Reference/Instruction Manual

CONTROL DATA®
162-1-B/162-2-B/162-3-B
MAGNETIC TAPE
SYNCHRONIZER

60100200

Record of Revisions

REVISION	NOTES
A	This manual combines the Preliminary Customer Engineering Instruction Manual, Pub. No. 60103300, and the Preliminary Reference Manual, Pub. No. 60100200. The C. E. Instruction Manual, 60103300, is now obsolete but the information contained therein is still valid.
B	Addition of Appendix E, Parts List and page 1-1 revised.
(6-2-65)	

Pub. No. 60100200
June, 1965

Address comments concerning this manual to:

Control Data Corporation
Technical Publications Department
4201 North Lexington Avenue
St. Paul, Minnesota 55112

or use Comment Sheet located in the rear of this book.

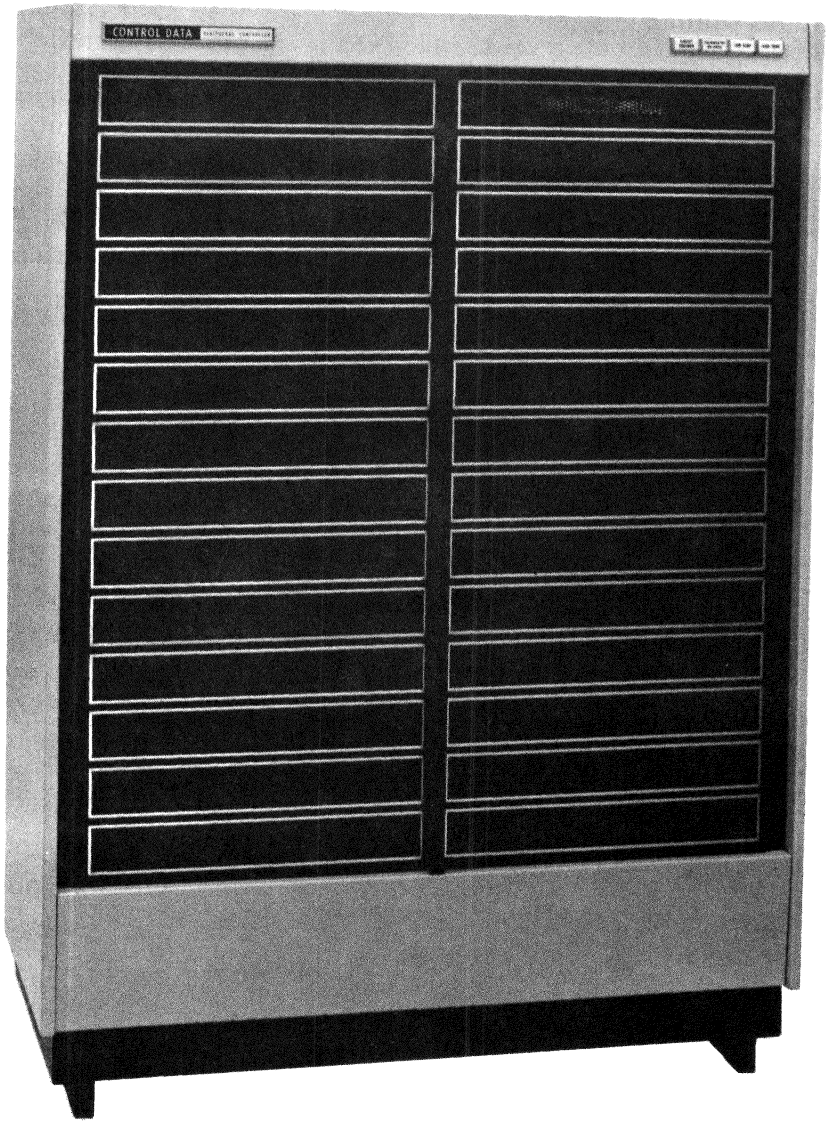
CONTENTS

FIGURES

TABLES

FIGURES

TABLES


CONTROL DATA

CHAPTER 1
DESCRIPTION

The CONTROL DATA* 162 Magnetic Tape Synchronizers are input/output devices for the Control Data 160 or 160-A Computers. Table 1-1 compares the salient characteristics of the three models available. In addition to the features mentioned, each synchronizer provides a read communication channel between one tape handler and a Control Data 166-2 Line Printer.

TABLE 1-1. CHARACTERISTICS

UNIT	TAPE HANDLERS	SPEED	REWIND	START	STOP	CHARACTER RATE
162-1-B	four(8) 603s	75 ips	320 ips	3 ms(. 15 inch)	3 ms(. 225 inch)	15 or 41. 7 KC
162-2-B	eight 606s	150ips	320 ips	3 ms(. 1 inch)	2 ms(. 225 inch)	30 or 83. 4 KC
162-3-B	eight 604s	75ips	320 ips	3 ms(. 15 inch)	3 ms(. 225 inch)	15 or 41. 7 or 60 KC

PHYSICAL DESCRIPTION

The 162 is constructed of standard Control Data logic cards mounted on one chassis. The chassis and the independent power supply is mounted in a B1 cabinet. The cabinet is 56-7/8 inches high, 42 inches wide, and 20-1/2 inches deep. The unit weighs 350 pounds and generates 4200 BTUs. Connectors are available for the following cables:

4 on-line logic cables**
16 logic cables from the tape handlers
2 logic cables from the printer

---

* Registered trademark of Control Data Corporation

** Two connectors are available for input, two for output; this permits other equipment to be connected within the system.

