: These bits select one of 32 head groups in the disk file. When bit 4 is a "0", a head group in stack 0 (head groups 0 through 15) is being selected, and when bit 4 is a "1", a head group in stack 1 (head groups 16 through 31) is being selected.

Write (12XX or 13XX)

This code initiates a variable-length Write operation in the disk file (refer to Figure 8). The controller automatically generates and writes a check byte at the end of the write buffer. This byte is checked at the end of each Read operation to verify the accuracy of data transmission. Writing is end-around within a head group.

11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	1	X	X	X	X	X	X	X
EQUIPMENT (CONTROLLER)			WRITE FUNCTION		SECTOR ADDRESS						

Figure 8. Write Function Code

Bits 9-11: These bits designate the controller to which the data channel is wired.

Bits 7 and 8: These bits designate the Write function.

Bits 0-6: These bits designate the address of the sector mark at which the Write operation is to begin.

Read (10XX or 11XX)

This code initiates a variable-length Read operation in the disk file (refer to Figure 9). At the end of the input buffer, the controller checks the next byte read from the disk file to verify the accuracy of data transmission. This byte was generated and written by the controller during the Write operation. Reading is end-around within a head group.

11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	X	X	X	X	X	X	X
EQUIPMENT (CONTROLLER)			READ FUNCTION		SECTOR ADDRESS						

Figure 9. Read Function Code

Bits 9-11: These bits designate the controller to which the Data Channel is wired.

Bits 7 and 8: These bits designate the Read function.

Bits 0-6: These bits designate the address of the sector mark at which the Read operation is to begin.

Disconnect (154X or 174X)

This code disconnects the Data Channel from the controller approximately 100 microseconds after the instruction is executed. The controller will not respond with a status word after the Disconnect function (refer to Figure 10).

11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	X	1	1	0	0	0	0	0
EQUIPMENT (CONTROLLER)			DISCONNECT								

Figure 10. Disconnect Code

Bits 9-11: These bits designate the controller to which the Data Channel is wired.

Bits 5-8: These bits designate the Disconnect function.

Bits 0-4: These bits are not used.

Status Words

First Status Word (XXXX)

When bit 7 of the Connect and Status function code is a "1", the controller returns the status word shown in Figure 11.

11	10	9	8	7	6	5	4	3	2	1	0
LOST DATA	NOT CONN	NOT READY	PARITY ERROR	STACK	SECTOR ADDRESS						

Figure 11. First Status Word

Bit 11: This bit is a "1" if a Lost Data condition occurs during a Read or Write operation. For example, the input or output buffer must follow a Read or Write function, respectively, within 90 microseconds or data is lost. The lost data bit remains present until a new Read or Write function is issued. If a lost data error occurs, the controller returns an Inactive signal to the Data Channel.

Bit 10: This bit is a "1" if the Data Channel has failed to connect to the controller because the controller has already been connected by the other Data Channel. No function other than status can be performed until a connect has been made.

Bit 9: This bit is a "1" when a Disk File Fault condition exists or when the disk file accessing mechanism is not yet verified as being "on track". No functions other than status can be performed when a Disk File Fault condition exists. All functions except a Read, Write,or Position Select can be performed when not on track. Any Read or Write function that is attempted when the disk file accessing mechanism is not on track is held up until on track is verified. A Position Select function is issued to the disk file only when an On-Point signal is present.

Bit 8: This bit is a "1" if a parity error was detected at the end of a Read operation and it remains present until a new Read or Write function is issued by program control.

Bit 7: This bit indicates to which stack the sector address (bits 0-6) refers. When this bit is a "0", stack 0 was the last stack used; when the bit is a "1", stack 1 was last used. This bit is always equal to bit 4 of the last Head Group Select function code.

Bits 0 through 6: These bits indicate the sector count plus one of the sector currently under the read/write heads. These bits are derived from the sector mark counters, and they reflect the sector address from the stack designated by bit 7.

Second Status Word (XXXX)

When bit 7 (17XX) of the Connect and Status function code is a "0", the controller returns the status word shown in Figure 12. This word indicates the last position addresses issued from the controller to each of the disk file units.

11	10	9	8	7	6	5	4	3	2	1	0
RETRACT	POSITION ADDRESS UNIT 1 (SEE NOTE)					RETRACT	POSITION ADDRESS UNIT 0				

NOTE

If Standard Option 10037 is used, bits 6 through 11 are "0's".

Figure 12. Second Status Word

PROGRAMMING CONSIDERATIONS

Sequencing Operations

After a connect has been made, functions can be issued in any order. Normally, functions are issued in the following sequence: Connect and Status, Position Select, Head Group Select, and Read or Write. Once a position and a head group have been selected, it is not necessary to reselect them for subsequent operations. For optimum use of the disk file system, two processors should be used.

At the end of a Read or Write operation, a status check should be performed to check for abnormal conditions such as Lost Data, Not Connected, Parity Error, or Not Ready. Status checks performed between sectors must be part of a very rapid sequence. If the postamble is of minimum size (28 bits), there will be only about 30 microseconds to perform the following:

1) Check Data Channel activity to see if the Data Channel was deactivated by the controller.
2) Deactivate the Data Channel if at the end of the buffer and the Data Channel is still active.
3) Issue Connect and Status function word.
4) Activate the Data Channel.
5) Input the status word.
6) Check the status word.
7) Deactivate the Data Channel.
8) Issue a new function word.

Positioning Times

There are 11 major positions spaced 0.370 inch apart. Each major position includes two minor positions spaced 0.020 inch to the right or left of each major position. This results in 33 possible positions of which 32 (positions 0 through 31) are available as data positions under program control. Refer to Figure 13 for position assignments. Position and access time are as follows:

Position	Milliseconds (maximum)
Adjacent major move	45
Average of several maximum positioning times between extreme major positions	110
Single minor move (0.020 inch)	20
Double minor move (0.040 inch)	25
Verification time	250 (microseconds maximum)
Latency time	52
Average of several worst-case access times (access time includes positioning, verification,and latency times)	162.25

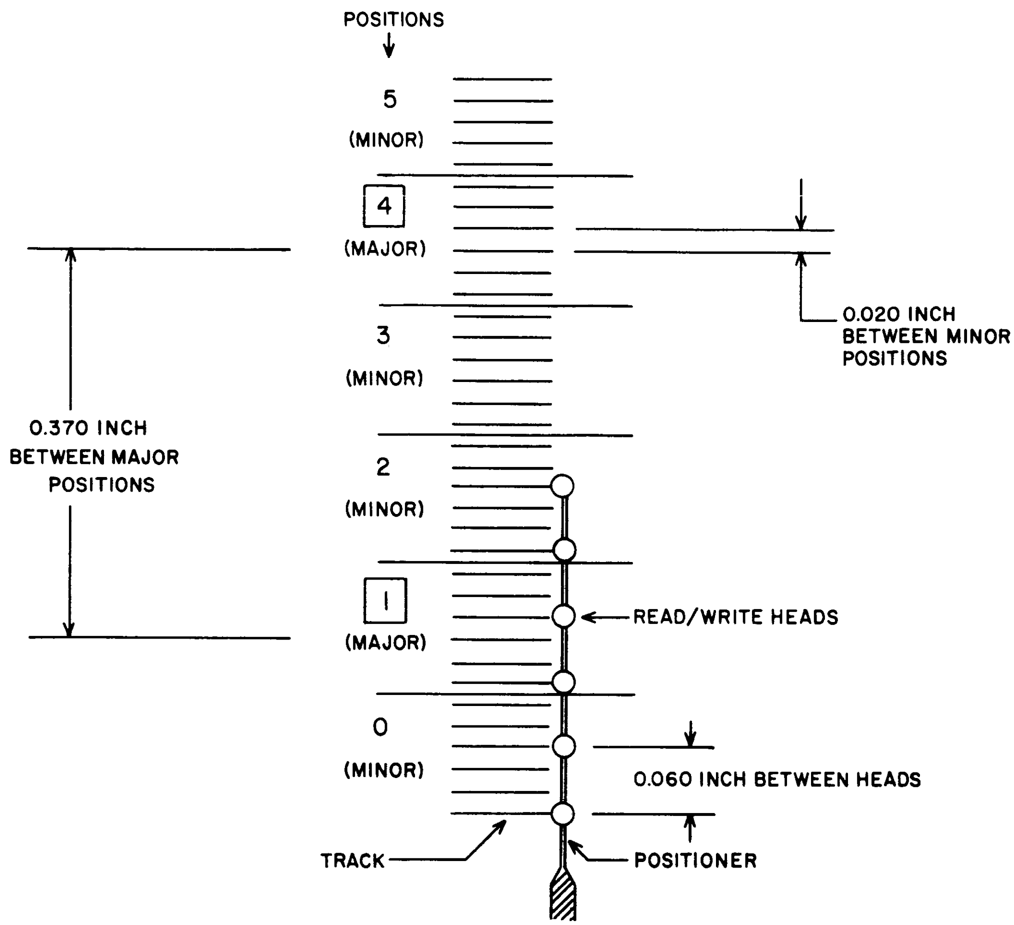


Figure 13. Major and Minor Positions

Head Switching

Since the preamble and postamble gap between sectors is at least 108 bits (129.6 microseconds) and head switching time is approximately 60 microseconds, the read/write heads can be switched between sectors. If the switching involves a new stack, there is a delay of at least 4 milliseconds before a Ready is present. This time is needed for the disk file positioning mechanism to send an On-Point signal to the controller.

Seek Overlap and Position Hold

Each disk file unit stores the last position and head group address issued to it. Thus, it is possible to have one disk file unit positioning while the other unit is reading, writing, switching heads, or positioning. It is also possible to have both units retain their position so that a larger amount of disk storage surface is available with no positioning delay. To transfer operations from one disk file unit to another, a Connect and Status function must be issued. There are three restrictions to these capabilities:

1) A Not Ready is present for at least 4 milliseconds after any Position Select function is issued.
2) There may be a delay of up to 250 microseconds to verify the new position when the operation is transferred to another unit.
3) If the operation is transferred to a new stack, there will be a delay of at least 4 milliseconds.

Data Transfer Rates

Data transfer takes place at the following rates:

1) The parallel 12-bit (byte) transfer rate is a nominal 847 kHz.
2) The nominal bit-to-bit (or byte-to-byte) transfer rate is 1.18 microseconds.

MANUAL OPERATION

OPERATING PROCEDURES

To bring the system up from a Power-Off state, turn on the main 400- and 60-hertz distribution power. The distribution boxes are usually located on a wall adjacent to the disk file and controller. Perform the following procedures:

1) Check that circuit breaker CB1 in the controller is turn on.
2) Open the end panel on the disk file to expose the maintenance panel. Make sure that all the toggle switches are in the down position (automatic operation) and that all the circuit breakers are turned on.
3) Press the START indicator switch on the end panel.
4) Open the large panels on the back side of the disk file to expose two maintenance panels. The top maintenance panel is for unit 0 and the bottom panel is for unit 1. Place the MODE switches on both panels in the NORMAL position.

5) Allow the disk file to run for 15 to 20 minutes. At the end of this time, check to see that the HYDRAULIC OIL TEMP indicators on the end panel are not lighted. The two READY indicators on the front side of the disk file should be lighted.

6) Issue an instruction to select one position (from 0 through 31) from program control to each disk file unit. This moves the disk file positioners off the retract position. The controller and disk file are now ready for program operation.

6641-A ECS/MASS STORAGE ADAPTER

CONTENTS

FIGURES

TABLES

6641-A ECS/MASS STORAGE ADAPTER

The CONTROL DATA® 6641 ECS/Mass Storage Adapter provides data transfer paths between 6000 Series Peripheral Processors (PPU's), Extended Core Storage (ECS), and peripheral devices attached to the adapter (refer to Figure 1). Two Data Channels interface the PPU's with the adapter logic. The adapter contains two interfaces for communication with the peripheral devices.

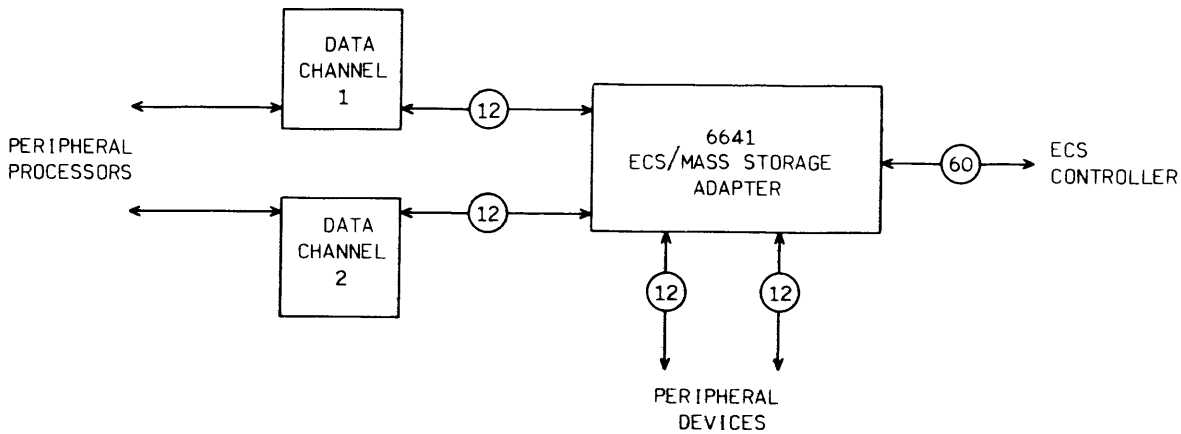


Figure 1. Typical Configuration

FUNCTIONAL DESCRIPTION

DATA PATHS

1. From a 12-bit Data Channel to a 12-bit peripheral device or to the 60-bit ECS.
2. From a peripheral device to a Data Channel or to ECS, or
3. From ECS to a Data Channel or to a peripheral device.

Data transfer through the adapter is accomplished by executing complementary transfers into and out of the adapter buffer (i.e., the input operations to the buffer and output operations from the buffer are independent of, but complementary to each other). Each input or output operation must be initiated by a separate function code. They are specific operations coordinated by the adapter logic to accomplish data transfer through the adapter buffer.

The adapter also provides a signal relay path between the PPU's and the peripheral devices. The signal relay path allows the PPU's to condition and status a peripheral device on one interface at thc same time data is transferring between the adapter buffer and the other peripheral interface. It is a complete 12-bit path which will relay all signals, including those required for data transfer, between the PPU's and the peripheral devices.

ADAPTER BUFFER REGISTER

The Adapter Buffer register, which is the primary data path through the adapter, can hold eleven 60-bit words. The buffer receives all data in rank 1 and transmits it from rank 11. It can receive or transmit one 60-bit word at a time, assemble 12-bit bytes into 60-bit words, and disassemble 60-bit words into 12-bit bytes.

Buffer Input

The Buffer register can receive data from the 60-bit ECS, a 12-bit Data Channel or a 12-bit peripheral device. Input to the buffer is an independent operation, separate from a buffer output and is initiated from the PPU by one of the input to buffer function codes.

During a buffer input from ECS, each 60-bit word is sent to rank 1 of the buffer; after the contents of rank 1 passes to rank 2, another 60-bit word can enter rank 1. Since the Buffer register consists of eleven 60-bit ranks, it can contain the entire 8-word, 480-bit ECS record. The 8-word block is the maximum transfer length per ECS reference, but a reference may transfer less than eight bytes. During a buffer input from a PPU or a peripheral device, the adapter assembles the 12-bit bytes into 60-bit words in rank 1 of the buffer.

Buffer Output

The Buffer register can send data to ECS, a PPU,or a peripheral device. A buffer output operation is initiated by one of the buffer output function codes from the PPU.

During a Buffer to ECS operation, the full 60-bit contents of rank 11 of the buffer are sent to ECS.

During a Buffer to Peripheral or a Buffer to PPU operation, rank 11 of the buffer is disassembled and sent in five 12-bit bytes to the peripheral device or PPU.

Buffer Transfer Rates

The adapter transfers an 8-word record (480 bits) to or from Extended Core Storage for each ECS reference, at a rate of 100 nsec per word within the record. The buffer size allows the adapter to maintain a data transfer rate of 1 μsec per 12-bit byte between ECS and a nonbuffered PPU or peripheral device. During multiple ECS record transfers, the adapter allows a maximum access time to Extended Core Storage of 15 μsec. Both the Data Channel and peripheral interfaces are designed to maintain a maximum rate of 1 μsec per 12-bit byte with the adapter buffer. The adapter provides 55 bytes of buffering during a PPU to peripheral transfer.

Signal Relay

The adapter provides the signal relay as an auxiliary signal and data path between the PPU's and the peripherals. Its primary purpose is to allow the PPU's to condition and status peripherals. It is a complete path which relays all signals between the PPU's and peripheral devices, including those required for data transfer. The adapter relay path design conforms to the customary 6000 relay philosophy but adapter Busy conditions and timing require special consideration. (See status responses.)

Because the signal relay path is not buffered, data transfer rates on the relay path depend on the buffering available in the peripheral device, the total cable lengths between the Data Channel and the peripheral device, and the delay incurred through the adapter. The delay through the adapter is 200 nsec maximum in each direction.

PROGRAMMING

ADAPTER AND PERIPHERAL EQUIPMENT NUMBERS

Four equipment number translators are contained in the adapter. Translations are assigned at each installation. Two of these specify the equipment numbers of the adapter. The other two specify the equipment numbers on each of the peripheral interfaces.

CODES

All adapter operations are controlled by 12-bit function codes, transmitted from a PPU to a Data Channel attached to the adapter. In Table 1, "S" equals the adapter equipment number. The adapter does not respond to unlisted function codes.

TABLE 1. ADAPTER FUNCTION CODES

CODE	DEFINITION
S000*	Override Reserve
S00X	Release
Bit 0	Release Data Channel Interface
Bit 1	Release ECS Interface
Bit 2	Release Peripheral Interface
S010	Return Status
S011	Return Byte Count
S020	Load Address
S021	Load Word Count
S022	Inhibit Word Count
S023	Load Byte Count
S024	Inhibit Byte Count
S030	PPU to Buffer
S031	Buffer to PPU
S040	Peripheral to Buffer
S041	Buffer to Peripheral
S050	ECS to Buffer
S051	Buffer to ECS
S052	Function Flag Register
S077	Clear Buffer
*S=Adapter Equipment Number	

FUNCTION CODES

Reserve Override (S000)

This function overrides the reserve of the other Data Channel by terminating all operations with the Data Channel and selecting and reserving the adapter for use by the executing Data Channel.

Release (S00X)

Release Data Channel Interface (Bit 0 = "1"): This function releases the reservation of the adapter by the executing Data Channel.

Release ECS Interface (Bit 1 = "1"): This function terminates all ECS activity with the adapter, clears the Address Counter, sets the Word Counter to the maximum count, and puts it in the enabled condition. If an ECS to Buffer transfer is terminated, the adapter buffer is cleared.

Release Peripheral Interfaces (Bit 2 = "1"): This function terminates all peripheral activity with the adapter, deactivates the peripheral interfaces, sets the Byte Counter to the maximum count, and puts it in the enabled condition. If a Peripheral to Buffer transfer is terminated, the adapter buffer is cleared.

Return Status (S010)

This function conditions the adapter to transmit one byte, the adapter status, to the PPU.

Return Byte Count (S011)

This function conditions the adapter to transmit two bytes, the contents of the adapter 18-bit Byte Counter, to the PPU. The lower 12 bits of the counter are transmitted in the first byte, and the upper 6 bits of the counter are transmitted in the lower 6 bits of the second byte.

Load Address (S020)

This function conditions the adapter to accept 2 data bytes from the PPU and to load these bytes into its 24-bit Address Counter. The first byte is loaded into the lower 12 bits of the counter, and the second byte is loaded into the upper 12 bits of the counter. Transmission of only one byte will leave the upper 12 bits of the counter unchanged.

Load Word Count (S021)

This function conditions the adapter to accept two data bytes from the PPU and to load these bytes into its 15-bit word counter. The first byte is loaded into the lower 12 bits of the Word Counter, and the lower 3 bits of the second byte are loaded into the upper 3 bits of the Word Counter. Transmission of only one byte will leave the upper 3 bits of the Counter unchanged.

Ignore Word Count (S022)

This function inhibits decrementing and zero-sensing of Word counter. This function is removed by a new Load Word Count (S021) or Release ECS (S002) function.

Load Byte Count (S023)

This function conditions the adapter to accept two bytes from the PPU and to load these bytes into its 18-bit Byte Counter. The first byte is loaded into the lower 12 bits of the counter, and the lower 6 bits of the second byte are loaded into the upper 6 bits of the counter. Transmission of only one byte will leave the upper 6 bits of the counter unchanged.

Ignore Byte Count (S024)

This function inhibits the decrementing and zero-sensing of the Byte counter.

PPU to Buffer (S030)

This function conditions the adapter to accept data from the PPU and to transfer the data to the Adapter Buffer. This function also clears the Adapter Buffer.

Buffer to PPU (S031)

This function conditions the adapter to transmit data from the Adapter Buffer to the PPU.

Peripheral to Buffer (S040)

This function causes the adapter to transfer data from the last selected peripheral interface to the Adapter Buffer.

Buffer to Peripheral (S041)

This function causes the adapter to transfer data from the Adapter Buffer to the last selected peripheral interface.

ECS to Buffer (S050)

This function causes the adapter to transfer data from Extended Core Storage to the Adapter Buffer, starting at the ECS address contained in the Adapter Address Counter.

Buffer to ECS (S051)

This function causes the adapter to transfer the data from the Adapter Buffer to Extended Core Storage, starting at the ECS address contained in the Adapter Address Counter.

Function Flag Register (S052)

This function causes the adapter to examine bit 23 of the address register. If bit 23 is set (equals "1"), the contents of the address register and a request are sent to the ECS controller for the Flag Register operation. If bit 23 is not set (equals "0"), the adapter takes no action. In either case, the Adapter responds to the function immediately.
The contents of the address register should be established by a Load Address operation prior to issuing the S052 function. ECS responds to S052 with an Abort or Accept signal. Status response 0200 or 1000 tells the PPU which signal responded.

Clear Buffer (S077)

This function clears the Buffer Register.

STATUS RESPONSES

Table 2 lists the status responses for the ECS Adapter.

TABLE 2. STATUS RESPONSES

CODE	DEFINITION
0001	ECS Interface Busy
0002	Peripheral I Interface Busy
0004	Peripheral II Interface Busy
0010	Buffer Input Busy
0020	Buffer Output Busy
0040	Peripheral Interface Deactivated
0100	Fake Response, Peripheral Interface
0200	ECS Abort
0400	ECS Parity Error
1000	ECS Accept

ECS Interface Busy (0001)

This response indicates that the adapter ECS interface is busy. This status will be detectable by the PPU upon execution of adapter function code S050, S051, or S052 initiating an ECS data transfer. It will remain until self-cleared upon transfer termination. If one of the following function codes is initiated during an ECS Interface Busy condition, the adapter will hold the function code and not respond to it until the interface becomes Not Busy:

Load Address (S020)
Load Word Count (S021)
Ignore Word Count (S022)
ECS to Buffer (S050)
Buffer to ECS (S051)
Function Flag Register (S052)

Peripheral Interface I Busy (0002)
Peripheral Interface II Busy (0004)

These responses indicate that the specified adapter peripheral interface is busy. This status will be detectable by the PPU upon execution of adapter function code S040 or S041 which initiates a peripheral data transfer. It will remain until self-cleared upon transfer termination. If a peripheral function code or one of the following adapter function codes is initiated to a peripheral interface while it is busy, the Adapter will hold the function code and not respond to it until the interface becomes Not Busy:

Load Byte Count (S023)
Ignore Byte Count (S024)
Peripheral to Buffer (S040)
Buffer to Peripheral (S041)

This status does not reflect the Busy status of the peripheral device.

Buffer Input Busy (0010)

This status indicates that a transfer of data to the Adapter Buffer is in progress. This status will be detectable by the PPU upon execution of one of the following function codes:

PPU to Buffer (S030)
Peripheral to Buffer (S040)
ECS to Buffer (S040)

It will remain until self-cleared by termination of the transfer. If one of these function codes is initiated during a Buffer Input Busy condition, the adapter will hold this function code and not respond to it until the present operation terminates.

Buffer Output Busy (0020)

This status indicates that a transfer of data from the Adapter Buffer is in progress. This status will be detectable by the PPU upon execution of one of the following function codes:

Buffer to PPU (S031)
Buffer to Peripheral (S041)
Buffer to ECS (S051)

It will remain until self-cleared upon termination of the transfer. If one of these function codes is initiated during a Buffer Output Busy condition, the adapter will hold the function by not responding to it until the present operation is terminated.

Peripheral Interface Deactivated (0040)

This status indicates that data transfer between a peripheral device and the Adapter Buffer was terminated because the device deactivated the peripheral interface. This status is cleared by the Release Peripheral Interface function or by adapter function codes S040 or S041 which initiate a new peripheral transfer.

Fake Response, Peripheral Interface (0100)

This status indicates that the adapter responded to data sent from the peripheral device to the adapter; however, the data was not transferred to the buffer. The Peripheral to Buffer operation was completed by fake responses in order to satisfy termination conditions in the peripheral device. (Refer to PPU/Buffer Data Transfers.)

ECS Abort (0200)

This status indicates that the ECS controller has returned an Abort signal in response to an Adapter ECS reference. This status is cleared by the initiation of a new ECS reference (S050, S051, or S052) or by the Release ECS Interface function.

ECS Parity Error (0400)

This status indicates that the ECS controller has transmitted a Parity Error signal following the transmission of a record to the adapter. This status is cleared by the initiation of a new ECS transfer (S050 or S051) or by the Release ECS Interface function.

ECS Accept (1000)

This status indicates that the ECS controller has returned an Accept signal in response to an adapter ECS reference. This status is cleared by the initiation of a new ECS transfer (S050, S051, or S052) or by the Release ECS Interface function. It is used primarily in conjunction with Flag Register function (S052).

SELECTION AND RESERVATION

A function signal from a Data Channel reserves the adapter for that channel if the adapter is not already reserved. The Release Data Channel Interface releases the reservation. An unreserved Data Channel can override a reservation by the other Data Channel by issuing the adapter Override Reserve (S000) function code. This function code disables all further communication with the other Data Channel interface and terminates all operations in progress with that interface by forcing its deactivation. This is the only function code executed by the unreserved Data Channel to which the adapter responds.

SIGNAL RELAY

Function Codes

Function codes not directed to the adapter are passed on to the peripheral interfaces. If a Peripheral to Buffer operation causes a peripheral interface to become Busy, function codes will not pass to the busy interface until the Peripheral to Buffer operation terminates and the PPU sends a function code translated by the adapter for the inhibited interface.

Data Transfer

The peripheral interface which is enabled for a signal relay is the last peripheral interface to which a function code was executed. Data and signals not directed to the adapter by the preceeding function code are relayed by the adapter between this peripheral interface and the Data Channel interface.

MASTER CLEAR

The Master Clear signal, transmitted to the adapter by the Data Channel during a Dead Start sequence, will cause the following actions in the adapter:

1. Transmission of the Master Clear signal to the attached peripheral devices and Extended Core Storage.
2. Clearing of all adapter operation modes, status bits, and controls.
3. Clearing of the Adapter Buffer, Address Counter, Word Counter, and Byte Counter.
4. Clearing of Data Channel interface reservations.

The Master Clear signal is effective only if the adapter is not reserved by the other Data Channel.

DATA TRANSFER

Data transfers via the Adapter Buffer are accomplished by executing buffer input and complementary buffer output transfers.

PPU/BUFFER DATA TRANSFERS

Initiation

A PPU/Buffer data transfer is conditioned by execution of adapter function code S030 or S031 by the PPU. The operation is initiated when the Data Channel is activated by the PPU.

Termination

The following conditions clear the mode of operation and terminate a PPU/Buffer data transfer:

1. Deactivation of the Data Channel by the PPU.

2. If the buffer is full during a PPU to Buffer transfer, ~~no buffer output transfer~~ no buffer output transfer is active, and the PPU is presenting data to the adapter. This causes the Adapter Buffer to be cleared and the Data Channel to be deactivated.

3. If the buffer is empty during a Buffer to PPU transfer, and a buffer input transfer has been terminated. This causes the adapter to deactivate the Data Channel.

4. Execution of the adapter function code S000 by the other Data Channel. This causes the adapter to deactivate to Data Channel.

ECS/BUFFER DATA TRANSFERS

Initiation

Execution of adapter function code S050 or S051 initiates ECS/Buffer transfers.

ECS Address

The ECS address used for a transfer is the contents of the lower 23 bits of the adapter 24-bit Address Counter. This counter is incremented by one as each 60-bit word is transferred between the adapter and ECS. Bits 21, 22, and 23 are not incremented. The counter is loaded from the PPU by use of adapter function code S020.

Word Counter

The length of an ECS to Buffer transfer is specified by the contents of the adapter 15-bit word counter. This counter decrements by one as each 60-bit word transfers between the adapter and ECS. It is loaded from the PPU by adapter function code S021. Adapter function code S022 inhibits decrementing and zero-sensing of this counter, passing transfer length control to other transfer termination conditions listed under Termination.

Termination

The following conditions terminate an ECS/Buffer data transfer and clear the mode of operation:

1. The word count equal to zero.

2. Receipt of an ECS Abort (0200) function code.

3. Execution of the adapter function code Release ECS Interface by the PPU. This clears the Adapter Buffer if an ECS to Buffer transfer terminates.

4. Termination of the buffer output transfer during an ECS to Buffer transfer. This clears the buffer.

5. Termination of a buffer input transfer during a Buffer to ECS transfer. This condition causes the data remaining in the buffer to be transferred to ECS before the operation terminates. If rank 1 is partially assembled at this time, it is completed with zeros and stored.

Initial Word Transfer

Disassembly of data bytes from rank 11 of the Adapter Buffer does not modify the data in that rank until all five bytes have been removed. At this time the rank is considered empty and the data from rank 10 moves into rank 11. Thus, if a Buffer to ECS transfer is initiated with rank 11 partially disassembled, the full word will be stored.

PERIPHERAL/BUFFER TRANSFERS

Initiation

Peripheral/Buffer data transfers are initiated by execution of adapter function code. S040 or S041.

Peripheral Selection

The peripheral interface path used for the transfer is the path to which the last peripheral function code was directed prior to initiation of the transfer. The peripheral device on this path must have been previously selected and addressed such that reception of the proper Channel Active, Full, and Empty signals from the adapter will initiate data flow. The adapter deactivates the path of the peripheral interface upon termination of the transfer.

Byte Count

The content of the adapter Byte Counter specifies the length of the Peripheral to Buffer transfer. This counter is loaded and enabled as a transfer termination parameter by use of adapter function code S023. The byte count decrements by one as each 12-bit is transferred between the adapter buffer and the peripheral device. Adapter function code S024 inhibits decrementing and zero-sensing of this counter, thus passing transfer length control to other transfer termination conditions.

Termination

The following conditions terminate a Peripheral/Buffer data transfer and clear the mode of operation.

1. The byte count equal to zero.
2. Deactivation of the peripheral interface path by the peripheral device.
3. Execution of the adapter function code Release Peripheral Interface by the PPU. This condition clears the adapter buffer if a Peripheral to Buffer transfer terminates.
4. If the buffer is full during a Peripheral to Buffer transfer, a complementary buffer output transfer has terminated, the peripheral device continues to input data to the buffer, and no buffer output is active. This condition clears the adapter buffer; if the Byte Counter has not been inhibited, the adapter will continue to respond to data from the peripheral device until condition 1, 2, or 3 terminates the operation.
5. If the buffer is empty during a Buffer to Peripheral transfer, a complementary buffer input transfer has terminated, and no buffer input transfer is active.

BYTE TRANSFER

The termination of a data transfer between the adapter buffer and either a PPU or a peripheral device can result in rank 11 being left partially disassembled or rank 1 being left partially assembled. The treatment of the partially assembled or disassembled word depends on the input and output instructions which were in progress at the time of the termination and the instruction which follows the termination. The various possible conditions which determine the treatment of the partial word are detailed in the following paragraphs.

Partial Disassembly of Rank 11

Partial disassembly of rank 11 can occur by termination of a Buffer to PPU or Buffer to Peripheral operation. If the buffer output following termination is either a Buffer to PPU or Buffer to Peripheral, the disassembly of rank 11 will continue. If the next buffer output is a Buffer to ECS operation, rank 11 is stored into ECS intact, ignoring the partially disassembled condition.

Partial Assembly of Rank 1

Partial assembly of rank 1 can occur by termination of a PPU to Buffer or Peripheral to Buffer operation. Following termination of the buffer input operation, the treatment of the partially assembled word depends upon which buffer output operation is in progress at the time the input terminates or is initiated following termination.

If a Buffer to ECS operation is in progress, the remainder of rank 1 is completed with zeroes for storage into ECS, further input operations are not accepted until the buffer is empty, and the Buffer to ECS operation terminates.

If a Buffer to PPU or Buffer to Peripheral operation is in progress or is initiated, the data in rank 1 is moved partially assembled through the buffer for transmission to the PPU or the peripheral. Only the bytes which had been assembled will be disassembled as data. By inhibiting further input to rank 1 until the partial word is disassembled, the adapter assembly control preserves the identity of these bytes.

If no buffer output is in progress and a PPU to Buffer or a Peripheral to Buffer operation is initiated, the assembly of rank 1 continues.

If an ECS to Buffer or Buffer to ECS operation is initiated following termination of the buffer input, no action will result in the adapter buffer. One of the other functions must be used to move data.

APPLICATION NOTES

EQUIPMENT NUMBER ASSIGNMENT

The two equipment numbers assigned to the adapter's Data Channel interfaces may be duplicated if they are attached to separate Data Channels. The equipment numbers of 6000 peripheral devices attached to the adapter's peripheral interfaces can not duplicate the equipment numbers assigned to the Data Channel interfaces or the equipment numbers of devices preceeding the adapter on a Data Channel.

When two or more CONTROL DATA® 6681's are attached to the adapter, each 6681 must be assigned a separate select/deselect equipment number. The equipment numbers of the 3000 peripherals on each 6681 can be duplicated. When Mode II Connect is being used, the equipment numbers of the 3000 peripheral devices can duplicate the 6000 equipment numbers.

When using Mode I Connect in a 6681 attached to an adapter, equipment number 0, equipment number 1, the select/deselect equipment number of the 6681, and the equipment numbers of attached 3000 peripheral devices can not be duplicated with other equipment on the 6000 channel. When a 6681 is attached to a peripheral interface of the adapter, the adapter translates only the upper three bits (select) of the equipment number intended for the 6681.

RELAY PATH DATA TRANSFERS

The relay path through the adapter is not fast enough to transfer data to or from the CDC® 6603 or 6638 Disk Files. However, any mass storage device which uses the CDC® 3234 Mass Storage Controller can use the relay path for data transfer if the adapter is the first device on the Data Channel.

6603 DISK FILE

The 6603 Disk File will hold a Write function code and will respond to it only when it is actually accessing the addressed sector. Data transfer to the 6603 must begin immediately after it responds to a Write function. To do this during a Buffer to Peripheral operation, the buffer must contain data before the Write function is sent to the 6603.

When sending data from ECS to a 6603 through the adapter buffer, the ECS to Buffer operation must be initiated before sending the Write function to the 6603.

When the buffer input comes from the PPU, the PPU must load the buffer with several bytes of data before sending the Write function to the 6603. The PPU must also initiate a PPU to Buffer operation for transfer of the remaining data immediately after receiving the response to the 6603 Write function.

RECORD HEADERS

The adapter allows the PPU to add or remove headers from data records being transferred directly between ECS and a peripheral device.

A header may be added to data being transferred from ECS to a peripheral device by sending the header from the PPU to the buffer, and following this by execution of the ECS to Buffer operation. When the buffer sends the data to the peripheral, the peripheral device receives the header and data as a continuous string. The header size must be a multiple of 60 bits to prevent a partial assembly of rank 1.

Headers may be removed from data being sent from a peripheral to ECS by sending the header from the buffer to the PPU and sending the data to ECS. Information in rank 11 of the buffer is not removed until all 5 bytes have been sent. The header size must be a multiple of 60 bits if it is to be removed. For this reason, up to 4 bytes (48 bits) of header information may be sent to the PPU without removing it from rank 11 of the buffer, thus allowing it to be transferred to ECS.

SELECTION AND RESERVATION

A Power On cycle clears adapter reservations. A dead start Master Clear clears adapter selections and reservations. The adapter relay path can not be used unless the adapter is reserved. Devices on the peripheral interfaces will not be available to the channel unless the dead start program contains an adapter function.

If a Data Channel has reserved the adapter and then issues a Master Clear, the adapter clears both peripheral interfaces before clearing the reservation.

When 6681 converters are attached to the peripheral interfaces, they become selected by the relayed Master Clear. The adapter must be functioned to establish reservation before the selected 6681 can be functioned via the adapter relay path.

6671-A DATA SET CONTROLLER

CONTENTS

FIGURES

TABLES

6671-A DATA SET CONTROLLER

The CONTROL DATA® 6671-A Data Set Controller is a multiplexer which interfaces 6000 Series Computer Systems with remote communications terminals. Terminals can be located several thousand miles away, anywhere that voice-grade telephone lines or telephone data service is available, thus providing immediate on-line access to a centrally located 6000 Series computing facility. The data set controller (DSC), together with a software package, permits users at remote terminal locations to write routines, debug programs, establish files, and modify existing data at any time without the necessity of requesting computer time. A typical 6000 Series computer interfaced with remote communications terminals is shown in Figure 1.

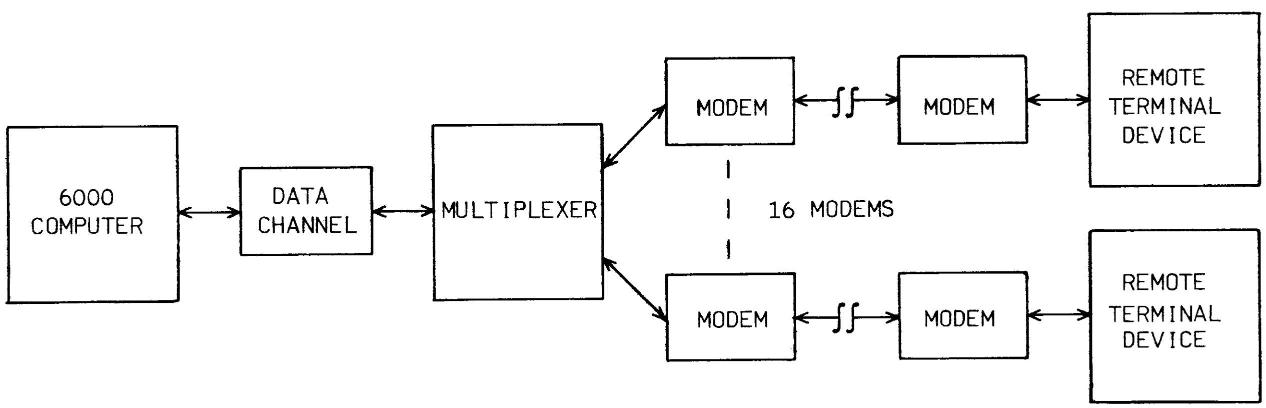


Figure 1. Typical Controller Application

FUNCTIONAL DESCRIPTION

The DSC interfaces as many as 16 remote-terminal modems (AT&T 103 Teletype Data Sets, 201A/B Dataphone Data Sets, or any standard interface as defined by EIA RS232 specifications). The 16 terminals can be arranged with any combination of modems.

DATA TRANSFER

Rate

The transfer rate of 12-bit data words between the 6000 Series Data Channel and the DSC is approximately 0.5 MHz. This permits the input of a 16-word block in approximately 32 μsec. Transmission rates of 8-bit characters (plus Data Control pulses) between the DSC and remote-terminal equipment are determined by the modem as follows:

103 Data Set	110 baud*
201A Data Set	2000 baud
201B Data Set	2400 baud

At these rates, with a terminal active, the DSC requires an input operation every 100 ms (110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud) or data may be lost.

Mode

The DSC operates in both Half- and Full-Duplex modes, the mode being determined by the type and configuration of modem used. Data is transferred between the DSC and terminals in only one direction at a time (either transmit or receive) in the Half-Duplex mode and in both directions at the same time in the Full-Duplex mode. Using the DSC, the system is capable of Full-Duplex operation with 16 2400-baud data terminals in either Line or Consecutive Character Data Block mode. The number of possible system configurations is dependent on the various modem speeds used and on the nature of the softward operating system. The interconnecting transmission lines between the DSC and the Data Channel and the major DSC circuits are shown in Figure 2.

*Baud=bits per second

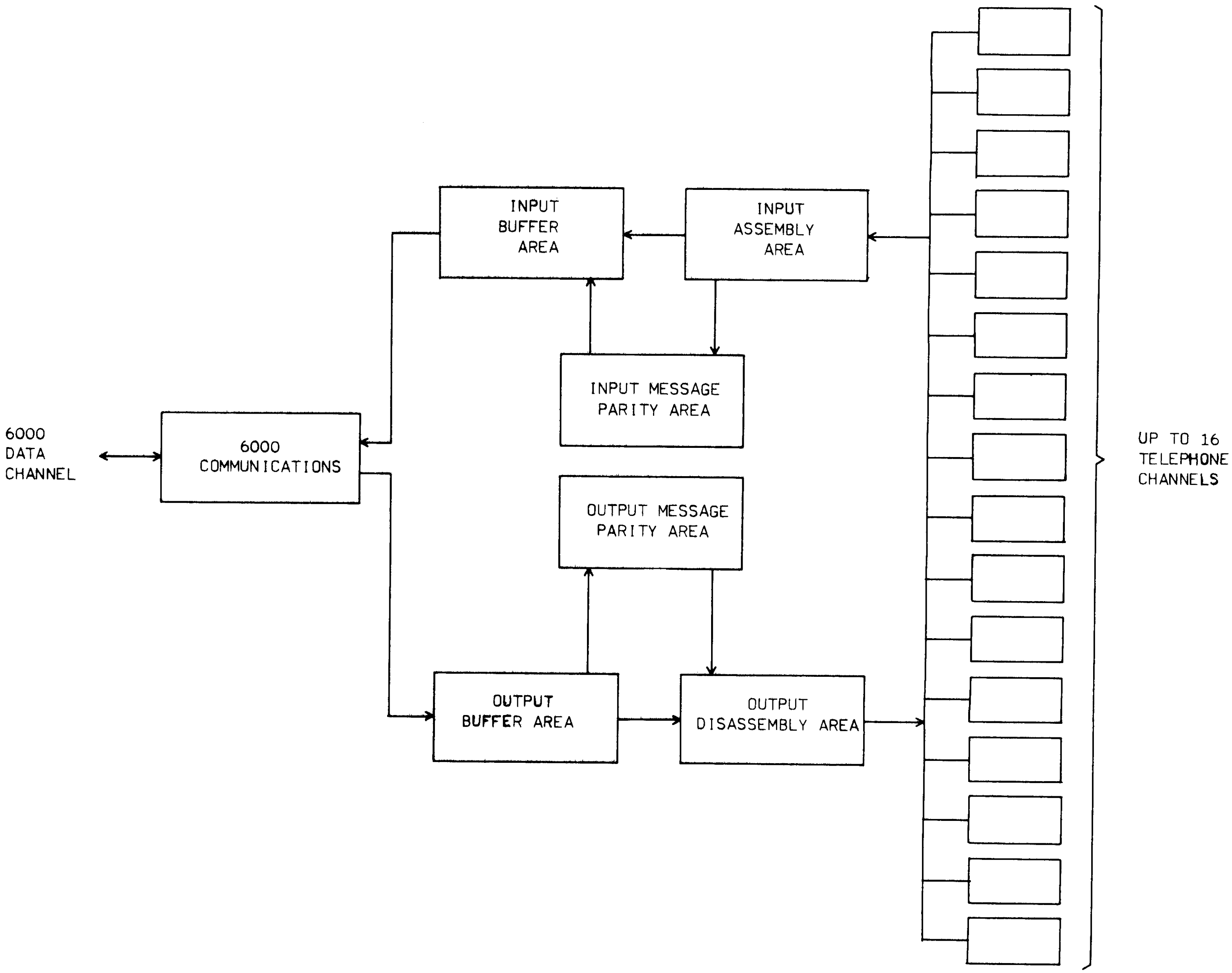


Figure 2. Controller Block Diagram

Data Channel ⟷ Controller

The transfer of data between the Data Channel and the DSC is in blocks containing from one to sixteen 12-bit data words. Each 12-bit data word uses the lower 8 bits to form a data character and the remaining 4 bits, as necessary, for I/O control. During output operations, I/O control bits must be generated by the programmer; during input operations, status bits are generated by the DSC.

Controller ⟷ Modem Terminals

The transfer of data between the DSC and the modem terminals is performed serially by means of 8-bit characters plus additional Start/Stop pulses, if required, for each character. The DSC then associates each data word in the data block with one of the sixteen terminals. It transfers data word 0 both to and from terminal 0 and transfers subsequently numbered data words to and from correspondingly numbered terminals. This format (order of operation) applies regardless of the number of terminals available or that require service. With 201 Data Sets, the DSC attaches a message parity character (MPC) to the output Data Channel message (MPC has odd character parity). Incoming data is checked for USASCII formated messages, and a message parity check character replaces the incoming MPC (MPC character parity not checked).

DATA STORAGE

Locations

The DSC uses a 64-word, 28-bit-per-word core memory (only 25 bits are actually used) to buffer data/control information to and from the modems. Sixteen core locations are used to store information received from or sent to the 6X00 Data Channel. A second group of 16 memory locations stores information used to control the disassembly of output characters. A third group of 16 memory locations stores information used to control the assembly of input characters. The final 16 locations store the MPC for input/output data.

Memory locations are assigned four to a communications channel. A portion of the address of each of these four words is identical. During an I/O operation, each word of a message is stored in the four-word portion of the memory which corresponds to its position in the message. For example, word 0-3 goes to the channel 0 portion; word 4-7 to channel 1, etc.

Each line operation requires that the three words (buffer, input, and output) be read for processing. The MPC word is read only when a character is completed and when a MPC must be updated or generated.

Memory Words

Core memory is partitioned according to line channels. Each line channel has an input information word, an output information word, a buffer word, and a message parity character associated with it (Figure 3).

The first word read from core memory during the processing of a telephone channel is the output information word which is read from location XXXX00. This word contains the following information:

Bits 0-7	Data is in the process of being disassembled.
Bits 8-11	Clock count (used for 103 teletype timing and synchronization).
Bits 12-15	Bit count to keep track of the disassembly process.
Bits 16	Indicates that an I/O instruction was in progress when this telephone channel was previously processed. The I/O operation will resume upon completion of this processing.
Bit 18	Used for synchronization of teletype data.
Bits 21-23	Used to convey carrier and phone line connection information to the telephone channel such that data is not lost.

The second word read from memory is the buffer word which is contained in the Output/Input Buffer registers and is read from location XXXX01. The Output Buffer holds in bits 0-11 information received from the Data Channel.

Next the updated output information word is returned to memory. The input information word is then read from location XXXX11. This word contains the following information:

Bits 0-7	Data in the process of being assembled.
Bits 8-11	Clock count (used for 103 timing and synchronization).
Bits 12-15	Bit count to keep track of assembly process.
Bits 16-17	Synchronization indicators for 201 modems.
Bits 18-20	Synchronization indicators for 103 modems.

After the reading of the input information word, the MPC word is read from memory location XXXX10 if either the input or output portions of the telephone channel require MPC updating. This word contains the output MPC in bits 0-7 and the input MPC in bits 12-19. Bit 20 indicates the next input character will be an MPC. The MPC word is then returned to memory.