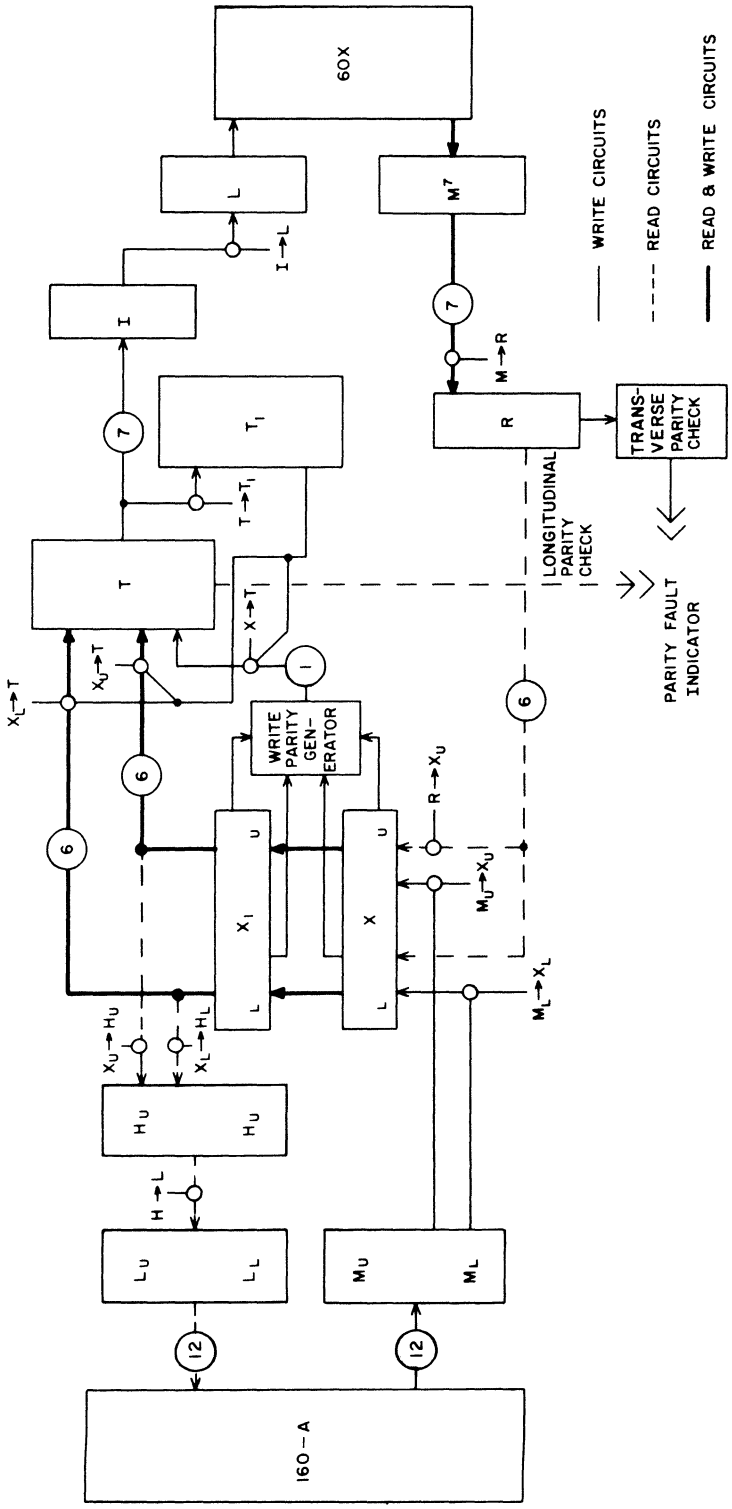


Figure 1-1. 162 Block Diagram

FUNCTIONAL DESCRIPTION

Computer-tape handler operation (on-line) is selected by computer EF codes. The EF codes control the following functions:

1) Preliminary selection
   - System
   - Tape handler
   - Word length
   - Parity
   - Density
2) Motion control
   - Backspace One Record
   - Search Backward to File Mark
   - Search Forward to File Mark
   - Rewind
   - Rewind Unload
3) Information transfer
   - Write
   - Write File Mark
   - Read
   - Status

Line printer-tape handler operation (simultaneous off-line) is selected by pseudo EF codes generated by the printer select switches. The pseudo EF codes select the following functions:

1) Motion control
   - Backspace One Record
   - Search Backward to File Mark
   - Search Forward to File Mark
2) Information transfer
   - Read

The on-line and simultaneous off-line circuits permit several system configurations. Two examples of maximum configurations are:

1) Tape handler A writing from computer (on-line)
   Tape handler B reading to printer (simultaneous off-line)

Other tape handlers standing by, rewinding, or searching

2) Tape handler A reading to computer (on-line)
Tape handler B reading to printer (simultaneous off-line)
Other tape handlers standing by, rewinding, or searching

TABLE 1-2. EXTERNAL FUNCTION CODES AND STATUS RESPONSES

EXTERNAL FUNCTION CODES		
CODE	COMPUTER INSTRUCTION	FUNCTION
Y11X	OUT	Write
Y11X	(no OUT)	Write end of file mark
Y12X	INA	Backspace tape one record
Y12X	(no INA)	Search backward to file mark
Y13X	INP	Read
Y13X	(no INP)	Search forward to file mark
Y14X		Status request
Y15X		Rewind unload
Y16X		Rewind load
Y171		Odd parity (binary)
Y172		Even parity (binary coded decimal)
210X		High density*
110X		Low density*
Y = 1: 6-bit mode Y = 2: 12-bit mode X = (0 to 7): designates one of the four (eight) 60X's		
STATUS RESPONSES		
0000		Odd parity selected - no errors
0001		Even parity selected - no errors
0002		Selected 60X not ready
0004		Parity error
0015		Illegal BCD detected on Write
0020		End of file read
0040		End of tape or Load point sensed
0100		High density
0200		Selected 60X busy

NOTE: Master bits 12, 13 or 22, 23 are used for second and third 162's.
Programmer consideration: 6-bit, 556 density, mode illegal for 162-2.
6-bit, 800 density, mode illegal for 162-3.

* 162-3 determines with a manual switch which densities will be high and low (200-556, 200-800, or 556-800)

ON-LINE PRELIMINARY SELECTIONS

SYSTEM TAPE HANDLER, WORD LENGTH	Selected by the initial EF code Y1nX (Y1 = system, Y = word length, X = tape handler) (Y = 1 or 2, X = 0 through 7). (See table 2 and chapter 3).
PARITY	Selected by a Y17X code (Y = 1 or 2, X = parity [1 - odd, 2 - even]).
DENSITY	Selected by a Y10X code (Y = density [1 - low, 2 - high] , * X = tape handler).

ON-LINE MOTION CONTROL

BACKSPACE ONE RECORD	Initiated by the Select code Y12X (Y = word length, X = tape handler) and an INA instruction. The 162 signals the tape handler to start reverse tape motion. Motion continues automatically until the tape handler recognizes an end of record gap. Motion then stops and the tape handler and the 162 are cleared for future operation.
SEARCH BACKWARD TO FILE MARK	Initiated by the Select code Y12X (Y = word length, X = tape handler) and no INA instruction. The 162 signals the tape handler to start reverse tape motion and to ignore end of record gaps. Tape motion continues automatically until a file mark (17_8 BCD) is sensed. Once the 162 has signalled the tape handler, it is available for operation with other tape handlers. When the initial tape handler has sensed the file mark, it is available for other operation.
SEARCH FORWARD TO FILE MARK	Initiated by the Select code Y13X (Y = word length, X = tape handler) and no INP instruction. Same as Search Backward except for tape motion direction.
REWIND	Initiated by the Select code Y16X (Y = word length, X = tape handler). The 162 sends the Rewind signal to the tape handler which

* 162-3 determines with a manual switch which densities will be high and low (200-556, 200-800, or 556-800).

REWIND (Cont'd)	starts high-speed reverse tape motion. The 162 is then available for operation with other tape handlers. Motion continues in the initial tape handler until the load point is sensed. The tape handler is then available for new operation using forward motion.
REWIND UNLOAD	Initiated by the Select code Y15X (Y = word length, X = tape handler). Similar to a Rewind operation except that the tape does not stop at load point, but is completely unloaded from the reel. Further operation necessitates manual reloading.

ON-LINE INFORMATION TRANSFER

WRITE	Initiated by the Select code Y11X (Y = word length, X = tape handler) and an OUT instruction. The 162 signals the tape handler to start forward tape motion. After a delay equal to the time required to move the tape three-fourths of an inch (record gap), the 162 receives a 12-bit computer output word. If the Assembly mode (12-bit word length) is selected, the 162 disassembles the computer word into two 6-bit words, generates a parity bit for each word, and passes them (highest order word first) to the tape handler. If the Character mode (6-bit word length) is selected, the 162 takes the lowest order six bits of the computer word, generates a parity bit for it, and passes it to the tape handler. The tape handler writes each word it receives from the 162 as a seven channel frame. Operation continues as long as the computer sends output words to the 162. When output ceases the 162 generates the following: 1) Check character gap (duration to move the tape the equivalent of three frames). 2) Check character (longitudinal parity bit for each

WRITE (Cont'd)	channel). The check character is passed to the tape handler to be recorded. Each recorded frame is read back to the 162 and checked for horizontal parity error. These read-back circuits (Write Reply) activate the End of Record circuits when they sense an end of record gap. At that time a check is made on the write reply longitudinal parity character. The End of Record circuits terminate operation and clear the tape handler of the 162 for future operation.
WRITE FILE MARK	Initiated by the Select code Y11X (Y = word length, X = tape handler) and no OUT instruction. The 162 signals the tape handler to start tape motion and, after a delay equal to the time required to move the tape six inches, sends the file mark to the handler. The file mark (17_8) is written as if it were a one-frame record of BCD information, i.e., data is recorded, a check character gap is left on the tape, and the check character is recorded. When the end of record gap is sensed by the Write Reply circuit, operation is terminated and the units are cleared for future operation.
READ	Initiated by the Select code Y12X (Y = word length, X = tape handler) and an INP instruction. The 162 signals the tape handler to start tape motion. The tape handler read heads sense each frame of recorded data and transfer the frame (seven bits) to the 162. If the Assembly mode (12-bit word length) is selected, the 162 assembles each two successive 6-bit words into a 12-bit input word (first word - highest order). If the Character mode (6-bit word length) is selected, the 162 assembles each 6-bit tape handler word into the lowest order of a 12-bit input word (upper six bits all "0's"). As each tape handler word passes through the 162, a new parity bit is generated for each six bits of data and compared to the recorded parity bit. If they differ, an indicator lights.

BACKSPACE ONE WORD	Initiated by pressing the following printer switches: Tape/Print Tape/Card Backspace The tape moves backward until a record gap is sensed.
SEARCH BACKWARD TO FILE MARK	Initiated by pressing the following printer switches: Tape/Print Tape/Card Master Clear (Press and hold before pressing the Backspace switch, continue holding until motion stops.) Backspace The tape moves backward until a file mark is sensed.

OFF-LINE INFORMATION TRANSFER (Read Only)

READ	Initiated by pressing the following printer switches: Tape/Print Tape/Card Step or Continuous The 162 assembles each two successive tape handler words into a 12-bit input word (first word - highest order). The 12-bit word is sent to the printer after each of its 6-bit words is checked for parity error. If the tape comes to an end of record, operation stops. If the printer Stop switch is pressed during operation, information transfer stops but tape motion continues until the end of record is sensed.

603/604/606 FUNCTIONAL CHARACTERISTICS

TAPE FORMAT

Magnetic tape provides a high speed, non-volatile 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 the oxide side of the tape over read/write heads. Information is written or read on independent tracks on the tape by seven recording heads placed vertically across the tape.

A 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 line of tape data consists of a 6-bit character and a parity (check) bit. Tracks 0 through 5 specify the character; trace 6 holds the parity bit (figure 1-2).

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 synchronizer.

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

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

REFLECTIVE SPOTS

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

The load point marker must be placed at least ten feet from the beginning of the tape on the supply reel (figure 1-3). This marker is placed with its one-inch dimension parallel to, and not more than 1/32 inch from the edge of the tape nearest the operator when the file reel is mounted.