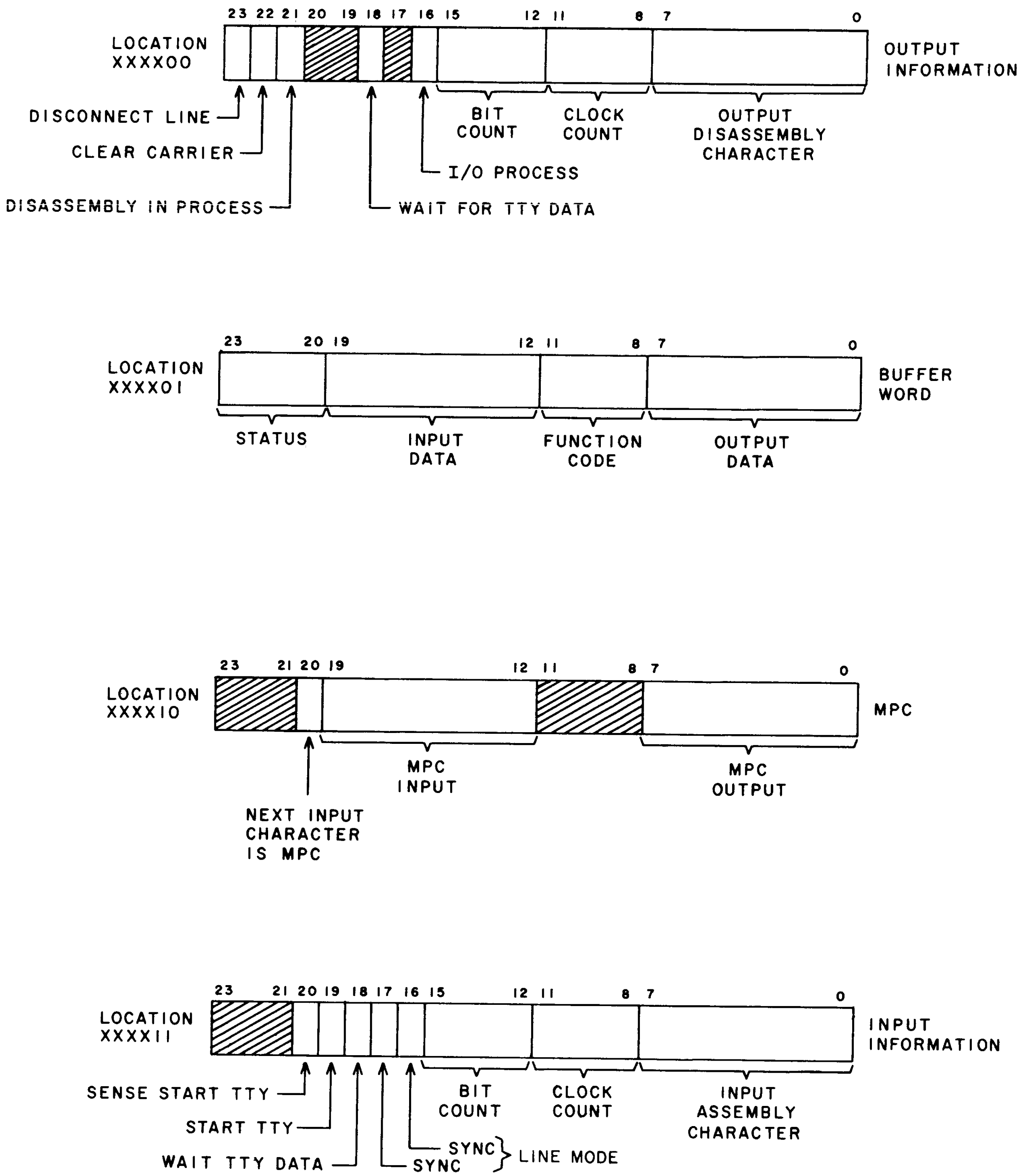


Figure 3. Memory Word Formats

Regardless of whether the MPC processing is performed or not, the final events are the return of the updated buffer and input information words to memory (in that order).

DATA CONTROL

To initiate a data transfer to a remote terminal, the processor must select the DSC by means of a function select code. This code contains an equipment code and select bits which designate the DSC operating modes. Two basic methods of sending function select codes to the DSC exist. One selects operating modes for the entire DSC and includes data transfers to or from the Data Channel and the presentation of DSC status. The other selects an operating mode for a single communication channel and includes the information necessary for the control of the modem. This latter function select code is transmitted to the DSC as part of an output word.

The DSC must receive a function select code before it can generate an Inactive and enable the requested operating mode. Nonacceptance of a code is indicated by no response from the DSC. The DSC is ready for an I/O operation when the processor has successfully selected the DSC and an operating mode.

Data Output

The processor, after selecting the output mode with a function select code, activates the DSC Data Channel and transfers a block of data words to the DSC. The data block is held in the DSC Output Buffer register. If the DSC receives a data word for a terminal when the Output Buffer register of the terminal is full, the DSC performs a pseudo-accept of the new data word and sets the Character Reject status bit. After completing the block storage, the DSC prepares the terminals which require an output for transmit operation. The DSC begins a data buffer transfer (if there is a valid character in the buffer) after receiving a signal indicating terminal readiness. The lower 8 bits (data character) for each terminal are transferred from the Output Buffer register to the Output Disassembly register if the disassembly section of the terminal is clear. If the Output Disassembly is not clear, the data transfer for that terminal must wait for the next data-transfer cycle. The DSC also transfers control information to the modem during the data transfer.

The DSC begins the serial transmission of characters after the Start pulse transmission. The bits are transferred to the modem according to the serial pattern set for 103 or 201 Data Sets and this transfer continues for each of the terminals. The DSC is ready for another data character following the transfer of the previous data character from the Output Buffer register to the Output Disassembly register. The DSC can store the next data character in the Output Buffer register while the preceding data character is in the Output Disassembly register.

Data Input

The terminal data input consists of taking the serial data bits from the active terminals and reassembling them in the Input Assembly register. When the character has been reassembled, the DSC transfers its data portion to the lower 8 bits of a terminal and sets bit 11 of the Input Buffer register of that terminal. The Input Assembly continues the reassembling and transferring of characters as long as serial data from the terminals is available.

After receiving an input function selection and a subsequent Activate pulse, the DSC transfers to the Data Channel up to 16 12-bit data words (contained in the Input Buffer). The data blocks may contain both completed data characters and words which contain zeros even though the I/O control bits may be set. The validity of data characters is detected by examining bit 11 of each data word.

If the DSC should complete the assembly of a data character when the Input Buffer of the terminal section is full, it writes the new data character into the buffer, destroying the previous character, and sets the Lost Data I/O control bit.

SIGNAL SYNCHRONIZATION

103 Data Set

Teletype Output: The DSC accepts a 12-bit word from the processor if the valid data bit of the word is set and transfers the lower 8 bits (0 through 7) to the Output Disassembly register. The DSC adds to this 8-bit data character a Start bit and two Stop bits (these synchronizing bits are deleted during Receive) to form an 11-bit synchronized character. This 11-bit word is then disassembled and transmitted serially beginning at an integral bit time.

Teletype Input: A Start bit from the modem is initially issued to the DSC. This Start bit is sampled several times to eliminate synchronization on a noise pulse. At 1/10 of a bit time after initiation, the DSC checks to determine if the Start bit has persisted. If it has, the DSC checks it again at what would be the center of the Start bit. If a Start bit is still present, the DSC begins to time out the next 10 bit times and samples each of them. The DSC assembles this character, sends it to the Input Buffer register, and then awaits another Start bit from the modem.

201A/B Data Sets

The DSC receives clock information from the modem (201A/B or its equivalent) for data both received and transmitted. It does not itself supply clock pulses to the modem.

Clocked Output: After receiving a 4XXX data word on a telephone-channel output, the DSC places the modem in the proper condition, if required, for data transmission. The first data bit is presented to the modem at the first clock pulse following confirmation of the modem condition.

The controlling computer program must generate synchronizing characters according to those required by the remote site along with the header, data, and end of message (EOM). The DSC appends the MPC with odd character parity immediately after the EOM character. MPC is calculated from the start of message (SOM) header character. Note that all characters are standard USASCII types.

Output data bits are transmitted at each clock pulse received from the modem. Any code needed for synchronization of receiving equipment must be supplied by the controlling computer program. (Refer to the appropriate equipment reference manual to determine the types of codes required.) The DSC sets the Output Failure status bit when a break in the flow of transmitted data occurs if the computer does not supply data characters at a fast enough rate.

Clocked Input: The processor initially sends an xx1XXX code to a specific telephone channel which returns bits under modem-clock regulation. The DSC monitors the incoming data until it detects an 8-bit 026 code (USASCII sync character). It then records the character and accepts another 8-bit byte. It examines this byte to determine if it is a 026 code. When two consecutive 026 codes are sensed, the DSC logic is synchronized with the data characters that follow. The DSC ignores any subsequent 026 codes after establishing synchronization. If a second 026 code is not found, the DSC logic considers a Non-synchronized condition exists and continues to check for two consecutive 026 codes.

The processor controlling the DSC must send an xx1XXX word to the telephone channel prior to the arrival of the first 026 code word, and any device supplying clocked information to the DSC must send a minimum of four 026 code words before each message to provide synchronizing reliability. Sync codes are never considered valid data.

Once synchronized, the DSC must be sent a function code to cause it to inaugurate a Sync Seeking sequence.

Message Parity Character

MPC Output: The DSC begins computing a message parity character when it transmits an USASCII SOM character. Any USASCII sync codes contained in the message which follows are ignored. The DSC appends a MPC with odd character parity immediately after the EOM character is transmitted.

MPC Input: The DSC begins computing a MPC when it receives an USASCII SOM character. USASCII sync codes contained in the message are ignored. After receipt of an EOM, the DSC takes the logical difference for the lower 7 bits of the next assembled character (incoming MPC) and its calculated MPC and sends it to the Input Buffer register.

PROGRAMMING

FUNCTION SELECT CODES

Function select codes (Table 1), after being recognized, select the DSC and designate its normal operating mode. Function code selection does not prevent the DSC from transferring output data characters from the buffer to the terminals, nor does it prevent input data characters from being transferred from the terminals to the buffer registers.

TABLE 1. FUNCTION SELECT CODES

OCTAL CODE	DESCRIPTION
X001*	Select Output
X002	Select Status Request
X003	Select Input

*The X portion must correspond to the setting of the Equipment Number switches.

Note: Additional codes are used for diagnostic test routines (see CE Manual).

Select Output (X001)

Receipt of this code enables the DSC, causing it to accept data blocks from the Data Channel. These blocks consist of as many as 16 data words. Figure 4 illustrates the output word format.

Select Status Request (X002)

The DSC transfers a 12-bit status word to the Data Channel input lines when it has received a X002 code. This code must be followed by a one word input operation in order to examine the status bits. Specific bit assignments are given in Figure 5.

Select Input (X003)

A Select Input code enables the DSC, causing it to transfer a data block to the Data Channel. As soon as it receives an Active (Activate Channel instruction), the DSC transfers a data block of up to 16 words (Figure 4). For block lengths less than 16 words, refer to Programming Considerations, Input Block Length.

After receiving a function select code, the DSC sends an Inactive to the processor to indicate it has recognized and accepted the code (no response by the DSC indicates it has not accepted the code). An Inactive is generated by the DSC when bits 9 through 11 of the function select code correspond to the code determined by the setting of the Equipment Number switches and a recognized operation select code has been received. These switches (located at J022A/B/C, respectively) are UP for a "1" and DOWN for a "0". After generating an Inactive, the DSC enables the selected operating mode (Output, Status Request, or Input) when it receives an Active from the Data Channel.

DATA WORD

The DSC communicates with the processor by means of a 12-bit data word. The 12-bit data word is comprised of either an 8-bit character which the DSC receives from or transfers to the terminals together with 4 output-control bits or 4 input-status bits, or a 12-bit status character (status word).

Output Word

The output word format required by the DSC during data transfers with the Data Channel is shown in Figure 4.

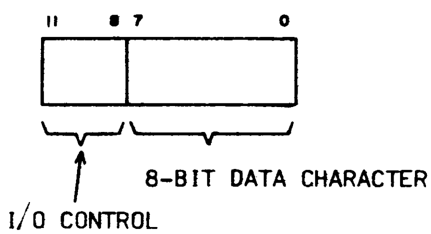


Figure 4. Output Word Format

The lower 8 bits (0 through 7) of the output word form the data character. The DSC, when enabled performs a serial transfer of the 8-bit data characters as shown in Table 2.

TABLE 2. DATA CHARACTER SERIAL TRANSFER

103 TELETYPE			201 CLOCKED FORMAT		
Transfer Sequence	Bit	Data Character Bit Position	Transfer Sequence	Bit	Data Character Bit Position
1	0	Start	1	0	0
2	1	1	2	1	1
3	2	2	3	2	2
4	3	3	4	3	3
5	4	4	5	4	4
6	5	5	6	5	5
7	6	6	7	6	6
8	7	7	8	7	7
9	8	0			
10	9	Stop			
11	10	Stop			

The upper 4 bits (8 through 11) of the output word provide I/O control and act, in various combinations, either as a flag for data characters or as a control for the modem. Any data to be transmitted must be accompanied by either a 4XXX or a 5XXX function code (see Table 3) which turns on the carrier. At least one character time should elapse before the processor sends out a 4XXX or 5XXX code if a 2XXX, 3XXX, or 6XXX function code was previously sent out to turn off the carrier.

TABLE 3. CONTROLLER DATA WORD FUNCTION CODES

CODE	DESCRIPTION
0XXX	A do-nothing function; no data is transferred.
1XXX	Enables the receiver section of the DCS to resync*. Does not affect the carrier or the line connection. No data should be contained in this word.
2XXX	Turns off the carrier. No data should be contained in this word.
3XXX	Turns off the carrier and allows the receiver to resync. No data should be contained in this word. The valid data character preceding this function code is transmitted prior to carrier turn-off. Note that MPC's appended to a clocked-data modem message are considered to be valid data characters.
*The resynchronization is immediate and does not wait for completion of the input character.	

TABLE 3. CONTROLLER DATA WORD FUNCTION CODES (Cont'd)

CODE	DESCRIPTION
4XXX	Turns on the carrier. Must be appended to all data words (see 5XXX code description).
5XXX	Turns on the carrier and resyncs the receiver. Can contain data to be transmitted; primarily a function for Full-Duplex operation. Should be used whenever it is desirable to resync the receiver and transmit data simultaneously.
6XXX	Resyncs the receiver, turns off the carrier, and disconnects the telephone connection. No data should be contained in this word. Used primarily to disconnect the phone line. NOTE The 2XXX, 3XXX, and 6XXX codes await the disassembly of the previous valid character before they affect the carrier; 4XXX and 5XXX codes act immediately. The 6XXX code does not wait for completion of the last bit of the last output character before becoming active. Software timing for the use of the 6XXX code is desirable.
7XXX	Resyncs the receiver and enables the telephone connections for data transmissions. This word contains no information to be transmitted.
X(1xx)XX (Bit 8 set)	Used to disconnect a modem when output operation has failed in the middle of a character. Indicates that any valid character in the Output Buffer should be ignored, and that any data accompanying the function code should be transferred into the buffer memory. The DSC does not recognize that it is disassembling a character on this terminal and it executes the incoming function.

Input Word

The input word format used by the DSC during data transfer with the Data Channel is shown in Figure 5.

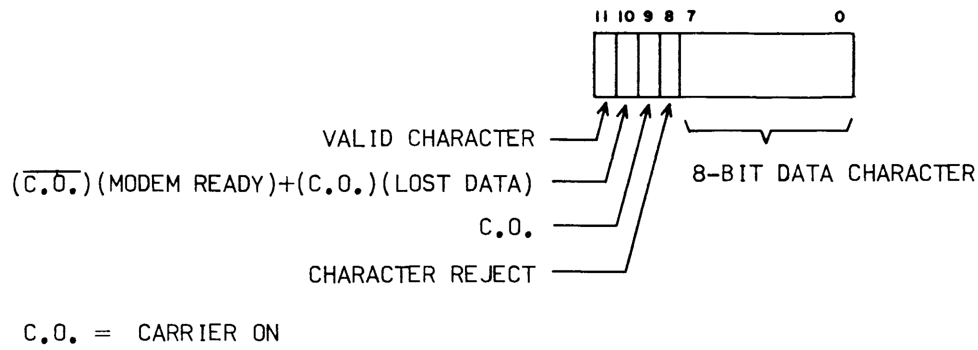


Figure 5. Input Word Format

Data Character (Bits 0 through 7): The lower 8 bits (0 through 7) of the input word form the data character. The DSC forms this character serially from data received from the modem. An all-zeros data character is transferred to the Data Channel when a MPC is passed by the DSC and no error has occurred. A non-zero character is transferred to the Data Channel if an error has occurred. The order of data character assembly is shown in Table 4.

TABLE 4. DATA CHARACTER ASSEMBLY

103 TELETYPE		201 CLOCKED FORMAT	
Incoming Bit Order	Bit Position Discarded	Incoming Bit Order	Bit Position Discarded
1	Discarded	1	0
2	1	2	1
3	2	3	2
4	3	4	3
5	4	5	4
6	5	6	5
7	6	7	6
8	7	8	7
9	0		
10	Discarded		
11	Discarded		

Character Reject (Bit 8): Bit 8 of the DSC input word sets if a Data Channel output word has been pseudo-accepted and then discarded (output buffer for that terminal was full). This control bit indicates that the DSC has not accepted a data output word. The DSC clears bit 8 after transferring the input word to the processor.

Terminal Ready (Bit 9): Bit 9 is set when the modem Interlock signal is present and indicates that a connection exists between the terminal and the modem. Bit 9 clears as the Interlock signal terminates.

Lost Data (Bit 10): When set, bit 10 of the DSC word indicates that the processor has failed to perform an input operation before the next character has been assembled. When a terminal is active, the processor must perform an input operation within 100 ms (110 baud), 4 ms (2000 baud) or 3.3 ms (2400 baud) after Input Required sets (status bit 1). The DSC clears this control bit 10 after transferring the input word to the processor. Note that USASCII sync characters are not considered to be data and, as such, do not cause a Lost Data condition to be indicated.

Valid Character (Bit 11): Bit 11 is set after the DSC assembles a complete data character from the active terminal. Bit 11 indicates that bits 0 through 7 contain a data character.

STATUS WORD

A status word provides the processor with a means of determining the condition of the DSC. The processor, to determine the status of the DSC, issues a Status Request code (X002) followed by an input operation. Figure 6 shows the format of the DSC status response word.

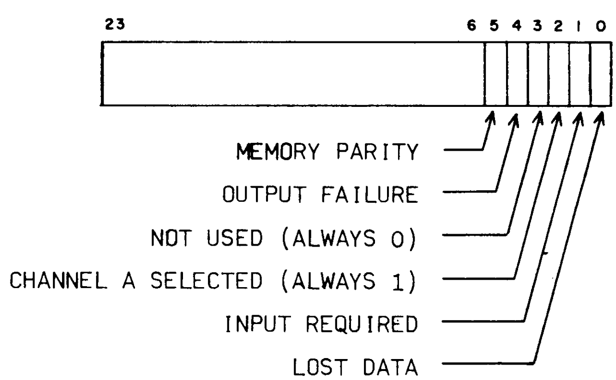


Figure 6. Status Response Word Format

DSC Lost Data (0005)

Status bit 0 sets when the processor fails to perform an input operation before a telephone channel has assembled the next input character. This status bit indicates the presence of lost data in at least one telephone channel. The DSC clears status bit 0 after receiving a Select Input code.

Input Required (0006)

Status bit 1 sets when a character is available for input. The input operation requested by DSC should follow within 100 ms (110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud) or data may be lost.

Channel A Selected (0004)

Bit 2 (always a "1") is required for CONTROL DATA® 6676 Data Set Controller Compatibility.

Output Failure (0024)

Status bit 4 sets when a Clocked Line or Block Mode (2000 or 2400 baud) output operation does not find a character to disassemble in the Output Buffer register. A XXX1 function code clears this bit (output).

Memory Parity Error (0044)

Status bit 5 sets when a parity error is detected in a data transfer to or from the DSC memory. A XXX2 function code (status) clears this bit after it has been presented to the Data Channel.

PROGRAMMING CONSIDERATIONS

Status

The DSC has the following two types of status available:

1. Equipment status - Consists of DSC Lost Data and Input Required; available by means of Status Request code.
2. Operation Control status - Consists of Lost Data and Terminal Ready indications (for input operations) and Character Reject indications (for output operations) for each channel.

Output Status Check

The output operation must be followed by an input operation to obtain complete status. The terminal for which an output character has been rejected will have bit 8 set in the next input word for the terminal. For example, if an output character to terminal 10 (word 10 of the output block) is rejected, the next input block will have bit 8 set in word 10.

Data Block Length

The I/O data block length can be a function of the terminals available if the DSC controls less than 16 terminals. For example, The I/O data blocks need only be eight words if a DSC only controls eight terminals and the terminals are consecutively numbered starting with terminal 0. The DSC considers all data transfers to start at terminal 0.

The output data block length can also be a function of the number of active terminals. The data block can be 10 words if only terminal 10 is active.

Input Block Length

An input operation may be up to 16 words long. Blocks shorter than 16 words can be read, but they should contain at least as many words as the number of active data terminals. Due to the nature of the 6000 Data Channel, the DSC will present the Data Channel with one more word than requested. In most situations this is of no consequence. In the DSC, however, the extra word presented will correspond to a data terminal one higher in number than the last word requested by the Data Channel. The DSC considers this word as having actually been transferred to the Data Channel and destroys any information that it may contain. It is possible, therefore, to lose data when a block of insufficient length is read.

To prevent loss of data on 16-word blocks, the DSC ceases to process Data Channel signals after 16 words (or after the first word on an input which follows a status function). Abnormal program termination will result if longer block inputs are attempted.

Output Timing

The DSC accepts 16 words from the Data Channel in 32 μsec (one word each 2 μsec) in a block-output format. The complete output on communication lines (including disassembly and transfer) requires an additional 100 ms (110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud). If the DSC receives a new data word before the preceding word is in the Output Disassembly register, the new word is lost and Character Reject sets in the next input word. Because of these output-timing restrictions, each output block should be followed by an input block in which bit 8 (Character Reject) is checked.

Input Timing

The DSC can transmit a 16-word data block to the Data Channel in 32 μsec (one word each 2 μsec). The time required by the DSC to assemble a complete input code from a terminal is the same as that required for data output. The DSC assembles the character and then transfers it to the Input Buffer register. With a word assembled and status bit 11 set, an input to the Data Channel must be activated within 100 ms

(110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud) or the word may be lost and result in Lost Data for the corresponding word.

General Timing

When a number of high- and low-speed data terminals are used with the DSC, it is advisable to connect the higher-speed terminals to the low-numbered channels and the lower-speed terminals to the high-numbered channels. In this way, the controlling computer program need communicate with only those terminals which require frequent servicing at a high rate. The slower terminals can then be serviced at a lower rate. These arrangements will provide a considerable shortening of programming time, but should be used only after consideration of the input block length.

Processor Restrictions

Input: The processor must perform inputs that equal or exceed the input character rate to avoid lost information.

Output: The processor must perform outputs that equal or exceed the character rate to avoid lost information when transmitting line-mode (clocked) information.

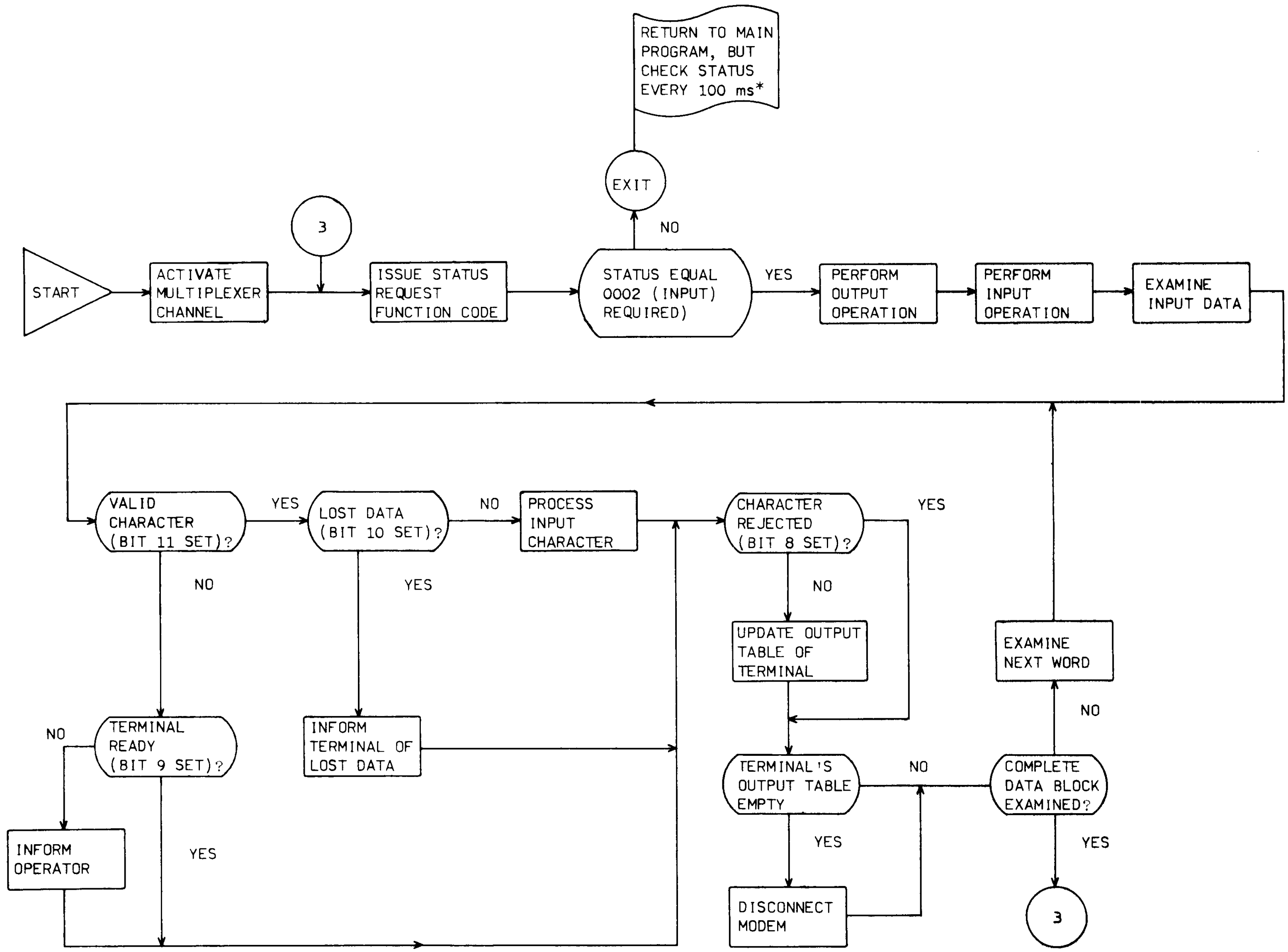
Character Format

During transmission, the DSC performs a serial transfer of the 11-bit synchronized data character. This serialized character stream is required for compatibility with the 6676 Data Set Controller. Refer to Table 2 for the 103/201 Data Sets character format and transfer sequence.

Programming Example

The flow chart (Figure 7) shows the DSC servicing routine and is useful in understanding the DSC operation. Programming the DSC is similar to programming other peripheral equipment. A typical ordering of programming steps is as follows:

1. Clear (dead start)
2. Function select status
3. Input status (determine if DSC requires service)
4. Function select output
5. Output data to terminals
6. Function select input
7. Input data plus I/O control bits for terminals



*100 ms (110 BAUD), 18 ms (600 BAUD)

Figure 7. Sample Controller Servicing Routine

OPERATION

The DSC employs 3000 Series logic and is entirely program controlled. In normal operation, the DSC requires no operator intervention and is on when system power is on. It can, however, be turned on or off at any time by means of the circuit breaker switch (CB1) contained in the cabinet. The operator control panel is shown in Figure 8, and the operator switches and indicators are described in Table 5. Table 6 lists the Modem Selection switches.

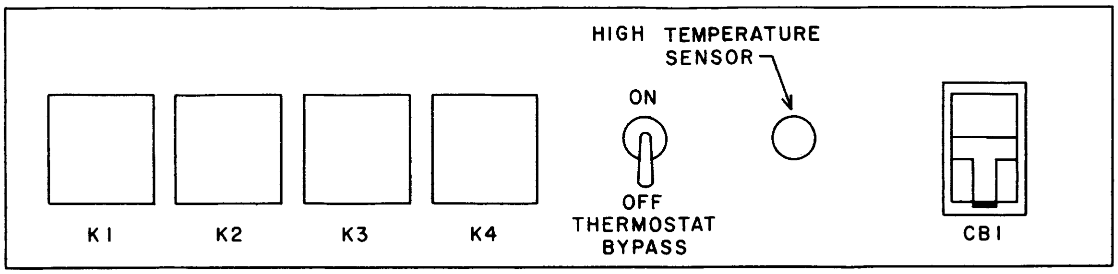


Figure 8. Operator Control Panel

TABLE 5. SWITCHES AND INDICATORS

NAME		FUNCTION
CB1	S*	Turns on 400-Hz power for the power supply and 60-Hz power for the blowers.
	I*	Lights when the CB1 switch on the power supply trips or is in the OFF position.
400-HZ CB1	S	Turns on the 400-Hz power for the power supply.
THERMOSTAT BYPASS	S	Bypasses the thermal-protection devices. For emergency use only.
	I	Lights when the thermostat is bypassed (switch in ON position).
Temperature Warning	I	Lights when temperature of air entering the cabinet is above 80°F, when a blower fails, or when a blower provides insufficient air circulation.
*S = Switch; I = Indicator		

TABLE 5. SWITCHES AND INDICATORS (Cont'd)

NAME		FUNCTION
High Temperature	I	Lights when air temperature inside the cabinet rises above 110^{o}F.
MASTER CLEAR	S	Generates a Clear pulse for DSC circuits and memory.
Equipment Number	S	These three 0-7 position switches determine the X portion of the function select code sent to the DSC.
Modem Selection	S	These switches determine which modem type (Teletype or Clocked Data) the DSC recognizes.

TABLE 6. MODEM SELECTION SWITCHES

SWITCH	LOCATION	DESCRIPTION
Channel 00	C044 A	
Channel 01	C044 B	
Channel 02	C044 C	
Channel 03	C044 D	
Channel 04	D044 A	Mode Selection:
Channel 05	D0dd B	
Channel 06	D044 C	UP for Teletype
Channel 07	D044 D	
Channel 08	E044 A	DOWN for Clocked Data
Channel 09	E044 B	
Channel 10	E044 C	
Channel 11	E044 D	
Channel 12	F044 A	
Channel 13	F044 B	
Channel 14	F044 C	
Channel 15	F044 D	

Note: For normal operations, the switches in 1J003 should be positioned so A is UP and B, C, D are DOWN. Consult the CE manual for switch functions.

6682-A/6683-A SATELLITE COUPLERS

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6682-A/6683-A SATELLITE COUPLERS

The CONTROL DATA* 6682-A/6683-A Satellite Couplers permit communication between two 6000 Series Computer Systems.

This section describes the relationship between the 6682/6683 Couplers and 6000 Series Data Channels. It also describes 6682/6683 function and status reply codes and provides pertinent programming information.

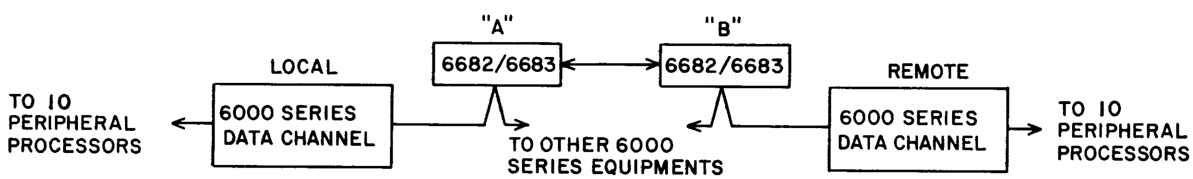

Figure 1. Typical Configuration

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 6682/6683 Satellite Couplers act as a data path between two standard 6000 Series Data Channels. Two 6682/6683 Couplers are required, one for each Data Channel. The couplers are connected by a standard 28-pair cable. Data can be transmitted between the couplers at a rate approaching one million 12-bit words per second.

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Throughout this section, the coupler attached to the initiating Data Channel is referred to as the local division. The other coupler is the remote division. Both divisions contain control logic, a Buffer register and input/output hardware. The divisions operate asynchronously.

A Data Channel may request remote division status and prepare the local division for either an input or an output operation.

STATUS

Status checks must be performed after selecting the local division for either an input or an output operation. The check is accomplished by selecting Status Request (S200) via a FAN or FNC instruction, activating the channel and reading in one word. A status check determines:

1) If the remote processor has selected the local 6682 system for an output operation (status reply bit 0 is set).

2) If the remote processor has selected the local 6682 system for an input operation (status reply bit 1 is set).

3) If data placed in the local division's Buffer register has been accepted by the remote division (status reply bit 2 is clear).

If the remote processor requests permission to output, the local processor should execute an input instruction to obtain a data word from the 6682/6683. If the remote processor requests permission to input, the local processor should execute an output instruction to send a data word to the 6682/6683. Likewise, local processor requests should be honored by the remote processor.

If both processors make the same request simultaneously, one of the two must change its request (i.e., issue new function code) prior to initiation of the operation. If the change is not made and if both processors activate their respective channels and initiate write operations, both channels hang up. If they hang up, a Dead Start Master Clear must be used to clear them.

SELECT

Each of the three function codes will select the local coupler. A division must always be selected with the appropriate request prior to initiating a Read or Write operation.

CODES

The 6682/6683 function codes listed in Table 1 select one division of the coupler. They also prepare this division for a status check and input/output operations.

Function codes are transmitted to the division via FAN and FNC instructions.

In all discussion of codes, bit 0 is in the rightmost position. A detailed description of each code follows Table 1.

TABLE 1. SATELLITE COUPLER CODES

Function Codes	
Output	S000*
Input	S100
Status Request	S200
Status Reply Codes	
Output Channel Request	0001
Input Channel Request	0002
Busy	0004

Function Codes

Output (S000) *

This code selects the 6682/6683 Coupler for an output operation.

Input (S100)

This code selects the 6682/6683 Coupler for an input operation.

*S is the select code (0-7) for the 6682/6683. It is established at installation and ordinarily is not changed.

Status Request (S200)

This code makes the 6682/6683 status word available to the Peripheral Processor. A one-word input operation must follow to read in the status word.

Status Reply Codes

Output Channel Request (0001)—Bit 0

Bit 0 is set when the other processor has selected its 6682/6683 Coupler for an output operation.

Input Channel Request (0002)—Bit 1

Bit 1 is set when the other processor has selected its 6682/6683 Coupler for an input operation.

Busy (0004)—Bit 2

Bit 2 is set when a data word is in the local division Buffer register and has not yet been accepted by the remote division.

PROGRAMMING CONSIDERATIONS

Data Format

Data is transmitted between the divisions in 12-bit words. There is no conversion or reformatting of the data.

Transmission Length

Transmission length may be determined by any one of the following ways:

1) All transmissions consist of equal length blocks,

2) All transmissions are headed by a word count code word, or
3) Transmission length is determined by the PPU performing the output operation.

Regardless of which of the above methods is used, the number of words read by one PPU should always be within three* of the number written by the other PPU to avoid hanging up the PPU performing the Write operation. The PPU sending the information hangs up if the PPU receiving the information concludes its input operation more than three words before the channel sending the information terminates its output operation. It remains hung up until cleared by a Dead Start Master Clear.

If the PPU performing the output operation determines the transmission length, ** the PPU reading the information should continue to input information until its channel becomes inactive. The 6682/6683 connected to this channel causes the channels to become inactive after it has received the last of the data available to it from the 6682/6683 connected to the channel doing the output. Thus, the channel doing the input can determine if more data is available by performing an Active Jump. If more data is available, the initiation of a new input operation restarts data flow without loss of information.

One-Word Output

The channel performing a Write operation may be deactivated following a one-word output. This permits the channel to be used in connection with other devices on it. The word, however, remains in the 6682/6683 Buffer register until either it is accepted by the remote channel or it is cleared by a Dead Start Master Clear.

Transient Data

Up to four words can be in the 6682/6683 Coupler system (the two divisions and the connecting cables) at the same time. One word can be in the Output register of the remote 6682. The second on the lines connecting the couplers. The third and fourth words can be in the local division's Buffer and Input registers respectively. If four words are in the system, at least one must be read to avoid hanging up the channel that is performing a Write operation.

---

*See Transient Data

**End of Transmission must be indicated by the PPU performing the output operation. This deactivates its channel.

6681-A/B DATA CHANNEL CONVERTER

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6681-A/B DATA CHANNEL CONVERTER

The CONTROL DATA* 6681-A/B Data Channel Converter permits the use of 3000 Series peripheral equipment in a 6000 Series Computer System.

This section presents generalized programming information for the 6681 and describes the relationship of the 6681 to other devices. Detailed programming information for the 3000 Series peripheral equipments that are controlled by the 6681 is given in separate sections.

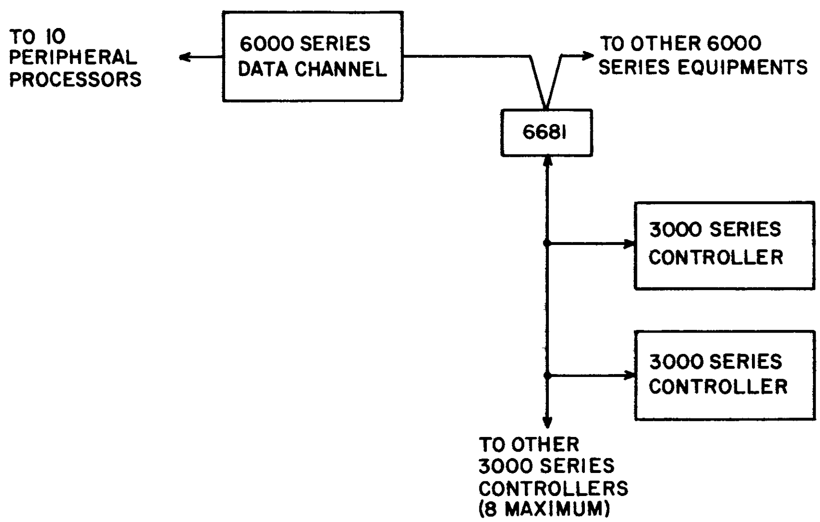

Figure 1. Typical Configuration

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

Figure 1 shows how the 6681 Data Channel Converter fits into a 6000 Series Computer System. The 6681 attaches to one of the computer system Data Channels. It may share

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the Data Channel with several other 6000 Series peripheral devices such as a 6622 Tape Controller or 6602 Console. Up to eight 3000 Series peripheral equipments may be attached to the 6681.

To prepare one of the 3000 Series equipments for operation, the 6681 must be selected first. Then, the desired 3000 Series equipment must be selected (connected). These two select operations are accomplished by function codes sent from a Peripheral Processor via the Data Channel.

Because some 6681 function codes may conflict with function codes assigned to other 6000 Series equipment on the same Data Channel, the 6681 converter differs from other 6000 Series equipment in three ways.

1) The converter must be attached to the Data Channel ahead of all other 6000 Series devices.
2) When selected, the 6681 Converter does not relay information to other equipment on the Data Channel. This arrangement prevents unwanted activity in the other devices on the Data Channel.
3) The converter must be deselected before other 6000 Series equipments sharing the Data Channel can be selected.

3000 SERIES INTERRUPT FEATURE

All 3000 Series peripheral equipments have an interrupt feature which enables the equipments to notify the 6681 when certain operating conditions occur. Any of the following interrupt conditions can be selected or released in an equipment by function codes:

1) Interrupt on Ready, or Ready and Not Busy,
2) Interrupt on End of Operation, and
3) Interrupt on Abnormal End of Operation.

The sections describing each 3000 Series equipment list the interrupt select function codes and define the interrupt conditions.

If one of the selected interrupt conditions occurs in an equipment, the equipment sends an Interrupt signal to the 6681 converter. This signal sets 1 bit in the 6681 status word. Bits 3 through 10 of the 12-bit status word indicate interrupts from the eight possible equipments served by the 6681. The status bit that is set depends on the equipment number of the device sending the interrupt, as follows:

Equipment Number	6681 Status Bit
0	3
1	4
.	.
.	.
.	.
6	9
7	10

An equipment need not be connected to the 6681 to send an Interrupt signal. Thus the interrupt feature can provide a limited status check of a device even if it is not connected.

An interrupt status bit in the 6681 remains set as long as the equipment maintains the Interrupt signal. An Interrupt signal can be cleared by:

1) A 6681 Function Master Clear (1700) which master clears all 3000 Series devices attached to the 6681.

2) A function code sent to the interrupting equipment. See the sections describing 3000 Series equipments for proper code.

PROGRAMMING

CODES

Two sets of codes are required to operate a 3000 Series peripheral equipment via a 6681 Converter:

1) The 6681 function and status reply codes, and
2) The connect function and status codes for the specific 3000 Series equipment.

The 6681 function codes permit the computer to connect the 3000 Series equipment and to transmit 3000 Series function codes to the connected equipment. They also permit the sensing of both converter and external equipment status and enable the flow of data between the Data Channel and the 3000 Series equipment via the 6681. Table 1 lists the 6681 function codes; a description of each code follows the table.

The 3000 Series codes include connect, function and status reply codes. The 3000 Series function codes are used to prepare a connected device for an input/output operation. These function codes do not affect the unconnected devices. The 3000 Series status codes permit monitoring operating conditions of several devices. See the sections describing the 3000 Series equipments for a complete list of these codes.

Table 1 lists the function and status reply codes applicable to the 6681. Function codes are transmitted to the 6681 by Peripheral Processor FAN (76) and FNC (77) instructions. In all codes, bit 0 is the rightmost bit. Each code is described in the section following Table 1.

TABLE 1. 6681 DATA CHANNEL CONVERTER CODES

Select/Deselect Codes	
Select Converter	2000
Deselect Converter	2100
Connect Codes	
Connect Equipment (Mode I)	NUUU*
Connect Initiate (Mode II)	1000
Function Codes	
Function Transmit (Mode I)	0FFF**
Function Initiate (Mode II)	1100
Data Input/Output Codes	
Input Initiate I	1400
Input Initiate II	1401
Input Initiate III	1500
Input Initiate IV	1501
Output Initiate I	1600
Output Initiate II	1601
Master Clear Code	
6681 Function Master Clear	1700
Status Request Codes	
Converter Status Request	1200
Equipment Status Request	1300
6681 Status Reply Codes	
Reply	XXX0
Reject (Internal or External)	XXX1
Internal Reject	XXX2
Transmission Parity Error	XXX4
Equipment Interrupts	XX1X-2XXX

*N = 4-7 (equipment number)
UUU = Lower 9 bits of connect code

**FF = Lower 9 bits of function code

Function Codes

Select Converter (2000)

This code selects the 6681 Converter from among the 6000 Series devices sharing the same Data Channel.

Deselect Converter (2100)

This code deselects the 6681 Converter. The 6681 must be deselected before another 6000 Series device on the same Data Channel can be used.

Connect Equipment (NUUU)

This code connects equipment 4, 5, 6, or 7 and units UUU, where N = Equipment number (restricted to 4-7) and UUU = Lower 9 bits of the connect code.

Connect Initiate (1000)

This code, specifying mode II operation, directs the 6681 Converter to send the next data word received to the 3000 Series equipments as a connect code. This code can be used to connect any equipment 0-7.

Function Transmit (0FFF)

This code, specifying mode I operation, causes the converter to transmit the 12-bit function code (0FFF), to the connected equipment. FFF may be the lower 9 bits of any 12-bit code whose upper 3 bits are zeros.

Function Initiate (1100)

This code, specifying mode II operation, directs the converter to send the next data word received to the connected 3000 Series equipment as a function code. This code can be used to transmit any 3000 Series function code to the connected equipment.

Input Initiate I (1400)

This code prepares the converter for an input operation. It permits termination of the input by either an end of record from the equipment or a channel disconnect from the processor.* The code remains in effect until another 6681 function code is received.

Input Initiate II (1401)

This code replaces Input Initiate (1400) when the normal external to internal BCD conversion, which occurs in some 3000 Series equipments, is not desired. The negate BCD condition is cleared when the Data Channel is inactivated. However, the 6681 remains in Input mode (1400 state) until another 6681 function code is received.

Input Initiate III (1500)

This code prepares the converter for an input operation. It permits termination of the input by a channel disconnect only. This code should not be used for magnetic tape inputs.** It remains in effect until another 6681 function code is received.

Input Initiate IV (1501)

This code replaces Input Initiate (1500) when the normal external to internal BCD conversion is not desired. The negate BCD condition is cleared when the Data Channel is inactivated. However, the 6681 remains in Input mode (code 1500 state) until another 6681 function code is received.

Output Initiate I (1600)

This code prepares the converter for an output operation. It permits termination of the output by a channel disconnect. The code remains in effect until another 6681 function code is received.

*An End of Record disconnect effected by a 1400 code will not free a waiting IAN (70) instruction. Therefore the software must determine the Active status of the channel prior to executing subsequent IAN instructions to prevent a PPU hang up. The 1400 code does however free a waiting IAM (71) instruction.

**A magnetic tape transport always stops tape motion when it senses the end of a record. However, when code 1500 or 1501 is in effect the 6681 does not disconnect the Data Channel on end of record. Thus the Peripheral Processor hangs up on the input instruction.

Output Initiate II (1601)

This code replaces Output Initiate (1600) when the normal internal to external BCD conversion is not desired. The negate BCD condition is cleared when the Data Channel becomes inactive. However, the 6681 remains in output mode (code 1600 state) until another 6681 function code is received.

6681 Function Master Clear (1700)

This code master clears all 3000 Series equipment attached to the converter as well as the conditions within the 6681.

Converter Status Request (1200)

This code permits the 6000 Series processor to input converter status. A one-word input must follow to read in the status response.

Equipment Status Request (1300)

This code permits the 6000 Series processor to input the status response from the connected 3000 Series equipment. A one-word input must follow to read in the status word.

Status Reply Codes

Two types of status codes are available from the 6681:

1) 6681 Converter status codes, and
2) Equipment status codes.

The 12-bit 6681 status response (Table 1) indicates the Reply, Reject, Parity Error and Interrupt signals from the attached 3000 Series equipments. Function code 1200 makes this response available to the Peripheral Processor. A one-word data input must follow to read in the status word.

Each 3000 Series equipment has a 12-bit status response which is available when the equipment is connected to the 6681, or after the equipment rejects a connect code. Each bit in the response indicates a condition within the equipment such as Ready, Busy or End of Tape. A Peripheral Processorrequests status from the connected equipment by sending function code 1300 to the 6681. It must then perform a one-word input to read in the response.

The equipment status codes are different for each equipment and are listed in the sections describing the individual equipments.

Reply (XXX0)—Bit 0

Bit 0 is cleared if the 3000 Series equipment returns a Reply signal (indicating acceptance) in response to a connect or function code.

Reject (Internal or External) (XXX1)—Bit 0

Bit 0 is set when the 3000 Series equipment returns a Reject signal to the 6681 in response to a connect or function code. An Internal Reject will also set this bit along with bit 1.

Internal Reject (XXX2)—Bit 1

Bit 1 is automatically set (along with bit 0) after a delay of 100 usec if the 3000 Series equipments fail to return a Reply or Reject in response to a connect or function code.

Transmission Parity Error (XXX4)—Bit 2

Bit 2 is set when the connected 3000 Series equipment senses a parity error in a function code or output data. In the case of certain 3000 Series equipments a parity error may also occur during an input operation. A parity error during a connect code will not set this bit.

Equipment Interrupts (XX1X-2XXX)—Bits 3-10

Bits 3-10 each indicate the Interrupt signal from one of the eight possible 3000 Series equipments. If equipment N sends an interrupt, status bit N+3 is set. The status bit remains set until the equipment drops the Interrupt signal.

SELECTING THE 6681 CONVERTER

The 6681 converter must be selected from among other 6000 Series devices that share the same Data Channel before it can communicate with a 3000 Series peripheral equipment. The selection is accomplished by the Select (2000)* code transmitted by a Peripheral Processor FAN (76) or FNC (77) instruction. Selection activates the 6681 and inactivates all other 6000 Series input/output devices on the Data Channel that are attached beyond the 6681.

A Dead Start Master Clear automatically selects all 6681 Converters in the computer system.

DESELECTING THE 6681 CONVERTER

Once selected the 6681 Converter remains selected until deliberately deselected by function code 2100*. The 6681 must always be deselected before any other 6000 Series input/output device on the same Data Channel can be used.

Where two 6681's on the same Data Channel have been selected by a Dead Start Master Clear the first 6681 must be deselected before the second can be deselected. This is because a 6681, when selected, does not relay codes sent from the Data Channel to more distant equipment.

CONNECTING A 3000 SERIES EQUIPMENT

After the 6681 Converter is selected, one of the eight possible 3000 Series equipments attached to the 6681 may be connected. The connect operation activates one of these equipments and automatically deactivates the other seven. Thus, only one of the eight possible equipments can be connected at a given time.

---

*Where two 6681 Converters share a common Data Channel one of the converters is assigned different Select and Deselect codes such as 2200 and 2300 or 2400 and 2500.

A 12-bit connect code of the following form connects a 3000 Series equipment.

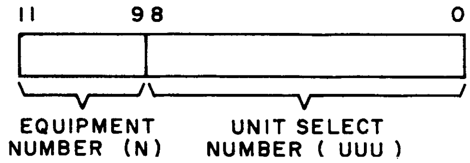

Figure 2. Connect Code Format

Bits 9-11 designate the equipment number of the device to be connected. Each of the eight possible 3000 Series equipments is assigned a unique number (0-7) by means of an eight-position Equipment Number switch. Bits 0-8 designate one of several possible units subordinate to the equipment. For example, a tape controller ranks as an equipment and each of the several attached tape transports is a unit, designated by a Unit Select Number. In the case of equipments which have no subordinate units, such as a card reader, bits 0-8 are not used.

A connect code is sent from a Peripheral Processor via the 6681 to an attached 3000 Series equipment. There are two methods of sending a connect code: mode I connect and mode II connect. The mode I connect operation requires only one 6681 function code from the Peripheral Processor, but is restricted to connecting only equipments 4-7. A mode II connect operation requires a 6681 function code followed by a one-word data output. It can connect any of the eight possible equipments.

A connect is broken only by connecting another equipment, a Dead Start Master Clear or a 6681 Function Master Clear (1700). Deselecting the 6681 or disconnecting the data channel does not clear a connect.

Mode I Connect

The 6681 performs a mode I connect operation whenever the Peripheral Processor sends a function code in the range 4UUU - 7UUU. The 6681 simply forwards the code to the attached 3000 Series equipments as a connect code. Normally, the equipment corresponding to the upper octal digit (4-7) connects, and any previously connected equipment automatically disconnects.

If an equipment connects successfully, it returns a Reply signal to the 6681 which in turn sends an Inactive signal to the data channel. This signal disconnects the Data Channel making it available for another operation.

Certain equipments may not be able to connect under some conditions. In such cases the equipment returns a Reject signal to the 6681. The Reject acts like a Reply in that it causes the 6681 to send an Inactive signal to the Data Channel. In addition the Reject sets a status bit (bit 0) in the 6681 indicating that the connect code was rejected. The conditions which cause the 3000 Series equipments to reject a connect code are listed in the sections describing each equipment.

Neither a Reply nor Reject is returned if a connect code addresses a nonexistent equipment or if the equipment malfunctions. In these cases the 6681 generates an Internal Reject after 100 usec. An Internal Reject:

1) Causes the 6681 to send an Inactive signal to the Data Channel, and
2) Sets the Reject status bit (bit 0) and also sets an Internal Reject status bit (bit 1) in the 6681.

The 3000 Series equipments check each connect code sent from the 6681 for correct parity. If a parity error occurs no equipment connects and neither a Reply nor a Reject is returned to the 6681. After a delay of 100 usec an Internal Reject sets status bits 0 and 1.

The sample program outline at the end of this chapter shows the steps in a mode I connect operation.

Mode II Connect

A mode II connect operation requires two steps:

1) Function code 1000 (Connect Initiate) is sent to the 6681 by a FAN (76) or FNC (77) instruction. This code merely conditions the 6681 for a mode II connect operation and is not sent to the 3000 Series equipments. The 6681 returns an Inactive signal to release the Data Channel.
2) A one-word output, containing the connect code, is sent to the 6681 by a Peripheral Processor output instruction, OAM (73) - or OAN (72). The 6681 forwards this output word to the 3000 Series devices as a connect code.

As in a mode I connect there are three possible responses to the connect code sent by a mode II connect operation:

1) Reply - Indicates addressed equipment successfully connected.

2) Reject - Indicates addressed equipment could not connect. The Reject status bit (bit 0) in the 6681 is set.

3) No Response - The 6681 generates an Internal Reject after 100 usec. The Internal Reject status bit (bit 1) and Reject status bit (bit 0) are both set.

Any of the three responses causes the 6681 to send an Empty signal to the Data Channel indicating receipt of the output word. If an OAN instruction has been executed, a Full Jump instruction (FJM, 66) should follow the data output to delay the program until the 6681 accepts the output word. Then, a Disconnect Channel instruction (DCN, 75) should follow to deactivate the Data Channel.

The result of a parity error for a mode II connect is the same as for a mode I connect:

1) No equipment connects, and

2) The 6681 generates an Internal Reject after 100 usec, which sets the Reject status bits (bits 0 and 1).

After a mode II connect operation is complete, the 6681 status response should be checked for a Reject.

NOTE

A status check should follow only after the mode II connect is complete. There is no response from the 3000 Series equipments when the Connect Initiate code (1000) is sent to the 6681. Thus a status check at this time is not significant.

The sample program outline at the end of this section shows a mode II connect example.

SENDING FUNCTION CODES TO 3000 SERIES EQUIPMENTS

After a 3000 Series equipment is connected it will accept 12-bit function codes from the 6681. Function codes establish operating conditions within an equipment or initiate operations such as tape rewind. The function codes applicable to the 3000 Series equipments are listed in the sections describing each equipment.

The function codes sent from the 6681 to the 3000 Series equipments are distinct from function codes transmitted by the Peripheral Processor to the 6681 (listed in Table 1).

As in a connect operation there are two methods of transmitting function codes to a 3000 Series equipment.

1) Mode I: A mode I function operation requires only a single Peripheral Processor function instruction (FAN or FNC), but is restricted to a 9-bit function code.

2) Mode II: A mode II function operation requires a function instruction followed by a one word data output. A full 12-bit function code can be sent by the mode II procedure.

Mode I Function

A mode I function operation is similar to a mode I connect. The 6681 performs a mode I function operation whenever the Peripheral Processor sends function code 0FFF. The quantity FFF can be any 9-bit 3000 Series function code. The 6681 merely forwards the code 0FFF to the connected equipment as a function code.

The 6681 receives one of three possible responses from the 3000 Series equipment in response to a function code:

1) Reply - Indicates that the equipment accepted the code,

2) Reject - Indicates that the equipment did not accept the code. This signal sets the Reject status bit (bit 0) in the 6681, or

3) No Response - The 6681 generates an Internal Reject after 100 usec. The Internal Reject status bit (bit 1) and Reject status bit (bit 0) are both set.

The Reject and no-response conditions vary for different equipments. In general, most 3000 Series equipments reject function codes that direct an operation that conflicts with an operation already in progress.

A code that is not applicable to the equipment, a parity error or equipment malfunction will yield no response.

Any of the three responses causes the 6681 to send an Inactive signal to the Data Channel releasing it for another operation.

The connected 3000 Series equipment checks each function code for correct parity. If the equipment senses a parity error the following occurs:

1) The equipment does not accept the function code and does not return a Reply or Reject.

2) It returns a Parity Error signal that sets the Parity Error status bit (bit 2) in the 6681.

3) After 100 usec the 6681 generates an Internal Reject that sets the Reject status bits (bits 0 and 1).

A status check should follow a mode I function operation to test for a reject or parity error.

An example of a mode I function procedure is shown in the sample program outline at the end of this section.

Mode II Function

A mode II function operation is similar to a mode II connect. Two steps are necessary:

1) Function code 1100 (Function Initiate) is sent to the 6681 by a FAN (76) or FNC (77) instruction. This code conditions the 6681 for a mode II function operation and is not forwarded to the 3000 Series equipment. The 6681 returns an Inactive signal to release the Data Channel.

2) A one-word output containing the desired 12-bit function code is sent to the 6681 by one of the output instructions, OAM (73) or OAN (72). The 6681 forwards this output word to the 3000 Series equipment as a function code.

The responses to a mode II function operation are the same as for a mode I function:

1) Reply - Indicates that the equipment accepted the code.

2) Reject - Indicates that the equipment could not accept the code. The Reject status bit (bit 0) in the 6681 is set.

3) No Response - The 6681 generates an Internal Reject after 100 usec. The Internal Reject status bit (bit 1) and Reject status bit (bit 0) are set.

Any of these responses causes the 6681 to send an Empty signal to the Data Channel indicating receipt of the output word. If an OAN (72) instruction has been executed, Full Jump instruction (FJM, 66) should follow the data output to delay the program until the

6681 accepts the output word. Then, a Disconnect Channel instruction (DCN, 75) should follow to deactivate the Data Channel.

The result of a parity error for a mode II function is the same as for a mode I function.

1) The Parity Error status bit (bit 2) is set,
2) The 6681 generates an Internal Reject, after 100 usec, which sets the Reject status bits (bits 0 and 1), and
3) The equipment does not accept the function code.

After a mode II function operation is complete, a status check should follow to sense for a parity error or reject. The status check is significant only after the second step of the procedure is completed.

The steps in a mode II function procedure are shown in the sample program outline at the end of this section.

TRANSMITTING DATA

An input or output operation can proceed only after the desired equipment is connected to the 6681.

Input

There are three basic steps to an input operation:

1) Send an Input Initiate function code. This code conditions the 6681 for an input operation.
2) Execute Channel Activate instruction. This action signals the equipment (via the 6681) to begin sending data. For example, it starts tape motion or initiates a card cycle.
3) An input instruction must follow to read in the data from the sending device.

There are four Input Initiate codes. They each prepare the 6681 for a slightly different type of input operation.

1) Code 1400 (Input Initiate I) - When this code is in effect the input operation will be terminated when the peripheral equipment reaches the end of a record or by a Channel Disconnect from the Peripheral Processor. When the equipment senses the end of a record it causes the 6681 to send an Inactive signal which disconnects the Data Channel. The Peripheral Processor then exits to the next instruction.

2) Code 1401 (Input Initiate II) - This code is identical to code 1400 except that the external to internal BCD* conversion, that normally takes place in some 3000 Series equipments, is suppressed.

3) Code 1500 (Input Initiate III) - When this code is in effect the input operation can be terminated only by a Channel Disconnect from the Peripheral Processor. This code should not be used to initiate a magnetic tape input operation. A magnetic tape unit always stops tape motion when it senses the end of a record. However, in the case of code 1500 the 6681 does not disconnect the Data Channel on end of record; thus, the Data Channel will remain in the active state and the Peripheral Processor will hang up.

4) Code 1501 (Input Initiate IV) - This code is identical to code 1500 except that the external to internal BCD conversion that normally takes place in some 3000 Series equipments, is suppressed.

On some equipments there may be significant delay between the Channel Activate instruction that signals the start of an input operation and the time that the first data word is available from the equipment. For example, in the 3248 Card Reader Controller there is a delay of 20 ms between the start of card motion and the availability of the first card column. During this period the Peripheral Processor can be used for some other task. The latent period is different for each 3000 Series equipment and can be found in the sections describing each device. If the delay is unknown, an input instruction should immediately follow the Channel Activate instruction.

If Input Initiate code 1500 or 1501 is used the 6681 does not inactivate the Data Channel on end of record. A channel disconnect instruction must immediately follow the input instruction to notify the equipment of the end of operation.

There is no transmission parity check during input for most 3000 Series devices. However, in some tape and drum equipments an error may occur that will set the Parity Error status bit in the 6681.

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*BCD refers to binary coded decimal codes.

Input Initiate codes 1400 and 1500 remain in effect until the next 6681 function code is received. The negate external to internal BCD condition, established by codes 1401 and 1501, is cleared when the Data Channel is disconnected by the Peripheral Processor. When the negate condition is established by code 1401 an End of Record signal from the external equipment also clears the condition. In either case the 6681 reverts to the normal input state (code 1400 or 1500). An input operation is normally followed by a Status Request function code. Thus, each input operation usually requires a new Input Initiate code.

Output

There are five basic steps in an output operation:

1) Send an Output Initiate function code to prepare the 6681 for an output operation.
2) Execute channel activate instruction. This action notifies the equipment (through the 6681) that an output operation is about to begin. In response, the connected device prepares to receive data; e.g., start card motion or tape motion.
3) An output instruction must follow to send data to the equipment.
4) A Full Jump instruction (FJM, 66) should follow the output instruction to delay the program until the 6681 has accepted the last output word.
5) The Peripheral Processor must then execute a Disconnect Channel instruction (DCN, 75). This step releases the Data Channel and notifies the equipment of the end of the record.

There are two Output Initiate codes:

1) Code 1600 (Output Initiate I) - This code conditions the 6681 for an output operation.
2) Code 1601 (Output Initiate II) - This code is identical to code 1600 except that the internal to external BCD conversion that normally takes place in some 3000 Series equipments is suppressed.

In some 3000 Series equipments there is delay between the Channel Activate instruction that flags the start of an output operation and the time that the equipment is ready to a accept the first data word. During this period the Peripheral Processor can be used for some other purpose. If the delay is unknown, the output instruction should immediately follow the Channel Activate instruction.

The 3000 Series equipments check each output word for correct parity. If a parity error occurs, the equipment returns a signal that sets the Parity Error status bit (bit 2) in the 6681. A status check should follow an output operation to determine if a parity error has occurred.

Output Initiate code (1600) remains in effect until the next 6681 function code is received. The negate internal to external BCD condition, established by code 1601 is cleared when the Peripheral Processor disconnects the Data Channel at the end of the output operation. The 6681 reverts to the normal output state (code 1600 state) at this time. An output operation is normally followed by a Status Request function code which clears the output condition in the 6681. Thus, each output operation usually requires a new Output Initiate code.

CLEARING A PARITY ERROR

If a status check reveals that a parity error has occurred, a 6681 Function Master Clear (code 1700) must be executed to clear the parity error conditions in the 3000 Series equipments. This action also clears the 6681 Parity Error status bit (bit 2).

If the 6681 is alternately operating two 3000 Series equipments on a time sharing basis, a special precaution must be observed in clearing a parity error. Care must be taken to wait until the slowest equipment completes its operation before issuing the Master Clear code. This procedure assures that the Master Clear does not cause loss of data.

PROGRAMMING EXAMPLES

The following program outlines show the steps in a 6681 input or output operation. Both mode I and mode II connect and function procedures are shown.

Following is an outline of an input program using mode I programming:

	Instruction	Explanation	
AJM	Active jump	Wait for inactive channel	
FAN or FNC	Function	Select 6681 (2000)*	
FAN or FNC	Function	Equipment connect (NUUU)	Mode I Connect
FAN or FNC	Function	Converter Status Request (1200)	Mode I Connect
ACN	Activate channel	Initiate input	Mode I Connect
IAN	Input one word to A	Input converter status reply	Mode I Connect
DCN	Disconnect channel	Release Data Channel for another operation	Mode I Connect
	Status check	Check for reject	Mode I Connect
FAN or FNC	Function	Equipment function, i.e., rewind etc. (0FFF)	Mode I Function
FAN or FNC	Function	Converter Status Request (1200)	Mode I Function
ACN	Activate channel	Initiate input	Mode I Function
INA	Input one word to A	Input equipment status reply	Mode I Function
DCN	Disconnect channel	Release Data Channel for another operation	Mode I Function
	Status check	Check for reject or parity error	Mode I Function
FAN or FNC	Function	Prepare 6681 for input (1500)	
ACN	Activate channel	Initiate input - start tape motion etc.	
IAM	Input instruction	Read in block of data	
DCN	Deactivate channel	Terminate input	
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input	
INA	Input one word to A	Input converter status	
	Status check	Check for parity error or interrupt	
DCN	Deactivate channel	Terminate input	
FAN or FNC	Function	Deselect 6681 (2100)*	

*This step is necessary only if 6681 has not been previously connected.

Following is an outline of an output program using mode II:

	Instruction	Explanation	
AJM	Active jump	Wait for inactive channel	
FAN or FNC	Function	Select 6681 (2000) *	
FAN or FNC	Function	Equipment Connect Initiate (1000)	
ACN	Activate channel	Initiate output of connect code	
OAM or OAN	Output one word	Output equipment connect code (code NUUU)	
FJM	Full jump	Wait for acceptance of connect code	Mode II Connect
DCN	Disconnect channel	Terminate output	
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input of status reply	
INA	Input one word to A	Input status reply	
DCN	Disconnect channel	Terminate input	
	Status check	Check for reject	
FAN or FNC	Function	Equipment Function Initiate (1100)	
ACN	Activate channel	Initiate output of input function code	
OAM or OAN	Output one word	Output equipment function code (FFFF)	
FJM	Full jump	Wait for acceptance of function code	
DCN	Disconnect channel	Terminate output	Mode II Function
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input of status reply	
INA	Input one word	Input status reply	
DCN	Disconnect channel	Terminate input	
	Status check	Check for reject or parity error	
FAN or FNC	Function	Prepare 6681 for output (1600)	
ACN	Activate channel	Initiate output of data - start tape motion etc.	
OAM or OAN	Output data	Output block of data words	
AJM	Active jump	Wait for completion of output	
DCN	Disconnect channel	Terminate read	

*6681 must be deselected only if another 6000 Series device on the same Data Channel is to be used.

	Instruction	Explanation
FAN or FNC	Function	Converter Status Request (1200)
ACN	Activate channel	Initiate input of status reply
INA	Input one word	Input status reply
	Status check	Check for parity error or interrupt
DCN	Disconnect channel	Terminate input
FAN or FNC	Function	Deselect (2100) 6681

6673-A/6674-A DATA SET CONTROLLER

CONTENTS

FIGURES

TABLES

6673-A/6674-A DATA SET CONTROLLER

The CONTROL DATA® 6673-A/6674-A Data Set Controller interfaces 6000 Series computers with leased telephone transmission lines. This enables data transfer between a central computer complex and a remote computer system.

The 6673/6674 consists of a Data Channel Adapter (DCA), a multiplexer, and up to four data set controllers (DSC). The 6673/6674 cabinet also provides mounting for DATA PHONE® data sets. Each installation determines how many DSC's and data sets are used. The 6673-A/6674-A uses the AT&T 301-B Data Set which provides a transmission rate of 40.8 kilobits/second. Communication over leased line requires two AT&T data sets; one data set terminates each end of the transmission line.

Figure 1 shows a typical configuration with four DSC's. The multiplexer assigns individual DSC's to transmit or receive. Each DSC converts 12-bit parallel words from the computer (via the DCA) to serial bits for the data set. The data set transmits serial data received from the DSC over a leased transmission line. The DSC at the receiving end of the line converts this serial data into 12-bit parallel words for computer input.

Each DSC includes a cyclic code generator and Error Detection circuit that enables detection of error bursts of 12 bits or less. An error burst is any pattern of errors whose length is the number of bits between the first and last errors of a transmission.

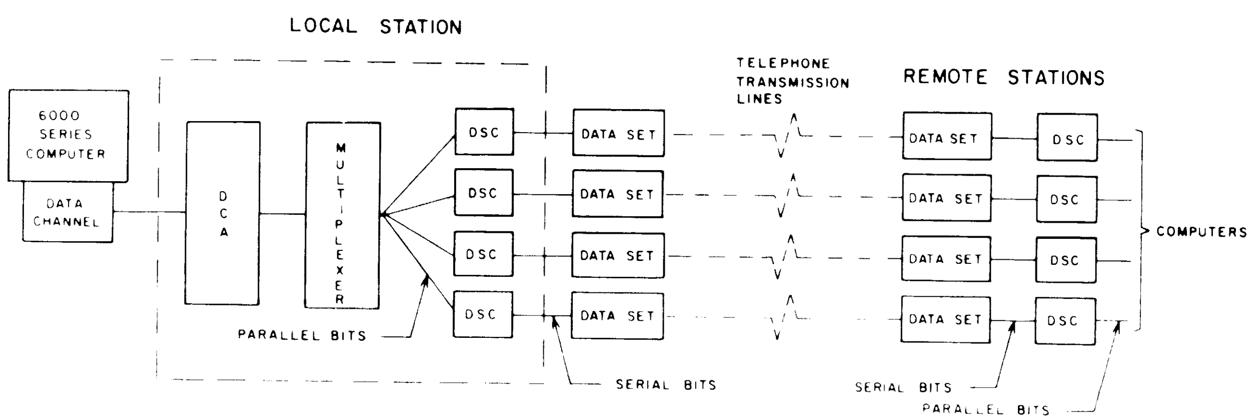

Figure 1. Typical Configuration

The transmitting DSC generates a cyclic code with each data block transmitted. A DSC may receive an interrupt word if it is not transmitting or receiving data. The interrupt word sets a status bit in the DSC. The equipment contained in the 6673/6674 is described below:

The Data Channel Adapter is a high-speed interface between the multiplexer of the 6673/6674 and a 6000 Series Peripheral Processor Data Channel. It provides the necessary logic signal conversions, resynchronization, and signal relay functions for the input/output operations. During an output operation the DCA converts the 6000 Series pulse signals to 1600 Series static signals. During an input operation the DCA converts the 1600 Series static signals to 6000 Series pulse signals, resynchronizes the pulse signals, and transfers them to the applicable Peripheral Processor via the Data Channel.

The multiplexer assigns each DSC to transmit or receive as directed by the computer and permits up to four transmit or receive operations to occur simultaneously. The exact number of high-and low-speed lines per multiplexer which can be serviced by a Peripheral Processor depends on the amount of processing required for the input and output data and on the manner in which this is handled by the operating system. The number of lines can be determined after a careful analysis of system data flow.

The DSC converts parallel data received from the computer to serial data for the data set and vice versa. A data set connects to each DSC and transmission line to receive and transmit serial data on the long distance communication facilities. The data sets provide synchronous clock pulses to bit-time the DSC and to modulate or demodulate the transmission line carrier. The data set consists of a signal controlled transceiver with an internal oscillator that produces synchronous clock pulses. The data set clocks out serial data from the DSC to phase modulate the carrier frequency during transmission. The data set demodulates incoming line signals to recover control signals and data.

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*When a data set is used with a 6673/6674, the remote data set controller must be a CONTROL DATA 3275-C, or 8529-B to utilize the cyclic code error detection capability.

FUNCTIONAL DESCRIPTION

Two stations, the local and the remote, constitute a communication network (Figure 1). The local station includes the 6000 Series computer and the 6673/6674; the remote station contains the other computer and peripheral equipment. With the exception of the computer and associated equipment, each station contains compatible DSC's and identical data sets. A leased transmission line connects the stations through the terminating data sets.

Each DSC operates in half-duplex; that is, data is exchanged in only one direction at a time. When one DSC is in the Transmit mode, the other must be in the Receive mode; to exchange data in the opposite direction, both DSC's must reverse modes.

Although data is transferred in half-duplex, control signals and response indications utilize the full-duplex capability of the data set. Both the response and the control signals are automatic functions.

During transmission from the local station to the remote station, the local station is in the Transmit mode and the remote station is in the Receive mode. With both stations active, data at the local station is exchanged in the following manner (Figure 2):

1) The local computer selects a local DSC (0-3) for the Transmit mode.
2) The DSC transmits a sync word.
3) The computer selects the DSC and sends it a data word.
4) The remote station acknowledges the sync word with a Response.
5) The DSC disassembles the first parallel data word received from the computer and transmits it serially, highest order bit first.
6) By sampling the status-all bits, the computer detects when a specific DSC (0-3) requires another data word for transmission (or contains a complete data word received from the remote station).
7) When the complete data block is transmitted, the DSC transmits the cyclic code word.

With both stations active, data is received from the remote station in the following manner:

1) The local computer selects a DSC for Receive mode.
2) The DSC receives the sync word and returns a response.
3) Each data word received is assembled into a 12-bit parallel word.
4) The computer samples status-all and inputs the data word.
5) When the complete data block is received, the DSC checks the received

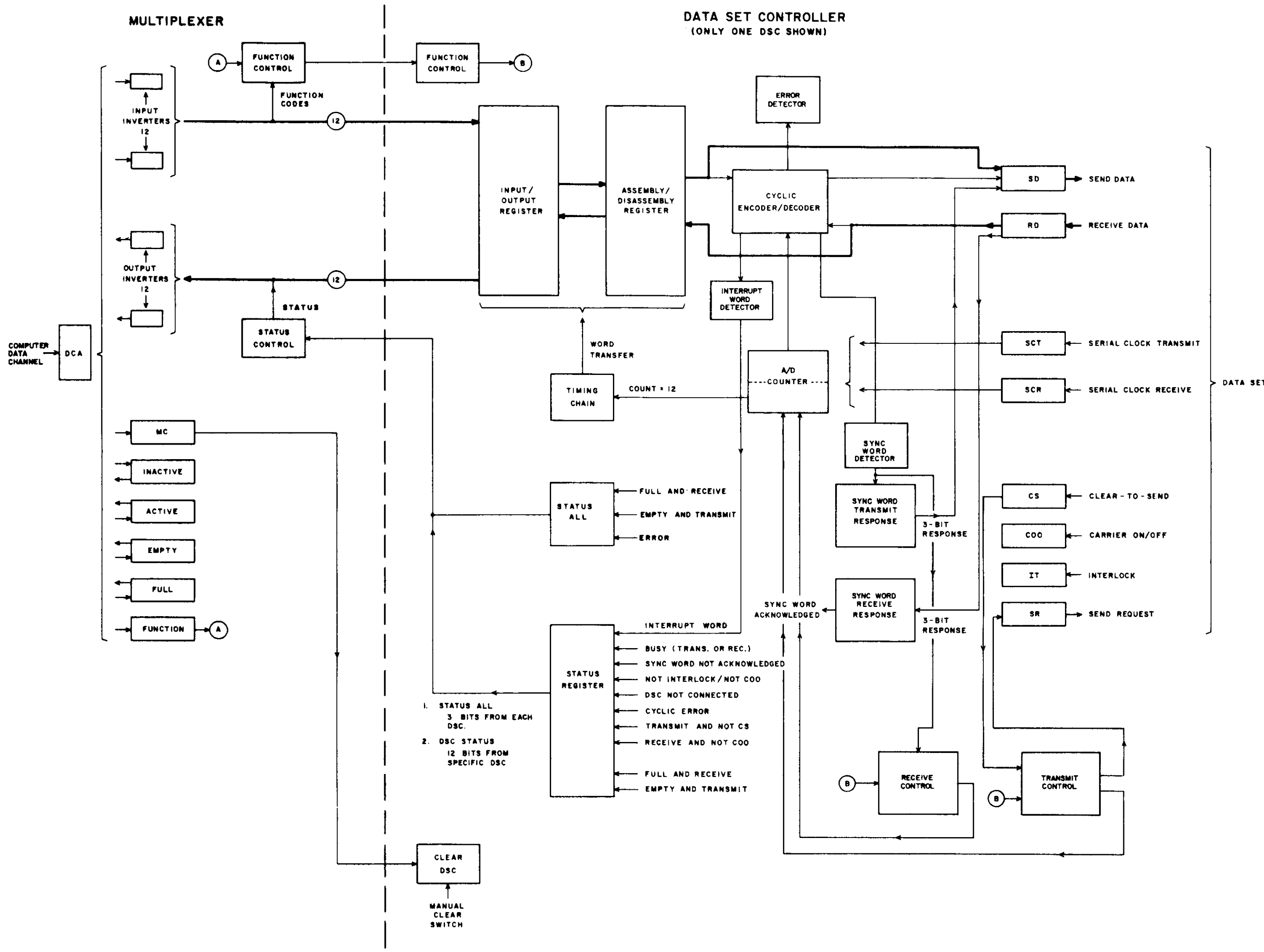

Figure 2. 6673/6674 Block Diagram

cyclic code word against one it has generated. If they do not agree, the DSC sets the cyclic code-error status bit.

The method of communication presented above is the basic sequence, and many elaborations are possible. The section on Programming, describes these variations and discusses the signals that control communication between the computer, the multiplexer, the DSC, and the data sets.

PROGRAMMING

All data transfer operations via the 6673/6674 are controlled by the local computer. Receive and Transmit operations from a specific DSC are initiated by function codes from the computer. The status-all word from the multiplexer enables the computer to determine when a DSC requires service. Operation of a DSC is monitored by requesting a status word from the respective DSC.

CODES

Control Signals

Communication signals between the 6673/6674 and the computer or between the 6673/6674 and the data set are listed in Tables 1 and 2 (Figure 2). Understanding the function of these signals clarifies the purpose of certain function or status codes. Communication signals are not transferred over data lines.

TABLE 1. COMMUNICATION SIGNALS BETWEEN CONTROLLER AND COMPUTER

SIGNAL	DESCRIPTION
External Master Clear	A static "1" appears on the line whenever the 6000 Series dead start panel is used to start the system.
Function	A static "1" signal is produced on the line when an external function code is present on the data lines for examination and translation by the 6673/6674. An Inactive signal from the 6673/6674 removes the static "1" signal.
Inactive (from 6673/6674)	A static "1" signal is produced on the line as a response to an EXF request if the 6673/6674 is selected.

TABLE 1 (Cont'd)

SIGNAL	DESCRIPTION
Active (from 6673/6674)	A static "1" signal is produced on the line as a response to an Active (from DCA) if the 6673/6674 is selected. This is cleared by an Inactive from the DCA.
Active (from DCA)	A static "1" signal is produced by the Data Channel while it is activated.
Inactive (from DCA)	A static "1" signal from the DCA indicates that the computer has deactivated the Data Channel.
Full (from DCA)	A static "1" signal accompanies each word of output information. Signal indicates output data present on lines. The signal is turned off by an Empty from the 6673/6674.
Full (from 6673/6674)	A static "1" signal is produced by the 6673/6674 when a data or status word is available. The signal is turned off by an Empty from the DCA.
Empty (from DCA)	A static "1" signal indicates that the DCA has accepted the input word from the 6673/6674. The signal is turned off by dropping the Full in the 6673/6674.
Empty (from 6673/6674)	A static "1" signal indicates that the 6673/6674 has accepted the output word from the DCA. This signal is turned off by dropping the Full signal in the DCA.

TABLE 2. COMMUNICATIONS SIGNALS BETWEEN CONTROLLER AND DATA SET

SIGNAL	DESCRIPTION
Serial Clock Transmit (SCT)	The SCT circuit furnishes the master clock timing signals for the DSC in the Transmit mode. The data set SCT signal is a square wave (40.8 kHz - 301-B).
Send Data (SD)	The SD line carries the serial data from the DSC to the data set where the information is sampled during the negative transition of the SCT square wave.
Serial Clock Receive (SCR)	Similar to the SCT signal, the SCR signal clocks the received data to the DSC. SCR synchronization depends upon the SCT signals at the transmitting set.

TABLE 2 (Cont'd)

SIGNAL	DESCRIPTION
Receive Data (RD)	RD consists of incoming serial data which is sent to the DSC and sampled during the negative transition of the SCR square wave.
Interlock (IT)	An On signal to the DSC indicates that the data set is on, that it can transmit data, and that it is not in a test condition.
Carrier On-Off (COO)	An On signal to the DSC indicates that the line carrier is present at the data set.
Send Request (SR)	The DSC delivers an On signal to the data set when it is ready to transmit data. The data set should respond with a CS signal.
Clear-to-Send (CS)	When the SR circuit is turned on by the DSC, the CS circuit should be switched on by the data set indicating that it will accept data. When the SR circuit is again turned off, the CS circuit is switched off.

Function Codes

The 6673/6674 translates and interprets the external function (EXF) codes listed in Table 3. The function codes represent commands or requests from the computer. The EXF code format is shown in Figure 3.

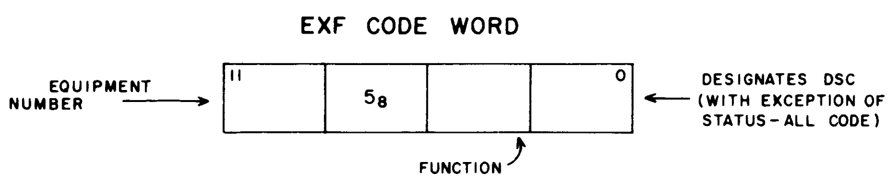

Figure 3. EXF Code Format

TABLE 3. EXTERNAL FUNCTION CODES

DEFINITION	CODE	NOTES
Request Status-all	S504	Enables 3 status-all bits from each of the four DSC's.
Request Status	S51N	Enables a status word (12 bits) from DSC N. N represents the number assigned to the selected DSC.

TABLE 3 (Cont'd)

DEFINITION	CODE	NOTES
Select	S52N	Selects DSC N
Clear	S53N	Clears DSC N
Select Transmit	S54N	Selects DSC N for data transmission
Select Receive	S55N	Selects DSC N to receive data from the data set for transfer to the computer.
Clear Interrupt Word Received Status Bit	S56N	Clears Interrupt Word Received FF and status bit 2^0 in controller N (interrupt word = 7622).

S = Equipment number

Status Response Word

The status response indicates the state or condition of a specific DSC. The computer (S51N EXF code) must request the status word and designate the respective DSC (Figure 4 and Table 4). The 12 lines that carry status information also convey parallel data to the computer.

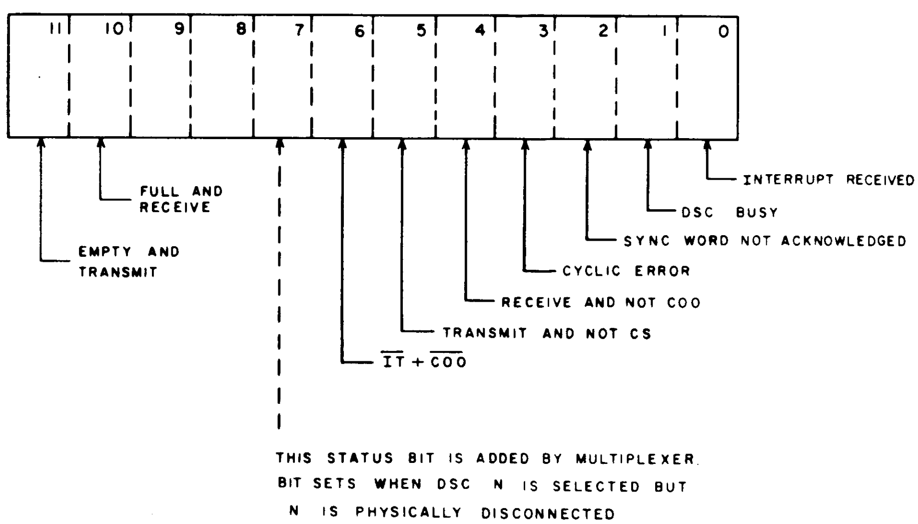

Figure 4. DSC 0 Status Word

TABLE 4. STATUS RESPONSES

DEFINITION	CODE	NOTES
Interrupt Word Received	0001	Indicates that an interrupt word was received from the remote station and that this station wants attention. The interrupt word is received when the 6673/6674 is not transmitting or receiving.
Control Busy	0002	Indicates that the controller is busy. The controller may be selected and waiting for a sync word, transmitting, or receiving (data or code word).
Sync Word Sent and Not Acknowledged	0004*	Indicates that the controller has sent out a sync word but has not received a response from the remote station.
Cyclic Code	0010	Indicates that the code word received from the remote station does not compare with the code generated by the cyclic decoder in the DSC.
Select for Receive and $\overline{\text{COO}}$	0020	Indicates an equipment failure. This occurs when the DSC is selected to receive and the line carrier signal is not present at the data set ($\overline{\text{COO}}$).
Select for Transmit and $\overline{\text{CS}}$	0040	Indicates equipment failure. This occurs when the DSC is selected to transmit and the Clear-to-Send signal is not present at the data set ($\overline{\text{CS}}$).
$\overline{\text{IT}}$ or $\overline{\text{COO}}$	0100	Indicates equipment failure. $\overline{\text{COO}}$ indicates the line-carrier signal is lost; $\overline{\text{IT}}$ indicates a malfunction in the local data set.
Controller Not Connected or in Test Mode	0200	Indicates that the equipment referenced is not physically connected, or in the Test mode.
Full and Receive	2000	Indicates that the 6673/6674 is selected for receive and I/O register is full.
Empty and Transmit	4000	Indicates that the 6673/6674 is selected for transmit and the I/O register is empty.

*Data set controller at remote station must include sync word acknowledge circuit to enable status bit 4.

Status-all Response Word

The status-all word (3 bits from each DSC) is requested before each multiplexer cycle

(S504 EXF code). The status-all word is transferred over the 12 lines that transfer data to the computer. Figure 5 shows the status-all word.

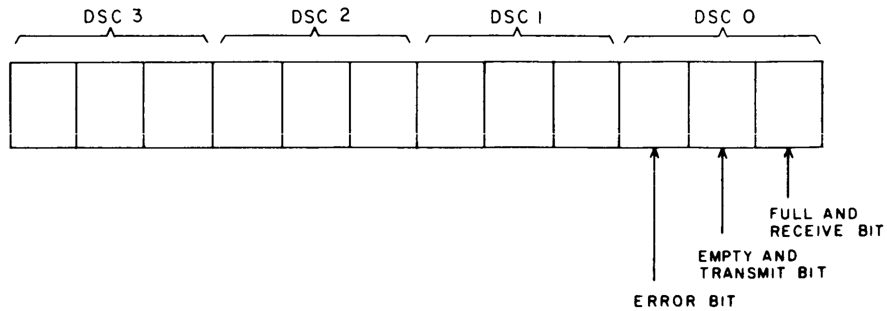

Figure 5. Status-all Word

TABLE 5. STATUS-ALL RESPONSES

DESCRIPTION	CODE	NOTES
Full and Receive	XXX1	Selected for receive and I/O register full
Empty and Transmit	XXX2	Selected for transmit and I/O register empty
Error	XXX4	Any of the following error conditions a) Selected for receive and not COO b) Selected for transmit and not CS c) Cyclic code error

The above status-all responses are for DSC 0.

MODES OF OPERATION

Transmit Mode

The following 6673/6674 signal interchanges occur when the local computer is transmitting to a remote station. Figure 6 illustrates signal paths.

Transmit Mode Programming Example

Initial Conditions: The 6673/6674 is operational but no transmit or receive operation is in process. Although the multiplexer may service up to four DSC's, the operation of only one DSC is described (page 11). Additional DSC's would operate in an identical manner. The following sequence assumes that the COO and IT data set signals are present and all units are cleared.

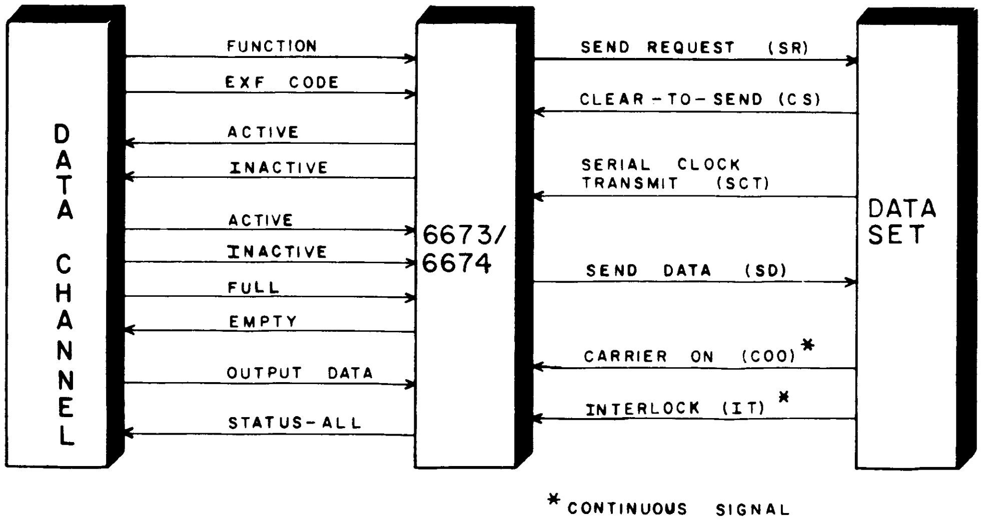

Figure 6. Transmit Mode

Multiplexer:

1) Function and EXF codes select transmit DSC 0.

2) Multiplexer selects DSC 0 for transmit.

   a) This enables the Empty and Transmit status bit in DSC 0 portion of status-all word (Figure 7).

   b) DSC 0 sends out sync word to data set (approximately 300 μsec to send out complete word).

3) Multiplexer may select the remaining three DSC's to transmit or receive if requested by EXF code.

4) The computer requests status-all. Since the Input/Output (I/O) register of DSC 0 is cleared, the Empty and Transmit status-all bit for DSC 0 is a "1".

5) Status-all word is sent to the computer.

6) The computer recognizes Empty and Transmit status of DSC 0.

7) On next multiplexer cycle, computer selects DSC 0 (select code S520).

8) Computer outputs 12-bit data word to DSC 0. DSC 0 accepts word and stores it in the I/O register. Word is transferred to Assembly/Disassembly (A/D)

register and transmitted upon completion of sync word transmission.

9) Computer now services remaining DSC's if they are used and require service.

10) The computer continues to sample the status-all word until it detects another "1" (indicating that one of the DSC's requires service).

Controller DSC 0:

1) When the 12-bit sync word is transmitted, the 12th serial bit enables an I/O register →A/D register transfer. This transfers the first data word to the A/D register.

2) Step 1 (Figure 7) transfers the first data word to the A/D register. This enables the following:

   a. With the I/O register empty, the Empty and Transmit status-all bit again becomes a "1" and DSC 0 can accept another word.

   b. The data word in the A/D register is sent to the cyclic encoder and transmitted bit by bit. It requires approximately 300 μsec to transmit each 12-bit word.

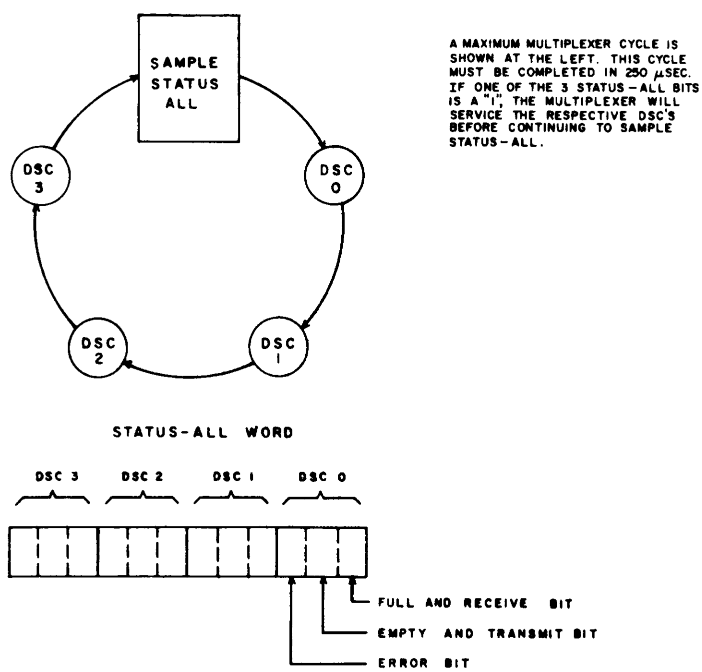

Figure 7. Multiplexer Cycle

3) When the 12th data bit is transmitted, an I/O→A/D transfer brings the next data word to the A/D register. The transmit operation continues in this manner for the entire data block.

4) During the serial transfer of the last word in the data block the last word is in the A/D register, but the I/O register does not contain a new data word. Transferring the 12th bit of the last data word from A/D, enables the DSC to gate out the cyclic code. Upon completion of the code transmission, the transmit function terminates.

5) After transmission of the cyclic code word, a sync word is not transmitted for 300 μ sec. This delay allows the receiving DSC to recognize the end of the data block and check the code word.

Receive Mode

The following control signals are interchanged between the Data Channel, the 6673/6674, and a data set during a receive operation. Data is transferred from a remote station to the local computer. Refer to Figure 8 for a signal flow diagram.

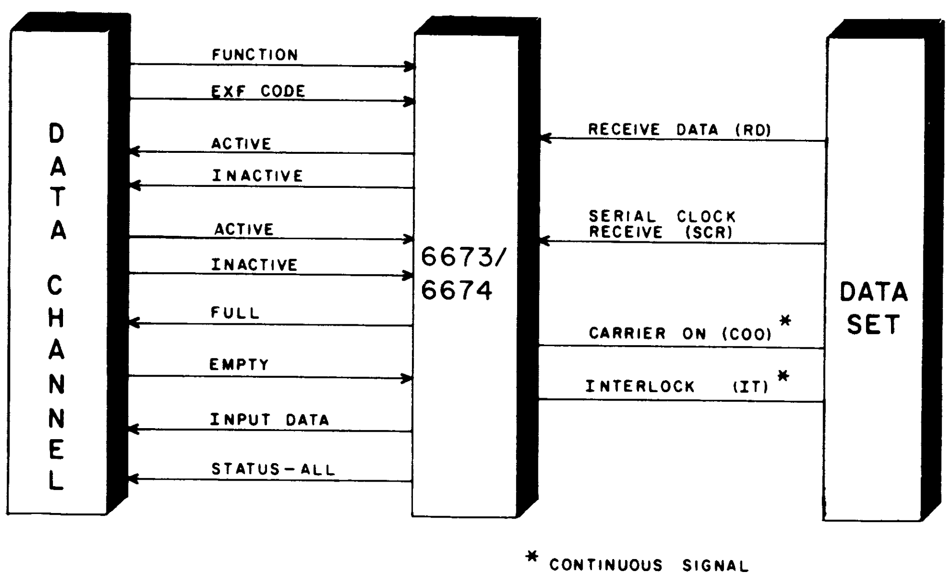

Figure 8. Receive Mode

Receive Mode Programming Example

Initial Conditions: The 6673/6674 is operational but no transmit or receive operation is in process. The operation of only one DSC is described; the operation of the other three DSC's is identical. The following sequence assumes that the COO and SCR data set signals are present and all units are cleared.

Multiplexer:

1) Function and EXF codes select DSC 0 to receive.

2) Multiplexer selects DSC 0 to receive.

3) When DSC 0 detects a sync word, the word is recognized by the Cyclic Encoder/Decoder circuit. The 12th bit of the sync word enables a gate which allows DSC 0 to receive data and enables a 3-bit response to the transmitting data set. The 3-bit response clears the Sync Word Not Acknowledged bit at the transmitting DSC. The 12-bit sync word is not loaded into the A/D register.

4) The first word of the data block follows the sync word. The A/D register assembles this data word; the 12th bit of this word enables an A/D→I/O register transfer. Data words are received and assembled at a rate of 300 usec per word.

5) When the I/O register is loaded, the Full and Receive status bit in the DSC 0 portion of the status-all word sets.

6) The next time the computer requests status-all, it detects the "1" (Full and Receive) in the DSC 0 status-all word.

7) The computer recognizes this "1" and selects DSC 0 (select code S520).

8) The computer inputs the 12-bit data word from DSC 0.

9) Thereupon, the computer services the remaining DSC's if they require service.

10) The computer continues to sample status-all until it detects another "1" in the status-all word.

11) When the 12th bit of the second data word is loaded into the A/D register, the A/D register transfers this word to the I/O register. This sets the Full and Receive status-all bit and the process is repeated.

Controller DSC 0: Controller 0 continues to receive and assemble data words at 300 μsec/word until the computer has accepted the entire data block. Words in the I/O register must be transferred to the computer or the next A/D→I/O transfer will terminate the receive operation.

The computer must know the length of the data block transferred from the remote station. For example, assume that the data block consists of 100 words; the computer will then input exactly 100 words. If the computer does more inputs, the last word (the code word) and the "idle pattern" that follow are accepted as data.

The code word always follows the last word in the data block. When the 12th bit of the code word is loaded into the A/D register, the last data word has been transferred to the computer. The 12th bit of the next word ("idle pattern" transmission) sets the cyclic-error status bit if the code word in the I/O register does not compare with the output of the cyclic encoder/decoder. Setting the cyclic-error status bit also sets the status-all error bit.

To terminate the receive operation after the last word is accepted by the computer, the Data Channel must be deactivated or the DSC deselected. The DSC is deselected by one of the following:

1) Selecting another DSC
2) Requesting status-all
3) Requesting status of the DSC

PROGRAMMING CONSIDERATIONS

Interrupt

An interrupt word from a remote computer indicates that the remote station requires attention. The local computer checks the 6673/6674 interrupt status bit and selects the associated DSC to receive (if so programmed).

Error Detection

The DSC automatically checks for errors when receiving data blocks. A circuit in the DSC, the Cyclic Encoder/Decoder circuit, signals the computer if an error is detected. Both the transmitting and the receiving DSC have a Cyclic Encoder/Decoder circuit. This circuit generates a code word which is transmitted after the last word of a data block. The receiving DSC compares the code word received from the remote station with the code word generated at the receiving DSC; if they are not identical, the data block is in error.

A scheme for encoding and decoding blocks of data by generating a 12-bit cyclic code is used. This provides the following error detection capabilities:

1) Any odd number of errors
2) All error bursts of 12 bits or less
3) 99.5 percent of all error bursts of 13 bits

4) 99.98 percent of all error bursts of 14 bits or greater.

An error burst is any pattern of errors whose length is the number of bits between the first and last errors of a transmission. The cyclic code is one of the most effective and economical error detection techniques for serial transmission presently known.

A maximum line efficiency of 99.4 percent can be achieved when the length of the data block is 341 12-bit words.

Testing

Data transmission and reception may be checked without computer control through a control panel on the DSC. The control panel generates a data block consisting of a sync word, a 12-bit word, and a cyclic word. Checking data through the DSC saves valuable computer time.

Response Circuit

The DSC Response circuit enables the computer to check whether the remote station recognizes the sync word. The receiving DSC automatically returns a response code to the transmitting DSC when the receiving DSC detects a sync word. This allows the transmitting computer to determine if communication has been established. Response code transmission is simultaneous with data reception.

MANUAL OPERATION

The 6673/6674 operates entirely under computer control in normal operation. Before operation, however, the operator must set the initial conditions (described on page 18).

Figure 9 shows the control panel on the multiplexer and the DSC's; Table 6 lists the controls or indicators on the control panels.