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

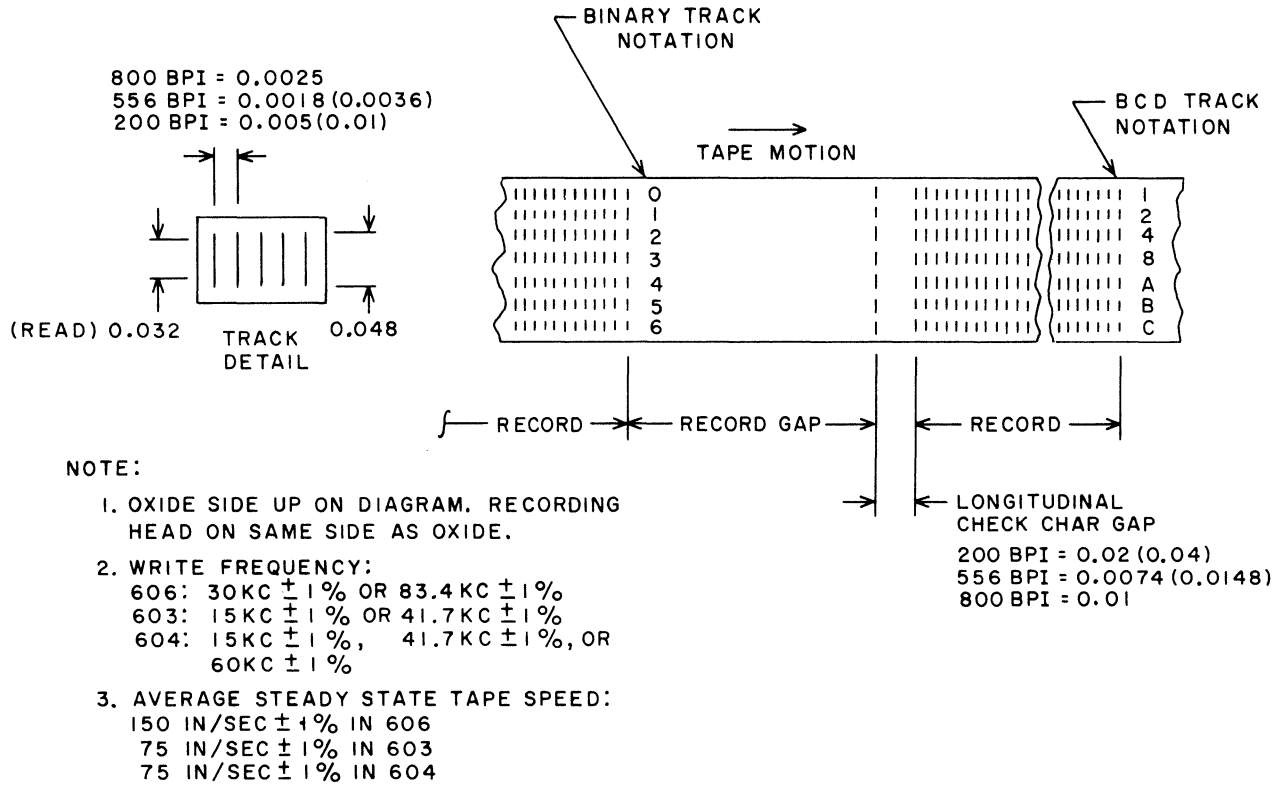


Figure 1-2. Bit Assignments on Tape

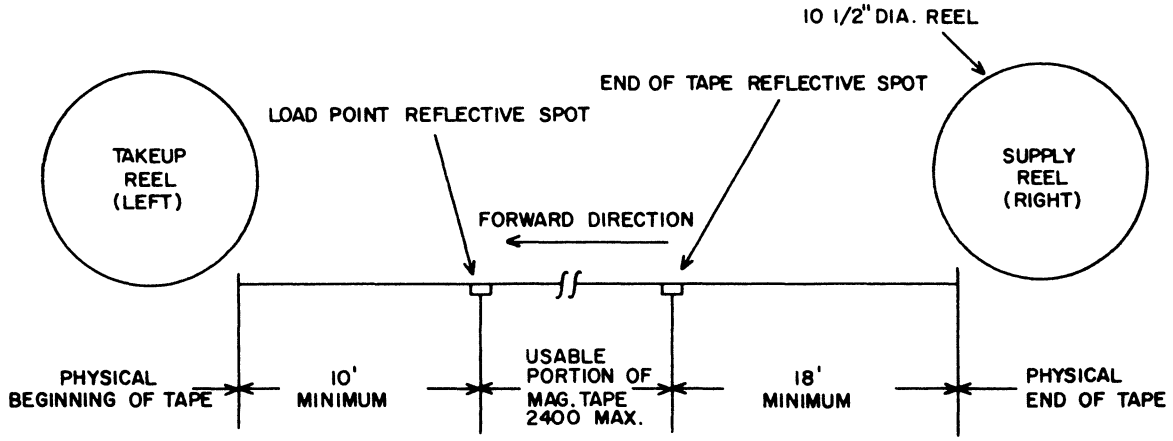


Figure 1-3. Physical Layout of Tape

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. The marker is placed with its one-inch dimension parallel to, and not more than 1/32 inch from the edge of the tape nearest the tape unit (when reel is mounted).

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

FILE PROTECTION RINGS

The back of the file reel has a slot near the hub which accepts a plastic file protection ring (figure 1-4). 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 signalled by the overhead lights which turn on immediately after the tape load procedure is executed. The lights remain on until the ring is removed or the tape unit is placed in the unload status. The ring should be removed from the file reel after writing to avoid loss of records through accidental rewriting.

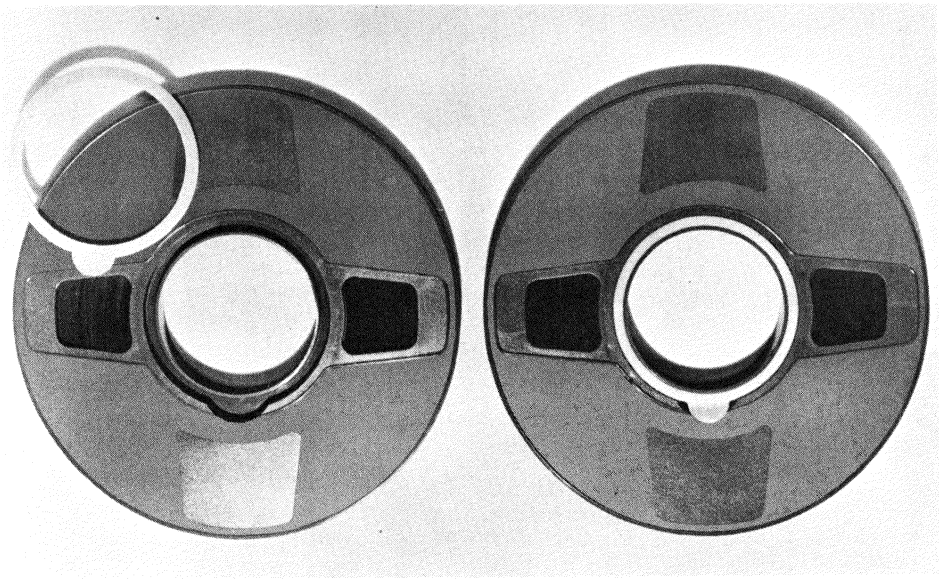


Figure 1-4. File Protection Ring

CHAPTER 2
OPERATION

162 ON-LINE OPERATING INSTRUCTIONS

Make certain necessary cables are connected:

2 cables to the computer

2 cables to each tape handler

1 power cable

162 OFF-LINE OPERATING INSTRUCTIONS

1) Make certain necessary cables are connected:

2 cables to the printer off-line jacks

2 cables to tape handler "7"

1 power cable (same as on-line)

2) Select parity mode (table 2-1).