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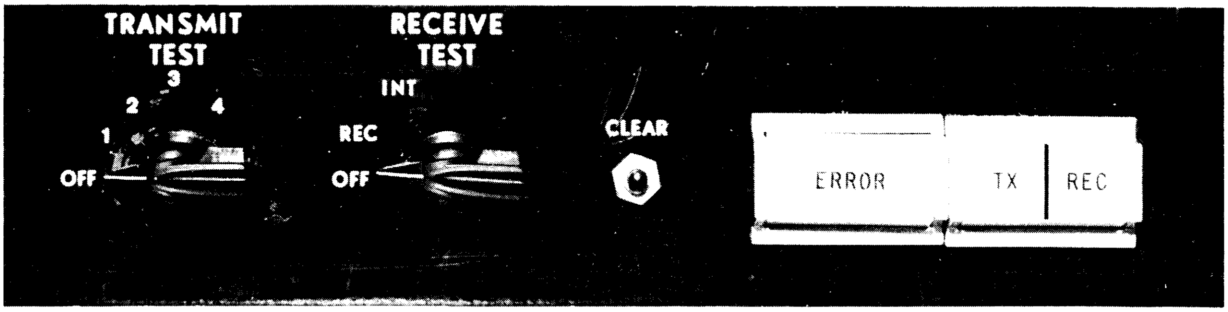
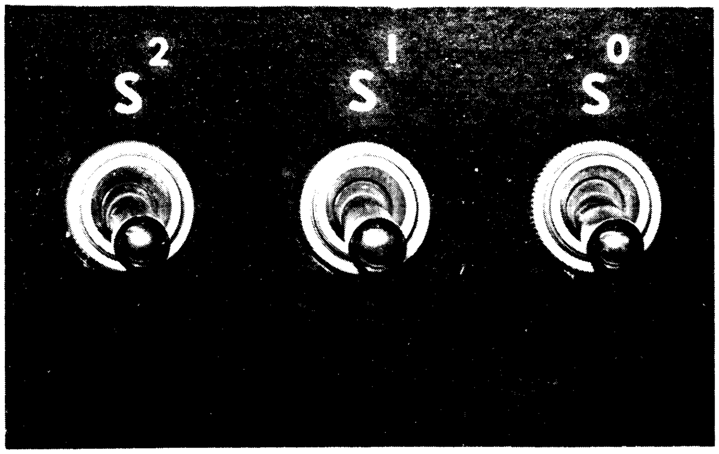


DSC CONTROL PANEL

1562



MULTIPLEXER CONTROL PANEL

Figure 9. 6673/6674 Control Panel

TABLE 6. DSC AND MULTIPLEXER CONTROL PANELS

DSC		
CONTROLS	DESCRIPTION	FUNCTION
TX/REC	Indicator	The TX indicator lights when the DSC is transmitting; the REC indicator lights when the DSC receives information.
ERROR	Indicator	Momentarily lights to indicate that the cyclic decoder has detected an error.
TRANSMIT TEST OFF, 1, 2, 3, 4	Rotary Switch	Simulates the Transmit mode on positions 1-4. Each word is as follows: Position 1 000 000 000 000 Position 2 111 111 111 111

TABLE 6 (Cont'd)

CONTROLS	DESCRIPTION	FUNCTION
		Position 000 001 101 101 Position 111 110 010 010 (Highest order bit transmitted first)
RECEIVE TEST OFF REC INT	Rotary Switch	REC position simulates the Receive mode for maintenance purposes when another DSC transmits one-word data blocks. DSC searches for the sync word and checks for errors. INT position simulates interrupt for maintenance; the Interrupt FF sets if the proper code word is received from a remote DSC.
CLEAR	Momentary Switch	Clears the DSC as a preface to new commands for maintenance purposes.
MULTIPLEXER		
S^2, S^1, S^0,	Toggle Switches	The three toggle switches on the multiplexer labeled S^2, S^1, and S^0, assign the 6673/6674 an equipment number on the Data Channel. This allows the octal digit represented by "S" in the function code (SXXX) to be assigned any value (0-7).

INITIAL CONDITIONS FOR OPERATION

The operator establishes the operating conditions by adjusting switches (Table 6).

1) Check cabinet circuit breaker to determine if power is on.
2) Check Transmit and Receive Test switches. For normal operation they must be in OFF position. In the Test mode, position RECEIVE TEST switch on the DSC at one station to REC or INT and position the TRANSMIT TEST switch on the DSC at the other station to position 1, 2, 3, or 4.
3) Always clear the DSC after power is applied.

6684-A DATA CHANNEL CONVERTER

CONTENTS

FIGURES

TABLES

6684-A DATA CHANNEL CONVERTER

The CONTROL DATA® 6684-A Data Channel Converter is an interface which permits the use of 3000 Series peripheral equipments in 6000 Series Computer Systems.

This section presents generalized programming information for the 6684 and describes its relationship to other equipment. Detailed programming information for 3000 Series peripheral equipment controlled by the 6684 is given in separate sections.

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

Figure 1 shows the role of the 6684 Data Channel Converter in a 6000 Series Computer System. The 6684 Converter attaches to one of the Data Channels and may share the channel with up to seven other 6000 Series peripheral equipments, e.g., a 6622 Magnetic Tape Controller, a 6602 Console Display, or other 6684 converters. As many as eight 3000 Series peripherals can be attached to the 6684.

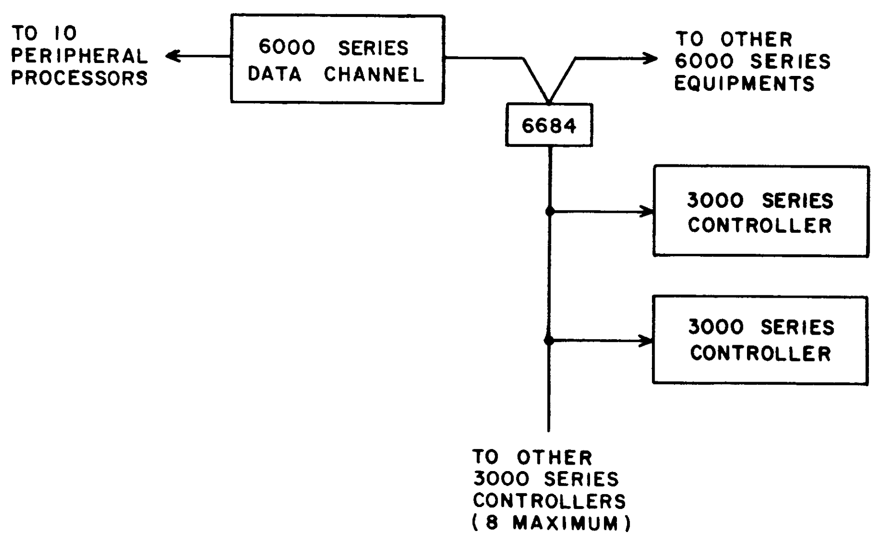


Figure 1. Typical Configuration

To prepare one of the 3000 Series equipments for operation, the 6684 first must be selected; then the desired 3000 Series equipment is selected (connected). These two select operations are accomplished by function codes sent from a Peripheral Processor via the **Data** Channel.

Some 6684 function codes may conflict with function codes assigned to other 6000 Series equipment on the same Data Channel. The 6684 Converter differs from other 6000 Series equipment. These differences are:

1. The converter must be attached to the Data Channel ahead of all other 6000 Series devices.
2. When selected, it does not relay information to other equipment on the Data Channel. This prevents unwanted activity caused by like function codes in the other equipments on the Data Channel.
3. The converter must be deselected (2100) before other 6000 Series equipments sharing the Data Channel can be selected.
4. A Master Clear (MC) on a dead-start automatically selects all 6684 converters in the computer system.

3000 SERIES INTERRUPT FEATURE

All 3000 Series peripheral equipments have an interrupt feature which enable them to notify the 6684 when specific operating conditions occur. Most of these use interrupt conditions which can be selected or released in an equipment by function codes. They are:

1. Interrupt on Ready, or Interrupt on Ready and Not Busy.
2. Interrupt on End of Operation, and
3. Interrupt on Abnormal End of Operation

The section describing each 3000 Series equipment gives interrupt select function codes and defines interrupt conditions.

When one of the selected interrupt conditions occurs in an equipment, the equipment sends an Interrupt signal to the 6684 Converter and sets a corresponding bit in the converter status word. Bits 3 through 10 of the 12-bit status word indicate interrupts from any one of the eight possible equipments served by the converter. The status bit set depends on the equipment number of the device sending the interrupt:

Equipment No.	0	1	2	3	4	5	6	7
6684 Status Bit	3	4	5	6	7	8	9	10

An equipment need not be connected to the converter to send an Interrupt signal. The interrupt feature thus provides a limited status check for an equipment even though it is not connected.

An interrupt status bit in the 6684 Converter is present as long as the equipment maintains the Interrupt signal. An Interrupt signal can be cleared by any of the following:

1. A converter Master Clear function. This clears all 3000 Series equipments attached to the converter.
2. A function code sent to the interrupting equipment (see the sections describing 3000 Series equipments for proper code).
3. A Dead Start MC from the 6000 Data Channel.

PROGRAMMING

CODES

Two sets of codes are required to operate a 3000 Series peripheral equipment via a 6684 Converter:

1. the function and status response codes for the 6684 Converter, and
2. the connect function and status codes for the specific 3000 Series equipment.

The converter function codes allow the computer system to connect the 3000 Series equipment and to transmit 3000 Series function codes to the connected equipment. They also permit the sensing of both converter and external equipment status and enable the flow of data between the Data Channel and the 3000 Series equipment via the 6684 (see Table 1).

The 3000 Series codes include connect, function, and status reply. They are used to prepare a connected equipment for an input/output operation and do not affect the unconnected equipment. The 3000 Series status codes permit monitoring of operating conditions of several equipments. See the sections describing the 3000 Series equipments for a complete list of these codes.

Table 1 lists the function codes applicable to the 6684 Converter. Function codes are transmitted to the converter by Peripheral Processor FAN (76) and FNC (77) instructions. In all codes, bit 0 is rightmost. Each code is described in the section following Table 1.

Table 3 lists the status reply codes for the 6684. A description of each code follows Table 3.

TABLE 1. 6684 DATA CHANNEL CONVERTER FUNCTION CODES

Select/Deselect	
Select Converter	2000*
Deselect Converter	2100
Connect	
Connect Equipment (Mode I)	NUUU**
Connect Equipment (Mode II)	1000
Function	
Function Transmit (Mode I)	OFFF†
Function Initiate (Mode II)	1100
Data Input/Output	
Input EOR Initiate	14XX§
Input Initiate	15XX
Output Initiate	16XX
Master Clear	
Function Master Clear	1700
Status Request	
Converter Status Request	1200
Equipment Status Request	1300

*Where two 6684 Converters share a common Data Channel, one of the converters is assigned different Select and Deselect codes such as 2200 and 2300, or 2400 and 2500.

**N = 4-7 (equipment number)
UUU = Lower 9 bits of connect code

†FFF = Lower 9 bits of function code

§Initiate conditions are defined by XX

Function Codes

Select Converter (2000)

This code selects the converter from among the 6000 Series equipments sharing the same Data Channel. Where two 6684 Converters share a common Data Channel, one of the converters is assigned different Select and Deselect codes such as 2200 and 2300, or 2400 and 2500.

Deselect Converter (2100)

This code deselects the converter. Note that this converter must be deselected before another 6000 Series equipment on the same Data Channel can be used.

Connect Equipment, Mode I (NUUU)

This code connects equipment 4, 5, 6, or 7 and units UUU, where N = equipment number (restricted to 4-7) and UUU (lower 9 bits) = unit number.

Connect Initiate, Mode II (1000)

This code, specifying Mode II operation, directs the converter to send the next data word received to the 3000 Series equipments as a connect code. The Connect Initiate code can be used to connect any equipment, 0-7. The 1000 code should be followed by a 1-word output where the data is the connect code.

Function Transmit, Mode I (0FFF)

This code, specifying Mode I operation, causes the converter to transmit the 12-bit function code (0FFF) to the connected equipment. FFF can be the lower 9 bits of any 12-bit code whose upper 3 bits are zeros.

Function Initiate, Mode II (1100)

This code, specifying Mode II operation, directs the converter to send the next data word received to the connected 3000 Series equipment as a function code. This code can be used to transmit any 3000 Series function code to the connected equipment. The 1100 code should be followed by a 1-word output when the data is the function code.

Input EOR Initiate (14XX)

This code prepares the converter for an input operation. It permits the termination of the input by either an End-of-Record signal from the equipment or by a Channel Disconnect from the Peripheral Processor. Initiate conditions are defined by XX.

Data passes through the converter in two modes, A and B. In Mode A, data passes through the converter unaltered; in Mode B, the two 6-bit characters are translated from internal binary coded decimal (BCD) to DCP (display code). This mode of operation is determined by the second octal digit (8^1). When this digit is "0", Mode A is selected; when it is "1", Mode B is selected. See Table 2 for Mode B translations. When the first octal digit (8^0) is a "1", it enables a Negate BCD Conversion line to the external

TABLE 2. MODE B TRANSLATIONS

CHAR	DPC	INT. BCD	CHAR	DPC	INT. BCD
None Assigned*	00	16	6	41	06
A	01	21	7	42	07
B	02	22	8	43	10
C	03	23	9	44	11
D	04	24	+	45	20
E	05	25	-	46	40
F	06	26	*	47	54
G	07	27	/	50	61
H	10	30	(	51	74
I	11	31	)	52	34
J	12	41	$	53	53
K	13	42	=	54	13
L	14	43	space	55	60
M	15	44	,	56	73
N	16	45	.	57	33
O	17	46	≡	60	76
P	20	47	[	61	17
Q	21	50	]	62	72
R	22	51	:	63	12
S	23	62	≠	64	14
T	24	63	→	65	75
U	25	64	∨	66	52
V	26	65	∧	67	77
W	27	66	↑	70	55
X	30	67	↓	71	56
Y	31	70	<	72	32
Z	32	71	>	73	57
0	33	00	≤	74	15
1	34	01	≥	75	35
2	35	02	¬	76	36
3	36	03	;	77	37
4	37	04			
5	40	05			

*Note that although DPC 00 and internal BCD character 16 have not been assigned, they are translated for future use. The translation above holds for both input and output Mode B operations.

equipment. Any combination of Negate BCD and Mode B Selects is permissible. The Input EOR Initiate condition remains in effect until another 6684 function code is received.

Input Initiate (15XX)

This code prepares the converter for an input operation. It permits termination of the input only by a channel disconnect and should not be used for magnetic tape inputs *. In Mode B operation (see Input EOR Initiative preceding), the two 6-bit characters are translated from internal BCD to DCP. When the first octal digit of this code (8^0) is a one, a Negate BCD Conversion line to the external equipment is enabled. Any combination of Negate BCD and Mode B Selects is permissible. The Input Initiate condition remains in effect until another 6684 function code is received.

Output Initiate (16XX)

This code prepares the converter for an output operation and permits termination of the output by a channel disconnect. In Mode B operation (see Input EOR Initiative preceding), the two 6-bit characters are translated from DCP to internal BCD. When the first octal digit of this code (8^0) is a one, a Negate BCD Conversion line to the external equipment is enabled. Any combination of Negate BCD and Mode B Selects is permissible. The Output Initiate condition remains in effect until another 6684 function code is received.

Function Master Clear (1700)

This code master clears all 3000 Series equipment attached to the converter as well as the conditions within the 6684.

Converter Status Request (1200)

This code permits the 6000 Series processor to input converter status. A 1-word input must follow to read in the status response.

Equipment Status Request (1300)

This code permits the 6000 Series processor to input the status response from the connected 3000 Series equipment. A 1-word input must follow to read in the status word.

NOTE

Any 1XXX function code sent to the 6684 clears the previous 1XXX function condition.

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*A magnetic tape transport stops tape motion when it senses the end of a record. However, when code 15XX is in effect the 6684 does not disconnect the Data Channel on end-of-record. Thus the Peripheral Processor hangs up on the input instruction.

Status Reply Codes

Two types of status codes are available from the 6684 Converter:

1. Converter status codes
2. Equipment status codes

The 12-bit converter status responses (Table 3) are Reply, Reject, Parity Error, and Interrupt signals from the attached 3000 Series equipments. Function code 1200 makes this response available to the Peripheral Processor. A 1-word data input must follow to read in the status word.

TABLE 3. STATUS REPLY CODES

CODE	DESCRIPTION
XXX0	Reply
XXX1	Reject (Internal or External)
XXX2	Internal Reject
XXX4	Transmission Parity Error
XX1X-2XXX	Equipment Interrupts

Every 3000 Series equipment provides a 12-bit status response. This is available at the time the equipment is connected to the converter and after the equipment has rejected a Connect code. Each bit in the response code indicates a condition within the equipment, such as Ready, Busy, or End of Tape. A Peripheral Processor makes a status request to the connected equipment by sending a 1300 function code to the converter; it then performs a 1-word input to read in the response.

Equipment status codes differ for each equipment and are listed in the manual describing the individual equipments. The converter codes are defined in the following paragraphs.

Reply (XXX0)

Digit $8^0 = 0$ (bit 0 clear) if the 3000 Series equipment returns a Reply signal indicating acceptance in response to a connect or function code.

Reject, Internal or External (XXX1)

Digit $8^0 = 1$ (bit 0 set) when the 3000 Series equipment returns a Reject signal to the 6684 in response to a connect or function code. An Internal Reject will also set this bit and bit 1.

Internal Reject (XXX2)

Digit 8^0 = 010 (bit 1 set) after a delay of 100 μ sec if the 3000 Series equipment fails to return a Reply or a Reject in response to a connect or function code only.

Transmission Parity Error (XXX4)

Digit 8^0 = 100 (bit 2 set) when the connected 3000 Series equipment senses a parity error in a function code or output data. With some 3000 Series equipments a parity error may also occur during an input operation. A parity error during a connect code will not set this bit.

Equipment Interrupts (XX1X-2XXX)

Bits 3-10 each indicate the Interrupt signal from one of the eight possible 3000 Series equipments. If equipment N sends an interrupt, status bit N+3 is set and remains set until the equipment drops the Interrupt signal.

SELECTING THE CONVERTER

The 6684 Converter must be selected from among other 6000 Series equipment that share the same Data Channel before it can communicate with a 3000 Series peripheral equipment. The selection is accomplished by the Select (2000) function code* transmitted by a Peripheral Processor FAN (76) or FNC (77) instruction. Selection activates the 6684 Converter and renders inactive all other 6000 Series input/output equipment on the Data Channel attached beyond the converter.

A Dead Start Master Clear automatically selects all 6684 Converters in the computer system.

DESELECTING THE CONVERTER

Once selected, the 6684 Converter remains selected until it is intentionally deselected by function code 2100.* The converter must always be deselected before any other 6000 Series input/output equipment on the same Data Channel can be used.

If two converters on the same Data Channel have been selected by a Dead Start Master Clear, the first converter must be deselected before the second can be deselected.

*Where two 6684 Converters share a common Data Channel, one of the converters is assigned different Select and Deselect codes such as 2200 and 2300, or 2400 and 2500.

This occurs because, when selected, the 6684 Converter does not relay codes sent from the Data Channel to more distant equipment.

CONNECTING A 3000 SERIES EQUIPMENT

After the 6684 Converter has been selected one of the eight possible 3000 Series equipments attached to it may be connected. The Connect operation activates the equipment and automatically deactivates the other seven so that only one of the eight possible equipments can be connected at a given time.

A 12-bit connect code of the following form connects a 3000 Series equipment.

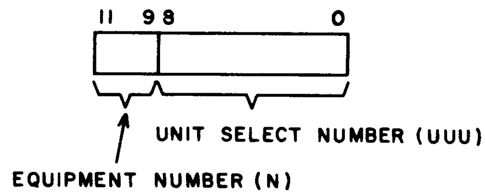

Figure 2. Connect Code Format

Bits 9-11 determine the equipment number of the device to be connected. Each 3000 Series equipment (maximum of 8) is assigned a number (0-7) by means of an 8-position Equipment Number switch. Bits 0-8 designate one of several possible units which are subordinate to the equipment. For example, a tape controller ranks as an equipment, and each of the attached tape transports is a unit designated by a Unit Select number. With equipments having no subordinate units (such as a card reader), bits 0-8 are not used.

A connect code is sent from a Peripheral Processor via the converter to an attached 3000 Series equipment. Two methods of sending a connect code are used: Mode I connect and Mode II connect. A Mode I connect operation requires only one 6684 function code from the Peripheral Processor, but is restricted to connecting only equipments 4-7. A Mode II connect operation requires a 6684 function code followed by a 1-word data output. It can connect any of the eight possible equipments.

A connect is broken only by connecting another equipment, by a Dead Start Master Clear, or by a 6684 Function Master Clear (1700). Deselecting the 6684 or disconnecting the Data Channel does not clear a connect.

Mode I Connect

The 6684 Converter performs a Mode I connect operation whenever the Peripheral Processor sends a function code in the form 4UUU - 7UUU. The converter simply forwards the code to the attached 3000 Series equipments as a connect code. Normally, the equipment corresponding to the upper octal digit (4-7) connects, and any previously connected equipment automatically disconnects.

If an equipment connects successfully, it returns a Reply signal to the converter, which in turn sends an Inactive signal to the Data Channel. This signal disconnects the Data Channel making it available for another operation.

Some equipment may not be able to connect under certain conditions. In such cases the equipment returns a Reject signal to the converter. The Reject acts as a Reply, causing the converter to send an Inactive signal to the Data Channel. In addition, the Reject sets a status bit (bit 0) in the 6684 indicating that the connect code was rejected. The conditions which cause the 3000 Series equipments to reject a connect code are listed in the sections describing each equipment.

Neither a Reply nor a Reject is returned if a connect code addresses a nonexistent equipment or if a malfunction occurs in the equipment. In such cases the 6684 generates an Internal Reject after 100 usec.

An Internal Reject:

1. causes the 6684 to send an Inactive signal to the Data Channel, and
2. sets the Reject status bit (bit 0) and also sets an Internal Reject status bit (bit 1) in the 6684.

The 3000 Series equipments check for parity of each connect code sent from the converter. If a parity error occurs, no equipment connects and either a Reply or Reject is returned to the converter. After a delay of 100 usec an Internal Reject sets status bits 0 and 1.

A sample program outline at the end of this chapter provides an example of a Mode I connect operation.

Mode II Connect

A mode II connect operation requires two steps:

1. Function code 1000 (Connect Initiate) is sent to the 6684 by a FAN (76) or FNC (77) instruction. This code merely conditions the converter for a Mode II connect operation and is not sent to the 3000 Series equipments. The converter returns an Inactive signal to release the Data Channel.

2. A 1-word output, containing the connect code, is sent to the converter by an output instruction OAM (73) or OAN (72) from the Peripheral Processor. The converter forwards this output word to the 3000 Series equipments as a connect code.

As in a Mode I connect, there are three possible responses to the connect code sent by a Mode II connect operation:

1. Reply - indicates addressed equipment successfully connected

2. Reject - indicates addressed equipment could not connect. The Reject status bit (bit 0) in the converter is set

3. No response - The converter generates an Internal Reject after 100 usec. The Internal Reject status bit (bit 1) and the Reject status bit (bit 0) are both set.

Any of the three responses causes the converter to send an Empty signal to the Data Channel, indicating receipt of the output word. If an OAN (72) instruction has been executed, a Full Jump instruction (FJM, 66) should follow the data output to delay the program until the converter accepts the output word. Then a Disconnect Channel instruction (DCN, 75) should follow to deactivate the Data Channel.

The result of a parity error for a Mode II connect is the same as for a Mode I connect:

1. no equipment connects, and

2. the 6684 generates an Internal Reject after 100 usec, which sets the Reject status bits (bits 0 and 1).

After a Mode II connect operation is complete, the converter status response should be checked for a Reject.

NOTE

A status check should follow only after the mode II connect is complete. There is no response from the 3000 Series equipments when the Connect Initiate code (1000) is sent to the 6684. Thus a status check at this time is not significant.

A sample program outline at the end of this section provides an example of a Mode II connect operation.

SENDING FUNCTION CODES TO 3000 SERIES EQUIPMENTS

After a 3000 Series equipment is connected, it accepts 12-bit function codes from the 6684 Converter. Function codes establish operating conditions within an equipment or they initiate operations such as tape rewind. The function codes applicable to the 3000 Series equipments are listed in the sections describing each equipment.

The function codes sent from the converter to the 3000 Series equipments are distinct from function codes transmitted by the Peripheral Processor to the converter (see Table 1).

As in a connect operation, there are two methods of transmitting function codes to a 3000 Series equipment:

1. Mode I: A Mode I function operation requires only a single Peripheral Processor function instruction (FAN or FNC), but is restricted to a 9-bit function code.
2. Mode II: A Mode II function operation requires a function instruction followed by a 1-word data output. A full 12-bit function code can be sent by the Mode II procedures.

Mode I Function

A Mode I function operation is similar to a Mode I connect. The converter performs a Mode I function operation whenever the Peripheral Processor sends a 0FFF function code. The quantity FFF can be any 9-bit 3000 Series function code. The converter forwards the 0FFF code to the connected equipment as a function code.

The converter receives one of three possible responses from the 3000 Series equipment in response to a function code:

1. Reply - Indicates that the equipment accepted the code.
2. Reject - Indicates that the equipment did not accept the code. This signal sets the Reject status bit (bit 0) in the 6684.
3. If, after 100 usec, neither a Reply or Reject is received, the 6684 generates an Internal Reject that sets the Reject status bits (bits 0 and 1).

A status check should follow a Mode I function operation to test for a Reject or a parity error. An example of a Mode I function procedure is given in the sample program at the end of this section.

Mode II Function

A Mode II function operation is similar to a Mode II connect. Two steps are necessary:

1. Function code 1100 (Function Initiate) is sent to the 6684 by a FAN (76) or FNC (77) instruction. This code conditions the 6684 for a Mode II function operation and is not forwarded to the 3000 Series equipment. The 6684 returns an Inactive signal to release the Data Channel.
2. A 1-word output containing the desired 12-bit function code is sent to the 6684 by one of the output instructions, OAM (73) or OAN (72). The 6684 forwards this output word to the 3000 Series equipment as a function code.

The responses to a Mode II function operation are the same as for a Mode I function:

1. Reply - Indicates that the equipment accepted the code
2. Reject - Indicates that the equipment could not accept the code. The Reject status bit (bit 0) in the 6684 is set.
3. No Response - The 6684 generates an Internal Reject after 100 usec. The Internal Reject status bit (bit 1) and Reject status bit (bit 0) are set.

Any one of these responses causes the converter to send an Empty signal to the Data Channel, indicating receipt of the output word. If the OAN (72) instruction has been executed, a Full Jump instruction (FJM, 66) should follow the data output to delay the program until the converter has accepted the output word. Then a Disconnect Channel instruction (DCN, 75) should follow to deactivate the Data Channel.

The result of a parity error for a Mode II function is the same as for a Mode I function:

1. the Parity Error status bit (bit 2) is set,
2. the Converter generates an Internal Reject, after 100 usec, which sets the Reject status bits (bits 0 and 1), and
3. the equipment does not accept the function code.

After a Mode II function operation is complete, a status check should follow to sense for a parity error or Reject. The status check becomes significant only after the second step of the procedure has been completed. The steps in a Mode II function procedure are given in the sample program at the end of this section.

DATA TRANSFER

An input or output operation can proceed only after the desired equipment is connected to the 6684 Converter and after the converter has been selected.

INPUT

There are three basic steps to an input operation:

1. To send an Input Initiate or an Input EOR Initiate function code. This code conditions the 6684 for an input operation.
2. To send an Execute Channel Activate instruction. This action signals the equipment (via the 6684) to begin sending data. For example, it starts tape motion or initiates a card cycle.
3. To issue an input instruction to read in the data from the sending device.

The main input function codes are 14XX and 15XX. Each code prepares the converter for a specific input operation.

An input function code of 1400 causes input operation to terminate either when the peripheral equipment reaches an end of record or when a channel disconnect is received from the Peripheral Processor. An end of record sensed by the equipment causes the converter to supply an Inactive signal which disconnects the Data Channel. The Peripheral Processor then exits to the next instruction.

An input function code of 1401 suppresses the external-to-internal BCD conversion that normally takes place in some 3000 Series equipment. In other respects this code is identical to 1500.

Digit 8^1 in both the 14XX and 15XX input function codes determines the mode of operation. Mode A passes data through the converter unaltered and is selected when digit 8^1 is 0; Mode B translates the two 6-bit characters from internal BCD to DCP when the digit is 1.

On some equipments there may be significant delay between the Channel Activate instruction that signals the start of an input operation and the time the first data word is available from the equipment. For example, in the 3248 Card Reader Controller there is a delay of 20 ms between the start of card motion and the availability of the first card column.

During this period the Peripheral Processor can be used to perform some other task. The latent period is different for each 3000 Series equipment and its length can be found in the sections describing each device. If the delay is unknown, an input instruction should immediately follow the Channel Activate instruction.

If Input Initiate code 15XX is used, the 6684 Converter does not deactivate the Data Channel on end of record. A Channel Disconnect instruction must immediately follow the input instruction to notify the equipment of the end of operation. The converter does not check parity on the data it inputs, and there is no transmission parity check during input for most 3000 Series peripheral equipments. However, in some tape and drum equipments an error may occur that will set the Parity Error status bit in the converter.

Input function codes 14XX and 15XX remain in effect until the next converter function code is received. The Negate External to Internal BCD condition, established by codes 14X1 and 15X1, is cleared when the Peripheral Processor sends a new I/O function without having digit 8^0 equal to "1". An input operation is normally followed by a status request function code. Thus, each input operation usually requires a new Input Initiate code.

OUTPUT

There are five basic steps in an output operation:

1. To send an Output Initiate function code to prepare the converter for an output operation.
2. To execute a Channel Activate instruction. This action notifies the equipment (through the 6684) that an output operation is about to begin. In response, the connected device prepares to receive data; e.g., starts card motion or tape motion.
3. To perform an output instruction to send data to the equipment.
4. To perform a Full Jump instruction (FJM, 66) following the output instruction to delay the program until the 6684 has accepted the last output word.
5. To cause the Peripheral Processor to execute a Disconnect Channel instruction (DCN, 75). This step releases the Data Channel and notifies the equipment of the end of the record.

The Output Initiate code is 16XX. A 0 in digit 8^0 conditions the converter for an output operation; a 1 in this digit suppresses the normal internal-to-external BCD conversion.

A 0 in digit 8^1 provides operation in sub-mode A to pass data through the converter unaltered; a 1 in this digit provides sub-mode B operation to translate the two 6-bit characters from internal BCD to DCP.

In some 3000 Series equipments, a delay exists between the Channel Activate instruction that flags the start of an Output operation and the time that the equipment is ready to accept the first data word. During this period the Peripheral Processor can be used for some other purpose. If the delay is unknown, the output instruction should immediately follow the Channel Activate instruction.

The 6684 Converter generates a parity bit for each 12-bit data word for correct parity. If a parity error occurs, the equipment returns a signal that sets the Parity Error status bit (bit 2) in the converter. A status check should follow each Output operation to make certain that no parity error has occurred.

Output Initiate code 1600 remains in effect until the next converter function code is received. The Negate Internal to External BCD condition, established by code 16X1 is cleared when the Peripheral Processor sends a new I/O function without 8^0 equal to 1. An Output operation is normally followed by a Status Request function code which clears the output condition in the Converter. Thus, each Output operation usually requres a new Output Initiate code.

CLEARING A PARITY ERROR

If a status check reveals that a parity error has occurred, a 6684 Function Master Clear (code 1700) must be executed to clear the parity error conditions in the 3000 Series equipments. This action also clears the 6684 Parity Error status bit (bit 2).

If the converter is alternately operating two 3000 Series equipments on a time-sharing basis, a special precaution must be observed in clearing a parity error. Care must be taken to wait until the slowest equipment completes its operation before issuing the Master Clear code. This procedure assures that the Master Clear does not cause a loss of data.

The following outlines show the steps in programming a 6684 Converter input and output operation. Connect and function procedures for both Mode 1 and Mode 2 are illustrated.

Following is a general input program using Mode 1 programming:

	Instruction	Explanation	
AJM	Active Jump	Wait for inactive channel	
FAN or FNC	Function	Select 6684 (2000)*	
FAN or FNC	Function	Equipment connect (NUUU)	
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input	
IAN	Input one word to A	Input converter status reply	Mode 1 Connect
DCN	Disconnect channel	Release Data Channel for another operation	
	Status check	Check for reject	
FAN or FNC	Function	Equipment function, i. e., rewind etc. (0FFF)	
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input	Mode 1 Function
INA	Input one word to A	Input equipment status reply	
DCN	Disconnect channel	Release Data Channel for another operation	
	Status check	Check for reject or parity error	
FAN or FNC	Function	Prepare 6684 for input (15XX)	
ACN	Activate channel	Initiate input (start tape motion etc.)	
IAM	Input instruction	Read in block of data	
DCN	Deactivate channel	Terminate input	
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input	
INA	Input one word to A	Input converter status	
	Status check	Check for parity error or interrupt	

*This step is necessary only if 6684 has not been previously connected.

	Instruction	Explanation
DCN	Deactivate channel	Terminate input
FAN or FNC	Function	Deselect 6684 (2100)*

Following is general output program using Mode 2 programming:

	Instruction	Explanation	
AJM	Active jump	Wait for inactive channel	
FAN or FNC	Function	Select 6684 (2000)**	
FAN or FNC	Function	Equipment connect initiate (1000)	
ACN	Activate channel	Initiate output of connect code	
OAM or OAN	Output one word	Output equipment connect code (code NUUU)	
FJM	Full jump	Wait for acceptance of connect code	Mode 2 Connect
DCN	Disconnect channel	Terminate output	
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input of status reply	
INA	Input one word to A	Input status reply	
DCN	Disconnect channel	Terminate input	
	Status check	Check for reject	
FAN or FNC	Function	Equipment Function Initiate (1100)	
ACN	Activate channel	Initiate output of input function code	
OAM or OAN	Output one word	Output equipment function code (0FFF)	
FJM	Full jump	Wait for acceptance of function code	
DCN	Disconnect channel	Terminate output	Mode 2 Function
FAN or FNC	Function	Converter Status Request (1200)	
ACN	Activate channel	Initiate input of status reply	
INA	Input one word	Input status reply	
DCN	Disconnect channel	Terminate input	
	Status Check	Check for reject or parity error	

*6684 must be deselected only if another 6000 Series device on the same Data Channel is to be used.

**This step is necessary only if 6684 has not been previously connected.

	Instruction	Explanation
FAN or FNC	Function	Prepare 6684 for output (16XX)
ACN	Activate channel	Initiate output of data (start tape motion etc.)
OAM or OAN	Output data	Output block of data words
AJM	Active jump	Wait for completion of output
DCN	Disconnect channel	Terminate read
FAN or FNC	Function	Converter Status Request (1200)
ACN	Activate channel	Initiate input of status reply
INA	Input one word	Input status reply
	Status check	Check for parity error or interrupt
DCN	Disconnect channel	Terminate input
FAN or FNC	Function	Deselect (2100) 6684*

*6684 must be deselected only if another 6000 Series device on the same Data Channel is to be used.

362X-A/B MAGNETIC TAPE CONTROLLERS

CONTENTS

FIGURES

TABLES

362X-A/B MAGNETIC TAPE CONTROLLERS

The CONTROL DATA* 362X-A/B Magnetic Tape Controllers facilitate high-speed transfer of data between CONTROL DATA 606 and/or 607 Magnetic Tape Transports** and 6681 Data Channel Converters. (See Figure 1.)

This section describes the disassembly of data received from the Data Channel and the assembly of data received from the tape unit. It also describes the connect, function, and status codes and provides pertinent programming information.

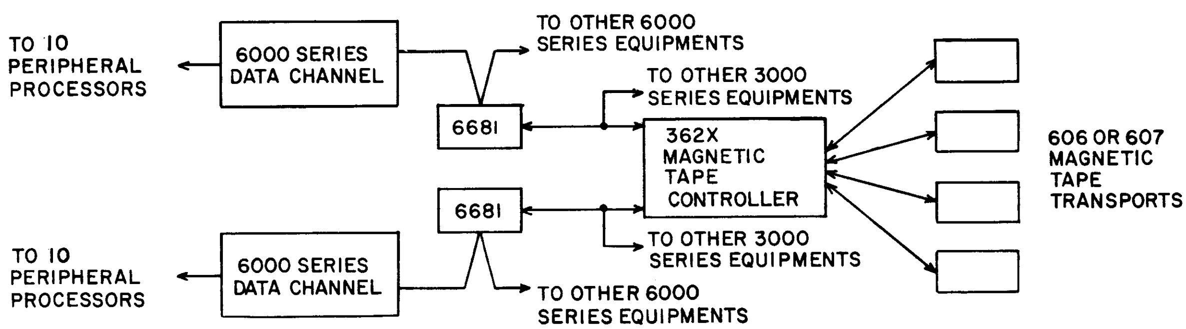

Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation
**The program must be adapted if 606 and 607 Tape Units are mixed.

SYSTEM RELATIONSHIP

The 362X Controller consists of as many as four read/write controls. Each control may be physically attached to one 6681 Converter. Each converter, through its associated control, can communicate with any attached tape unit, providing the tape unit is not in use or reserved. All converters may communicate with their logically connected tape units simultaneously.

Converters attached to the controller need not be associated with the same Central Processor.

The 362X Controller is available with the following options:

3622	Two read/write controls to control one to sixteen 606/607 Magnetic Tape Transports.
3623	Four read/write controls to control one to eight 606/607 Magnetic Tape Transports.
3624	Four read/write controls to control one to sixteen 606/607 Magnetic Tape Transports.
3625	Three read/write controls to control one to eight 606/607 Magnetic Tape Transports.
3626	Three read/write controls to control one to sixteen 606/607 Magnetic Tape Transports.

TAPE UNIT DESIGNATION

The attached tape units may be divided into two banks, 0 and 1. However, if eight or fewer units are attached, they generally belong to bank 0.*

*Depends on system configuration.

Each tape unit in a particular bank must have a unique numerical designation, 0-7*. Tape units in bank 0 are referred to as units 0U and those in bank 1 as units 1U. When the numerical designation of a unit is changed, any existing connection and/or reservation is cleared.

ASSEMBLY/DISASSEMBLY

During Write operations, a control receives data from its converter 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.

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 converter. The first character received comprises the upper 6 bits of the byte, and the next character comprises the lower 6 bits.

DATA TRANSMISSION

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.

Record/File Formats

The data written on tape as the result of a single output instruction constitutes a record. 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).

*The numerical designation (U) is determined by the Unit Select switch. This switch is located on the tape unit.

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 always terminates 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 usec/frame; 556 characters/inch, 12 usec/frame; 800 characters/inch, 8 usec/frame. With 606 Tape Units, only low density (200 characters/inch) and high density (556 characters/inch) are available.

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

PARITY CHECKING

Transmission Parity Checking

Connect codes, function codes, and data are transmitted between the converter 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, a "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 converter. Instead, a red indicator in the EQUIPMENT NUMBER switch of each equipment detecting the error lights. These parity error conditions must be cleared by a 6681 Function Master Clear prior to a new connect attempt.

*If the device is connected, it automatically disconnects.

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 converter, and a red indicator in the EQUIPMENT NUMBER switch lights. Since neither a Reject nor a Reply is returned to the converter, it generates an Internal Reject after a wait of 100 usec. These parity error indications must be cleared by a 6681 Function 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 by the control 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 converter. The data is written on tape. All operations continue** unless appropriate programming steps have been taken to sense for all Parity Error signals and rewrite the data. These parity error indications must be cleared by a 6681 Function Master Clear. The equipment must then be reconnected and the appropriate functions reselected prior to the new output.

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 parity bit to each character and relays it to the tape unit.

Approximately 2 or 3 ms*** 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.

*Though operations may continue normally, the validity of a new function code and/or data prior to a 6681 Function Master Clear is questionable.

**The validity of the data received from this point until a 6681 Function Master Clear is questionable.

***Two milliseconds for 606/607 Tape Units.

Vertical Parity Error Checking: A vertical (transverse) parity error exists when the number "1" bits on the six data lines plus the parity line is incorrect. 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, or 6681 Function Master Clear.

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, or 6681 Function Master Clear.

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

INTERRUPTS

A 362X Tape Control can be programmed to send an Interrupt signal to the converter when any one of the conditions specified by the three interrupts occurs. A Select Interrupt code permits the control 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 converter. The Interrupt signal remains up until cleared by reselecting the interrupt, selecting release interrupt, or master clearing the system. The Interrupt signal is transmitted on the equipment's interrupt line to the converter.

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 converter has a unique equipment number, each uses a different interrupt line. A 6681 Channel Status Request (1200) can identify the equipment sending the Interrupt signal by inspecting the interrupt lines.

PROGRAMMING

CODES

All connections and operations are controlled by 12-bit connect and function codes in conjunction with appropriate 6681 function codes. 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. 362X MAGNETIC TAPE CONTROLLER CODES

Connect Code	
Connect Tape Unit	N0UU*
Function Codes	
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
Status Reply Codes	
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 (200 bpi)	X0XX
Density (556 bpi)	X1XX
Density (800 bpi)	X2XX
Lost Data	X4XX
End of Operation	1XXX
Vertical or Longitudinal Parity Error	2XXX
Reserved (by other converter)	4XXX

*N = equipment number of read/write control, UU = bank designation and setting of the Unit Select switch.

**607 Tape Units only.

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

Connect Code

A control must be connected to its converter before it can respond to either a 362X function code or an Input/Output instruction. The connection is accomplished by transmitting the equipment Connect Tape Unit code (N0UU) to the control by an appropriate 6681 function code.* The N portion of the code must contain the equipment number of the read/write control. The UU portion of the code designates one of the sixteen possible tape units ($00\text{-}17_8$). Each control examines every Connect code transmitted from its attached converter. A Reply signal,** indicating a connect, is returned to the converter from a control if:

1) The requested tape unit (UU) is Not Busy, not reserved and not connected to the other converter,
2) The N portion of the Connect code matches the setting of the Equipment Number switch on the read/write control.
3) The UU portion of the Connect code matches the bank designation and setting of the UNIT SELECT switch on an unreserved tape unit, and
4) A transmission parity error is not detected.

If the requested tape control is busy or the requested unit is reserved or connected to the other converter, a Reject signal is returned to the converter requesting the connect. Equipment status is also made available to that converter so that the cause for the reject may be determined. Note that in the case of a rewinding tape, the tape control is not busy and a connect can be made even though the unit busy status is up.

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 converter from the control. Equipment status is not made available to the converter. If the control is already connected, it automatically disconnects. The tape unit connected through the control remains reserved for that converter until released, cleared, or given a new unit number. If neither a Reply nor a Reject is returned to the converter from any of its attached equipments within 100 usec, it generates an Internal Reject. The Internal Reject causes the same results as the reject.

If the UU portion of the Connect code does not match the setting of any UNIT SELECT switch, a Reject signal is returned to the converter.

---

*See 6681 Converter function codes under Connect (modes I and II).

**A Reply or a Reject signal tells the 6681 Converter to send an Inactive signal to the 6000 Series Data Channel. A 6681 Channel Status Request (1200) function code is used to determine which of these signals was returned to the converter.

Tape units physically attached to the 362X Controller may be unconnected and unreserved, connected to a converter, or reserved by a converter.

Unconnected and unreserved units may be connected by any converter attached to the controller. Once a converter is connected to a particular unit (i.e., a communication path is established), that unit remains reserved for that converter even though the converter disconnects the unit by connecting (or attempting to connect) to another unit or equipment. Once a unit is reserved by a converter, no other converter has access to the unit. Since it is possible for one converter to reserve all tape units, care must be taken to release those units not essential to the current program. If more than one converter attempts to connect simultaneously, a scanner determines the converter to be connected.

Connect Tape Unit (NOUU)

This code connects the desired unit. N is the equipment number of the Read/Write control. UU is the unit number of a specific tape unit.

Function Codes

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 are transmitted to the control by appropriate 6681 function codes. Table 1 contains a complete list of function codes. A detailed description of each code can be found on the following pages.

There are three classifications of codes:

1) Operating*
2) Nonoperating, and
3) Interrupt

Operating Codes: There are seven operating codes as follows:

1) Rewind
2) Rewind Unload

*Operating codes cause the control to become Busy.

3) Backspace
4) Search Forward to File Mark
5) Search Backward to File Mark
6) Write File Mark, and
7) Skip Bad Spot

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

Nonoperating Codes: There are nine nonoperating codes as follows:

1) Release
2) Binary
3) Coded
4) Densities (3)
5) Clear
6) Set Reverse Read, and
7) Clear Reverse Read

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: The remaining six function codes include the following Interrupt codes:

1) Select Interrupt on Ready and Not Busy
2) Release Interrupt on Ready and Not Busy
3) Select Interrupt on End of Operation
4) Release Interrupt on End of Operation
5) Select Interrupt on Abnormal End of Operation
6) Release Interrupt on Abnormal End of Operation

Interrupt codes are never rejected and always cause a Reply signal to be returned to the converter.

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.

Release (0000)

This code clears both the existing unit connection and the converter reservation for the unit. It does not clear reserve logic on any other tape units reserved by that converter.

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 all tape unit reservations made by the converter as well as the existing unit connection. It permits other converters to gain access to these units.

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

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 (600 inches per second) to load point. It is ineffective 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.

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.

---

*607 Tape Units only.

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 converter 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).

Release Interrupt on Ready and Not Busy (0021)

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

---

*607 Tape Units only.

Select Interrupt on End of Operation (0022)

This code causes the controller to send the Interrupt signal to the converter 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.

Release Interrupt on End of Operation (0023)

This code clears an Interrupt on End of Operation selection and the 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 converter 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.

Release Interrupt on Abnormal End of Operation (0025)

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

---

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

Status Reply Codes

Status reply codes permit the monitoring of several control/unit operating conditions. These codes are made available to the converter over 12 status lines following a connect or a rejected connect attempt. A 6681 External Equipment Status (1300) Function code makes 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 reply word is the sum of the individual codes.

Ready (XXX1)—Bit 0

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)—Bit 1

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 5 ms after tape motion stops. Bit 1 is cleared approximately 5 ms 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

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

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.

*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.

Load Point (XX2X)—Bit 4

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

End of Tape (XX4X)—Bit 5

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 (X0XX, X1XX, X2XX)—Bits 6 and 7

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

Lost Data (X4XX)—Bit 8

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 is cleared by a new Connect or function code or a Master Clear (see Lost Data, page 18).

End of Operation (1XXX)—Bit 9

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 operation, operating function, or clearing operation is initiated.

Vertical or Longitudinal Parity Error (2XXX)—Bit 10

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.

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*Reverse Read is possible with 607 Tape Unit only.

Reversed (by other converter) (4XXX)—Bit 11

Bit 11 is set when a converter attempts to connect to a reserved unit. It is cleared by issuing a Release or Clear code or clearing the equipment.

PROGRAMMING CONSIDERATIONS

Reverse Read*

The 362X 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 362X Controller must first receive function code 0041 Set Reverse Read (0041). 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 362X Controller to indicate that the 12-bit bytes should be assembled into a word in reverse order.

Data transfer continues until the word count in the control word equals zero. 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.

---

*607 Tape Units only.

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 during normal Read.

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

Lost Data

The Lost Data condition occurs in two cases:

1) When the converter 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, 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 Disconnect Channel instruction.

MANUAL OPERATION

SWITCHES AND INDICATORS

Equipment Number Switches

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 the equipment uses.

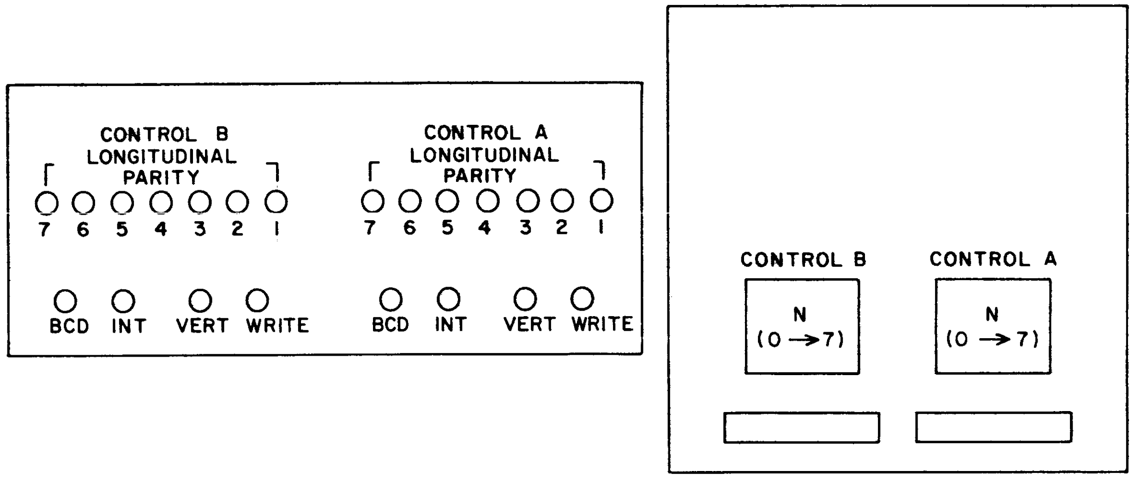

Figure 2. 362X Switch and Indicator Panel*

When a control is connected to a tape unit, a white indicator in the switch lights. This indicator also lights when a connection cannot be made because the tape unit is reserved by another channel.

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

LONGITUDINAL PARITY Indicators

Seven LONGITUDINAL 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.

*Located on the 362X Controller logic chassis.

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, or 6681 Function 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.

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) Dead Start Master Clear
   This clears all tape units connected and reserved by all controls. It also clears the logic in all controls. No status signals are available to the converter after executing this operation.

2) 6681 Function Master Clear (1700)
   This instruction:
   a) Clears the present connection control N may have with a tape unit.
   b) Releases all tape (i.e., clears reserve logic) which control N may have reserved.
   c) Performs a Master Clear on control N read, write, and function logic. No status signals are available to the converter after executing this instruction.

3) 362X Clear (0005)
   This 362X Function code:
   a) 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 converter.

b) Releases all tape units control N may have reserved.

4) 362X Release (0000)
This 362X Function code clears only the connection and the reservation for the connected tape unit. It does not clear the reservations for any other tape units.

5) Power On Master Clear
When power is applied to the 362X Controller, all tape units connected and reserved by all controls are cleared. Logic in all controls is also cleared. No status signals are available to the converter after power is applied.

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

All clear operations (except for Release code) place the 362X Controller in binary format.

342X-A MAGNETIC TAPE CONTROLLERS

CONTENTS

FIGURES

TABLES

342X-A MAGNETIC TAPE CONTROLLERS

The CONTROL DATA* 342X-A Magnetic Tape Controllers facilitate high-speed transfer of data between CONTROL DATA 603 and 604 or 606 and 607 Magnetic Tape Transports and 6681 Data Channel Converters.** (See Figure 1.)

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

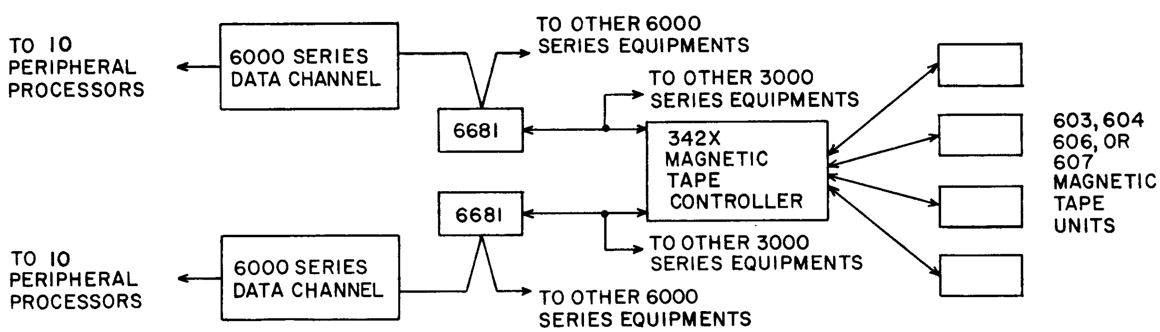

Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation

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

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 342X Controller consists of two read/write controls. Each control may be physically attached to one 6681 Converter. Each Converter, through its associated control, can communicate with any attached tape unit, providing the unit is not in use or reserved. Both converters may communicate with their respective logically connected tape units simultaneously.

Data Channels serving the 342X Controller need not be associated with the same Central Processor.

The 342X is available with the following options:

3421	Two read/write controls to control one to four magnetic tape transports.
3422	Two read/write controls to control one to six magnetic tape transports.
3423	Two read/write controls to control one to eight magnetic tape transports.

TAPE UNIT DESIGNATION

Each tape unit may have either a unique numerical designation (0- 7) or be in a Standby condition. These are determined by a Unit Select switch.* The unit cannot be connected when it is on STANDBY. When the numerical designation of a unit is changed, any existing connection and/or reservation is cleared.

*This switch is located on the tape unit.

ASSEMBLY/DISASSEMBLY

During Write operations, each control receives data from its converter 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.

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 converter. The first character received comprises the upper 6 bits of the byte, and the next character comprises the lower 6 bits.

DATA TRANSMISSION

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.

Record/File Formats

The data written on tape as the result of a single output instruction constitutes a record. 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).

An End of Record signal is sent to the converter during a Read operation when a tape unit detects a record gap or a file mark. This signal always terminates the Read. A Read operation also terminates when the Peripheral Processor disconnects the Data Channel after completing the input instruction.

Transfer Rates

Read or Write operations may be performed with 607 Tape Units at any one of three densities: 200 characters/inch, 33 usec/frame; 556 characters/inch, 12 usec/frame; 800 characters/inch, 8 usec/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.

Density and parity (binary or BCD) formats should be selected or determined prior to a Read or Write operation.

PARITY CHECKING

Transmission Parity Checking

Connect codes, function codes, and data are transmitted between the converter 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, a "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 converter. Instead, a red indicator in the Equipment Number switch of each equipment detecting the error lights. These parity error conditions must be cleared by a 6681 Function Master Clear prior to a new connect attempt.

*If the device is connected, it automatically disconnects.

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 converter, and a red indicator lights in the Equipment Number switch. Since neither a Reject not a Reply is returned to the converter, it generates an Internal Reject after a wait of 100 usec. These parity error indications must be cleared by a 6681 Function 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 by the control 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 converter. The data is written on tape. All operations continue ** unless appropriate programming steps have been taken to sense for all Parity Error signals and rewrite the data. These parity error indications must be cleared by a 6681 Function Master Clear. The equipment must then be reconnected and the appropriate functions reselected prior to the new output.

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 parity bit to each character and relays it to the tape unit. Approximately 2 or 3 ms*** 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 incorrect. The number of "1" bits must be odd for binary data and even for BCD data.

*Though operations may continue normally, the validity of a new function code and/or data prior to a 6681 Function Master Clear is questionable.

**The validity of the data received from this point until a 6681 Function Master Clear is questionable.

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

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, or 6681 Function Master Clear.

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, or 6681 Function Master Clear.

INTERRUPTS

The 342X Tape Control can be programmed to send an Interrupt signal to the converter 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 converter. The Interrupt signal remains up until cleared by reselecting the interrupt, selecting release interrupt, or master clearing the system. The Interrupt signal is transmitted on the equipment's interrupt line to the converter.

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 to 5, all Interrupt signals coming from this control are transmitted on interrupt line 5. Since each equipment attached to a converter has a unique equipment number,

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

each uses a different interrupt line. A 6681 Converter Status Request (1200) can identify the equipment sending the Interrupt signal by inspecting the interrupt lines.

PROGRAMMING

CODES

All connections and operations are controlled by 12-bit connect and function codes in conjunction with appropriate 6681 function codes. 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).

Connect Code

A control must be connected to its converter before it can respond to either a 342X function code or an input/output instruction. The connection is accomplished by transmitting the equipment Connect Tape Unit code (N00U) to the control by an appropriate 6681 function code.* The N portion of the code must contain the equipment number of the read/write control. The U portion of the code designates a specific tape unit. Each control examines every Connect code transmitted from its attached converter. A Reply signal,** indicating a connect is returned to the converter from a control if:

1) The requested tape unit (U) is Not Busy, is not reserved, or connected to the other converter.
2) The N portion of the Connect code matches the setting of the Equipment Number switch on the read/write control,
3) The U portion of the connect code matches the setting of the UNIT SELECT switch on an unreserved tape unit, and
4) A transmission parity error is not detected.

If the requested tape unit is Busy, reserved, or connected to the other converter, a Reject signal** is returned to the converter requesting the connect. Equipment status is also made available to that converter so that the cause for the reject may be determined.

---

*See 6681 Converter function codes under Connect (Modes I and II).

**A Reply or a Reject signal tells the 6681 Converter to send an Inactive signal to the 6000 Series Data Channel. A 6681 Channel Status Request (1200) function code is used to determine which of these signals was returned to the converter.

TABLE 1. 342X MAGNETIC TAPE CONTROLLER CODES

Connect Code	
Connect Tape Unit	N00U*
Function Codes	
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
Status Reply Codes	
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 (200 bpi)	X0XX
Density (556 bpi)	X1XX
Density (800 bpi)	X2XX
Lost Data	X4XX
End of Operation	1XXX
Vertical or Longitudinal Parity Error	2XXX
Reserved (by other converter)	4XXX

*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. This code is for 604 and 607 Tape Units only.

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 converter from the control. Equipment status is not made available to the converter. If the control is already connected, it automatically disconnects. The unit connected through the control remains reserved for that converter until released, cleared, or given a new unit number. If neither a Reply nor a Reject is returned to the converter from any of its attached equipments within 100 usec, it generates an Internal Reject. The Internal Reject causes the same result as the 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 converter.

Tape units physically attached to the 342X Controller may be unconnected and unreserved, connected to a converter, or reserved by a converter.

Unconnected and unreserved units may be connected by any converter serving the controller. Once a converter is connected to a particular unit (i.e., a communication path is established), that unit remains reserved for that converter even though the converter disconnects the unit by connecting (or attempting to connect) to another unit or equipment. Once a unit is reserved by a converter, no other converter has access to the unit. Since it is possible for one converter to reserve all tape units, care must be taken to release those units not essential to the current program. If more than one converter attempts to connect simultaneously, a scanner determines the converter to be connected.

Connect Tape Unit (NOUU)

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

342X 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 are transmitted to the control by 6681 mode I or mode II function procedure. Table 1 contains a complete list of 342X function codes.

There are three classifications of codes:

1) Operating*
2) Nonoperating, and
3) Interrupt

Operating Codes: There are seven operating codes as follows:

1) Rewind
2) Rewind Unload
3) Backspace
4) Search Forward to File Mark
5) Search Backward to File Mark
6) Write File Mark, and
7) Skip Bad Spot

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

Nonoperating Codes: There are nine nonoperating codes as follows:

1) Release
2) Binary
3) Coded
4) Densities (3)
5) Clear
6) Set Reverse Read, and
7) Clear Reverse Read

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: The remaining six function codes include the following Interrupt codes·

1) Select Interrupt on Ready and Not Busy

* Operating codes cause the control to become Busy.

2) Release Interrupt on Ready and Not Busy
3) Select Interrupt on End of Operation
4) Release Interrupt on End of Operation
5) Select Interrupt on Abnormal End of Operation
6) Release Interrupt on Abnormal End of Operation

Interrupt codes are never rejected and always cause a Reply signal to be returned to the converter.

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.

Release (0000)

This code clears both the existing unit connection and the converter reservation for the unit. It does not clear reserve logic on any other tape units reserved by that converter.

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.

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

Clear (0005)

This code clears all tape unit reservations made by the converter as well as the existing unit connection. It permits other converters to gain access to these units.

*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 (600 inches per second) to load point. It is ineffective 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.

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 until either a file mark is detected or the tape is unloaded

*604 and 607 Tape Units only.

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 converter 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).

Release Interrupt on Ready and Not Busy (0021)

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

---

*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 converter 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.

Release Interrupt on End of Operation (0023)

This code clears an Interrupt on End of Operation selection and the 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 converter 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.

Release Interrupt on Abnormal End of Operation (0025)

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

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

Status Reply Codes

Status reply codes permit the monitoring of several control/unit operating conditions. These codes are made available to the converter over 12 status lines following a connect or a rejected connect attempt. A 6681 External Equipment Status (1300) Function code makes these codes available to the Peripheral Processor.

See Table 1 for a complete list of these codes. If two or more conditions exist simultaneously, the status reply word is the sum of the individual codes.

Ready (XXX1)—Bit 0

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)—Bit 1

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 5 ms after tape motion stops. Bit 1 is cleared approximately 5 ms 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

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

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.

*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.

Load Point (XX2X)—Bit 4

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

End of Tape (XX4X)—Bit 5

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 (X0XX, X1XX, X2XX)—Bits 6 and 7

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

Lost Data (X4XX)—Bit 8

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 is cleared by a new Connect or function code or a Master Clear (see Programming Considerations).

End of Operation (1XXX)—Bit 9

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 operation, operating function, or clearing operation is initiated.

Vertical or Longitudinal Parity Error (2XXX)—Bit 10

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.

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

Reserved (by other converter) (4XXX)—bit 11

Bit 11 is set when a converter attempts to connect to a reserved unit. It is cleared by issuing a Release or Clear code or clearing the equipment.

PROGRAMMING CONSIDERATIONS

Reverse Read*

The 342X 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 342X Controller must first receive function code 0041 Set Reverse Read (0041). 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 342X Controller to indicate that the 12-bit bytes should be assembled into a word in reverse order.

Data transfer continues until the word count in the control word equals zero. 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.

*604 and 607 Tape Units only.

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 during normal Read.

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

Lost Data

The Lost Data condition occurs in two cases:

1) When the converter 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, 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 Disconnect Channel instruction.

MANUAL OPERATION

SWITCHES AND INDICATORS

Equipment Number Switches

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 the equipment uses.

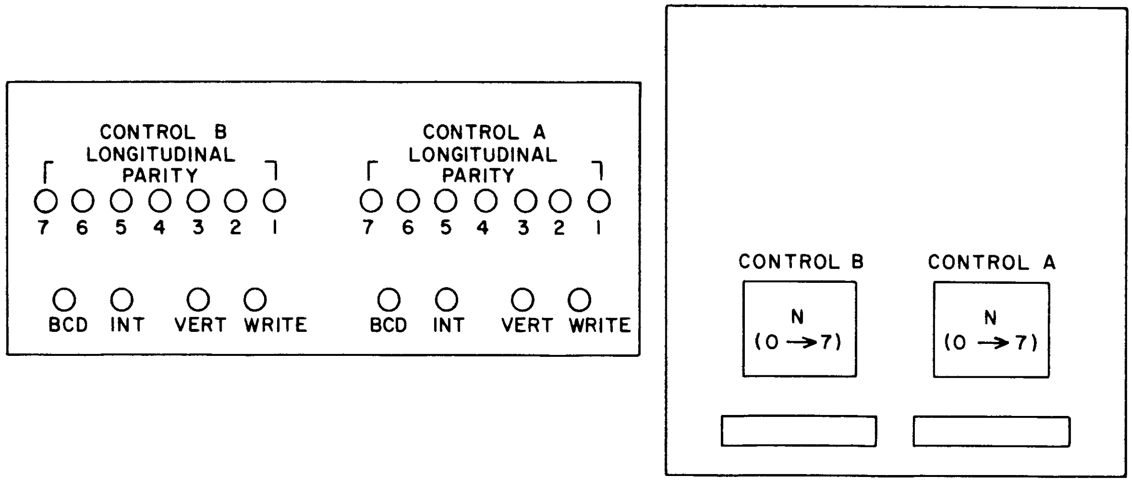

Figure 2. 342X Switch and Indicator Panel*

When a control is connected to a tape unit, a white indicator in the switch lights. This indicator also lights when a connection cannot be made because the tape unit is reserved by another channel.

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

LONGITUDINAL PARITY Indicators

Seven LONGITUDINAL 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.

*Located on the 342X Controller logic chassis.

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, or 6681 Function 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.

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) Dead Start Master Clear
   This clears all tape units connected and reserved by all controls. It also clears the logic in all controls. No status signals are available to the converter after executing this operation.

2) 6681 Function Master Clear (1700)
   This instruction:
   a) Clears the present connection control N may have with a tape unit.
   b) Releases all tape (i.e., clears reserve logic) which control N may have reserved.
   c) Performs a Master Clear on control N read, write and function logic. No status signals are available to the converter after executing this instruction.

3) 342X Clear (0005)
   This 342X Function code:
   a) 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 converter.

b) Releases all tape units control N may have reserved.

4) 342X Release (0000)

This 342X Function code clears only the connection and the reservation for the connected tape unit. It does not clear the reservations for any other tape units.

5) Power On Master Clear

When power is applied to the 342X Controller, all tape units connected and reserved by all controls are cleared. Logic in all controls is also cleared. No status signals are available to the converter after power is applied.

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

All clear operations (except for Release code) place the 342X Controller in binary format.

SUPPLEMENTARY INFORMATION
MAGNETIC TAPE EQUIPMENT

CONTENTS

FIGURES

SUPPLEMENTARY INFORMATION
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, and

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 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.

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* forma at the end of each record; the number of "1's" in each record track is made even.

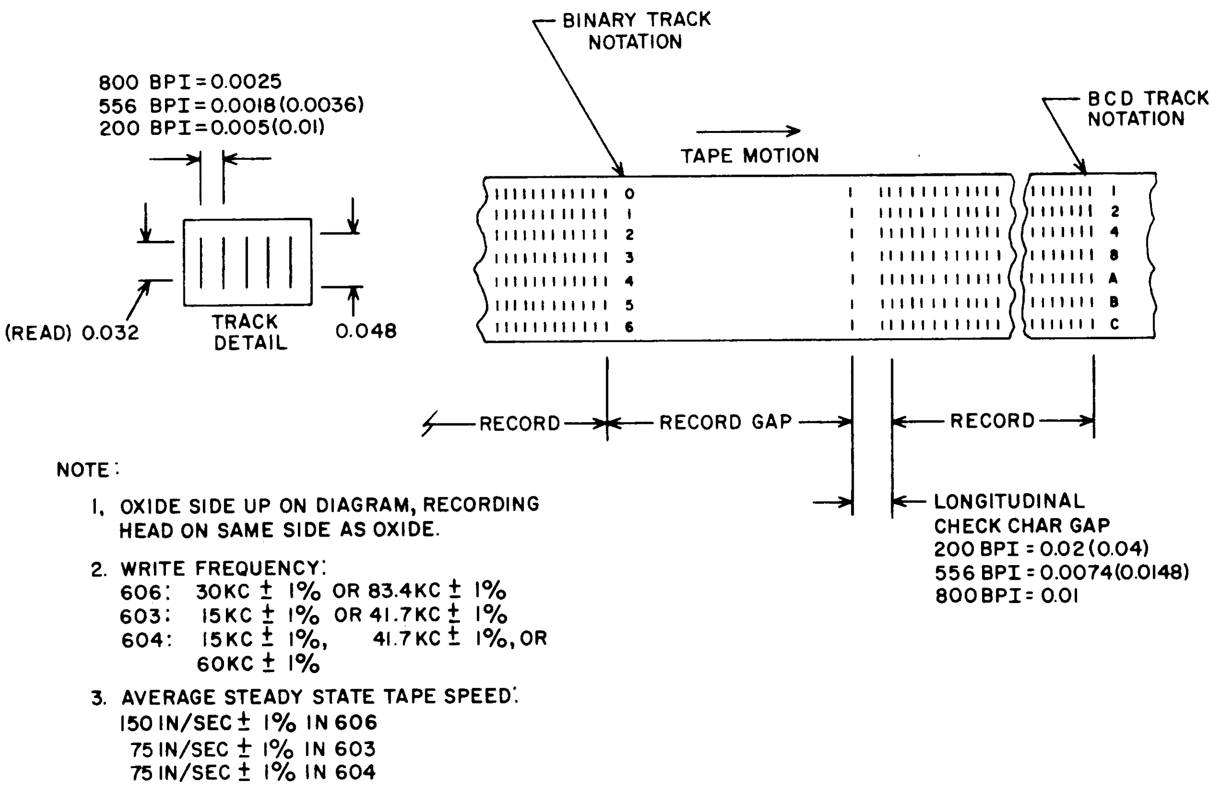

Figure 1. Bit Assignments on Tape

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

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, 1-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.

The load point marker must be placed at least 10 feet from the beginning of the tape on the supply reel (Figure 2). This marker is placed with its 1-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 1-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.

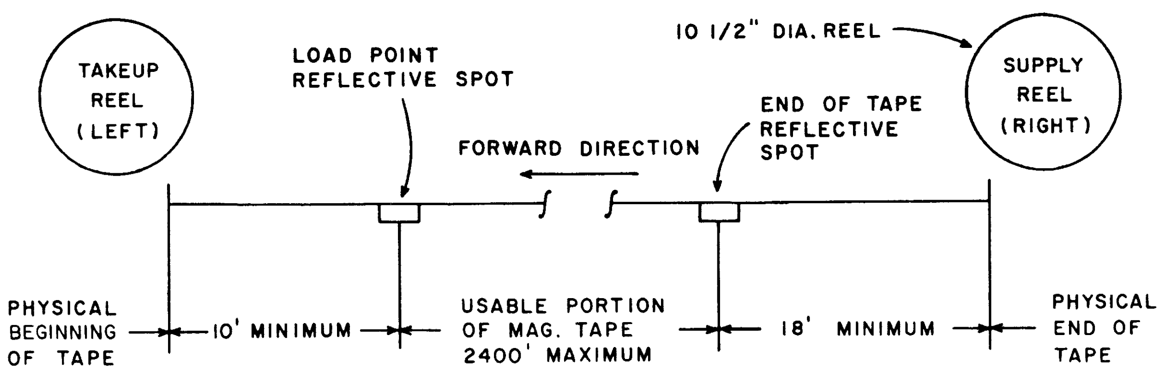

Figure 2. Physical Layout of Tape

FILE PROTECTION RINGS

The back of the file reel has a slot near the hub which accepts a plastic file protection ring (Figure 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.

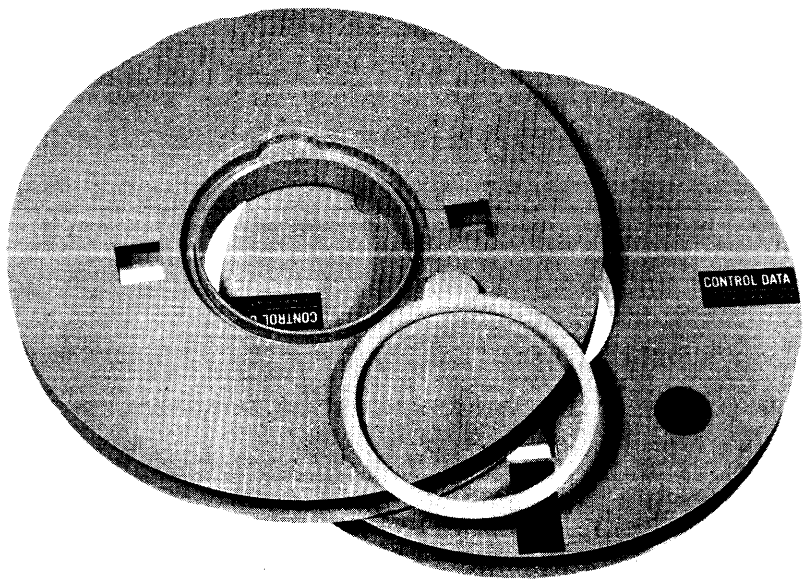

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Figure 3. File Protection Ring

603/604/606/607 MANUAL OPERATION

SWITCHES AND INDICATORS

The manual controls (Figures 4 and 5) 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 the tape marker is sensed or the CLEAR switch is pushed. It is lighted during this operation.

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.

POWER	FORWARD	REVERSE	REWIND
WRITE	READ	DENSITY LO	DENSITY HI
UNLOAD	LOAD	READY	CLEAR

Figure 4. 603/606 Operator's Control Panel

POWER	FORWARD	REVERSE		REWIND
WRITE	READ	200	556	800
UNLOAD	LOAD	READY		CLEAR

Figure 5. 604/607 Operator's Control Panel

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.

*603/606 Tape units

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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*604/607 Tape units

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 6).
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) 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.

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

12) Push door up.

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

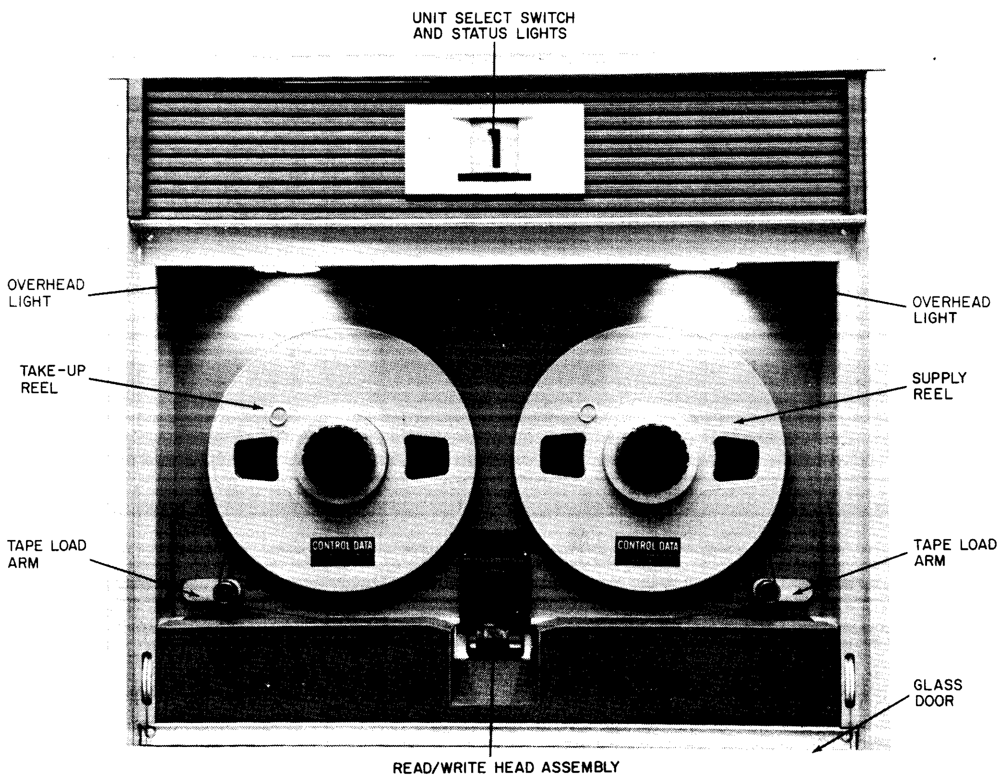

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Figure 6. Tape Load and Unload Mechanics

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 front door down.
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 to the nearest load point marker.

3446-A/3644-A CARD PUNCH CONTROLLERS

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FIGURES

TABLES

3446-A/3644-A CARD PUNCH CONTROLLERS

This section describes a card punch system consisting of a CONTROL DATA* 3446-A or 3644-A Card Punch Controller and a CONTROL DATA* 415 or an IBM 523 Card Punch. These systems operate with a 6681 Data Channel Converter. Figure 1 shows a typical system configuration. Table 1 lists the specifications for systems using either punch.

The controller occupies a cabinet separate from the basic card punch.

The two controllers are similar except that the 3644 Controller is a two-control device, and the 3446 Controller attaches to only one Data Channel Converter.

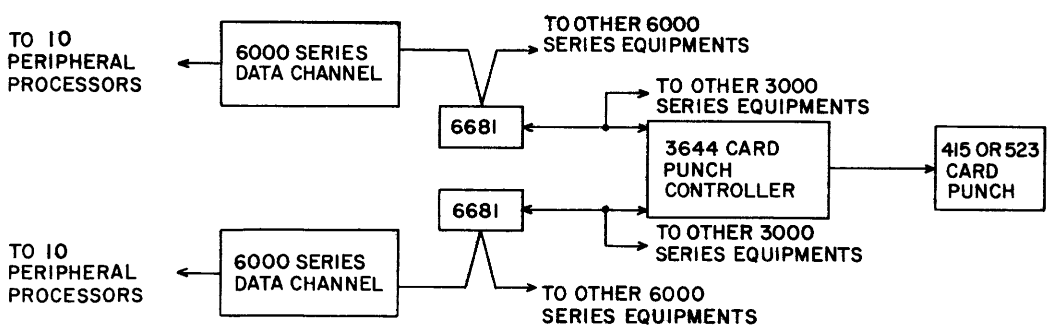

Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation

TABLE 1. SYSTEM SPECIFICATIONS

	CONTROL DATA 415 Punch	IBM 523 Punch
Processing Speed	250 cards/minute	100 cards/minute
Input Hopper Capacity	1,200 cards	725 cards
Stacker Capacity	1,500 cards	725 cards
Type of Cards	80-column	80-column
Data Transfer Rate: Buffer memory in controller permits high-speed transfer from data channel, 2,560 usec per 80-column card.		

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 3446 and 3644 Controllers perform control and data conversion function necessary to operate a CONTROL DATA 415 or IBM 523 Punch under control of a 6681 Data Channel Converter.

The 3446 Controller is a single-control device and is attached by cables to only one converter. It is assigned a unique equipment number (0-7) to distinguish it from other equipments attached to the converter.

The 3644 Controller contains two connect-reserve controls and can be attached by cables to two converters. Reserve logic in each control prevents both converters from communicating simultaneously with the controller. An equipment number is assigned to each connect-reserve control.

CARD FORMAT

The card punch system can handle 80-column cards only. Cards can be punched in either Hollerith or binary format. The card is described under Punch Card Format and Codes. (See Supplementary Information, Card Equipment section.)

BUFFER MEMORY

The controller contains a buffer memory that holds 80 12-bit words (one card image). This memory permits the converter to transfer at a very rapid rate the bytes necessary to punch one card. The information is then read-out at the relatively slow rate required by the punch. When the actual punching takes place, the converter need not be connected to the punch system and may be used to serve some other device.

The memory can be fully loaded in 2.2 ms for a Hollerith card (40 bytes) or in 2.5 ms for a binary card (80 bytes). The time required to punch a card is:

1) 240 ms for the 415 Punch, and
2) 600 ms for the 523 Punch.

PUNCHING CARDS

The card punch system is controlled by a converter. It punches cards only as long as the Data Channel transmits data bytes in response to a Write (output) instruction.

The controller forms a card image in a buffer memory from a series of 12-bit data bytes. A card is punched after the card image is formed. The controller forms the card image on a column-by-column basis. Normally, the controller performs a BCD (binary coded decimal) to Hollerith conversion. The controller interprets each 12-bit byte as two 6-bit internal BCD codes. It converts each of these codes to a Hollerith code. (Table 1 in the Supplementary Information, Card Equipment section lists the two sets of corresponding codes.) Thus, in the first byte, the upper 6 bits are translated into a Hollerith code which is punched in column one of the card. The lower 6 bits are also translated into a Hollerith code which is punched in column two of the card. The second byte is translated into two Hollerith codes that are punched in columns three and four. Forty 12-bit bytes are required to fill an 80-column card.

When the Negate BCD to Hollerith mode selected by a function code is in effect, each byte is punched directly in a separate card column. There is no code conversion. Bit 11 of each byte is punched in the top row (row 12) and bit 0 is punched in the bottom row (row 9). Eighty 12-bit bytes are required to fill a card.

The number of data bytes transferred by a single Write instruction may be fewer, the exact number, or more than required to fill one card. When fewer bytes than 40 (BCD) or 80 (binary) are sent to the punch, a card is punched when the Data Channel terminates the Write operation. If a single Write operation transfers more bytes than can be punched on a card, a second card is punched when the first is filled.

CARD CHECK-READ

The card punches have a check-read station location behind the punch station. After a card is punched, it is read and checked for errors while the next card is being punched. As a card image is formed in buffer memory, a count of "1's" is accumulated. This count is stored by the controller. When the card is check-read, a total hole count is prepared and this count is compared with the original count. If the two counts do not agree, an error exists in the card. This condition causes the controller to send an Interrupt signal if the Abnormal End of Operation interrupt is selected. A status line also indicates a comparison error.

LAST CARD CHECK

Normally, a card is check-read only when the next card is punched. When punch operations end, the last card punched does not advance through the check-read station. A function code is available to initiate a check-read cycle for the last card.

SORTING*

A special function code (Select Offset Stacker) offsets a card slightly as it enters the stacker. The code must be issued for each card to be offset within 60 ms after the card is check-read.

PARITY

All information exchanged between the converter and controller is checked for parity.

*Available on CONTROL DATA 415 Punch only.

Parity Error in Connect Code

The controller checks the Connect code sent from the converter for correct parity. If a parity error is present, the controller does not connect, and PARITY ERROR indicators on all equipments cabled to the converter light. A 6681 Function Master Clear should be executed to clear the PARITY ERROR indicators before another operation is executed.

Parity Error in Function Code

The controller checks each function code sent from the data channel for proper parity. If a parity error occurs in a function code, a PARITY ERROR indicator on the controller lights, and the controller sends a Parity Error signal to the converter. The controller does not execute the function. The Parity Error signal sets the input/output parity error bit in the Data Channel. This signal should be cleared by a 6681 Function Master Clear before another operation is initiated.

Parity Error During Write Operation

During Write operations, the controller checks each data byte sent from the converter for correct parity. If a parity error occurs, the PARITY ERROR indicator on the controller lights, and the controller sends a Parity Error signal to the converter. If the converter does not terminate the Write operation, the card punch uses the faulty data. The Parity Error signal should be cleared by a 6681 Function Master Clear.

INTERRUPT

Each of the following interrupt conditions can be selected by function codes:

1) Interrupt on Ready and Not Busy,
2) Interrupt on End of Operation, or
3) Interrupt on Abnormal End of Operation.

The section on function codes defines each of these conditions.

When one of the selected Interrupt conditions occurs, the controller sends an Interrupt signal to the 6681 Data Channel Converter. An Interrupt signal remains on the line until cleared by a 6681 Function Master Clear, reselection of the Interrupt condition (function code), release of the Interrupt condition (function code), or a Clear (0005) function code.

The card punch system transmits the Interrupt signal to the converter on one of eight interrupt lines. The setting of the eight-position Equipment Number switch on the controller determines which line is used. For example, if the switch is set to 4, the Interrupt signal goes out on line 4. Since each input/output device attached to the converter is assigned a unique equipment number, each device uses a separate interrupt line. A 6681 Channel Status Request (1200) can identify which of several equipments attached to a converter sends an interrupt by inspecting the eight interrupt lines.

PROGRAMMING

CODES

Table 2 lists all the codes applicable to the 3446/3644 Controllers. A detailed explanation of each code can be found in the following pages.

TABLE 2. 3446/3644 CARD PUNCH CONTROLLER CODES

Connect Code	
Connect Punch	N000*
Function Codes	
Release and Disconnect	0000
Negate BCD to Hollerith Conversion	0001
Release Negate BCD to Hollerith Conversion	0002
Select Offset Stacker**	0003
Check Last Card	0004
Clear	0005
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
Status Reply Codes	
Ready	XXX1
Busy	XXX2
Fail to Feed	X1XX
Interrupt on Ready and Not Busy	X2XX
Interrupt on End of Operation	X4XX
Interrupt on Abnormal End of Operation	1XXX
Compare Error	2XXX
Reserved (by other converter) (3644 only)	4XXX

*N = equipment number of controller
**CONTROL DATA 415 Card Punch only

Connect Code

The card punch system must be connected to a converter before it responds to a function code or Write operation. A Connect code (N000), transmitted to the equipment by an appropriate 6681 function code, connects the punch system to the converter issuing the code. The N portion of the code must match the setting of the eight-position Equipment Number switch. (On the 3644 Controller, there are two Equipment Number switches, one for each control.) When the controller connects, it returns a Reply signal* to the converter.

A Connect code that does not match the Equipment Number switch setting disconnects the controller if previously connected.

The two-channel 3644 Controller contains a reservation feature that prevents interference between the two converters. When the 3644 Controller connects, the reservation is established for the connecting converter. This reservation remains in effect even if the converter disconnects the 3644 Controller by connecting another device. A reservation can be cleared only by a 6681 Function Master Clear, or Release and Disconnect function code (0000).

If a converter attempts to connect the 3644 Controller while it is reserved by the other converter, the 3644 Controller generates a Reject* signal.

Even though a Connect operation results in a Reject, the 3644 Controller enables status information to the rejected converter so that the reason for the reject can be determined.

The 3446 Controller is a single control device and thus does not contain a reservation feature.

If for some reason the controller fails to return either a Reply or a Reject to the 6681 within 100 usec, the 6681 generates an Internal Reject. This signal acts the same as a Reject from an external device.

Connect Punch (N000)

This code connects the punch system to a converter. The N portion of the code must match the setting of the Equipment Number switch.

*A Reply or a Reject signal tells the 6681 converter to send an Inactive signal to the processor. A 6681 Channel Status Request (1200) is used to determine which of these signals was returned to the converter.

Function Codes

Function codes set up or release various operating conditions in the punch system. Table 2 lists all the function codes applicable to the 3446/3644 Controllers.

A 3446/3644 function code is transmitted to the controllers via appropriate 6681 function codes.

The punch system accepts certain 3446/3644 function codes only when it is Not Busy. If one of these codes arrives during a Busy period, the controller returns a Reject signal to the converter.

Any codes not listed in Table 2 are do-nothing codes. The controller returns a Reply in response to such codes, but no action follows.

Release and Disconnect (0000)

This code disconnects the controller and clears the converter reservation. All interrupt selections and Negate BCD to Hollerith selections are cleared. The controller recognizes and replies to this function whether it is Busy or Not Busy.

Negate BCD to Hollerith Conversion (0001)

This code suppresses the normal internal BCD to Hollerith conversion so that data bytes can be punched directly on a card. Each byte is punched in a separate column. The controller rejects this code when Busy.

Release Negate BCD to Hollerith Conversion (0002)

This code returns the controller to the normal internal BCD to Hollerith Conversion mode. The controller rejects this code when Busy.

*Select Offset Stacker (0003)**

This code offsets a card by 3/8 inch in the output stacker of the CONTROL DATA 415 Card Punch. If the selection is to be effective (i.e., offset the card just read), it must be issued within 60 ms after the controller becomes Not Busy. If it is not issued within 60 ms, the card may be only partially offset or not offset at all. A separate function code must be issued for each card to be offset. The function is rejected if the controller is Busy.

Check Last Card (0004)

After the converter has sent out data for the last card and the card has been punched, the card is positioned at the postpunch read station. The Check Last Card code advances the punch one cycle and performs the total hole count check on the last card. Also, in case of a feed failure, this code should be used to check the last card prior to manual intervention. The controller rejects this code when Busy.

Clear (0005)

A Clear code removes any interrupt selection or Interrupt condition and reestablishes the BCD to Hollerith mode of operation. It does not release a reservation or connection. The controller rejects this code when Busy.

Select Interrupt on Ready and Not Busy (0020)

This code conditions the punch system to send an Interrupt signal when it is idle and ready to begin an operation. The controller is Ready when:

1) Cards are present in the input hopper, prepunch, punch, and postpunch stations, and

2) The chip box and stacker are not full.

The controller becomes Not Busy after a card is punched only if the converter has terminated the output operation. The controller accepts this code whether it is Busy or Not Busy.

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*415 Card Punch only

Release Interrupt on Ready and Not Busy (0021)

This code inhibits Interrupt on Ready and Not Busy. It also clears the Interrupt signal when it is caused by the Read and Not Busy condition. The controller accepts this code whether Busy or Not Busy.

Select Interrupt on End of Operation (0022)

This code conditions the punch system to send an Interrupt signal at the end of a card punch cycle if one of the following occurs:

1) The data channel terminates the Write operation,
2) The punch system becomes Not Ready, or
3) A comparison error is generated.

The controller rejects this code when Busy.

Release Interrupt on End of Operation (0023)

This code inhibits Interrupt on End of Operation. It also clears the Interrupt signal when caused by an end of operation. The controller rejects this code when Busy.

Select Interrupt on Abnormal End of Operation (0024)

This code conditions the punch system to send an Interrupt signal at the end of a punch cycle if any of the following conditions occur:

1) Feed failure,
2) Stacker full,
3) Input hopper empty,
4) Chip box full, or
5) Comparison error.

Any of the above conditions cause the controller to become Not Ready. Thus, this interrupt may occur concurrently with Interrupt on End of Operation. The controller rejects this code when Busy. The interrupt causing conditions must be corrected before punch operations can resume.

Release Interrupt on Abnormal End of Operation (0025)

This code inhibits Interrupt on End of Operation. It also clears the Interrupt signal when caused by an abnormal condition.

Status Codes

Various operating conditions in the punch system are indicated by signals on the twelve status lines. Each line is 1 bit of a standard 12-bit status response. Of these the punch system uses only 8 bits. Each status bit is assigned an octal code corresponding to its position in the 12-bit status response. If two or more conditions exist simultaneously, the Status Response code is the sum of the individual codes. This information is available following a Connect or an attempted Connect and can be sensed by means of a 6681 Equipment Status Request (1300). Table 2 lists the status conditions.

Three of the status lines indicate the three conditions that can cause the controller to send an Interrupt signal. Thus, the status feature can be used to identify the cause of an interrupt.

Ready (XXX1)—Bit 0

The ready status bit indicates that the punch system can proceed with a Punch operation. The punch is Ready when:

1) Cards are present in the input hopper, prepunch, punch, and postpunch stations,
2) The stacker is not full, and
3) The chip box is not full.

Once Ready, the punch remains Ready until one of the above conditions is not met. If a Not Ready condition arises during a Punch operation, the status bit drops only at the end of the punch cycle.

If the punch STOP switch is pressed, the punch becomes Not Ready at the end of the current punch cycle. The punch becomes Ready again when the RESET or READY switch is pressed.

Busy (XXX2)—Bit 1

The punch system becomes Busy when the converter initiates a Write operation to load the buffer memory. After the Write operation terminates, the punch remains Busy until the card cycle is complete.

A Check Last Card (0004) function code also causes the punch system to become Busy while the hole count check is completed.

Fail to Feed (X1XX)—Bit 6

A feed failure indicates that when a punch cycle was initiated, a card did not feed from the hopper into the prepunch station.

Interrupt on Ready and Not Busy (X2XX)—Bit 7

This bit indicates that Interrupt on Ready and Not Busy (0020) was selected and that this condition now exists.

Interrupt on End of Operation (X4XX)—Bit 8

This bit indicates that Interrupt on End of Operation (0022) was selected and that this condition now exists.

Interrupt on Abnormal End of Operation (1XXX)—Bit 9

This bit indicates that Interrupt on Abnormal End of Operation (0024) was selected and that this condition now exists.

Compare Error (2XXX)—Bit 10

This bit indicates that the card punched on the previous cycle did not have total hole count equal to the "1" count. The bit remains up until another code is issued to the controller.

Reserved (by other converter) (4XXX)—Bit 11

This bit indicates that the punch is reserved by another converter (3644 Controller only).

PROGRAMMING CONSIDERATIONS

Programming Procedure

A typical order of steps in programming the punch system is:

1) Clear (Dead Start or 6681 Function Master Clear)
2) Connect
3) Function (select interrupts or Negate BCD to Hollerith mode)
4) Initiate Write operation (normally, a separate Write operation is initiated for each card).
5) Copy status when interrupt occurs to determine reason for end of operation
6) Function (check last card after all cards have been punched, and
7) Function (Release and Disconnect)

Timing

Table 1, System Specifications, indicates the maximum rates for the two punches. Regardless of the punch being used, fully loading the buffer memory requires 2,200 usec for Hollerith punching and 2,560 usec for binary punching. To maintain maximum punching rates, the Data Channel must initiate a new Write operation for the next card shortly after the punch system becomes Not Busy. When the 415 Punch is used, the new Write must be started within 24 ms for full-speed operation. With the 523 Punch, the new Write must start within 15 ms after the system becomes Not Busy to maintain maximum rate.

When the 415 Punch is used, the punch system becomes Not Busy about 238 ms after the buffer memory is loaded. If the 523 Punch is used, the system becomes Not Busy approximately 598 ms after the memory is loaded.

SWITCHES AND INDICATORS

Card Punch Switches and Indicators

Refer to Supplementary Information, Card Equipment section, for a description of switches and indicators on the CONTROL DATA 415 Punch and the IBM 523 Punch.

Controller Switches and Indicators

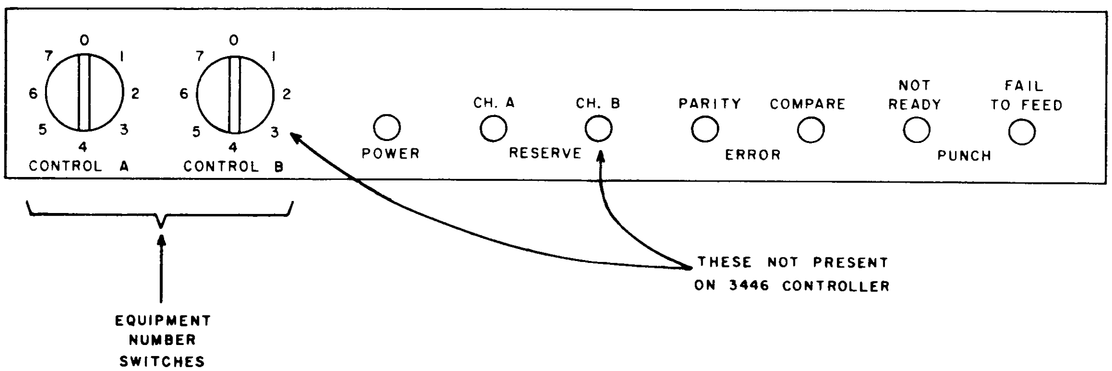

Figure 2. Controller Switches and Indicators

Equipment Number Switches: On the 3446 Controller, there is one Equipment Number switch; on the 3644 Controller, there are two; one for each connect-reserve control. This eight-position switch (0-7) determines the equipment number (corresponds to upper 3 bits of Connect code) of a controller. It also determines on which of eight interrupt lines the controller sends an Interrupt signal.

RESERVE Indicators: These indicators (CH A/CH B) indicate the converter reserving the punch. They light following a connect and are turned off by a Release and Disconnect (0000) or a 6681 Function Master Clear. On the single-channel 3446 Controller, there is only one RESERVE indicator.

PARITY ERROR Indicator: This indicator indicates a parity error in the transmission of a Connect or function code from the converter to the controller. It is turned off by a 6681 Function Master Clear.

COMPARE ERROR Indicator: This indicator shows that the controller sensed a difference between the prepunch bit count and postpunch hole count during the comparison check. The indicator is turned off by any function code.

PUNCH NOT READY Indicator: This indicator indicates the punch is not in operable condition due to one of the following conditions:

1) Cards not present in hopper, prepunch, punch, or postpunch stations,
2) Stacker full,
3) Chip box full, or
4) Feed failure.

PUNCH FAIL TO FEED Indicator: This indicator indicates a card failed to feed from the hopper to the prepunch station. It causes a punch Not Ready condition. It is turned off by manually advancing cards from the hopper.

OPERATING PROCEDURE

To prepare the punch for operation:

1) Turn punch On,
   a) On the 415 Punch, two power switches are located on switch panel
   b) On the 523 Punch, the power switch is located on end panel.
2) Place cards face down in hopper with row 9 facing the direction of card feed,
3) Check to see that the chip box and stacker are not full, and
4) Advance cards into prepunch and postpunch stations,
   a) On the 415 Punch, press SINGLE PICK switch twice,
   b) On the 523 Punch, press START switch twice.
5) Master Clear from computer,
6) The NOT READY and FAIL TO FEED indicators on the controller should not be lighted, and
7) The punch is now ready for an operation under program control.

3447-A/3649-A CARD READER CONTROLLERS

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3447-A/3649-A CARD READER CONTROLLERS

This section describes card reader systems consisting of a CONTROL DATA* 405 Card Reader controlled by a CONTROL DATA 3447-A or 3649-A Card Reader Controller. These systems operate with a 6681 Data Channel Converter. Figure 1 shows a typical system configuration. Table 1 gives system specifications.

The controllers supplement basic reader logic and are mounted in the 405 Reader cabinet. The two controllers are similar; however, the 3649 Controller is a double-control device; the 3447 Controller is a single-control device.

This section presents data formats, the function of the controller, programming information, and operating instructions.

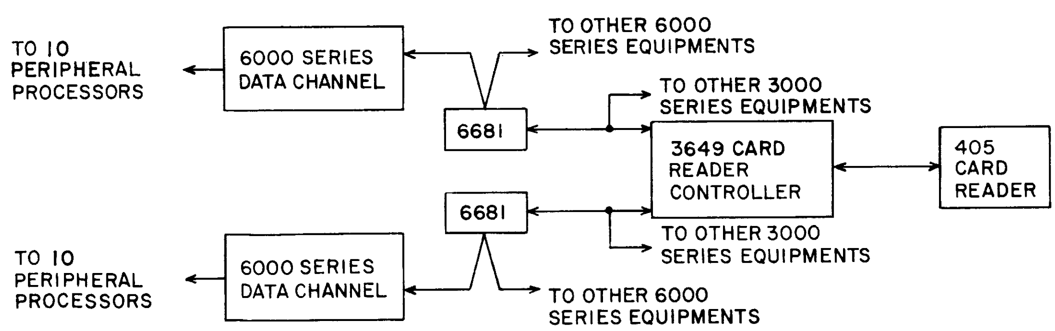

Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation

FUNCTIONAL DESCRIPTION

TABLE 1. SYSTEM SPECIFICATIONS

Reading Rate	1,200 80-column cards per minute 1,600 51-column cards per minute
Input Tray	4,000-card capacity
Receiving Trays	4,000-card primary receiving tray 240-card secondary receiving tray
Data Transfer Rates: Buffer memory in controller permits high-speed transfer to converter: 390 usec/80-column card.	

SYSTEM RELATIONSHIP

The 3447 and 3649 Controllers perform control and data conversion functions necessary to operate a 405 Card Reader into a 6681 Data Channel Converter.

The 3447 Controller is a single-control equipment and is connected by cables to only one converter. It is assigned a unique equipment number (0-7) to distinguish it from other equipments attached to the converter.

The 3649 Controller contains two connect-reserve controls and can be connected by cables to two converters. Reserve logic in each control prevents both converters from communicating simultaneously with the 3649 Controller. An equipment number is assigned to each connect-reserve control.

CARD FORMAT

A punched card contains either 51 or 80 12-bit columns arranged as shown in Figure 1, in the Supplementary Information, Card Equipment section. A punch in any bit position is a logical "1". Cards can be either Hollerith or binary format. In Hollerith format, each column contains a combination of punches that specifies one alphanumeric character. (Table 1, in the Supplementary Information, Card Equipment section, lists the Hollerith codes.) In binary format, each card column is a 12-bit binary quantity.

A punched card whose column 1 contains a 7 and 9 punch is unconditionally a binary card, although any card may be interpreted as binary by means of a function code. A Hollerith card containing punches in rows 7 and 8 of column 1 is a file card, which may be used to send an Interrupt on Abnormal End of Operation signal.

READ OPERATION

The card reader system is controlled by a converter. It reads cards only when the converter requests data in response to a Read (input) instruction. All data on a card must be read by a single Read operation. If a Read operation requests only enough input bytes to partially read a card, the data on the unread portion of the card is lost. The next Read operation reads the next card.

Cards are read column-by-column, beginning with column 1.

The controller transfers card information to the converter in 12-bit bytes. Normally, the controller interprets each card column as a Hollerith code and converts this code to a corresponding 6-bit BCD code. Two BCD codes are assembled into a 12-bit byte. Each byte contains an odd-numbered column code in the upper 6 bits and the next column code (even-numbered) in the lower 6 bits. When a 51-column card is read, the lower 6 bits of the last input byte (byte 26) contain all zeros.

Table 1, in the Supplementary Information, Card Equipment section, lists the Hollerith codes and corresponding BCD codes. Any combination of bits not shown in Table 1 is an illegal Hollerith code. The controller converts such a code to one of the BCD codes listed in Table 1. However, in this case, the BCD code loses its meaning. There is no alarm or indication that an illegal code has been processed.