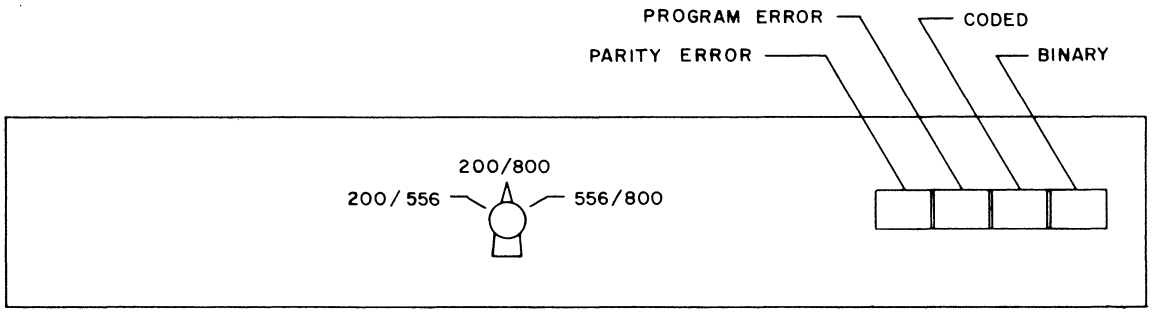


Figure 2-1. 162-3 Control Panel

TABLE 2-1. 162 CONTROLS

Binary	S/I*	Press to select Binary.
Coded	S/I	Press to select Coded.
Parity Error	I	Indicates that the 162 has sensed a parity error or an illegal BCD.
Program Error	I	Indicates that the 162 has sensed an illegal BCD or that a backspace selection was made while the tape was at load point.
162-3 Density Switch		
800-200	S/I	Presets high density equal to 800 bpi low density equal to 200 bpi
800-556	S/I	Presets high density equal to 800 bpi low density equal to 556 bpi
556-200	S/I	Presets high density equal to 556 bpi low density equal to 200 bpi

*S = Switch
I = Indicator

166-2 OPERATING INSTRUCTIONS

1) Place forms control tape on machine.
2) Load forms compartment (raise drum arm before placing forms on tractors).
3) Press the Logic On switch.
4) When the Logic On indicator lights, press the Printer On switch.
5) Check positioning of paper.
6) Press the Zero Disable switch if the data block contains 00 codes (Binary Parity mode) which should not be printed as colons.
7) Press the Master Clear switch.
8) Select Parity mode by pressing Binary/Coded switch on the 162.
9) Select Density mode by pressing Density switch on the tape handler.
10) Set printer Tape/Print switch to the PRINT position.
11) Set printer Tape/Card switch to the TAPE position.
12) a) For a one-line print operation press the printer Step switch.
    b) For a continuous print operation (to record gap) press the printer Continuous switch.

c) For a search forward operation hold down the printer Master Clear switch and press either the Step or Continuous switch. Hold Master Clear until tape motion stops.

d) For a backspace one record operation press the printer Backspace switch.

e) For a search backward operation hold down the printer Master Clear switch and press the Backspace switch. Hold Master Clear until tape motion stops.

603/604/606 OPERATING INSTRUCTIONS

APPLICATION OF POWER

To initially energize the tape unit:

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

The Power switch on the front 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 2-2).
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 take-up reel. Thread tape on the outside of the supply tape load arm, over 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 Selection switch (0-7 or standby) to desired program selection number.

9) Press Clear switch.

10) Press Load Point switch. Tape will drop in columns, move forward, and stop on load point marker. Load Point light will turn on. If tape continues moving forward for more than three or four seconds, 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.

11) If the unit is to be controlled by the synchronizer, press the Ready switch. If it is to be manually operated and the Ready switch has been pushed, press the Clear switch.

12) Push up door.

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

TAPE UNLOAD PROCEDURE

1) Press Clear switch.

2) Press Unload switch. All tape will automatically be drawn from the take-up reel and wound on the supply reel. The Unload indicator will light.

3) Slide down front door.

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

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

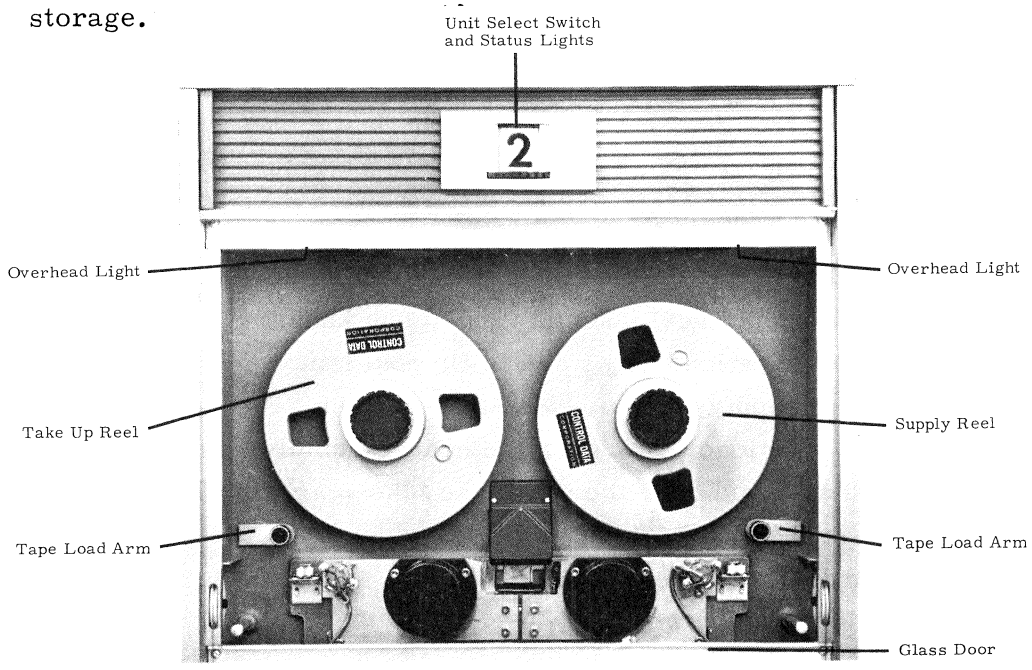


Figure 2-2. Tape Load and Unload Mechanics

MANUAL OPERATION

The manual controls and indicators for operating each tape unit are mounted on a panel located below the front door of the unit (figure 2-3). The functions of the controls are described in table 2-2.