Binary cards, indicated by punches in rows 7 and 9 in column 1, are read directly. That is, the 12 bits (or rows) in each card column are sent to the converter as a 12-bit byte. The top row (row 12) is the upper bit in the byte; the bottom row (row 9) corresponds to bit 0.

A 3447-A/3649-A function code establishes the Negate Hollerith to BCD mode. When this mode is in effect, the reader system treats all cards as binary cards.

Each card is a record of data. After each card is read, the controller sends an End of Record signal to the converter. This signal causes the converter to terminate the Read operation. The Read operation may also be terminated by an Inactive signal from the processor.

BUFFER MEMORY

The controller contains a buffer memory that holds 80 12-bit words, one card image. The reader enters data from each card into memory at a relatively slow rate (50 ms/ 80-column card). After a complete card has been entered, the converter can read the information from memory at a rapid rate (maximum rate: 390 usec/80-column card). The reader automatically enters another card into memory after the Data Channel has read-out the first card. During the 50-ms period required to reload the buffer memory, the converter can be used to service some other device.

Card motion stops if the converter does not unload the buffer memory within 1.5 ms after the buffer is loaded.

If a Read operation unloads only a portion of memory and then terminates, the next card immediately enters memory.

SORTING

A special function code (Set Gate Card) permits a limited Sorting operation. As cards are read, they normally flow to the primary stacker. Each time the Set Gate Card code is received, the reader diverts the current card to the secondary stacker.

PARITY

All data exchanged between the controller and converter is checked for parity.

Parity Error in Connect Code

The controller checks a Connect code sent from the converter for correct parity. If a parity error is present, the controller does not connect, and Parity Error indicators on all equipments cabled to the controller light. A 6681 Function Master Clear must be executed before the controller can proceed with another operation.

Parity Error in Function Code

If a parity error occurs in a function code, a Parity Error indicator on the controller lights and the controller sends a Parity Error signal to the converter. The controller does not execute the function. This signal must be cleared by a 6681 Function Master Clear before the controller can proceed with another operation.

INTERRUPT

An interrupt feature enables the card reader system to notify the converter when it can start an operation, when it has completed an operation, or when an abnormal condition makes further operation impossible.

The following interrupt conditions can be selected by function codes:

1) Interrupt on Ready and Not Busy
2) Interrupt on End of Operation
3) Interrupt on Abnormal End of Operation

The section on function codes defines each of these conditions.

When one of the selected interrupt conditions occurs, the controller sends an Interrupt signal to the converter. This signal can be detected by a 6681 Converter Status Function code (1200).

An Interrupt signal remains on the line until cleared by a 6681 Function Master Clear, reselection of the interrupt condition (function code), or release of the interrupt condition (function code).

The card reader system transmits the Interrupt signal to the converter on one of eight interrupt lines. The setting of the eight-position Equipment Number switch on the controller determines which line is used. For example, if the switch is set to 4, the Interrupt signal goes out on line 4. A 6681 Converter Status Function Code (1200) can identify which of several equipments attached to a data channel sends an interrupt by inspecting the eight interrupt lines.

PROGRAMMING

CODES

Table 2 lists all the codes applicable to the 3447 and 3659 Controllers. A detailed description of each code follows the table.

TABLE 2. 3447/3649 CARD READER CODES

Connect Code	
Connect Reader	N000*
Function Codes	
Release and Disconnect	0000
Negate Hollerith to Internal BCD Conversion	0001
Release Negate Hollerith to Internal BCD Conversion	0002
Set Gate Card	0004
Clear	0005
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
Status Reply Codes	
Ready	XXX1
Busy	XXX2
Binary Card	XXX4
File Card	XX1X
Fail to Feed or Stacker Full or Jam	XX2X
Input Tray Empty	XX4X
End of File	X1XX
Interrupt on Ready and Not Busy	X2XX
Interrupt on End of Operation	X4XX
Interrupt on Abnormal End of Operation	1XXX
Read Compare or Preread Error	2XXX
Reserved (by other converter)**	4XXX

*N = equipment number of controller
**3649 Controller only

Connect Code

The card reader system must be connected to a converter before it responds to a function code or input operation. A Connect code (N000), transmitted via an appropriate 6681 function code*, connects the reader system to the converter issuing the code. The N portion of the code must match the setting of the eight-position Equipment Number switch. (On the 3649 Controller, there are two Equipment Number switches, one for each converter.) When the controller connects, it sends a Reply signal** to the converter.

A Connect code that does not match the Equipment Number switch setting disconnects the controller if previously connected.

The 3649 Controller contains a channel reservation feature that prevents interference between the two converters. When the 3649 Controller connects, a reservation is established for the connecting converter. This reservation remains in effect even if the converter disconnects the 3649 Controller by connecting another device. A reservation can be cleared only by a 6681 Function Master Clear or a Release and Disconnect function code (0000) sent from the reserving converter.

If a converter attempts to connect the 3649 Controller while it is reserved by the other converter, the 3649 Controller generates a Reject signal.**

Even though a Connect operation results in a Reject, the 3649 Controller enables status information to the rejected converter so that the reason for the Reject can be determined.

If for some reason a controller fails to return either a Reply or Reject, the converter generates an Internal Reject after 100 usec. This signal acts the same as a Reject from an external device.

Connect Reader (N000)

This code connects the card reader system to the converter that issues the codes. The N portion of the code must match the setting of the Equipment Number switch.

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*See 6681 Converter function codes under Connect (Modes I and II).

**A Reply or a Reject signal tells the 6681 Converter to send an Inactive signal to the processor. A 6681 Converter Status Request (1200) is used to determine which of these signals was returned to the converter.

Function Codes

Function codes set up or clear various operating conditions in the reader system. Table 2 lists all the function codes applicable to the 3447 and 3649 Controllers.

Function codes are transmitted to the controller via appropriate 6681 function codes. When the central processor executes a function instruction, the selected converter sends the function code to all attached devices, but only the connected device responds.

The 3447 Controller responds to all function codes by returning a Reply signal.* The 3649 Controller can accept certain function codes only when it is Not Busy. If it accepts a code, it returns a Reply signal. If the 3649 Controller cannot accept a code, it returns a Reject signal.*

Any codes not listed in Table 2 are do-nothing codes. The controller returns a Reply in response to such codes, but no action follows.

If for any reason the controller fails to return either a Reply or Reject, the converter generates an Internal Reject after 100 usec.

Release and Disconnect (0000)

This code disconnects the control and clears an existing reservation. All interrupt selections and the Negate BCD to Hollerith selection are cleared. When Busy, the 3649 Controller rejects this code. The 3447 Controller accepts this code at any time.

Negate Hollerith to Internal BCD Conversion (0001)

Release Negate Hollerith to Internal BCD Conversion (0002)

Normally, the controller performs a Hollerith to internal BCD conversion on all cards except those cards flagged as binary by punches in rows 7 and 9 in column 1. Code 0001 eliminates this conversion so that all cards are treated as binary cards. Code 0002 returns the controller to the normal Hollerith to internal BCD mode.

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*A Reply or a Reject signal tells the 6681 Converter to send an Inactive signal to the processor. A 6681 Converter Status Request (1200) is used to determine which of these signals was returned to the converter.

Set Gate Card (0004)

This code allows the reader to do a limited Card Sorting operation. The selected cards are directed to the secondary stacker. The code must be given for each card that is to be gated and must arrive within 1.5 ms after the last column of the selected card has been read.

Clear (0005)

This code clears any interrupt selection, Interrupt signal, or negate condition. It does not release a reservation.

Select Interrupt on Ready and Not Busy (0020)

This code conditions the reader system to send an Interrupt signal whenever data is available in the buffer memory for input and the converter has not initiated a Read operation.

Release Interrupt on Ready and Not Busy (0021)

This code inhibits interrupt on Ready and Not Busy. It also clears the Interrupt signal when caused by the Ready and Not Busy condition.

Select Interrupt on End of Operation (0022)

This code conditions the reader system to send an Interrupt signal whenever:

1) The converter terminates a Read operation, and
2) The reader system becomes Not Ready.

Release Interrupt on End of Operation (0023)

This code inhibits Interrupt on End of Operation. It also clears the Interrupt signal when caused by an end of operation.

Select Interrupt on Abnormal End of Operation (0024)

This code conditions the reader system to send an Interrupt signal when one of the following conditions occurs:

1) Stacker full or jammed,
2) Input tray empty,
3) Feed failure,
4) Compare or preread error (malfunctions),
5) The AUTO/MAN switch is changed to the MAN position, or
6) A file card (punches in rows 7 and 8 in column 1) is read.

Any of the first five conditions disable the device. The condition must be corrected before Read operations can resume.

Any of the first five conditions cause the reader to become Not Ready. Thus, Interrupt on End of Operation may occur along with Interrupt on Abnormal End of Operation.

Release Interrupt on Abnormal End of Operation (0025)

This code inhibits Interrupt on Abnormal End of Operation. It also clears the Interrupt signal when caused by an abnormal condition.

Status Reply Codes

Various operating conditions in the reader system are indicated to the converter on the 12 status lines. Each line is 1 bit of a 12-bit binary quantity. This information can be sensed by means of a 6681 Equipment Status Request (1300) whenever the reader system is connected. Table 2 lists the status conditions. If two or more conditions exist simultaneously, the Status Reply is the sum of the individual codes.

Three of the status lines indicate the three conditions that can cause the controller to send an Interrupt signal. Thus, the status feature can be used to identify the condition causing an interrupt.

Ready (XXX1)—Bit 0

The reader system becomes Ready when the first card has been loaded into memory and remains Ready throughout Read operations. This condition drops when one of the following abnormal conditions occurs:

1) Stacker full or jammed,
2) Input tray empty,
3) Compare or preread error,
4) The AUTO/MAN switch is changed to the MAN position, or
5) Feed failure.

These conditions also cause Interrupt on End of Operation and Interrupt on Abnormal End of Operation if selected.

Busy (XXX2)—Bit 1

The Reader system is busy:

1) Whenever a card is being entered into the buffer memory.
2) Whenever the Data Channel is reading data from the buffer memory.

The reader system becomes Not Busy upon either a normal or Abnormal End of Operation.

Binary Card (XXX4)—Bit 2

The presence of punches in rows 7 and 9 in column 1 on a card flags a binary card. The read station senses information in this column when loading memory. Bit 2 is present after card column one has been read.

File Card (XX1X)—Bit 3

This condition exists when a card containing a punch in rows 7 and 8 in column 1 of a Hollerith card is detected. This code is not generated when the Negate Hollerith to Internal BCD mode is in effect. The file card status bit is cleared by Negate Hollerith to Internal BCD Conversion (0001), Clear (0005), or reinitiating a Read operation. The controller also generates an Abnormal End of Operation interrupt after reading a file card if this interrupt condition has been selected.

Fail to Feed or Stacker Full or Jam (XX2X)—Bit 4

Input Tray Empty (XX4X)—Bit 5

These status conditions are abnormal conditions and are self-explanatory.

End of File (X1XX)—Bit 6

This status bit is "1" when the input tray is empty and buffer memory unloaded if the END OF FILE switch is on. When the input tray does not contain the last card of a file, the switch should be off to inhibit this status bit.

Interrupt on Ready and Not Busy (X2XX)—Bit 7

This bit indicates that Interrupt on Ready and Not Busy was selected and that this condition now exists.

Interrupt on End of Operation (X4XX)—Bit 8

This bit indicates that Interrupt on End of Operation was selected and that this condition now exists.

Interrupt on Abnormal End of Operation (1XXX)—Bit 9

This bit indicates that Interrupt on Abnormal End of Operation was selected and that one of the abnormal conditions now exists.

Read Compare or Preread Error (2XXX)—Bit 10

Bit 10 indicates that either a comparison error was detected during the transfer of card information to memory or a read amplifier was not functioning properly prior to reading the information from the card to memory.

Reserved (by other converter) (4XXX)—Bit 11

This code indicates that the reader is reserved by the other converter (3649 Controller only).

PROGRAMMING CONSIDERATIONS

Programming Procedure

A typical order of steps in programming the reader system is:

1) Clear (by 6681 Function Master Clear or Dead Start Master Clear),
2) Connect,
3) Function (select interrupts and operating mode),
4) Initiate Read operation, and
5) Copy Status when End of Operation interrupt occurs to determine reason for end of operation.

Card Cycle Timing

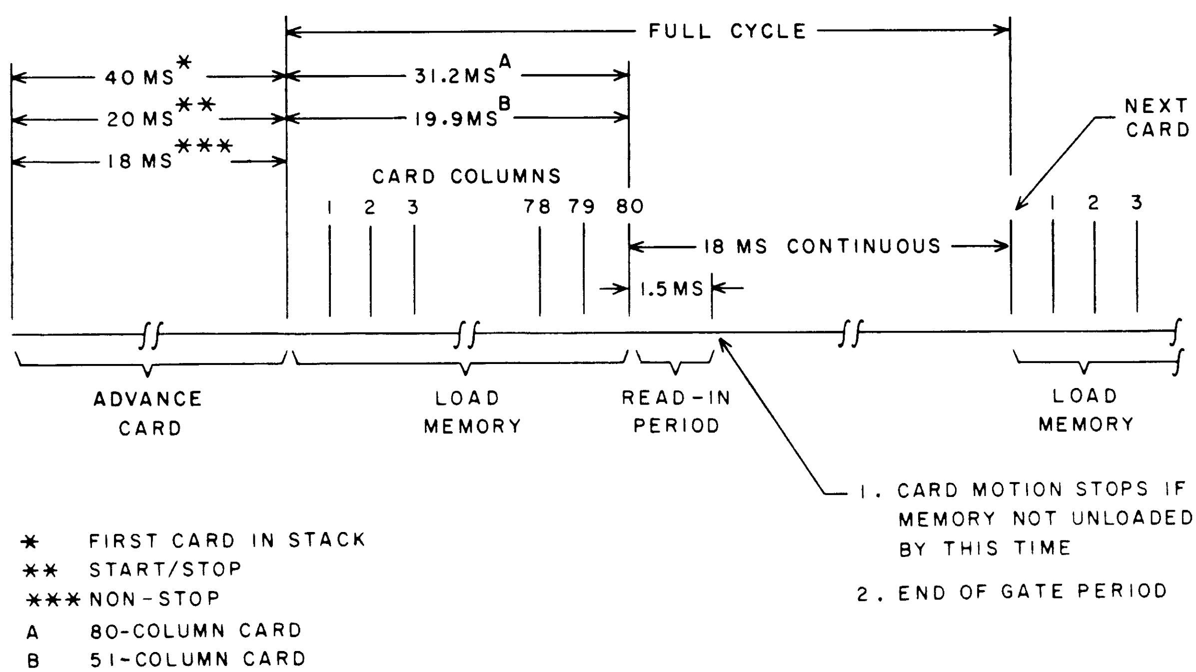

Figure 2. Card Cycle Timing

Figure 2 shows the timing for one card cycle. The converter need be connected to the reader system only while the contents of the buffer memory is read-in. As soon as the converter has unloaded buffer memory, the reader automatically enters the next card into memory. During the advance and load periods, the converter can disconnect from the reader system to service some other device.

After a card has been entered into memory, the converter must complete reading in this data within 1.5 ms or card motion stops. Unloading the memory requires a minimum of 384 usec for 80-column cards and 245 usec for 51-column cards.

When a card has been loaded into memory, the reader system becomes Not Busy if the converter does not begin a Read operation. In this case, the controller generates an interrupt if Interrupt on Ready and Not Busy has been selected.

MANUAL OPERATION

SWITCHES AND INDICATORS

Switches and Indicators on Card Reader

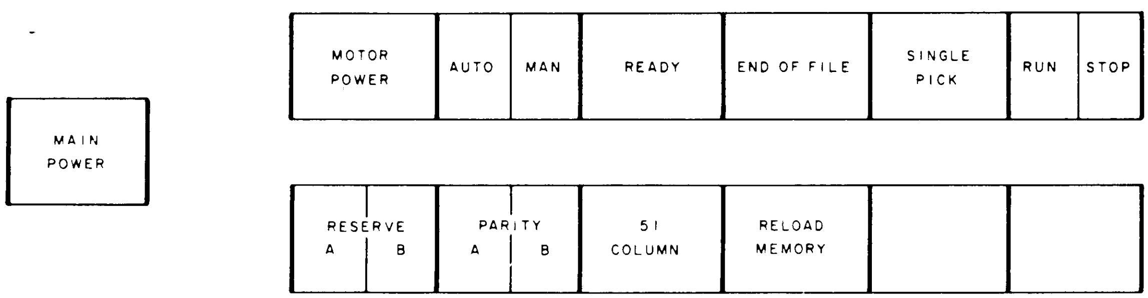

Figure 3. 3649 Card Reader Switches and Indicators

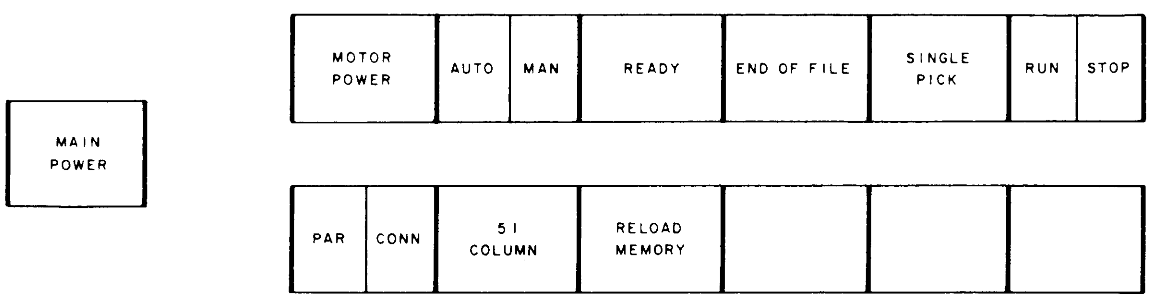

Figure 4. 3447 Card Reader Switches and Indicators

MAIN POWER Switch/Indicator: This switch controls all primary power and turns on the photocell light source. It is lighted when power is on.

MOTOR POWER Switch/Indicator: This switch controls power to the drive motors, the vacuum-pressure system, and the hopper-stacker vibrators. It is lighted when power is on.

AUTO/MAN Switch/Indicator: This two-position switch selects manual- or program-controlled modes of operation. Changing switch position to MAN drops the Ready status bit. The switch must be in the AUTO position when the reader system is used for computer input/output operations.

READY Switch/Indicator: This switch activates the reader if:

1) Input tray not empty,
2) No error conditions exist in the unit, or
3) Primary and secondary stackers are not full.

The switch lights to indicate the Ready condition. When the switch is pressed the first card is read into buffer memory. Thereafter, the reader system is under program control.

END OF FILE Switch/Indicator: Pressing this switch enables the reader system to generate an End of File status bit following the transmission of the data from the last card in the input tray. It is lighted when set.

SINGLE PICK Switch: This switch allows a single card to be cycled through the reader when the AUTO/MAN switch is in the MAN position. It does not light.

RUN/STOP Switch/Indicator: This switch allows manual control of card feed when the AUTO/MAN switch is in the MAN position. The set side is lighted.

RESERVE A/B Indicator*: This indicator lights if either of the associated converters is reserving the read station. The side corresponding to the reserving converter is lighted.

PARITY A/B Indicator**: This indicator indicates the converter on which a parity error occurred during the transmission of a Connect or function code.

51-COLUMN Switch/Indicator: Pressing this switch allows reading short (51-column) cards. It is lighted when set for 51-column card reading.

RELOAD MEMORY Switch: Pressing this switch feeds data from a new card into memory when the AUTO/MAN switch is in the AUTO position. It does not light.

Switches and Indicators on Controller

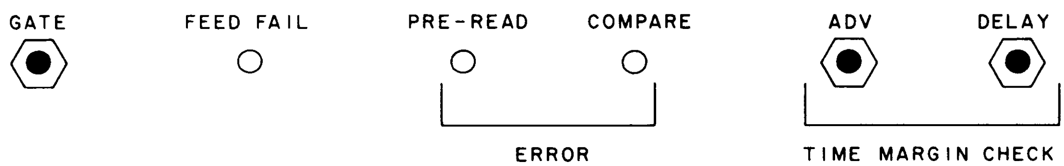

Figure 5. Controller Switches and Indicators

Equipment Number Switch***: On the 3447 Controller, there is one Equipment Number switch. On the 3649 Controller, there are two, one for each connect-reserve control. This eight-position switch (0-7) determines the equipment number (corresponds to upper 3 bits of Connect code) of a control. It also determines on which one of eight interrupt lines the control sends an Interrupt signal.

GATE Switch: This switch is for use by maintenance personnel only.

FEED FAIL Indicator: This indicator indicates a feed failure.

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*3649 Controller only.

**On the card reader control panel which is used with the 3447 Controller, this indicator is replaced by a PAR/CONN indicator. If the PAR side is lighted, a parity error occurred during transmission of a Connect or function code. If the CONN side is lighted, the reader system is connected to the converter.

***Located on the logic panel which is mounted on the back side of the 405 Card Reader cabinet.

PRE-READ ERROR Indicator: This indicator indicates an error in photocell logic. If the cards have not been multilated, call maintenance personnel for a read circuitry checkout.

COMPARE ERROR Indicator: This indicator indicates the read and checkout stations each gave a different "hole" count. Reread the card.

TIME MARGIN CHECK Switches: These two switches are for use by maintenance personnel only.

OPERATING PROCEDURE

The following steps are necessary to prepare the reader system for use:

1) Turn Equipment Number switch to desired position,
2) Place cards in input tray (refer to 405 Card Reader Loading Procedures, Supplementary Information, Card Equipment Section for card load procedure),
3) Press MAIN POWER switch on,
4) Press MOTOR POWER switch on,
5) Press AUTO/MAN switch to AUTO,
6) Press END OF FILE switch off unless the hopper load is a complete file,
7) Press READY switch (one card feeds through reader to initially load buffer memory),
8) Issue Master Clear from the computer, and
9) The READY switch should be lighted, indicating the controller is now Ready.

CAUTION

Cards may not be removed from the secondary stacker while the card reader is operating. With care, cards may be added to the input tray or removed from the primary stacker during operation.

SUPPLEMENTARY INFORMATION
CARD EQUIPMENT

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FIGURES

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SUPPLEMENTARY INFORMATION
CARD EQUIPMENT

This section contains information common to several of the card handling equipments as follows:

1) Card format and BCD/Hollerith codes,
2) 405 Card Reader loading procedure, and
3) 415 and 523 Punch switches and indicators.

PUNCHED CARD FORMAT AND CODES

A punched card contains either 51 or 80 12-bit columns arranged as in Figure 1. A punch in any bit position is a logical "1". Cards may be either Hollerith or binary format. In Hollerith format, each column contains a combination of punches that specifies one alphanumeric character. (Table 1 lists the Hollerith codes.) In binary format, each card column is a 12-bit binary quantity.

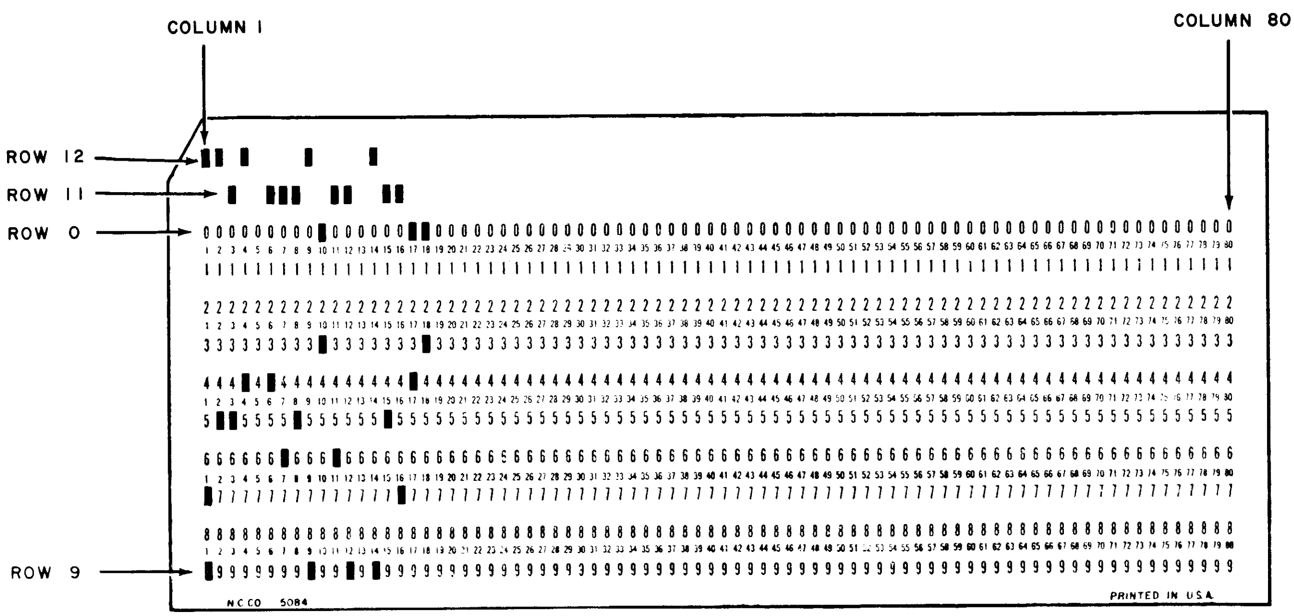


Figure 1. Punch Card Format

TABLE 1. BCD/HOLLERITH CARD CODES

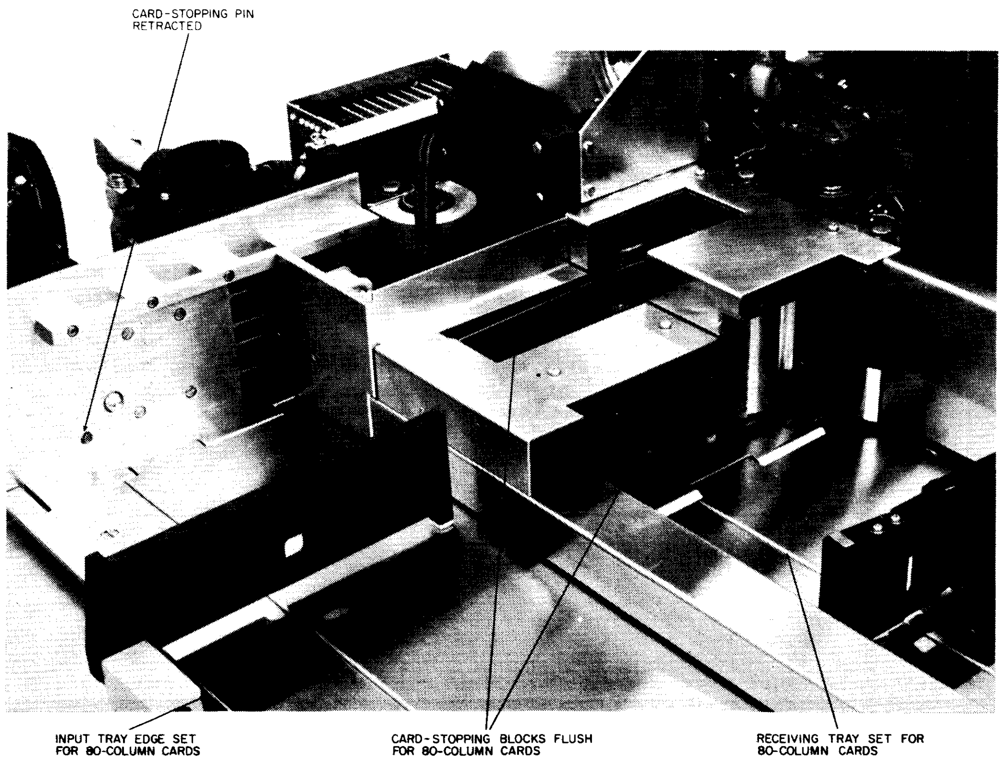
Internal BCD Code	Char	Hollerith Code	Internal BCD Code	Char	Hollerith Code
00	0	0	40	(minus)-	11
01	1	1	41	J	11, 1
02	2	2	42	K	11, 2
03	3	3	43	L	11, 3
04	4	4	44	M	11, 4
05	5	5	45	N	11, 5
06	6	6	46	O	11, 6
07	7	7	47	P	11, 7
10	8	8	50	Q	11, 8
11	9	9	51	R	11, 9
12		8, 2	52	-0	11, 0
13	=	8, 3	53	$	11, 8, 3
14	(dash) -	8, 4	54	*	11, 8, 4
15		8, 5	55		11, 8, 5
16		8, 6	56		11, 8, 6
17		8, 7	57		11, 8, 7
20	+	12	60	(Space)	Blank
21	A	12, 1	61	/	0, 1
22	B	12, 2	62	S	0, 2
23	C	12, 3	63	T	0, 3
24	D	12, 4	64	U	0, 4
25	E	12, 5	65	V	0, 5
26	F	12, 6	66	W	0, 6
27	G	12, 7	67	X	0, 7
30	H	12, 8	70	Y	0, 8
31	I	12, 9	71	Z	0, 9
32	+0	12, 0	72		0, 8, 2
33	.	12, 8, 3	73	,	0, 8, 3
34	)	12, 8, 4	74	(	0, 8, 4
35		12, 8, 5	75		0, 8, 5
36		12, 8, 6	76		0, 8, 6
37		12, 8, 7	77		0, 8, 7

405 CARD READER LOADING PROCEDURES

1) Set guide edge of supply tray and receiving tray for length of card being used. Narrow half of each tray may be removed, turned end-for-end and reassembled as necessary.

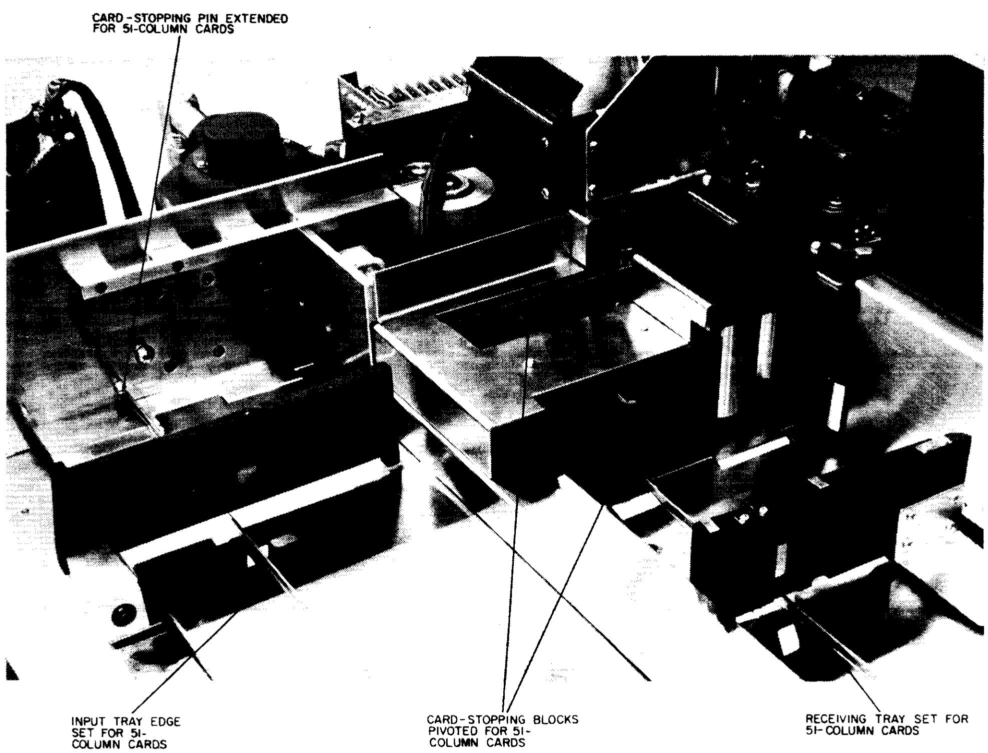
2) Load cards into supply tray, placing column 1 at right as cards face entrance of read station.

3) Check input wall of secondary and main receiving trays if 80-column (long) cards are used. Hinged card-stopping blocks should be positioned so that a flush surface is formed at each input wall (Figure 2). The hinged block assemblies must be pivoted to protrude from the wall surfaces of each receiving tray if 51-column (short) cards are to be used (Figure 3).



1594

Figure 2. Card Trays Set for 80-Column Cards



1595

Figure 3. Card Trays Set for 51-Column Cards

4) At input tray, set card-stopping pin to protrude from the face plate if short cards are to be used; turn pin clockwise to form flush wall if long cards are being used (Figures 2 and 3).

5) Place equipment in manual mode of operation by pressing AUTO/MAN switch (MAN indicator on).

6) STOP indicator should be on; if not, press RUN/STOP switch.

7) Press MOTOR POWER switch; indicator should light.

8) Press READY switch.

9) Press SINGLE PICK switch to initiate transport of single card from supply tray to receiving tray. If difficulty is experienced in performing this operation (failure to pick single card), check input throat for possible obstruction.

10) Remove card from receiving tray or secondary bin and replace in supply tray.

11) Press AUTO/MAN switch to return unit to Auto mode.

11) Press AUTO/MAN switch to return unit to Auto mode.

415 CARD PUNCH SWITCHES AND INDICATORS

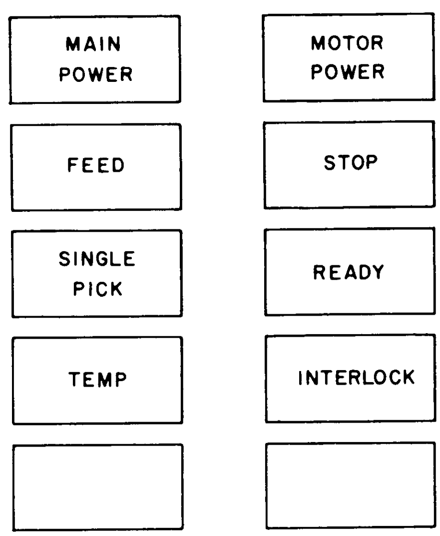


Figure 4. 415 Punch Switches and Indicators

MAIN POWER Switch/Indicator

This switch applies power to the cooling fans and the power supplies. It is lighted when power is on.

MOTOR POWER Switch/Indicator

This switch applies power to the punch motor. It is lighted when power is on.

FEED Indicator

This indicator is lighted when a card jam exists.

STOP Switch/Indicator

This switch causes the punch to become Not Ready. It is lighted when the punch is in a Not Ready condition.

SINGLE PICK Switch/Indicator

This switch advances cards one cycle. It is lighted until the advance has been completed.

READY Switch/Indicator

This switch clears punch logic and puts the punch in Automatic mode. It is lighted when punch is in Ready condition.

TEMPERATURE Indicator

This indicator is lighted whenever the card punch temperature exceeds 100^{o} F.

INTERLOCK Indicator

This indicator is lighted when the head panel, hood panel, or right door is open.

523 CARD PUNCH SWITCHES AND INDICATORS

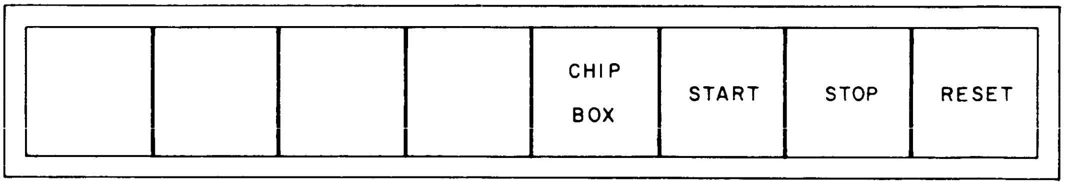


Figure 5. 523 Punch Switches and Indicators

ON/OFF Switch

This switch applies power to the punch. It is located on the end panel on the right.

START Switch

This momentary-contact switch causes the cards to advance one cycle. From an initial load, pressing this switch twice advances cards into all stations. At the end of the operation, pressing switch twice unloads punched cards.

STOP Switch

This switch causes the punch to become Not Ready.

RESET Switch

This switch causes the punch to become Ready following a reload or unload. It does not advance the cards.

CHIP BOX Indicator

This indicator is lighted whenever the chip box is full.

3256-A/3659-A LINE PRINTER CONTROLLERS

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3256-A/3659-A LINE PRINTER CONTROLLERS

The CONTROL DATA* 3256-A and 3659-A Line Printer Controllers facilitate printing of data received from 6681 Data Channel Converters. Either controller may be used to operate the CONTROL DATA 501 Printer (1, 000 lines per minute) or the 505 Printer (500 lines per minute). (See Figure 1.)

This section describes the disassembly of data received from the converter. It also describes the Connect, function, and status codes and provides pertinent programming information.

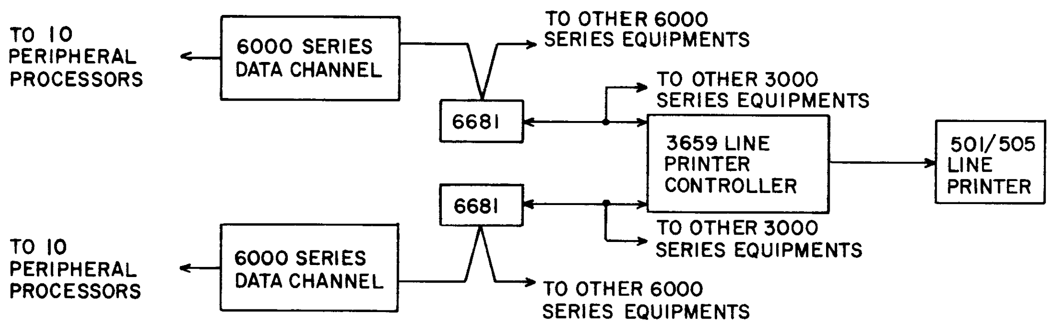

Figure 1. Typical Configuration

*Registered trademark of Control Data Corporation

FUNCTIONAL DESCRIPTION

3256 CONTROLLER

The 3256 Controller has one write control. This control can be physically attached* to one 6681 Converter. Thus, the 3256 Controller can be connected at any time without the possibility of a connect reject.

A special error checking option may be installed in the 3256 Controller. See 3256 Error Checking Option for programming information.

3659 CONTROLLER

The 3659 Controller has two write controls. Each control can be physically attached to one 6681 Converter. Either converter, through its associated control, can communicate with the printer provided it is not in use or reserved by the other converter.

The converters serving the 3659 Controller need not be associated with the same central processor.

With the preceding exceptions, the following information is applicable to both controllers.

BUFFER MEMORY

These controllers store one line of data (up to 136 characters) in a magnetic core memory until the data is printed. This feature permits the converter to load one line of characters into the memory at high speed. The converter can then disconnect to service another device while the slower printing operation is being performed.

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*Though a control may be physically attached to a converter, it does not respond to Function or Input/Output instructions until it has been connected by a Connect code.

PRINT OPERATION

The printer system (controller plus basic printer) disassembles a series of 12-bit bytes from the converter into 6-bit BCD codes and prints a character corresponding to each code.

In a printed line, the character designated by the upper 6 bits of a byte precedes the character corresponding to the lower 6 bits. Each line of print contains up to 136 characters; thus, 68 bytes are required to form a full line.

The controller forms each line of print in a buffer memory. After 68 bytes have been received, the controller temporarily stops accepting data and begins the actual print operation. When the line has been printed, the controller starts to form the next line in the buffer memory. After a line is printed, the paper is automatically advanced one space if no other spacing operation is programmed.

If an Inactive signal terminates an output operation before a full line is formed, the partial line is printed. A new output operation starts a new line.

PAPER ADVANCE

The printer system has a very flexible paper advancing system that is controlled by function codes. Certain function codes, such as Single Space and Double Space, cause spacing operations to occur directly. Other codes turn spacing control over to the printer's format tape reader. If no spacing operations are programmed by means of the function codes, the printer automatically single spaces after each line is printed. The eight-level format tape reader can be used to provide any page format desired. A loop of punched tape is the controlling medium. Loops of various lengths can be used to provide different page lengths.

A tape loop contains one frame for each line of the page format. During any spacing operation, the format tape advances one frame each time the paper advances one line. Paper spacing can be programmed to begin automatically after a line is printed or upon receipt of certain function codes. Once a spacing operation begins, the paper (and the tape loop) advances until a hole is detected in a preselected position on the tape.

There are two main types of spacing codes:

1) Preprint spacing codes, and
2) Postprint spacing codes.

A preprint spacing code initiates a one-time spacing operation. An example of these codes is Select Format Tape Level 1 for Preprint Spacing (0021). This code causes the paper to advance until a hole is detected in the first level of the tape loop.

Postprint spacing codes set up automatic spacing operations which occur after each line is printed. These codes remain in effect until cleared. An example of these codes is Select Format Tape Level 5 for Postprint Spacing (0005). When this code is in effect, a spacing operation begins after each line is printed. The paper advances until a hole is detected in the fifth level of the tape loop.

Tape levels one through six are used to control Preprint and Postprint Spacing operations. A punch in level seven is used to designate the last line of a form. A function code is available that advances the paper to the last line. The top of the form is designated by a punch in level eight. The printer can be programmed to advance paper until the reader senses a hole in level eight.

The section on function codes following Table 1 describes each of the paper spacing codes. Preparation of the format tape is discussed in the Manual Operation section.

PRINTING RATE

A printer system using the 501 Printer can operate at a maximum rate of 1,000 lines per minute. The 505 Printer can print at rates up to 500 lines per minute. To maintain maximum printing rates for either printer, certain programming restrictions must be observed. These restrictions are outlined in the Programming Considerations section.

PARITY

Connect codes, function codes, and data are transmitted between the converter 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 converter. Instead, a red indicator lights in the Equipment Number switch of each equipment detecting the error. These parity error conditions must be cleared by a 6681 Function Master Clear prior to a new connect attempt.

Parity Error in a Function Code

If a parity error is detected, the requested functions are not performed, a Parity Error signal is returned to the converter, and a red indicator in the Equipment Number switch lights. Since neither a Reject or a Reply is returned to the converter, it generates an Internal Reject after a wait of 100 usec. These parity error indications must be cleared by a 6681 Function 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 sends both a Reply and a Parity Error signal to the converter. A red indicator in the Equipment Number switch also lights.

The data is stored in printer memory, but not printed. Three options are available at this point.

1) A 6681 Function Master Clear may be executed. In this case, the control must be reconnected, the appropriate function reselected, and the line of data transmitted to the printer a second time.

2) The STOP switch and then the START switch may be pressed. In this case, only the line of data in printer memory is printed.

*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 6681 Function Master Clear is questionable.

3) The PARITY ERROR OVERRIDE switch may be pressed. In this mode, printing continues without regard to parity errors. In the last two cases, the validity of the data printed is questionable.

Parity error indications are cleared by pressing the STOP and START switches in sequence, or a 6681 Function Master Clear.

INTERRUPTS

The controllers can be programmed to send an Interrupt signal to the converter when any one of the conditions specified by the three interrupts materializes. A Select Interrupt code permits the controller to consider as a group* several of the operating conditions which may occur. 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 converter. 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 to the converter currently connected to or reserving the equipment or, in the case of the 3256 Controller, via the physically connected converter whether or not the converter is currently servicing 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 five. Since each equipment attached to a converter has a unique equipment number, each uses a different interrupt line. A 6681 Channel Status Request (1200) can identify the equipment sending the Interrupt signal by inspecting the interrupt lines.

3256 ERROR CHECKING OPTION

An optional error checking feature is available for the 3256 Controller. This option automatically checks each line printed for:

1) A positive printout of a character** in each column programmed for printing,

---

*See explanation of function codes following Table 1 for a list of these conditions and for a breakdown of the three possible groups.

**This check does not assure that the correct character was printed.

2) An erroneous printout of a character in a column not programmed for printing, and

3) A printout of more than one character per column (overprint).

If a print error is detected, the following occurs:

1) A "1" is sent on the error status line (status bit 10), and

2) The controller sends an Interrupt signal if Interrupt on Abnormal End of Operation has been selected.

PROGRAMMING

CODES

Tables 1 and 2 list the codes applicable to the printer system. Connect, function and status reply codes are defined in the sections following Table 1. In all discussion of codes, bit 0 is the rightmost bit.

TABLE 1. 3256/3659 LINE PRINTER CONTROLLER CODES

Connect Codes	
Connect Printer	N000*
Function Codes	
Release and Disconnect	0000, 0040
Single Space	0001
Double Space	0002
Advance to Last Line	0003
Page Eject	0004
Auto Page Eject	0005
Suppress Space	0006
Clear Format Selection	0010
Select Format Tape Level 1 for Postprint Spacing	0011
Select Level 2	0012
Select Level 3	0013
Select Level 4	0014
Select Level 5	0015
Select Level 6	0016
Select Preprint Spacing	0020
Select Format Tape Level 1 for Preprint Spacing	0021
Select Level 2	0022
Select Level 3	0023
Select Level 4	0024
Select Level 5	0025
Select Level 6	0026
Select Interrupt on Ready and Not Busy	0030
Release Interrupt on Ready and Not Busy	0031
Select Interrupt on End of Operation	0032
Release Interrupt on End of Operation	0033
Select Interrupt on Abnormal End of Operation	0034
Release Interrupt on Abnormal End of Operation	0035
Status Reply Codes	
Ready	XXX1
Busy	XXX2
Paper Out	XX1X
Last Line of Form	XX2X
Interrupt on Ready and Not Busy	X2XX
Interrupt on End of Operation	X4XX
Interrupt on Abnormal End of Operation	1XXX
Error**	2XXX
Reserved (by other converter)***	4XXX

*N = equipment number of the control
**From 3256 Controllers equipped with the error checking option only
***3659 Controller only

Connect Code

A control must be connected to its converter before it can respond to either a 3256/3659 function code or a Write instruction. The connection is accomplished by transmitting the Connect code (N000) to the equipment by an appropriate 6681 function code.* Each control examines every Connect code transmitted from its attached converter. A control connects and returns a Reply** to the converter if:

1) The printer is not connected to or reserved by the other converter,
2) The N portion of the Connect code matches the setting of the Equipment Number switch, and
3) A transmission parity error is not detected.

If the 3659 Controller is connected to or reserved by another converter or if a Write operation is still in process, a Reject signal** is returned to the converter requesting the connect. Equipment status is also made available to that converter so that the cause for the reject may be determined.

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 converter from this equipment. Equipment status is not made available to the converter. If the controller is already connected, it automatically disconnects. It does, however, remain reserved for that converter until released, cleared, or given a new equipment number. If neither a Reply nor a Reject is returned to the converter from any of its attached equipments within 100 usec, it generates an Internal Reject.

The 3659 Controller contains a channel reservation feature. It may be unconnected and unreserved, connected to a converter, or reserved by a converter.

An unconnected and unreserved printer may be connected by any converter serving the controller. Once a converter is connected to a particular unit (i.e., a communication path is established), the printer remains reserved for that converter even though the converter disconnects the printer by connecting (or attempting to connect) to another unit or equipment. Once the printer is reserved by a converter, no other converter has

*See 6681 Converter function codes under Connect (Modes I and II).

**A Reply or a Reject signal tells the 6681 Converter to send an Inactive signal to the processor. A 6681 Converter Status Request code (1200) is used to determine which of these signals was returned to the converter.

access to it. Since a 6681 Function Master Clear from the nonreserving channel has no effect on the printer system, care must be taken to release it when it is not essential to the current program. If more than one converter attempts to connect simultaneously, a scanner determines the converter to be connected.

Connect Printer (N000)

This code connects the printer. N must match setting of Equipment Number switch.

Function Codes

3256/3659 function codes are used to prepare the connected control and/or printer for an output operation (they have no effect on unconnected controls). Function codes are transmitted to the control by appropriate 6681 function codes. (See Table 1 for a complete list of 3256/3659 function codes.)

There are two classifications of function codes: operating and nonoperating.

Operating codes*: These codes cause paper motion and are divided into Preprint and Postprint codes.

Preprint operating codes initiate paper motion, cause the control to become Busy, and are self-clearing. These codes include: Single Space, Double Space, Advance to Last Line, Page Eject, and Select Format Tape Level L for Preprint Spacing.

Postprint codes do not initiate paper motion. Instead, paper motion is initiated automatically following the printing of a line of data. The postprint codes are Auto Page Eject and Select Format Tape Level L for Postprint Spacing. They may be cleared by the Clear Format Selection code, the Select Format Tape Level L for Preprint Spacing code, a Clear Channel instruction, or a Master Clear.

Nonoperating codes: The remaining codes are considered nonoperating. They are not accepted during a printing operation but are accepted while an operating function is being executed.

*Operating codes cause the controller to become Busy

A control examines only one code at a time. First, it checks for parity errors. If none are found, it returns a Reply provided the function code is legal and the request can be performed. If the code is illegal or if it cannot be performed, a Reject is returned to the converter.

Release and Disconnect (0000, 0040)

These codes which clear the existing connect, reserve, and interrupt selections are effective only if received from the connected converter. Either one is recognized and replied to by the printer immediately upon receipt.

Single Space (0001)

This code advances paper one line. It does not clear Postprint Spacing selections. It is self-clearing.

Double Space (0002)

This code advances paper two lines. It does not clear Postprint Spacing selections. It is self-clearing.

Advance to Last Line (0003)

This code advances paper until a hole is detected in Format Tape Level 7. The last line of the form that may be printed should then be in position for printing. This code does not clear Postprint Spacing selections. It is self-clearing.

Page Eject (0004)

This code advances paper until a hole is detected in Format Tape Level 8. The first line of the new form to be printed should then be in position for printing. This code does not clear Postprint Spacing selections. It is self-clearing.

Auto Page Eject (0005)

This code, together with the detection of a hole in Format Tape Level 7, advances the paper until a hole is detected in Format Tape Level 8. Format Tape Level 7 indicates the last line of the form that may be printed. Format Tape Level 8 indicates the first line of the new form that may be printed. Auto Page Eject takes precedence over all other Postprint Spacing selections.

Suppress Space (0006)

This code suppresses the next Postprint Spacing operation. It is ignored by Preprint Spacing operations, and it is self-clearing.

Clear Format Selection (0010)

This code clears all format selections as well as Auto Page Eject. It then selects Format Tape Level 1 for Postprint Spacing.

Select Format Tape Level L for Postprint Spacing (001L)

These codes cause automatic advancement of paper following each print operation. Advancement continues until a hole is detected in the selected level. The selections are cleared by Clear Format Selection (0010), Select Preprint Spacing (0020), or a 6681 Function Master Clear. L is a number from 1 to 6 designating any one of the lower six tape levels.

Select Preprint Spacing (0020)

This code clears all Postprint Spacing selections except Auto Page Eject. It must be used prior to selecting a tape format level for Preprint Spacing. It does not initiate paper motion.

Select Format Tape Level L for Preprint Spacing (002L)

These codes initiate the advancement of paper. Advancement continues until a hole is detected in the selected level. These selections are self-clearing. L is a number from 1 to 6 designating any one of the lower six levels of the format tape.

Select Interrupt on Ready and Not Busy (0030)

This code causes the control to send an Interrupt signal to the converter when the printer system is Ready and Not Busy (i.e., power is applied, paper is in position, the START switch is lighted, data is not being transmitted to printer memory, and no paper motion is in progress). The control does not reject this code.

Release Interrupt on Ready and Not Busy (0031)

This code clears an Interrupt on Ready and Not Busy selection and the Ready and Not Busy Interrupt signal if it is up. The control does not reject this code.

Select Interrupt on End of Operation (0032)

This code causes the control to send an Interrupt signal to the converter when a line of data has been printed. (Selected postprint paper motion is also initiated at this time.) The code also causes an Interrupt signal to be returned 14 ms after completion of any preprint paper motion if memory has not been reloaded.

If memory is loaded during preprint paper motion, an Interrupt signal is returned following printing of the data only. The control does not reject this code.

Release Interrupt on End of Operation (0033)

This code clears an Interrupt on End of Operation selection and the End of Operation Interrupt signal if it is up. The control does not reject this code.

Select Interrupt on Abnormal End of Operation (0034)

This code causes the control to send an Interrupt signal to the converter when an Abnormal End of Operation occurs. The control rejects this code.

Release Interrupt on Abnormal End of Operation (0035)

This code clears an Interrupt on Abnormal End of Operation selection and the Abnormal End of Operation Interrupt signal if it is up. The control does not reject this code.

Status Reply Codes

Status codes permit the monitoring of several control/unit operating conditions. These codes are made available to the converter over 12 status lines following a connect or a rejected connect attempt. A 6681 Equipment Status Request (1300) makes 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 Reply code is the sum of the individual codes.

Ready (XXX1)—Bit 0

Bit 0 is set when the printer is mechanically Ready.

Busy (XXX2)—Bit 1

Bit 1 is set when data is being printed, paper is being advanced, or memory is being loaded.

Paper Out (XX1X)—Bit 3

Bit 3 is set when there is no paper under the print head.

Last Line of Form (XX2X)—Bit 4

Bit 4 is set when a hole is detected in Format Tape Level 7. This should indicate the last line of the form is in printing position.

Interrupt on Ready and Not Busy (X2XX)—Bit 7

Bit 7 is set if Interrupt on Ready and Not Busy is selected and this condition now exists.

Interrupt on End of Operation (X4XX)—Bit 8

Bit 8 is set if Interrupt on End of Operation is selected and at least one condition specified by the selection exists.

Interrupt on Abnormal End of Operation (1XXX)—Bit 9

Bit 9 is set if Interrupt on Abnormal End of Operation is selected and at least one condition specified by the selection now exists.

Error (2XXX)—Bit 10*

Bit 10 is set when a print error is detected.

*Reserved (by other converter) (4XXX)**—Bit 11*

Bit 11 is set when the printer is reserved by the other converter.

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*From 3256 Controller equipped with error checking option.

**3659 Controller only

TABLE 2. CHARACTERS ARRANGED BY INTERNAL BCD CODES

Internal BCD	External BCD	Character Printed	Internal BCD	External BCD	Character Printed
00	12	0	40	40	- (minus)
01	01	1	41	41	J
02	02	2	42	42	K
03	03	3	43	43	L
04	04	4	44	44	M
05	05	5	45	45	N
06	06	6	46	46	O
07	07	7	47	47	P
10	10	8	50	50	Q
11	11	9	51	51	R
12	00	: (colon)	52	52	$\vee$ (OR)
13	13	= (equals)	53	53	$ (dollar sign)
14	14	≠ (not equal)	54	54	* (asterisk)
15	15	≤ (less than or equal)	55	55	↑ (arrow up)
16	16	% (percent)	56	56	↓ (arrow down)
17	17	[(open bracket)	57	57	> (greater than)
20	60	+ (plus)	60	20	blank
21	61	A	61	21	/ (slash)
22	62	B	62	22	S
23	63	C	63	23	T
24	64	D	64	24	U
25	65	E	65	25	V
26	66	F	66	26	W
27	67	G	67	27	X
30	70	H	70	30	Y
31	71	I	71	31	Z
32	72	< (less than)	72	32	] (closed bracket)
33	73	. (period)	73	33	, (comma)
34	74	) (closed parenthesis)	74	34	((open parenthesis)
35	75	≥ (greater than or equal)	75	35	→ (right arrow)
36	76	¬ (NOT)	76	36	≡ (identity)
37	77	; (semicolon)	77	37	$\wedge$ (AND)

TABLE 3. CHARACTERS ARRANGED BY CHARACTER ROWS

Character Row	Character Printed	Internal BCD	External BCD
1	0	00	12
2	1	01	01
3	2	02	02
4	3	03	03
5	4	04	04
6	5	05	05
7	6	06	06
8	7	07	07
9	8	10	10
10	9	11	11
11	A	21	61
12	B	22	62
13	C	23	63
14	D	24	64
15	E	25	65
16	F	26	66
17	G	27	67
18	H	30	70
20	J	41	41
21	K	42	42
22	L	43	43
23	M	44	44
24	N	45	45
25	O	46	46
26	P	47	47
27	Q	50	50
28	R	51	51
29	S	62	22
30	T	63	23
31	U	64	24
32	V	65	25
33	W	66	26
34	X	67	27
35	Y	70	30
36	Z	71	31
37	. (period)	33	73
38	- (minus)	40	40
39	+ (plus)	20	60
40	= (equals)	13	13
41	((open paren-thesis)	74	34
42	) (closed paren-thesis)	34	74
43	/ (slash)	61	21
44	* (asterisk)	54	54
45	, (comma)	73	33
46	≠ (not equal)	14	14
47	$ (dollar sign)	53	53
48	: (colon)	12	00
49	≤ (less than or equal)	15	15
50	% (percent)	16	16
51	[(open bracket)	17	17
52	] (closed bracket)	72	32
53	→ (right arrow)	75	35
54	≡ (identity)	76	36
55	∧ (AND)	77	37
56	∨ (OR)	52	52
57	¬ (NOT)	36	76
58	↑ (arrow up)	55	55
59	↓ (arrow down)	56	56
60	> (greater than)	57	57
61	< (less than)	32	72
62	≥ (greater than or equal)	35	75
63	; (semicolon)	37	77
64	blank (no character)	60	20

Character Codes

Table 2 lists the printer Character Set and the corresponding codes. Both internal and external BCD codes are shown for each character. Normally, the printer prints according to the internal BCD codes.

Table 3 shows the printer characters in the order that they appear on the printer drum. Table 3 and the rules below under Printing Rate can be used to obtain the maximum printing rates.

PROGRAMMING CONSIDERATIONS

Function Codes - Release and Disconnect (0000 and 0040)

Should either of these two codes be received by the control while a line is being printed, the printing operation continues to completion. This is true even if the other converter connects and issues a 6681 Function Master Clear during this time interval. Since these codes clear existing interrupt selections, the releasing converter does not receive new Interrupt signals. However, should the newly connected converter request interrupts, it receives them when the appropriate conditions occur.

Printing Rate

Maximum printing rate (1, 000 lines per minute for the 501, 500 lines per minute for the 505 and up to 136 characters per line) can be maintained if:

1) The character set is confined to 48 consecutive rows on the printer drum of the 501 and to 56 consecutive rows for the 505.
2) Automatic single spacing is maintained between lines.
3) The data channel begins to load a new line of data into the buffer memory within 11 ms after the End of Operation interrupt is generated at the end of the previous line. The buffer memory can be fully loaded in 3.5 ms.

Table 3 shows the order of characters on the printer drum and aids the programmer in selecting a consecutive row character set. If all 64 characters are used, the 501 printer rate may be reduced to 800 lines per minute with automatic single spacing, and the 505 printer rate, to 444 lines per minute.

MANUAL OPERATION

SWITCHES AND INDICATORS

3256/3659 Switches and Indicators

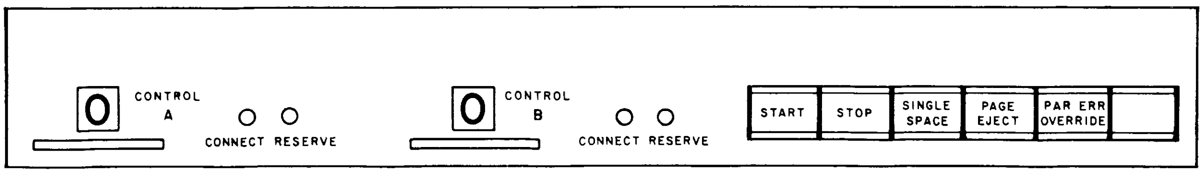

Figure 2. 3659 Controller Switch and Indicator Panel

Equipment Number Switch: An 8-position Equipment Number switch is associated with each 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 used by the equipment.

A white indicator in this switch is lighted whenever power is applied to the control. A red indicator in this switch is lighted when a transmission parity error is detected. The Parity Error indicator is turned off by a 6681 Function Master Clear, or by pressing the STOP and START switches in sequence.

CONNECT Indicators: The CONNECT indicator associated with a control is lighted when the control is connected to its associated converter.

RESERVE Indicators: The RESERVE indicator associated with a control is lighted when the control is reserved by its associated converter.

START Switch: This momentary-contact switch puts the printer under computer control. A white indicator in the switch lights when the printer is Ready.

This switch may also be used to force the completion of a page if the printer has stopped due to a low paper supply. One line is printed each time the switch is pressed. This action may be repeated until a hole is detected in Format Tape Level 8. The START switch is of no further value until the paper supply is replenished. Then it causes printing to continue without a loss of information.

STOP Switch: This momentary-contact switch causes the controller to become Not Ready. If data is being transferred to printer memory when the switch is pressed, the loading continues to completion. No other data is accepted by the control while the switch is lighted.

CAUTION

Turn off the printer before turning off the 3256/3659 Controllers.

SINGLE SPACE Switch: This switch advances the paper one line.

PAGE EJECT Switch: This switch advances the paper until a hole is detected in Format Tape Level 8. The first line of the new form to be printed on should then be in position for printing.

PARITY ERROR OVERRIDE Switch*: This alternate-action switch provides the option of printing or stopping on detection of a data transmission parity error. If the switch is not lighted, operation stops when printer memory is loaded. If it is lighted, printing continues without regard to parity errors.

ERROR OVERRIDE Switch: This alternate-action switch provides the option of printing or stopping on detection of either a parity error or a print error. If the switch is not lighted and either type of error is detected, operation stops when printer memory is loaded. If it is lighted, printing continues without regard to errors.

*This switch is replaced by an ERROR OVERRIDE switch on 3256 Controllers modified for print error checking.

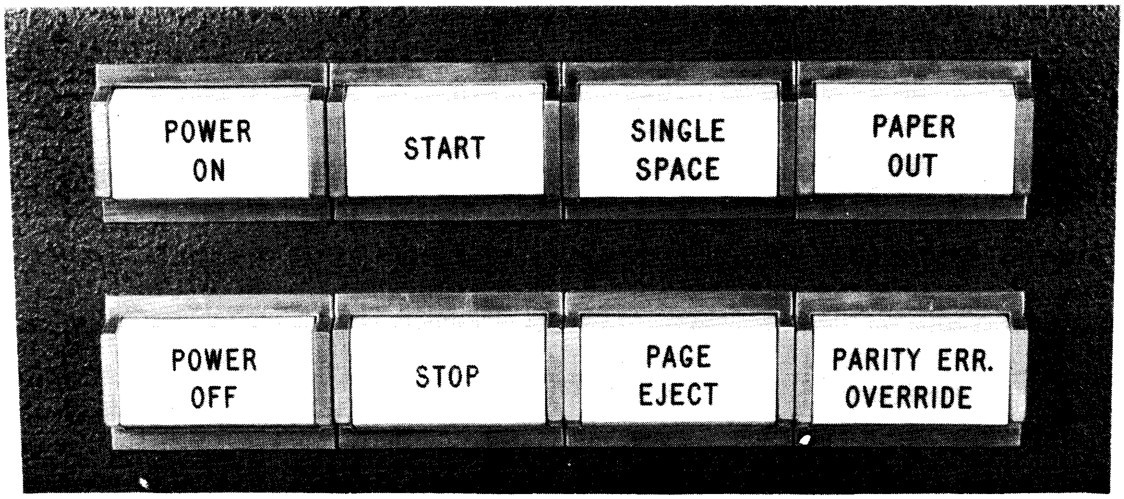

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Figure 3. 501/505 Switch and Indicator Panel

POWER ON Switch/Indicator: This switch applies power to printer. The indicator lights when power is on.

START Switch/Indicator: This switch enables the printing operation and is lighted when the unit is ready to print.

SINGLE SPACE Switch: This switch advances paper one space.

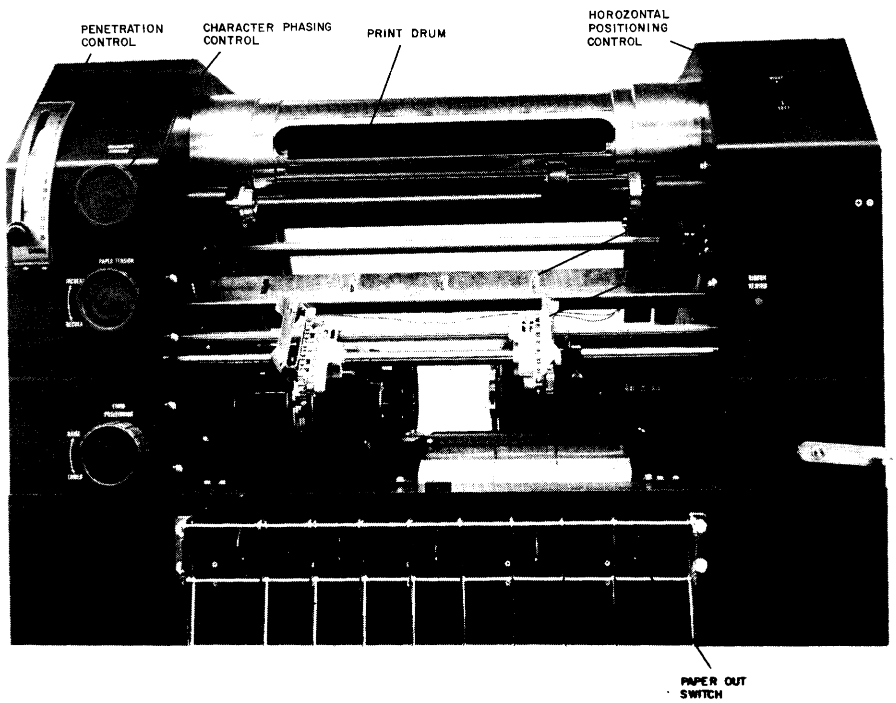
PAPER OUT Indicator: This indicator lights when the paper supply is depleted. The printer will stop.

POWER OFF Switch: This switch removes power to printer.

STOP Switch/Indicator: This switch disables the printing operation. It is lighted when printing is disabled.

PAGE EJECT Switch: This switch advances paper to the top of the next page.

PARITY ERR OVERRIDE Switch/Indicator: This switch permits the printer controller to ignore a parity error. It is lighted if Parity Error Override mode has been selected.



2172

Figure 4. 501/505 Printer

Penetration Control: This switch is used to vary the penetration of type characters according to the thickness of the paper form being used. For example: a six part form consisting of laminated levels of paper and carbon requires a specific setting of this control lever as compared to a one, two, or three part form. Adjustment of this control must be determined through trial and observation. Following a period of continued print operation, inspection of the printed copy may indicate variation of print density due to ribbon wear. Readjust this control as required and check for possibility of shift in character phasing adjustment.

CHARACTER PHASING Control: This control permits adjustment of hammer-to-print-drum timing such that a full character is printed when a hammer magnet is fired. When this control is improperly adjusted, the print character cycle results in a partial print condition (only the upper or lower half of the character is printed).

This adjustment will vary with the paper form combination being used. Readjustment is also essential when the drum speed selection is changed.

PAPER TENSION Control: This control permits vertical adjustment of paper tension between upper and lower tractors. Movement of this control results in vertical displacement of upper tractor drive pins relative to lower tractor drive pins. Proper adjustment of this control eliminates the loose paper condition which would otherwise actuate the paper tear switches and prevent normal print operation.

FORM POSITIONING Control: This control is used to adjust the entire paper form in the vertical direction to obtain proper alignment between the printed copy and the ruled lines contained on the paper form. This adjustment causes all four tractors to move vertically in an up or down direction, over a maximum range of 1/4 inch from center.

Horizontal Positioning Control: This control is used to adjust the entire paper form in the horizontal direction. Both upper and lower tractor mounting shafts move horizontally, shifting the paper form 15/32 inch (maximum) relative to the print drum. This adjustment does not affect horizontal paper tension.

RIBBON REWIND Switch: This switch aids in transferring ribbon from one roll to another when replacing worn ribbon. This switch bypasses the normal ribbon transport clutch circuit such that ribbon may be transported when equipment is not in the print mode of operation. Hold this switch in the depressed position for continuous ribbon transfer.

Hammer Bank Access Crank: This crank is used to move the hammer bank assembly in and out of the print position. Turning this crank in the counterclockwise direction provides clearance between the hammer bank assembly and printdrum to permit paper loading and service or removal of the hammer bank assembly. This crank must be turned to the maximum clockwise position to return the hammers to the print position.

Drum Speed Toggle Switch (501 only): This switch is used to switch rotational speed of print drum motor from high to low speed. This alternate speed selection results in print drum speeds of 1000 and 667 rpm, respectively. The high speed selection of 1000 rpm is considered the normal operating speed.

Where a 48-character printing format is being employed and where the Index pulse is initiating each print cycle, the low speed selection provides a printing rate of 667 lines per minute with double spacing between character lines. Without the low-speed option, and operating in those conditions outlined above, printing rate would be reduced to 500 lines per minute. Hence, a print rate increase of 167 lines per minute is obtained under these conditions, when the low speed selection is employed.

OPERATING PROCEDURES

Format Tape Preparation

The 8-level format tape is of punched mylar, approximately 13 inches long, joined in a continuous loop. This tape contains a number of frames equal to, or a multiple of, the number of lines on the printed page. If short forms are to be printed, duplicate hole patterns for several forms can be punched in the tape. Because of the physical characteristics of the reader mechanism, the tape must have a minimum length of 6-1/2 inches. During any spacing operation, the format tape is advanced one frame each time the paper advances one line.

As shown in Figure 5, the format tape includes a row of feed holes which engage cogs on a metal drum and drive the tape. Tape levels 1 through 8 are monitored by a photocell assembly, and paper is stopped when the selected level is sensed. Levels are selected by issuing the desired function codes. Selecting any level one through six for postprint spacing provides a means of extending the automatic single space feature to include more than one line. For example, if Select Format Tape Level 4 for Postprint Spacing (0014) is selected, paper starts moving after each line is printed and continues to move until the photocells sense a hole in level 4 of the tape. By using the preprint function codes, paper may be moved before printing. Preprint spacing operations are also controlled by holes in tape levels 1 through 6.

Level 8 must always contain only one hole punched in the first frame. This level may be selected by Page Eject (0004) or by pressing the PAGE EJECT switch on the control panel. When selected, level 8 moves paper to the top of the form.

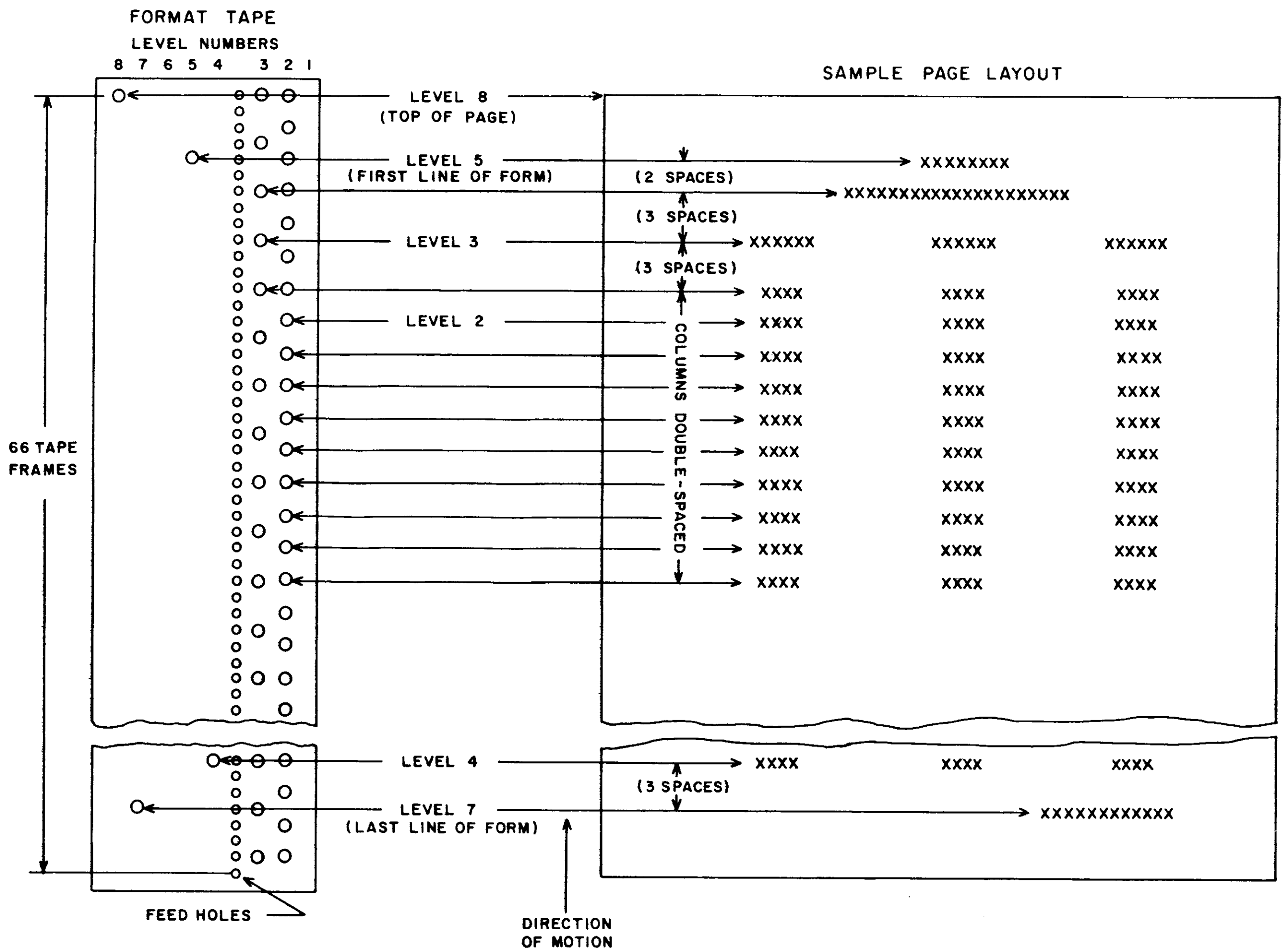


Figure 5. Spacing Example

Level 7 must also contain only one hole which corresponds to the last line of print. This hole may be punched in any frame according to the desired format. In the example shown, the hole in level 7 is in frame 62, consequently, the last line was printed on line 62 of the paper.

In the example (Figure 5), level 3 contains holes in every third frame, and level 2 contains holes in every second. This is a convenient arrangement because the sample form contains a number of triple spaces and double spaces. Selecting level 3 allows printing in lines 7, 10, and 13, double-spacing the main heading and triple-spacing to the column headings and the first tabulated figures.

Referring again to the sample page, note that a line is to be printed eight lines from the bottom on the page. To do this, punch a hole in frame 59 of level 4. Also, the double space function used in the preceding lines of print must be cleared and level 4 selected.

The last line to be printed is three spaces below the preceding line and, as mentioned above, is controlled by level 7 of the tape.

After the last line has been printed, level 8 must be selected to move paper to the top of the form.

Loading Format Tape

1) Press lower, extended portion of hinged bracket (see Figure 6) to right, causing bracket to pivot and move away from photocell station.
2) Hold tape loop in right hand such that the three outboard tape channels (from smaller sprocket holes) are nearest operator when inserting tape.
3) Insert tape between hinged bracket and photocell station, fitting tape between short (horizontal) guide posts which protrude from left of photocell block.
4) Fit sprocket holes of tape over sprocket drive wheel and over outer side of support post and short loop guide (see Figure 6). Release hinged bracket.

If the situation would arise where the punched tape is too long or too short to be used on the short tape loop guide, yet too short to be used on the long tape loop guide, remedy situation in the following manner:

5) Punch two complete tape formats in a continuous strip.

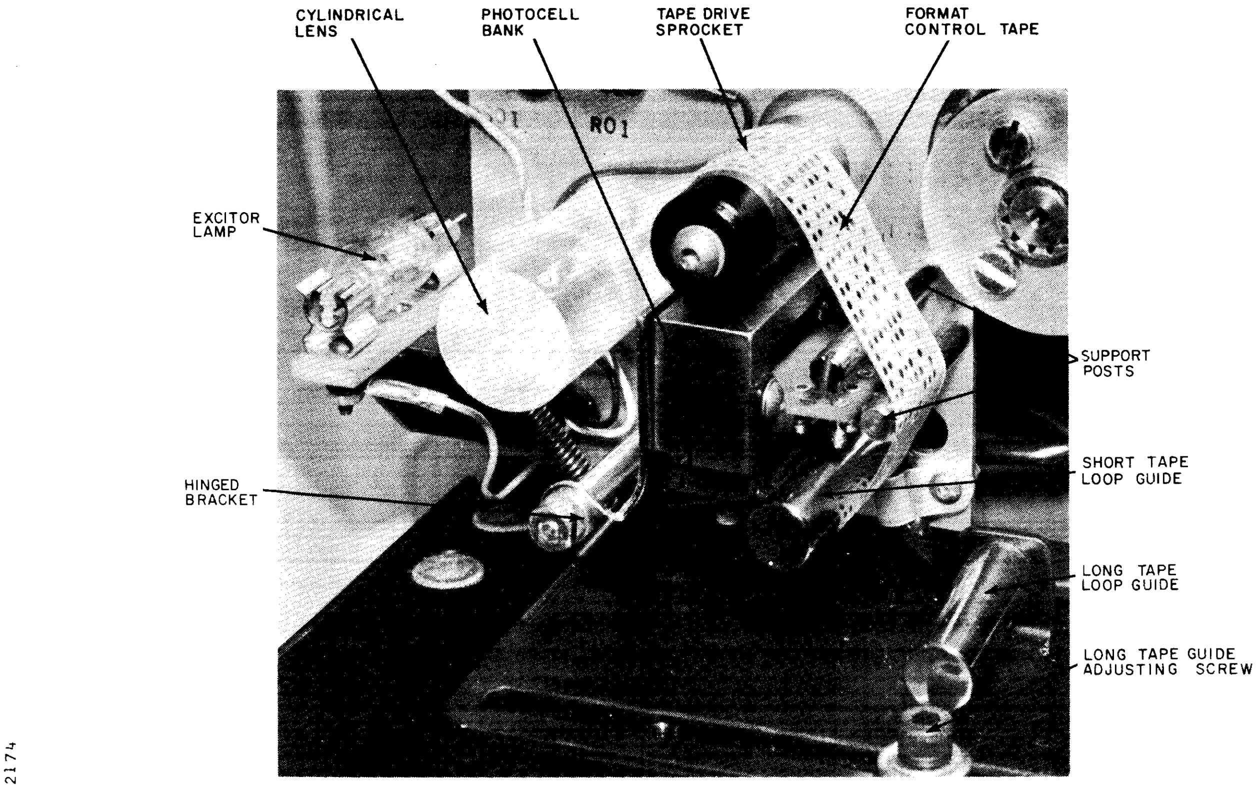


Figure 6. Format Tape Reader

6) Splice ends of tape to form closed loop, insert into reader and adjust the long tape loop guide to accommodate extra tape length. Do not apply excessive tension to tape when adjusting tape loop guide.

Loading Paper

1) Turn hammer bank access crank two to three turns counterclockwise.

2) Where programmed operation calls for use of perforated format control tape, install tape at format tape reader.

3) Press PAGE EJECT switch on control panel. This causes tape to move continuously and will stop when top of form is sensed at the format control tape.

4) Raise hinged pressure plates of all four tractors to permit insertion of paper forms.

5) Loosen extended locking screws (long shafts) of upper and lower left tractors. Select same detent position for each tractor as indicated by width of paper being used.

NOTE

A graduated scale (print line indicator assembly) may be used as an aid in positioning paper forms. This scale fits between the shroud guide pins located immediately above the lower tractor units, and aids in locating the position of the first print space.

6) When left edge of paper is positioned, tighten extended locking screws to fix upper and lower (left) tractors in position.

7) Insert paper between lower side of print drum and hammer bank, extending paper to upper tractors.

8) Turn hammer bank access crank fully clockwise.

9) Engage left perforated edge of paper with drive pins of left tractors (upper and lower).

10) Set vernier thumb screw of upper and lower right tractors to approximate central position.

11) Loosen extended locking screws of right tractor units (upper and lower). Adjust tractors such that perforations at right edge of paper fits on tractor drive pins. Tighten extended locking screws to set general position of these tractors.

12) Engage the right perforated edge of paper with drive pins of right tractors. Close pressure plates.

13) Set horizontal paper tension by varying the vernier thumb screws of right tractors.

14) Adjust PAPER TENSION control at left panel for proper paper tension in vertical direction.

15) Press SINGLE SPACE switch several times and observe paper holes and action of paper tear switches.

   a) If vertical paper tension is too loose, whipping action will result, causing paper tear switches to be activated. If vertical paper tension is too tight, paper holes will tear and elongate in the vertical direction. Adjust PAPER TENSION control at left panel.

   b) If horizontal paper tension is too tight, a tearing condition will be observed at the outer edges of paper holes. Adjust vernier thumb screw at both upper and lower right-hand tractors.

16) Press START switch and observe position of type with respect to top of paper form. If print is not properly positioned within one line of the desired location, paper must be removed from tractors, moved up or down as required and reinserted on tractor drive pins.

17) If paper forms are ruled, initiate print operation and adjust FORM POSITIONING control to locate printed line relative to ruled paper line.

18) Initiate another print operation. When this procedure places type alignment within one line of the desired location, use FORM POSITIONING control in making final adjustments.

Replacing Ribbon

1) Turn Hammer Bank Access Crank two to three turns in the counterclockwise direction to obtain necessary clearance between print drum and hammer bank assembly.

2) Press RIBBON REWIND pushbutton and hold until ribbon is transferred to outer roll.

3) Slacken ribbon by manually turning outer roll several revolutions in forward direction.

4) Grasp outer roll and push toward left side of printer. The right end of roll will disengage its drive cap, permitting removal of roll.

5) Unwind remaining ribbon from inner roll. Pull free end of ribbon from aperture between drum and hammer assembly. Discard worn ribbon and roll.

6) Remove inner roll by pushing to left until right end of roll disengages its drive cap. Reinstall in outer position.

7) Place new roll in the inner position such that ribbon leaves from bottom of roll. Be sure slot on right end of roll engages drive cap pin.

8) Insert two sheets of paper through the print aperture (between print drum and hammer assembly). Attach the end of the new ribbon to the outer sheets. Draw paper and ribbon through the aperture, toward front of printer.

9) Detach ribbon from paper. Pull ribbon over outer roll and fasten to the roll. Wind a few turns onto the roll, taking up slack by rotating roll several revolutions. Be sure slot in right end of roll engages drive cap pin.

10) Press RIBBON REWIND pushbutton. Ribbon should move at a steady rate and wind evenly.

11) If the ribbon telescopes during the loading procedure, grasp the ribbon firmly in both hands and place the end against a table. Press slowly and firmly until the ribbon is recentered on its core.

Caring for Ribbon

Ribbon life can be extended greatly if it is allowed to wear evenly. A print run which consistently prints in one area or track of the ribbon will stretch the ribbon in that area. It is therefore recommended that the ribbon be reversed whenever the printer is stopped to reload paper.

Clearing the Controller

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

1) Dead Start Master Clear
   A Dead Start Master Clear disconnects the controller, clears the existing reservations, and clears all logic. No status signals are available from the controller after a Dead Start Master Clear.

2) 6681 Function Master Clear (1700)
   This instruction:
   a) Clears any connection the converter may have with the printer,
   b) Releases any reservation the converter may have for the printer, and
   c) Performs a Master Clear on write and function logic. No status signals are available to the converter after executing this instruction.

3) Release and Disconnect (0000 and 0040)
   These function codes clear any connection and reservation the converter may have with the printer. The printer must be connected to the converter when this function code is issued. It does not clear reservations made by the other converter.

4) Power On Master Clear
   When power is applied to the controller, printer connections and reservations are cleared. Logic is also cleared. No status signals are available to the Data Channel after power is applied.

3691-A/B/C PAPER TAPE READER/PUNCH

CONTENTS

FIGURES

TABLES

3691-A/B/C PAPER TAPE READER/PUNCH

The CONTROL DATA* 3691-A/B/C Paper Tape Reader/Punch controller facilitates the transfer of data between a CONTROL DATA 350 Paper Tape Reader or a Teletype BRPE-11** Paper Tape Punch and a 6681 Data Channel Converter. (See Figure 1.)

This section describes the disassembly of data received from the converter and the assembly of data received from the reader. It also describes the connect, function, and status reply codes and provides pertinent programming information.

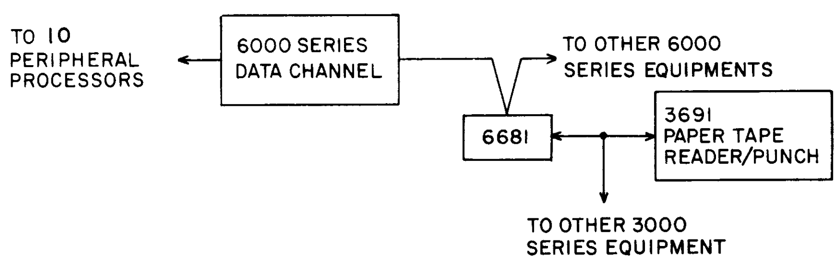


Figure 1. Typical Configuration

FUNCTIONAL DESCRIPTION

SYSTEM RELATIONSHIP

The 3691 Controller has one Read/Write control. This control may be physically attached to one 6681 Converter. Since the control is shared by both the reader and the punch, it is not possible for the converter to communicate with both devices simultaneously.

*Registered trademark of Control Data Corporation

**An NCR FM-82 Punch is installed on the 3691-B Controller.

ASSEMBLY/DISASSEMBLY

During Write operations, the control receives data from the converter in 12-bit bytes (i.e., 12 bits of data are received simultaneously on 12 data lines). The punch, however, can handle only 5 to 8 bits of data at a time.* The control, therefore, must either transfer only the lower 5 to 8 bits of a byte to the punch or it must disassemble the byte into two 6-bit characters for transfer to the punch.

During Read operations, the reader may transfer 5 to 8 bits of data to the control. The control must either transmit this data as received to the converter or it must assemble two 6-bit characters into a 12-bit byte and then transmit the byte to the converter.

PAPER TAPE FORMATS

The punch perforates tape of 5-, 7-, or 8-levels** at speeds of up to 110 characters per second.

Five-, seven-, or eight-level tape of standard widths can be read photoelectrically at speeds up to 350 characters per second. A switch on the unit must be set to indicate the number of tape levels being read.

MODES

Seven- or eight-level tape may be processed in Assembly/Disassembly mode (two 6-bit characters are processed per byte) or Character mode (the lower 5, 7, or 8 bits of the byte are used).

Five-level tape must be processed in Character mode.

---

*This depends on the tape level

**Two screws must be manually removed and replaced on the BRPE-11 guide when it is converted from 5-level for 7- or 8-level tape or from 7- or 8-level for 5-level tape.

PARITY

Connect codes, function codes, and data are transmitted between the converter 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, a "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 converter. Instead, the PARITY ERROR indicator lights. These parity error conditions must be cleared by a 6681 Function Master Clear prior to a new connect attempt.

Parity Error in a Function Code

If a parity error is detected, the requested functions are not performed, a Parity Error signal is returned to the converter, and the PARITY ERROR indicator lights. Since neither a Reject nor a Reply is returned to the converter, the Central Processor generates an Internal Reject after a wait of 100 usec. These PARITY ERROR indicators must be cleared by a 6681 Function 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 by the controller during a Write operation, the PARITY ERROR indicator lights and sends both a Reply and a Parity Error signal to the converter. The data is written on tape. All operations continue†† unless appropriate

*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 6681 Function Master Clear is questionable.

††The validity of the data received from this point until a 6681 Function Master Clear is questionable.

programming steps have been taken to sense the Parity Error signal and rewrite the data. These parity error indications must be cleared by a 6681 Function Master Clear. The equipment must then be reconnected and the appropriate functions reselected prior to the new output.

INTERRUPTS

The 3691 Controller can be programmed to send an Interrupt signal to the converter when any one of the conditions specified by the three interrupts* materializes.

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 converter. 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 to the converter currently connected to or reserving the equipment.

The 8-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 converter has a unique equipment number, each uses a different interrupt line. A 6681 Channel Status Request (1200) can identify the equipment sending the Interrupt signal by inspecting the interrupt lines.

PROGRAMMING

CODES

All connections and operations are controlled by 12-bit Connect and function codes in conjunction with appropriate 6681 function codes. In all discussion of codes, bit 0 is in the rightmost position. (See Table 1.)

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

TABLE 1. 3691 PAPER TAPE READER/PUNCH CODES

Connect Codes	
Connect Reader	N000*
Connect Punch	N001
Function Codes	
Release and Disconnect	0000
Assembly Mode	0001
Character Mode	0002
Clear	0005
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
Status Reply Codes	
Station Ready	XXX1
Station Busy	XXX2
Punch Tape Supply Low	XXX4
Reader Last Device	XX1X
Paper Motion Failure	XX2X
Interrupt on Ready and Not Busy	X2XX
Interrupt on End of Operation	X4XX
Interrupt on Abnormal End of Operation	1XXX

*N = equipment number of controller

Connect Codes

The controller must be connected to the converter before it can respond to either a 3691 function code or Read/Write instructions. Connection is accomplished by transmitting the equipment Connect code (N00U)** to the converter by an appropriate 6681 function code.*** The controller connects and returns a Reply† to the converter if:

**U = 0 for reader; U = 1 for punch

***See 6681 Converter function codes under Connect (Modes I - II)

†A Reply or a Reject signal tells the 6681 Converter to send an Inactive signal to the processor. A 6681 Converter Status Request (1200) is used to determine which of these signals was returned to the converter.

1) The N portion of the Connect code matches the setting of the Equipment Number switch, or

2) A transmission parity error is not detected.

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 converter from this equipment. Equipment status is not made available to the converter. If the controller was connected prior to receiving this code, it automatically disconnects. If neither a Reply nor a Reject is returned to the converter from any of its attached equipments within 100 usec, it generates an Internal Reject.

Connect Reader (N000)

This code connects the reader. N equals the setting of the Equipment Number switch on the paper tape reader controller.

Connect Punch (N001)

This code connects the punch. N equals the setting of the Equipment Number switch on the paper tape punch controller.

Function Codes

3691-A/B 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 are transmitted to the control by appropriate 6681 function codes. Table 1 lists these codes. A detailed description of each code follows the table.

The 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.

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

Release and Disconnect (0000)

This code clears the existing unit connection.

*Assembly Mode (0001)**

This code allows the following to occur:

Reader (Assembly Mode): The first frame of tape containing a level 7 hole is processed first. Data stored in levels 1 through 6 is placed in the upper 6-bit locations of the first byte. Data stored in levels 1 through 6 of the next frame is placed in the lower 6-bit locations of that byte. This sequence continues with odd frame data being placed in the upper 6 bits of a byte and the next (even) frame data completing the byte. When the last byte of a computer word has been transferred, the next frame begins a new word and should contain a level 7 hole. If the control hole does not appear, tape motion stops and an End of Record signal is sent to the converter.

Punch (Disassembly Mode): The first frame is punched with a level 7 hole and the information contained in the upper 6 bits of the first 12-bit byte. The lower 6 bits of the byte go to the second frame and so on. Thereafter, the level 7 hole is punched along with the upper 6 bits of the first byte of a computer word only.

Character Mode (0002)

This code allows the following to occur:

Reader: Information goes directly from the tape to the lower order bits (0-5, 6 or 7) of the byte. The information is stored in destination bit locations 0-5, 6 or 7.

Punch: The lower order bits (0-5, 6 or 7) of the computer word are transferred to the paper tape.

*Not applicable to 5-level tape.

Clear (0005)

This code clears all selected interrupts and Interrupt signals and puts the controller in Assembly/Disassembly mode.

Select Interrupt on Ready and Not Busy (0020)

This code causes the controller to send an Interrupt signal to the processor when the reader or the punch becomes Ready and Not Busy (i.e., power is applied, the READY switch is lighted, and neither a reader nor a punch cycle is in progress). The control does not reject this code.

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. The control does not reject this code.

Select Interrupt on End of Operation (0022)

This code causes the controller to send an Interrupt signal to the processor when the input/output operation is complete or when the controller becomes Not Busy. The control does not reject this code.

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. The control does not reject this code.

Select Interrupt on Abnormal End of Operation (0024)

This code causes the control to send an Interrupt signal to the processor when an Abnormal End of Operation occurs. The control does not reject this code.

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. The control does not reject this code.

Status Reply Codes

Status codes permit the monitoring of several control/unit operating conditions. These codes are made available to the converter over 12 status lines following a connect or a rejected connect attempt. A 6681 Equipment Status Request code (1300) makes 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 reply code is the sum of the individual codes.

Station Ready (XXX1)—Bit 0

Bit 0 is set when the connected device is Ready.

Station Busy (XXX2)—Bit 1

Bit 1 is set when either a Punch or a Read operation is in progress.

Punch Tape Supply Low (XXX4)—Bit 2

Bit 2 is set when the punch is connected and the remaining tape supply is considered less than the amount required for an average-length output.

Reader Last Device (XX1X)—Bit 3

Bit 3 is set when the reader was the previously connected device.

Paper Motion Failure (XX2X)—Bit 4

Bit 4 is set when there is no paper motion in response to an input/output request.

Interrupt on Ready and Not Busy (X2XX)—Bit 7

Bit 7 is set when Interrupt on Ready and Not Busy is selected and this condition now exists.

Interrupt on End of Operation (X4XX)—Bit 8

Bit 8 is set when Interrupt on End of Operation is selected and at least one condition specified by it now exists.

Interrupt on Abnormal End of Operation (1XXX)—Bit 9

Bit 9 is set when Interrupt on Abnormal End of Operation is selected and the channel is still busy. The device is connected and not busy or when Interrupt on Abnormal End of Operation is selected and the station is not busy and not ready, i.e., at the end of the punch cycle after the station goes not ready.

TIMING

Reader

A new Read must be initiated within 0.8 ms if tape stoppage is to be avoided.

Punch

A new Write must be initiated within 3 seconds if punch stoppage is to be avoided.

MANUAL OPERATION

SWITCHES AND INDICATORS

READY	STOP	PUNCH	LEADER	TAPE SUPPLY LOW		READER
CONNECT	PARITY ERROR		CIRCUIT BREAKER	THERMOSTAT BY - PASS	HIGH TEMP	LOW TEMP

Figure 2. 3691-B Switch and Indicator Panel

EQUIPMENT NUMBER Switch*

The Equipment Number switch is an 8-position switch. Its setting (0-7) designates the controller and corresponds to the N portion of the Connect code. It also determines the number of the interrupt transmission line that the equipment uses.

PUNCH Switch

This switch turns punch motor on and off.

LEADER Switch

This momentary-contact switch causes the punch to feed tape until the switch is released.

READER Switch

This switch turns the exciter and reader motor on and off.

READY Switch/Indicator

This momentary-contact switch makes the station Ready after loading or reloading. It is lighted when the unit is Ready.

*This switch is located on the logic panel

PARITY ERROR Indicator

If this indicator is lighted, a parity error is detected by the controller. A 6681 Function Master Clear instruction causes the indicator to go out.

CONNECT Indicator

This indicator lights when the station is connected.

STOP Switch

This momentary-contact switch causes the station to become Not Ready. Reader/punch motion stops.

TAPE SUPPLY LOW Indicator

This indicator lights when the punch tape supply is low.

CIRCUIT BREAKER Switch

When lighted, this switch indicates a power supply overload. Pressing the switch resets the circuit breakers. This switch also acts as a power switch, applying power to the logic chassis, blowers, and PUNCH and READER switches.

THERMOSTAT BY-PASS Switch/Indicator

This switch allows the reader/punch to be operated at above normal temperatures. It is lighted when activated.

CAUTION

When the BYPASS switch is turned on, there is no thermal protection. It is recommended that the equipment be operated in this condition only in an emergency.

HIGH TEMP Indicator

This indicator lights if the temperature at the top of the cabinet exceeds 110^{o} F. The power will be turned off.

LOW TEMP Indicator

This indicator lights if the temperature of the air entering at the bottom of the cabinet exceeds 80^{o} F.

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RECORD of REVISIONS

REVISION	NOTES
01	Preliminary Edition
(9-23-65)	
02	Publications Change Order 12155 which did not advance the Product Designation. Pages 1 and 6
(12-15-65)	under Visual Recording Equipment, page 17 under Mass Storage Equipment, pages 1, 2, and 4 in
	the 6682 section, and pages 3, 4, 6, 7, 11, 13, 14, 15, 16, 20, 21 and 24 in the 6681 section under
	Interface Equipment revised.
03	Publication Change Order 13333 which did not advance the Product Designation. The following
(4-13-66)	pages are revised: Under Tab Magnetic Tape Equipment, Section 6622 pages 1, 4, 5, 6, 7, 11, 12,
	15, 16, 17, 18 and 25. Section 607-B, pages 2, 4, 5, 6, 9, 12, 17, 21, 22 and 25. Under Tab
	Card Equipment, Section 6600, pages 1 and 2 under Section A and pages 1 and 6 under Section B.
	Under Tab Visual Recording Equipment, Section 6602, pages 7 and 12. Section 1612, pages 1, 2,
	6, 13, 14 and 18. Under Tab Mass Storage Equipment, Section 6603, pages 5, 11, 12, 15 and 16.
	Under Tab Interface Equipment, Section 6681, pages 1, 3, 7, 8, 10, 11, 12, 24, 25, 26, and 27.
	Under Tabs Card Equipment, Section 3446/3644 page 9, Section 3447/3649 page 9.
04	Publication Change Order 14006 covers the revision of Part 1 Magnetic Tape Equipment (Sections A
(6-24-66)	and B), and the following pages: 18 (1612 Printer), 26 and 27 (6681 Data Channel Converter), and
	6 (6600 Card Punch).
A	Manual Released. Publications Change Order 14967. The manual was completely revised including
(10-14-66)	two title changes in Section II as follows: 6600 Card Reader to 405-B Card Reader, and 6600 Card
	Punch Controller to 170 Card Punch Controller. The 6612 Console Display and the 6683 Satellite
	Coupler were added to Sections III and V respectively. This printing obsoletes all previous editions
	and raises the manual from a preliminary to a final edition.
B	Publication Change Order CA 15872 adds 6639-A Disk File Controller information to Mass Storage
(3-3-67)	Equipment Section.
C	Publications Change Order 16411 adds 6673-A/6674-A Data Set Controller information to 6000
(5-10-67)	Series Interface Equipment section.
D	Publications Change Order 17972 adds 6671-A Data Set Controller information to 6000 Series
(1-19-68)	Interface Equipment section and revises page 9 of 6603-A/B/C Disk File Controller information
	in Section IV. Obsoletes the 6671 Multiplexer Reference Manual (Pub. No. 60212900).
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F	Manual revised; includes Engineering Change Order 20823, publication change only. Page iii
(11-20-68)	(General Contents) revised. Added 6684-A (Section V) and 6641-A (Section IV).
G	Manual revised, includes Engineering Change Order 21349, publication change only. Page 6 of
(1-6-69)	6681 (Section V) and page 9 of 362X (Section VI) revised.
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6671-A DATA SET CONTROLLER

The CONTROL DATA® 6671-A Data Set Controller is a multiplexer which interfaces 6000 Series Computer Systems with remote communications terminals. Terminals can be located several thousand miles away, anywhere that voice-grade telephone lines or telephone data service is available, thus providing immediate on-line access to a centrally located 6000 Series computing facility. The data set controller (DSC), together with a software package, permits users at remote terminal locations to write routines, debug programs, establish files, and modify existing data at any time without the necessity of requesting computer time. A typical 6000 Series computer interfaced with remote communications terminals is shown in Figure 1.