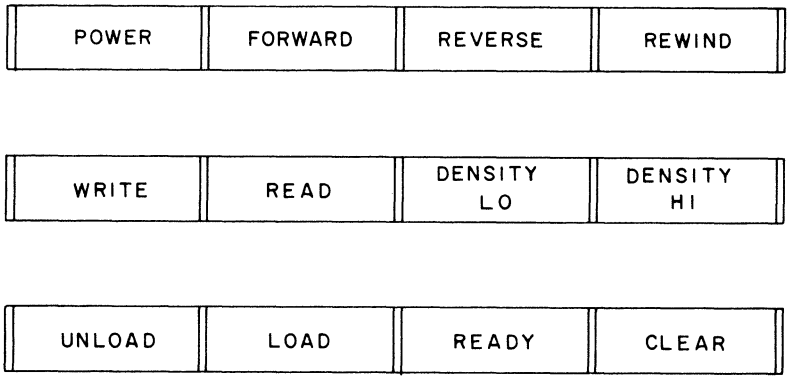
TABLE 2-2. 60X MANUAL CONTROLS AND INDICATORS

Name		Function
POWER	S*	Removes power from the tape handler.
	I**	Power is available to tape handler.
FORWARD	S	Moves tape forward at 150 (75) ips. Motion stops when end of tape marker is sensed.
	I	Tape is moving forward at 150 (75) ips.
REVERSE	S	Rewinds tape at 320 ips. Motion stops when load point marker is sensed.
	I	Tape is moving in reverse direction at 150 (75) or 320 ips.
REWIND	S	Rewinds tape at high speed (over 320 ips average). Motion stops at load point.
	I	Tape is moving at high speed reverse.
WRITE	I	Write operation is in progress.
READ	I	Read operation is in progress (not write reply).
UNIT SELECTION	S	Ten-position switch; 0-7 provide input designation and two standby positions disconnect unit from external control.
	I (White)	Unit select light 1.
	I (Red)	Unit select light 2.
OVERHEAD LIGHTS	I	File protection ring is on reel (unit can write) and tape unit is not in the unload position.
***DENSITY LOW	S	Selects low rate of information transfer.
	I	Low density selected.
***DENSITY HI	S	Selects high rate of information transfer.
	I	High density selected.
UNLOAD	S	Moves tape at 320 ips to unload position (all tape on supply reel). Tape load procedure must be performed to resume operation.
	I	Tape is in unload status.

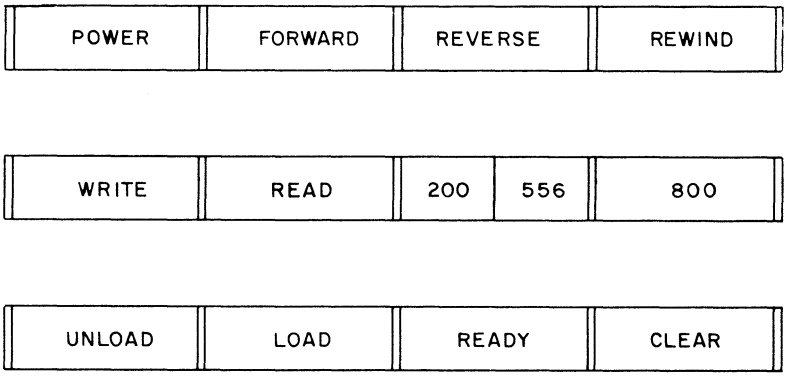
* Switch
** Indicator
*** The 604 has 3 density switch/indicators (200/556/800). See figure 2-3.

TABLE 2-2. (Cont'd)

Name		Function
LOAD	S	Moves tape forward at 150 (75) ips to load point marker. Motion stops when marker is sensed.
	I	Tape is at load point marker.
READY	S	Places 60X under external control.
	I	Unit is under external control.
CLEAR	S	Master clears all previous settings and conditions. Stops (immediately) tape motion. New manual selections are necessary to reselect tape unit and/or operation required.
	I	60X is cleared.



603/606 Control Panel



604 Control Panel

Figure 2-3. Operator Control Panels

SPECIAL INSTRUCTIONS

To simulate an Unload condition without removing all tape from the take-up reel, simultaneously press the Clear and Unload switches. The unload condition will be simulated but tape will not move. 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 Point switch. The tape will move forward and stop on the nearest load point marker. The Load Point indicator will be turned on.

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 ten turns around the supply reel.

3) Slide tape under head assembly.

4) Press the Load Point switch.

5) As soon as the Forward light turns on, press the Clear switch and then the Reverse switch. Tape will rewind on the nearest load point marker.

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

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

To move forward off a reflective marker and stop at nearest load point or end of tape marker, press the Forward and then the Load Point switch. Load Point indicator will light if motion stops at load point marker.

To reverse from a reflective marker and stop at nearest load point marker, press the Unload, Clear, and Reverse 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.

CHAPTER 3
PROGRAMMING

The 160-A input/output capabilities are activated by an External Function code:

75XX - The code is at the address found by adding the contents of the P register to XX. The next instruction is found at contents of P + 1.

7500 - The code is at the address found by adding the contents of the P register to 1. The next instruction is found at contents of P + 2.

The 160-A has two modes of input/output operation, buffered and normal.

BUFFERED

7200 - Initiates the Buffered Input circuits, is followed by the next location if the buffer is busy. The next location will hold the address for the alternate control. If the buffer is not busy, the next instruction is found at the contents of P + 2.

7300 - Initiates the Buffered Output circuits, is followed by the next location if the buffer is busy. The next location will hold the address for the alternate control. If the buffer is not busy, the next instruction is found at the contents of P + 2.

Prior to either of these instructions, circuits must be enabled to transfer information internally. This is accomplished by the following instructions:

0105 - (A) to Buffer Entry register. The next instruction is found at the contents of P + 2. If the buffer is busy, at P + 1.

0106 - (A) to Buffer Exit register. The next instruction is found at the contents of P + 2. If the buffer is busy, at P + 1.

0107 - Buffer Entry register to the A register.

016X - Store the contents of the Buffer Entry register at location 6X. Transfer the A register to the Buffer Entry register.

NORMAL

72XX - Initiates the Normal Input circuits. The address of the first input word is to be P + 00XX. The last word + 1 is found at the location referred to by P + 1.

73XX - Initiates the Normal Output circuits. The address of the first output word is to be P + 00XX. The last word + 1 is found at the location referred to by P + 1.

7600 - Input one word to the A register. Next instruction P + 1.

7677 - Output the contents of the A register. Next instruction P + 1.

74XX - Output XX. Next instruction P + 1.

TABLE 3-1. OPERATION DESCRIPTIONS

WRITE	Y11X starts tape motion forward. Output instruction triggers sprocket signal to tape handler and gates output word to the tape to be written.
WRITE FILE MARK	Y11X starts tape motion forward. After six inches of tape, file mark (17_8) and check character are written.
BACKSPACE ONE RECORD	Y12X starts tape motion reverse. Input instruction triggers signal to tape unit that enables the tape unit to recognize the end of record gap.
SEARCH BACKWARD TO FILE MARK	Y12X starts tape motion reverse. Without input instruction the tape unit recognizes only the file mark gap (not the record gap). Once the selection is made the 162 is free to communicate with other tape units.
READ	Y13X starts tape motion forward. Input instruction allows information to read from the tape.
SEARCH FORWARD TO FILE MARK	Y13X starts tape motion forward. Without input instruction the tape unit recognizes only the file mark gap (not the record gap). Once selection is made, the 162 is free to communicate with other tape units.
STATUS REQUEST	Y14X enables circuits that permit the computer to input the status response. The status response "busy" will be returned during a rewind or a search operation.
REWIND UNLOAD	Y15X starts reverse tape motion at high speed. Motion continues until tape has completely rewound off reel. 162 is free for other operation after initial selection.
REWIND LOAD	Y16X starts reverse tape motion at high speed. Motion continues until load point reflective spot is sensed. 162 is free for other operation after initial selection.

162 PROGRAM EXAMPLE

Write 500 words stored in locations 2000 through 2500.

ADDRESS	INSTRUCTION		DESCRIPTION
7000	7500	EXC	External Function code
7001	2171	select binary format for the 162	
7002	7500	EXC	
7003	2141	status request	
7004	7600	INA	Normal input to A
7005	0202	LPN	Logical product no address
7006	6002	ZJF	Condition met jump 02 locations. Condition not met go to present location +1.
7007	7702	SLS	Halt (if switch 2 is set)
7010	7500	EXC	
7011	2111	select 12-bit Write	
7012	7315	OUT	Address of the first word found 15 locations forward. Address of the last word found at location after this one (7013). Continue program at location 2 - this one (7014).
7013	2501	terminating address + 1	
7014	7500	EXC	
7015	2141	status request	
7016	7600	INA	Normal input to A
7017	0204	LPN	Logical product no address
7020	6002	ZJF	Condition met jump 02 locations. Condition not met go to present location + 1.
7021	7704	SLS	Halt (if switch 4 is set)
7022	2200	LDC	Load to A (constant)
7023	0001	variable determines non-stop or stop-start	
7024	0701	SBN	Subtract 1 from operand
7025	6501	NZB	Not zero jump back one location Zero continue
7026	6416	ZJB	Zero jump back 16 locations Not zero continue
7027	2000	starting address	

CHAPTER 4

PRINCIPLES OF OPERATION

Computer EF codes allow the CONTROL DATA 162 Magnetic Tape Synchronizer to perform the following functions:

1) Control the tape handlers in the system.
2) Transfer information back and forth between the computer and the selected tape handler.
3) Convert the data representation to a useable format.

The test is divided into the following sections:

A) Selection Circuits
- Synchronizer (162 system)
- Tape handler (part of the system)
- Recording mode
  - Density
  - Word format (assembly - 12 bit) (character - 6-bit)
  - Parity mode (BCD or binary)
- Operation

B) Control Circuits
- Timing
  - FT (function time) sequences selection and signal transfer
  - T (main timing) sequences operation and register transfer
- Control FFs
  - RC (read) controls Read functions
  - WC (write) controls Write functions
  - SC (status) controls Status function
  - BC (block) controls transfer of one record of data
- Motion
  - Forward
  - Reverse
  - Non-stop (writing or reading more than one record without stopping tape motion)
- End of Record (controls termination of 162 control)

C) Register Transfer (describes how data format is changed as it passes through the registers)

D) Operation

- Status
- Preliminary
  - Parity mode
  - Density
- Information transfer
  - Write
  - Write File Mark
  - Read
- Motion directives
  - Search Forward to File Mark
  - Backspace One Record
  - Search Backward to File Mark
  - Rewind Load
  - Rewind Unload

SELECTION CIRCUITS

In computer-magnetic tape operations, the computer EF code selects the following equipment and functions:

1) Synchronizer (162 system)
2) Tape handler (part of the system)
3) Recording mode
   - Density
   - Word format
   - Parity mode
4) Operation*

SYNCHRONIZER

The synchronizer is selected by a 21XX or 11XX EF code unless the 162 is already performing an operation that requires additional control. The Function Lockout and the Status Lockout circuits determine this condition (figure 4-1).

---

* Certain operations are also dependent on the presence or absence of additional computer I/O signals.