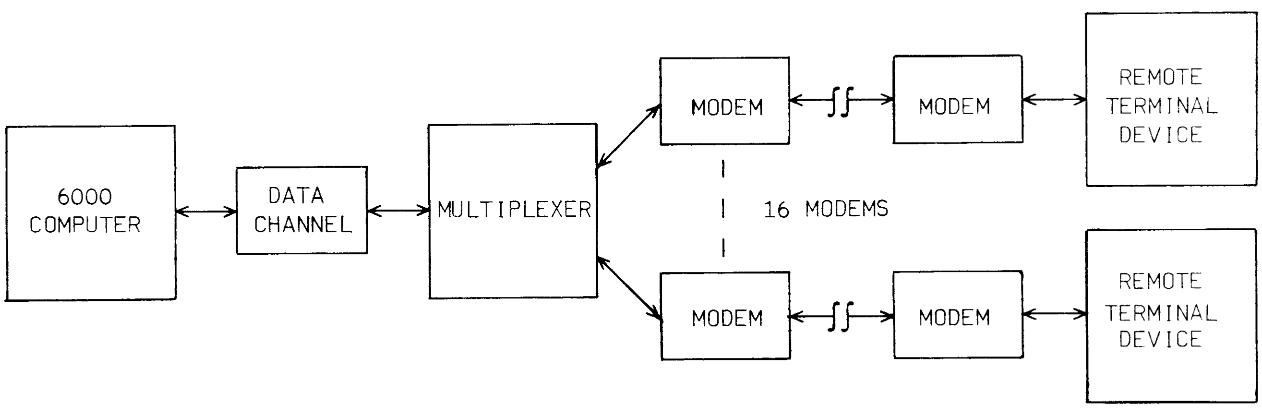


Figure 1. Typical Controller Application

FUNCTIONAL DESCRIPTION

The DSC interfaces as many as 16 remote-terminal modems (AT&T 103 Teletype Data Sets, 201A/B Dataphone Data Sets, or any standard interface as defined by EIA RS232 specifications). The 16 terminals can be arranged with any combination of modems.

DATA TRANSFER

Rate

The transfer rate of 12-bit data words between the 6000 Series Data Channel and the DSC is approximately 0.5 MHz. This permits the input of a 16-word block in approximately 32 μsec. Transmission rates of 8-bit characters (plus Data Control pulses) between the DSC and remote-terminal equipment are determined by the modem as follows:

103 Data Set	110 baud*
201A Data Set	2000 baud
201B Data Set	2400 baud

At these rates, with a terminal active, the DSC requires an input operation every 100 ms (110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud) or data may be lost.

Mode

The DSC operates in both Half- and Full-Duplex modes, the mode being determined by the type and configuration of modem used. Data is transferred between the DSC and terminals in only one direction at a time (either transmit or receive) in the Half-Duplex mode and in both directions at the same time in the Full-Duplex mode. Using the DSC, the system is capable of Full-Duplex operation with 16 2400-baud data terminals in either Line or Consecutive Character Data Block mode. The number of possible system configurations is dependent on the various modem speeds used and on the nature of the software operating system. The interconnecting transmission lines between the DSC and the Data Channel and the major DSC circuits are shown in Figure 2.

*Baud=bits per second

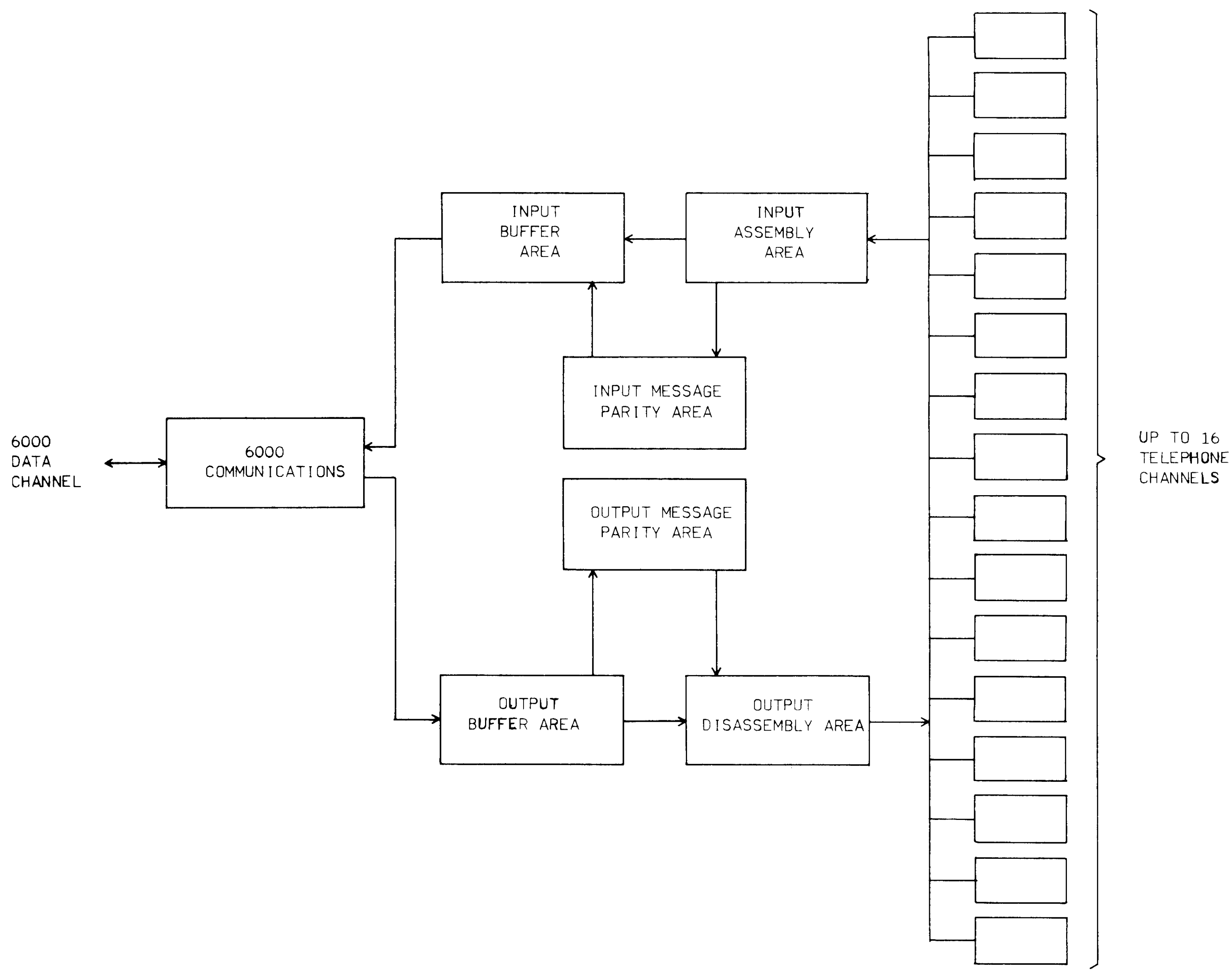


Figure 2. Controller Block Diagram

Data Channel ⟷ Controller

The transfer of data between the Data Channel and the DSC is in blocks containing from one to sixteen 12-bit data words. Each 12-bit data word uses the lower 8 bits to form a data character and the remaining 4 bits, as necessary, for I/O control. During output operations, I/O control bits must be generated by the programmer; during input operations, status bits are generated by the DSC.

Controller ⟷ Modem Terminals

The transfer of data between the DSC and the modem terminals is performed serially by means of 8-bit characters plus additional Start/Stop pulses, if required, for each character. The DSC then associates each data word in the data block with one of the sixteen terminals. It transfers data word 0 both to and from terminal 0 and transfers subsequently numbered data words to and from correspondingly numbered terminals. This format (order of operation) applies regardless of the number of terminals available or that require service. With 201 Data Sets, the DSC attaches a message parity character (MPC) to the output Data Channel message (the MPC itself has odd character parity). Incoming data is checked for USASCII formated messages, and a message parity check character replaces the incoming MPC (MPC character parity not checked).

DATA STORAGE

Locations

The DSC uses a 64-word, 28-bit-per-word core memory (only 25 bits are actually used) to buffer data/control information to and from the modems. Sixteen core locations are used to store information received from or sent to the 6X00 Data Channel. A second group of 16 memory locations stores information used to control the disassembly of output characters. A third group of 16 memory locations stores information used to control the assembly of input characters. The final 16 locations store the MPC for input/output data.

Memory locations are assigned four to a communications channel. For example: memory locations 0-3 are associated with channel zero, locations 4-7 with channel 1, etc. During an I/O operation with the computer each word went to the DSC is stored in one of the four locations associated with the channel for which it was intended. Words sent to the computer from the DSC are read from one of the four locations associated with the channel from which it was derived.

Each communication line operation requires that the three words (buffer, input, and output) be read for processing. The MPC word is read only when a character is completed and when a MPC must be updated or generated.

Memory Words

Core memory is partitioned according to line channels. Each line channel has an input information word, an output information word, a buffer word, and a message parity character associated with it (Figure 3).

The first word read from core memory during the processing of a telephone channel is the output information word which is read from location XXXX00. This word contains the following information:

Bits 0-7	Data in the process of being disassembled.
Bits 8-11	Clock count (used for 103 teletype timing and synchronization).
Bits 12-15	Bit count to keep track of the disassembly process.
Bits 16	Indicates that an I/O instruction was in progress when this telephone channel was previously processed. The I/O operation will resume upon completion of this processing.
Bit 18	Used for synchronization of teletype data.
Bits 21-23	Used to convey carrier and phone line connection information to the telephone channel such that data is not lost.

The second word read from memory is the buffer word which is contained in the Output/Input Buffer registers and is read from location XXXX01. The Output Buffer holds in bits 0-11 information received from the Data Channel.

Next the updated output information word is returned to memory. The input information word is then read from location XXXX11. This word contains the following information:

Bits 0-7	Data in the process of being assembled.
Bits 8-11	Clock count (used for 103 timing and synchronization).
Bits 12-15	Bit count to keep track of assembly process.
Bits 16-17	Synchronization indicators for 201 modems.
Bits 18-20	Synchronization indicators for 103 modems.

After the reading of the input information word, the MPC word is read from memory location XXXX10 if either the input or output portions of the telephone channel require MPC updating. This word contains the output MPC in bits 0-7 and the input MPC in bits 12-19. Bit 20 indicates the next input character will be an MPC. The MPC word is then returned to memory.

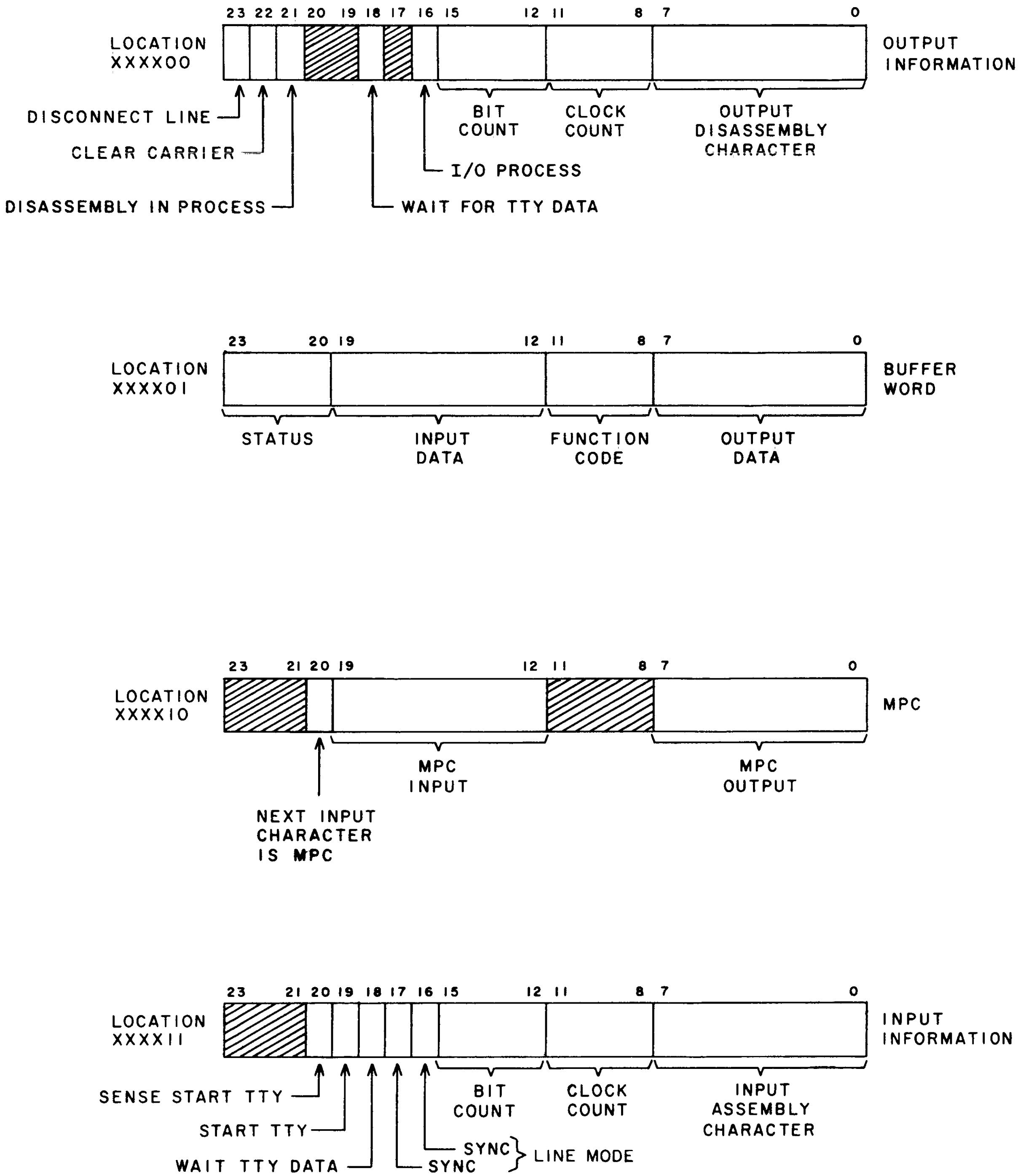


Figure 3. Memory Word Formats

Regardless of whether the MPC processing is performed or not, the final events are the return of the updated buffer and input information words to memory (in that order).

DATA CONTROL

To initiate a data transfer to a remote terminal, the processor must select the DSC by means of a function select code. This code contains an equipment code and select bits which designate the DSC operating modes. Two basic methods of sending function select codes to the DSC exist. One selects operating modes for the entire DSC and includes data transfers to or from the Data Channel and the presentation of DSC status. The other selects an operating mode for a single communication channel and includes the information necessary for the control of the modem. This latter function select code is transmitted to the DSC as part of an output word.

The DSC must receive a function select code before it can generate an Inactive and enable the requested operating mode. Nonacceptance of a code is indicated by no response from the DSC. The DSC is ready for an I/O operation when the processor has successfully selected the DSC and an operating mode by means of one of the codes in Table 1.

Data Output

The processor, after selecting the output mode with a function select code, activates the DSC Data Channel and transfers a block of data words to the DSC. The data block is held in the DSC Output Buffer register. If the DSC receives a data word for a terminal when the Output Buffer register for that terminal is full, the DSC performs a pseudo-accept of the new data word and sets the Character Reject status bit. After completing the block storage, the DSC prepares the terminals which require an output for transmit operation. The DSC begins a data buffer transfer (if there is a valid character in the buffer) after receiving a signal indicating terminal readiness. The lower 8 bits (data character) for each terminal are transferred from the Output Buffer register to the Output Disassembly register if the disassembly section of the terminal is clear. If the Output Disassembly is not clear, the data transfer for that terminal must wait for the next data-transfer cycle. The DSC also transfers control information to the modem during the data transfer.

The bits are transferred to the modem according to the serial pattern set for 103 or 201 (see Table 4). Data Sets and this transfer continues for each of the terminals. The DSC is ready for another data character following the transfer of the previous data character from the Output Buffer register to the Output Disassembly register. The DSC can store the next data character in the Output Buffer register while the preceding data character is in the Output Disassembly register.

Data Input

The terminal data input consists of taking the serial data bits from the active terminals and reassembling them in the Input Assembly register. When a character has been reassenbled, the DSC transfers its data portion to the lower 8 bits of the memory area for that terminal and sets bit 11 of the Input Buffer register of that terminal. The Input Assembly continues the reassembling and transferring of characters as long as serial data from the terminals is available.

After receiving an input function selection and a subsequent Activate pulse, the DSC transfers to the Data Channel up to 16 12-bit data words (contained in the Input Buffer). The data blocks may contain both completed data characters and words which contain zeros even though the I/O control bits may be set. The validity of data characters is detected by examining bit 11 of each data word.

If the DSC should complete the assembly of a data character when the Input Buffer of the terminal section is full, it writes the new data character into the buffer, destroying the previous character, and sets the Lost Data I/O control bit.

SIGNAL SYNCHRONIZATION

103 Data Set

Teletype Output: The DSC accepts a 12-bit word from the processor if the valid data bit of the word is set and transfers the lower 8 bits (0 through 7) to the Output Disassembly register. The DSC adds to this 8-bit data character a Start bit and two Stop bits (these synchronizing bits are deleted during Receive) to form an 11-bit asynchronous character. This 11-bit word is then disassembled and transmitted serially beginning at an integral bit time.

Teletype Input: A Start bit from the modem is initially issued to the DSC. This Start bit is sampled several times to eliminate synchronization on a noise pulse. At 1/10 of a bit time after initiation, the DSC checks to determine if the Start bit has persisted. If it has, the DSC checks it again at what would be the center of the Start bit. If a Start bit is still present, the DSC begins to time out the next 10 bit times and samples each of them. The DSC assembles this character, sends it to the Input Buffer register, and then awaits another Start bit from the modem.

201A/B Data Sets

The DSC receives clock information from the modem (201A/B or its equivalent) for data both received and transmitted. It does not itself supply clock pulses to the modem.

Clocked Output: After receiving a 4XXX data word on a telephone-channel output, the DSC places the modem in the proper condition, if required, for data transmission. The first data bit is presented to the modem at the first clock pulse following confirmation of the modem condition.

The controlling computer program must generate synchronizing characters according to those required by the remote site along with the header, data, and end of message (EOM). The DSC appends the MPC with odd character parity immediately after the EOM character. MPC is calculated from the start of message (SOM) header character. Note that all characters are standard USASCII types.

Output data bits are transmitted at each clock pulse received from the modem. Any code needed for synchronization of receiving equipment must be supplied by the controlling computer program. (Refer to the appropriate equipment reference manual to determine the types of codes required.) The DSC sets the Output Failure status bit when a break in the flow of transmitted data occurs if the computer does not supply data characters at a fast enough rate.

Clocked Input: The processor initially sends an xxiXXX code to a specific telephone channel which returns bits under modem-clock regulation. The DSC monitors the incoming data until it detects an 8-bit 026 code (USASCII sync character). It then records the character and accepts another 8-bit byte. It examines this byte to determine if it is a 026 code. When two consecutive 026 codes are sensed, the DSC logic is synchronized with the data characters that follow. The DSC ignores any subsequent 026 codes after establishing synchronization. If a second 026 code is not found, the DSC logic considers a Non-synchronized condition exists and continues to check for two consecutive 026 codes.

The processor controlling the DSC must send an xxiXXX word to the DSC prior to the arrival of the first 026 code word, and any device supplying clocked information to the DSC must send a minimum of four 026 code words before each message to provide synchronizing reliability. Sync codes are never considered valid data.

Once synchronized, the DSC must be sent a function code to cause it to inaugurate a Sync Seeking sequence.

Message Parity Character

MPC Output: The DSC begins computing a message parity character when it transmits an USASCII SOM character. Any USASCII sync codes contained in the message which follows are ignored. The DSC appends a MPC with odd character parity immediately after the EOM character is transmitted.

MPC Input: The DSC begins computing a MPC when it receives an USASCII SOM character. USASCII sync codes contained in the message are ignored. After receipt of an OEM, the DSC takes the logical difference between the lower 7 bits of the next assembled character (incoming MPC) and its calculated MPC and sends it to the Input Buffer register.

PROGRAMMING

FUNCTION SELECT CODES

Function select codes (Table 1), after being recognized, select the DSC and designate its normal operating mode. Function code selection does not prevent the DSC from transferring output data characters from the buffer to the terminals, nor does it prevent input data characters from being transferred from the terminals to the buffer registers.

TABLE 1. FUNCTION SELECT CODES

OCTAL CODE	DESCRIPTION
X001*	Select Output
X002	Select Status Request
X003	Select Input

*The X portion must correspond to the setting of the Equipment Number switches.

Note: Additional codes are used for diagnostic test routines (see CE Manual).

Select Output (X001)

Receipt of this code enables the DSC, causing it to accept data blocks from the Data Channel. These blocks consist of as many as 16 data words. Figure 4 illustrates the output word format.

Select Status Request (X002)

The DSC transfers a 12-bit status word to the Data Channel input lines when it has received a X002 code. This code must be followed by a one word input operation in order to examine the status bits. Specific bit assignments are given in Figure 5.

Select Input (X003)

A Select Input code enables the DSC, causing it to transfer a data block to the Data Channel. As soon as it receives an Active (Activate Channel instruction), the DSC transfers a data block of up to 16 words (Figure 4). For block lengths less than 16 words, refer to Programming Considerations, Input Block Length.

After receiving a function select code, the DSC sends an Inactive to the processor to indicate it has recognized and accepted the code (no response by the DSC indicates it has not accepted the code). An Inactive is generated by the DSC when bits 9 through 11 of the function select code correspond to the code determined by the setting of the Equipment Number switches and a recognized operation select code has been received. These switches (located at J022A/B/C, respectively) are UP for a "1" and DOWN for a "0". After generating an Inactive, the DSC enables the selected operating mode (Output, Status Request, or Input) when it receives an Active from the Data Channel.

DATA WORD

The DSC communicates with the processor by means of a 12-bit data word. The 12-bit data word is comprised of either an 8-bit character which the DSC receives from or transfers to the terminals together with 4 output-control bits or 4 input-status bits, or a 12-bit status character (status word). The position of a word in the data block determines the channel with which it will be associated. For example: The first word in the block is associated with channel 0, the second with channel 1, etc.

Output Word

The output word format required by the DSC during data transfers with the Data Channel is shown in Figure 4.

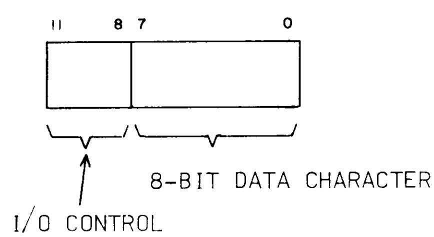
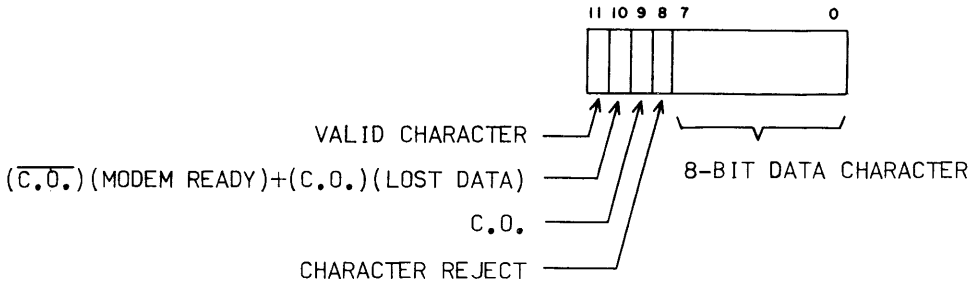


Figure 4. Output Word Format

The lower 8 bits (0 through 7) of the output word form the data character. The DSC, when enabled performs a serial transfer of the 8-bit data characters as shown in Table 2.



C.O. = CARRIER ON

Figure 5. Input Word Format

Data Character (Bits 0 through 7): The lower 8 bits (0 through 7) of the input word form the data character. The DSC forms this character serially from data received from the modem. An all-zeros data character is transferred to the Data Channel when a MPC is passed by the DSC and no error has occurred. A non-zero character is transferred to the Data Channel if an error has occurred. The order of data character assembly is shown in Table 4.

TABLE 4. DATA CHARACTFR ASSEMBLY/DISASSEMBLY

103 TELETYPE: MODEM Bit Order	103 TELETYPE: BIT USE Assembly	103 TELETYPE: BIT USE Disassembly	201 CLOCKED FORMAT: MODEM Bit Order	201 CLOCKED FORMAT: BIT USE Input and Output
1	Discard	Start (0)	1	0
2	1	1	2	1
3	2	2	3	2
4	3	3	4	3
5	4	4	5	4
6	5	5	6	5
7	6	6	7	6
8	7	7	8	7
9	0	0		
10	Discard	Stop (1)		
11	Discard	Stop (1)		

Character Reject (Bit 8): Bit 8 of the DSC input word sets if a Data Channel output word has been pseudo-accepted and then discarded (output buffer for that terminal was full). This control bit indicates that the DSC has not accepted a data output word. The DSC clears bit 8 after transferring the input word to the processor.

Terminal Ready (Bit 9): Bit 9 is set when the modem Interlock signal is present and indicates that a connection exists between the terminal and the modem. Bit 9 clears as the Interlock signal terminates.

Lost Data (Bit 10): When set, bit 10 of the DSC word indicates that the processor has failed to perform an input operation before the next character has been assembled. When a terminal is active, the processor must perform an input operation within 100 ms (110 baud), 4 ms (2000 baud) or 3.3 ms (2400 baud) after Input Required sets (status bit 1). The DSC clears this control bit 10 after transferring the input word to the processor. Note that USASCII sync characters (026 code) are not considered to be data and, as such, do not cause a Lost Data condition to be indicated.

Valid Character (Bit 11): Bit 11 is set after the DSC assembles a complete data character from the active terminal. Bit 11 indicates that bits 0 through 7 contain a data character.

STATUS WORD

A status word provides the processor with a means of determining the condition of the DSC. The processor, to determine the status of the DSC, issues a Status Request code (X002) followed by an input operation. Figure 6 shows the format of the DSC status response word.

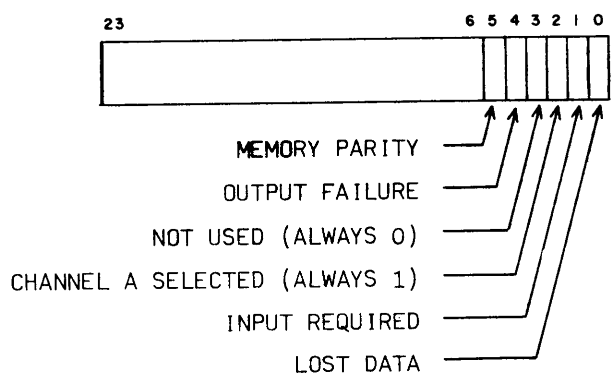


Figure 6. Status Response Word Format

DSC Lost Data (0005)

Status bit 0 sets when the processor fails to perform an input operation before a telephone channel has assembled the next input character. This status bit indicates the presence of lost data in at least one telephone channel. The DSC clears status bit 0 after receiving a Select Input code.

Input Required (0006)

Status bit 1 sets when a character is available for input. The input operation requested by DSC should follow within 100 ms (110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud) or data may be lost.

Channel A Selected (0004)

Bit 2 (always a "1") is required for CONTROL DATA® 6676 Data Set Controller Compatibility.

Output Failure (0024)

Status bit 4 sets when a Clocked Line or Block Mode (2000 or 2400 baud) output operation does not find a character to disassemble in the Output Buffer register. A XXX1 function code clears this bit (output).

Memory Parity Error (0044)

Status bit 5 sets when a parity error is detected in a data transfer to or from the DSC memory. A XXX2 function code (status) clears this bit after it has been presented to the Data Channel.

PROGRAMMING CONSIDERATIONS

Status

The DSC has the following two types of status available:

1. Equipment status - Consists of DSC Lost Data and Input Required; available by means of Status Request code.
2. Operation Control status - Consists of Lost Data and Terminal Ready indications (for input operations) and Character Reject indications (for output operations) for each channel.

Output Status Check

The output operation must be followed by an input operation to obtain complete status. The terminal for which an output character has been rejected will have bit 8 set in the next input word for the terminal. For example, if an output character to terminal 10 (word 10 of the output block) is rejected, the next input block will have bit 8 set in word 10.

Data Block Length

The I/O data block length can be a function of the terminals available if the DSC controls less than 16 terminals. For example, The I/O data blocks need only be eight words if a DSC only controls eight terminals and the terminals are consecutively numbered starting with terminal 0. The DSC considers all data transfers to start at terminal 0. The output data block length can also be a function of the number of active terminals. The data block can be 10 words if only terminal 10 is active, i.e., must service the highest numbered active channel.

Input Block Length

An input operation may be up to 16 words long. Blocks shorter than 16 words can be read, but they should contain at least as many words as the number of active data terminals. Due to the nature of the 6000 Data Channel, the DSC will present the Data Channel with one more word than requested. In most situations this is of no consequence. In the DSC, however, the extra word presented will correspond to a data terminal one higher in number than the last word requested by the Data Channel. The DSC considers this word as having actually been transferred to the Data Channel and destroys any information that it may contain. It is possible, therefore, to lose data when a block of insufficient length is read.

To prevent loss of data on 16-word blocks, the DSC ceases to process Data Channel signals after 16 words (or after the first word on an input which follows a status function). Abnormal program termination will result if longer block inputs are attempted.

Output Timing

The DSC accepts 16 words from the Data Channel in 32 μsec (one word each 2 μsec) in a block-output format. The complete output on communication lines (including disassembly and transfer) requires an additional 100 ms (110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud). If the DSC receives a new data word before the preceding word is in the Output Disassembly register, the new word is lost and Character Reject sets in the next input word. Because of these output-timing restrictions, each output block should be followed by an input block in which bit 8 (Character Reject) is checked.

Input Timing

The DSC can transmit a 16-word data block to the Data Channel in 32 μsec (one word each 2 μsec). The time required by the DSC to assemble a complete input code from a terminal is the same as that required for data output. The DSC assembles the character and then transfers it to the Input Buffer register. With a word assembled and status bit 11 set, an input to the Data Channel must be activated within 100 ms

(110 baud), 4 ms (2000 baud), or 3.3 ms (2400 baud) or the word may be lost and result in Lost Data for the corresponding word.

General Timing

When a number of high- and low-speed data terminals are used with the DSC, it is advisable to connect the higher-speed terminals to the low-numbered channels and the lower-speed terminals to the high-numbered channels. In this way, the controlling computer program need communicate with only those terminals which require frequent servicing at a high rate. The slower terminals can then be serviced at a lower rate. These arrangements will provide a considerable shortening of programming time, but should be used only after consideration of the input block length.

Processor Restrictions

Input: The processor must perform inputs that equal or exceed the input character rate to avoid lost information.

Output: The processor must perform outputs that equal or exceed the character rate to avoid lost information when transmitting line-mode (clocked) information.

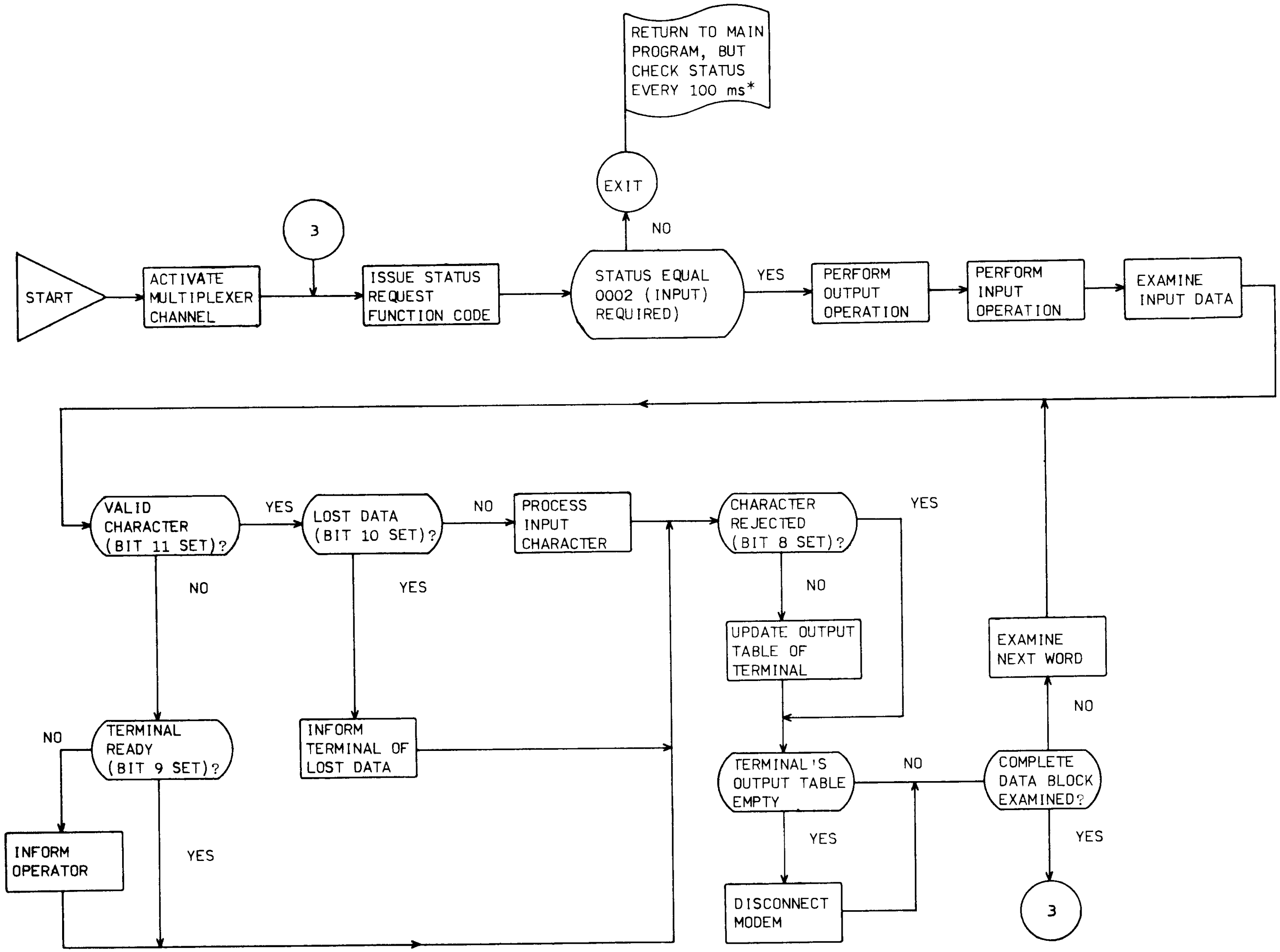
Character Format

During transmission, the DSC performs a serial transfer of the 11-bit synchronized data character. This serialized character stream is required for compatibility with the 6676 Data Set Controller. Refer to Table 2 for the 103/201 Data Sets character format and transfer sequence.

Programming Example

The flow chart (Figure 7) shows the DSC servicing routine and is useful in understanding the DSC operation. Programming the DSC is similar to programming other peripheral equipment. A typical ordering of programming steps is as follows:

1. Clear (dead start)
2. Function select status
3. Input status (determine if DSC requires service)
4. Function select output
5. Output data to terminals
6. Function select input
7. Input data plus I/O control bits for terminals



*100 ms (110 BAUD); THIS RATE VARIES ACCORDING TO THE SPECIFIC DATA SET EQUIPMENT BEING USED.

Figure 7. Sample Controller Servicing Routine

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Reference Manual

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CONTROL DATA® 6000 SERIES COMPUTER SYSTEMS

Peripheral Equipment Reference Manual

RECORD of REVISIONS

REVISION	NOTES
01	Preliminary Edition
(9-23-65)	
02	Publications Change Order 12155 which did not advance the Product Designation. Pages 1 and 6
(12-15-65)	under Visual Recording Equipment, page 17 under Mass Storage Equipment, pages 1, 2, and 4 in
	the 6682 section, and pages 3, 4, 6, 7, 11, 13, 14, 15, 16, 20, 21 and 24 in the 6681 section under
	Interface Equipment revised.
03	Publication Change Order 13333 which did not advance the Product Designation. The following
(4-13-66)	pages are revised: Under Tab Magnetic Tape Equipment, Section 6622 pages 1, 4, 5, 6, 7, 11, 12,
	15, 16, 17, 18 and 25. Section 607-B, pages 2, 4, 5, 6, 9, 12, 17, 21, 22 and 25. Under Tab
	Card Equipment, Section 6600, pages 1 and 2 under Section A and pages 1 and 6 under Section B.
	Under Tab Visual Recording Equipment, Section 6602, pages 7 and 12. Section 1612, pages 1, 2,
	6, 13, 14 and 18. Under Tab Mass Storage Equipment, Section 6603, pages 5, 11, 12, 15 and 16.
	Under Tab Interface Equipment, Section 6681, pages 1, 3, 7, 8, 10, 11, 12, 24, 25, 26, and 27.
	Under Tabs Card Equipment, Section 3446/3644 page 9, Section 3447/3649 page 9.
04	Publication Change Order 14006 covers the revision of Part 1 Magnetic Tape Equipment (Sections A
(6-24-66)	and B), and the following pages: 18 (1612 Printer), 26 and 27 (6681 Data Channel Converter), and
	6 (6600 Card Punch).
A	Manual Released. Publications Change Order 14967. The manual was completely revised including
(10-14-66)	two title changes in Section II as follows: 6600 Card Reader to 405-B Card Reader, and 6600 Card
	Punch Controller to 170 Card Punch Controller. The 6612 Console Display and the 6683 Satellite
	Coupler were added to Sections III and V respectively. This printing obsoletes all previous editions
	and raises the manual from a preliminary to a final edition.
B	Publication Change Order CA 15872 adds 6639-A Disk File Controller information to Mass Storage
(3-3-67)	Equipment Section.
C	Publications Change Order 16411 adds 6673-A/6674-A Data Set Controller information to 6000
(5-10-67)	Series Interface Equipment section.
D	Publications Change Order 17972 adds 6671-A Data Set Controller information to 6000 Series
(1-19-68)	Interface Equipment section and revises page 9 of 6603-A/B/C Disk File Controller information
	in Section IV. Obsoletes the 6671 Multiplexer Reference Manual (Pub. No. 60212900).
E	Manual revised; includes Engineering Change Order 20367, publications change only. Pages
(11-20-68)	1, 5, 8, 9, 10, and 11 (6602/6612) (Section III) revised.
F	Manual revised; includes Engineering Change Order 20823, publication change only. Page iii
(11-20-68)	(General Contents) revised. Added 6684-A (Section V) and 6641-A (Section IV).
G	Manual revised, includes Engineering Change Order 21349, publication change only. Page 6 of
(1-6-69)	6681 (Section V) and page 9 of 362X (Section VI) revised.
H	Manual revised; includes Engineering Change Order 24321, Publication change only. Pages 2,
(1-7-70)	4, 5, 7, 8, 9, 10, 12, 15, and 18 of 6671-A section revised.
J	Manual revised; includes Engineering Change Order 24834, publication change only. Section I
(3-2-70)	(607-B) P. 16, Section VI (Supplementary information) P. 2, and Section VIII (3256-A/3659-A)

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REVISION	NOTES
J(cont.)	P. 12 revised.

FORM CA 230-2

A status function is accomplished in the following way:

PPU Instruction	607-B Code	Step	Event
FAN(76) or FNC(77)	210U	1)	Select status of the previously selected tape unit.
ACN(74), IAN(70)		2)	Read status word into PPU A register.
		3)	PPU tests status word to determine conditions.

607 MAGNETIC TAPE TRANSPORTS

TAPE UNIT DESIGNATION

Each tape unit may have either a numerical designation (0 - 7) or be in Standby condition. These are determined by the Unit Select switch located on the tape transport. The transport cannot be used when it is on STANDBY. When the numerical designation of a unit is changed, any operation currently in progress with the transport is stopped and the PPU may hang up.

TAPE FORMAT

Magnetic tape provides a high-speed, non-volatile storage medium for recording and retaining information. The tape has a mylar base and is coated on one side with minute particles of iron oxide mixed with a binding agent. It is upon this coating that information is recorded. Extreme care is taken in the manufacture of the tape in order to eliminate any imperfection that could cause errors. Each roll of Control Data magnetic tape is therefore thoroughly tested before being used to guarantee its recording characteristics and performance.

Information is read (detected) or written (stored) by passing the oxide side of the tape over read/write heads. Information may be written on any of seven independent tracks on the tape. During a Read or Write operation, seven recording heads are placed vertically across the tape; therefore, 7 bits may be simultaneously recorded, one bit on each track. (See Figure 2 for the tape recording format.)

A seven-track non-return-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 a "0". Thus, each track of the tape is fully magnetized and the polarity is reversed as each "1" bit is recorded.

A frame of tape data consists of one 6-bit data character and one parity (check) bit for each character. Tracks 0 through 5 specify the characters while track 6 holds the parity bits (Figure 2). Two frames correspond to one data word from the PPU.

Data is recorded in binary or BCD format (just as they are represented in the memory). 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 in any line is even. The 607-B automatically adds the correct parity bit that accompanies each character.

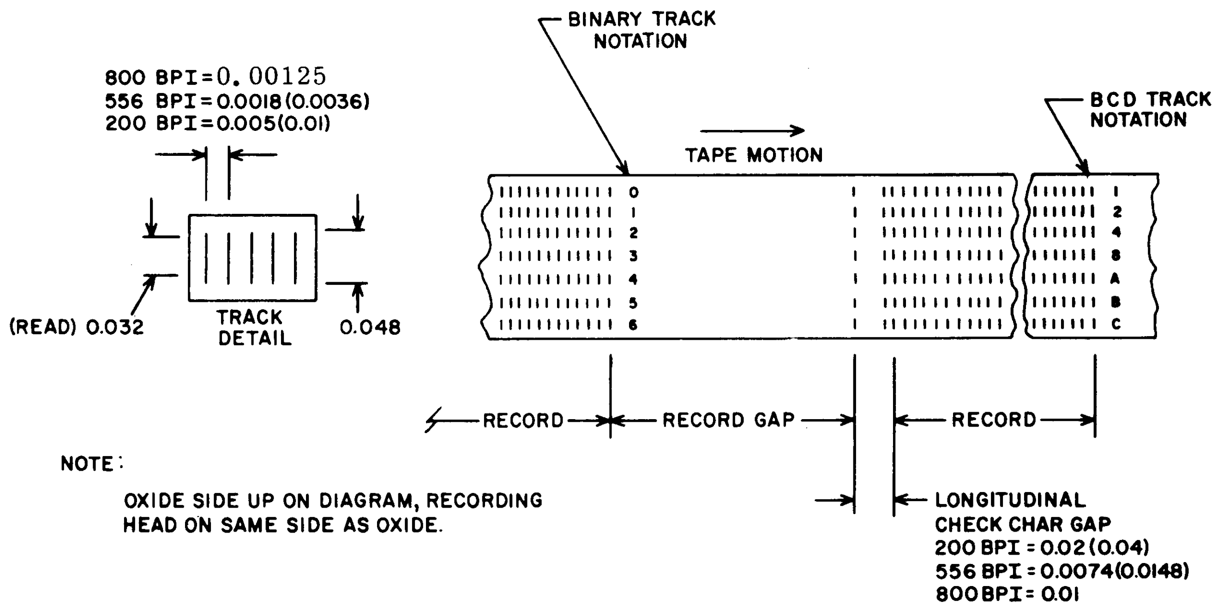

Figure 2. Bit Assignments on Tape

The controller records data on the tape in groups called records and files. A minimum of two frames of information constitutes a record. Adjacent records are separated by a 3/4-in. unrecorded area (record gap). A longitudinal parity frame is recorded at the end of each record such that the number of "1's" in each record track is made even.

During input/output operations the 607-B checks each character for correct vertical parity. If a parity error occurs a Parity Error status bit is set.

SUPPLEMENTARY INFORMATION 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, and
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 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.

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.

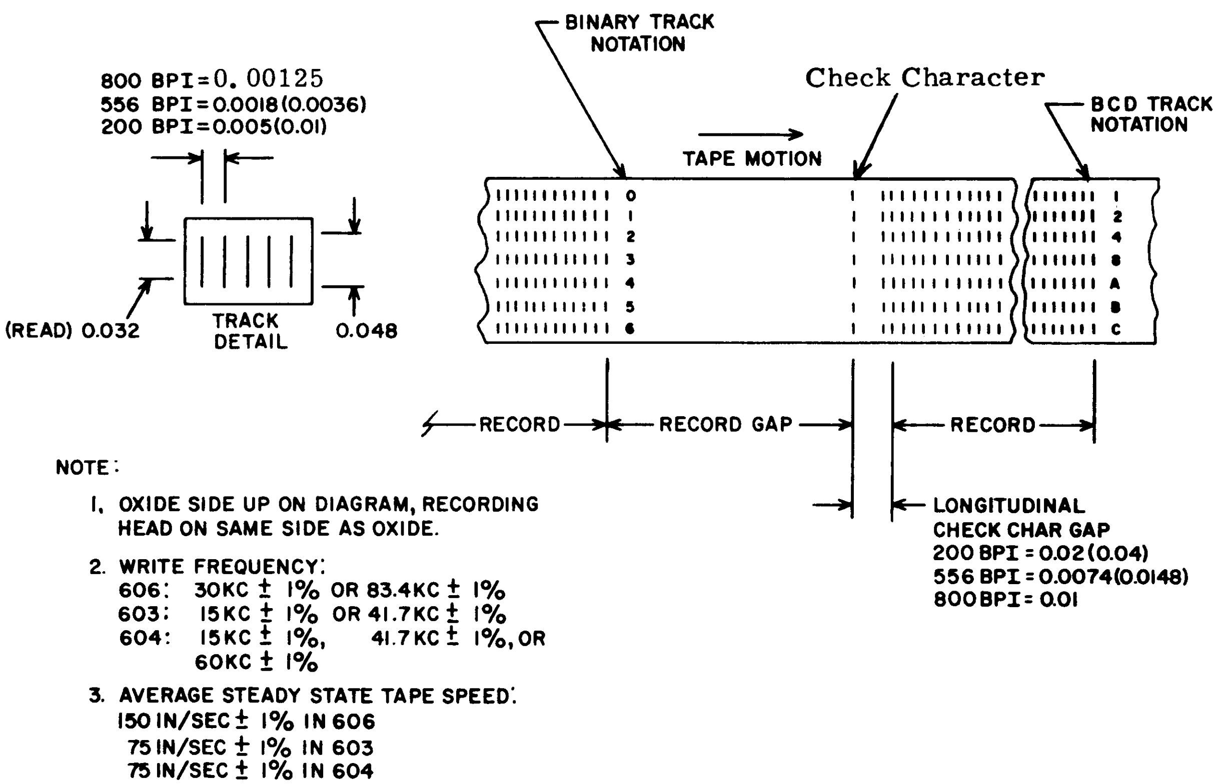

Figure 1. Bit Assignments on Tape

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

A control examines only one code at a time. First, it checks for parity errors. If none are found, it returns a Reply provided the function code is legal and the request can be performed. If the code is illegal or if it cannot be performed, a Reject is returned to the converter.

Release and Disconnect (0000, 0040)

These codes which clear the existing connect, reserve, and interrupt selections are effective only if received from the connected converter. Either one is recognized and replied to by the printer immediately upon receipt.

Single Space (0001)

This code advances paper one line. It does not clear Postprint Spacing selections. It is self-clearing.

Double Space (0002)

This code advances paper two lines. It does not clear Postprint Spacing selections. It is self-clearing.

Advance to Last Line (0003)

This code advances paper until a hole is detected in Format Tape Level 7. The last line of the form that may be printed should then be in position for printing. This code does not clear Postprint Spacing selections. It is self-clearing.

Page Eject (0004)

This code advances paper until a hole is detected in Format Tape Level 8. The first line of the new form to be printed should then be in position for printing. This code does not clear Postprint Spacing selections. It is self-clearing.

Auto Page Eject (0005)

This code, together with the detection of a hole in Format Tape Level 7, advances the paper until a hole is detected in Format Tape Level 8. Format Tape Level 7 indicates the last line of the form that may be printed. Format Tape Level 8 indicates the first line of the new form that may be printed. Auto Page Eject takes precedence over all other Postprint Spacing selections.

Suppress Space (0006)

This code suppresses the next Postprint Spacing operation. It is ignored by Preprint Spacing operations, and it is self-clearing.

Clear Format Selection (0010)

This code clears all format selections as well as Auto Page Eject. It then places the printer in Postprint Automatic Single Space mode.

Select Format Tape Level L for Postprint Spacing (001L)

These codes cause automatic advancement of paper following each print operation. Advancement continues until a hole is detected in the selected level. The selections are cleared by Clear Format Selection (0010), Select Preprint Spacing (0020), or a 6681 Function Master Clear. L is a number from 1 to 6 designating any one of the lower six tape levels.

Select Preprint Spacing (0020)

This code clears all Postprint Spacing selections except Auto Page Eject. It must be used prior to selecting a tape format level for Preprint Spacing. It does not initiate paper motion.

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