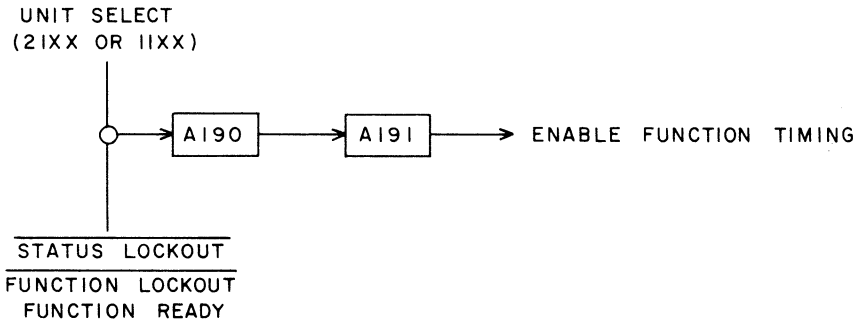


Figure 4-1. 162 Selection

Function Lockout

The Function Lockout is active if the 162 is performing one of the following selections:

1) Write
2) Write File Mark
3) Read
4) Search Forward to File Mark (only during selection)
5) Backspace One Record
6) Search Backward to File Mark (only during selection)

The Function Lockout II FF (figure 4-2) is set when the Function Ready signal, accompanying one of the above selections, terminates. The End of Record circuit is enabled when 162 control is no longer necessary. The Function Lockout II FF is cleared 25 usec after the End of Record circuit is enabled, thereby allowing further selection.

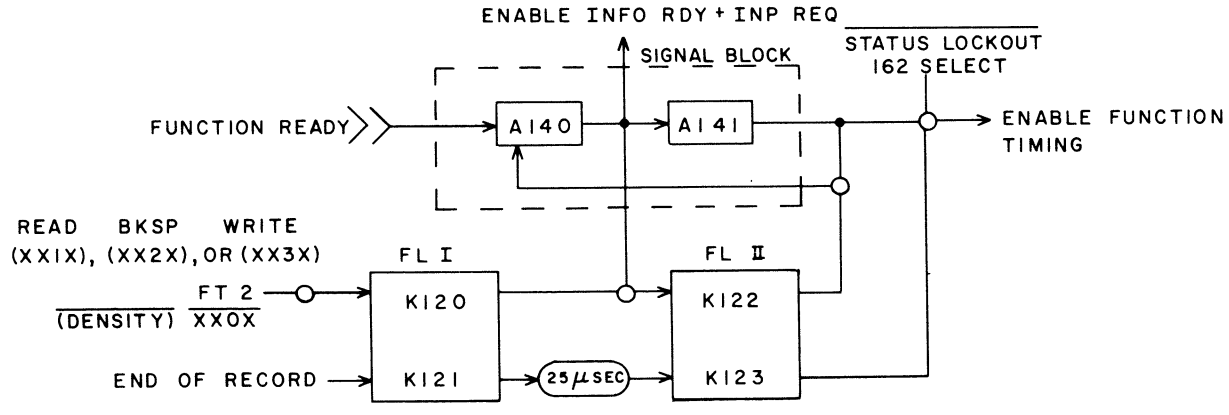


Figure 4-2. Function Lockout

If the computer issues another Function Ready signal while Function Lockout II is set, the external feedback of A140-A141 blocks the reception of an Information Ready signal or an Input Request signal. This allows the computer to communicate with other equipment during the time Function Lockout II is set.

Status Lockout

The Status Lockout FF (figure 4-3) is set by a Status selection. It blocks further selection until the Status Reply is sent to the computer.

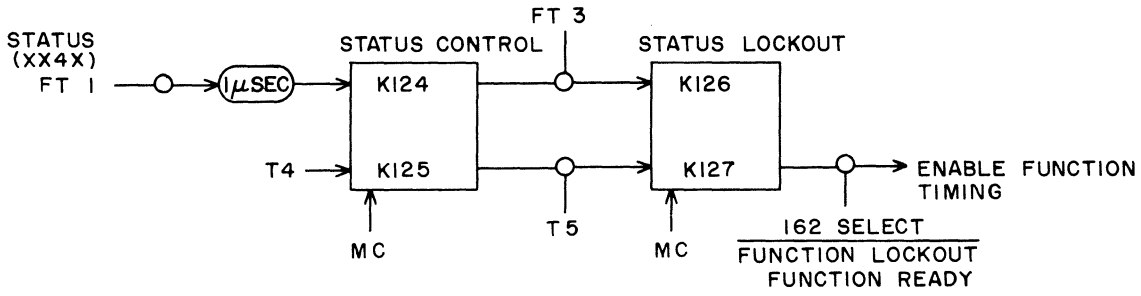


Figure 4-3. Status Lockout

TAPE HANDLER

For a tape handler to be selected, its Selection switch must be set to the same number as the octal digit n in the function code XXXn (figure 4-4). The Selection switch is located near the top of the tape handler.

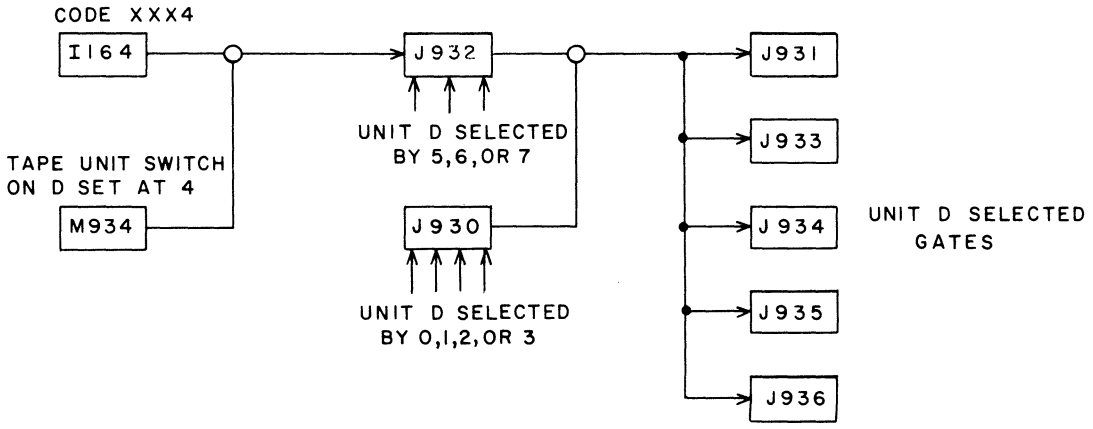


Figure 4-4. Tape Handler Select

RECORDING MODE

Density

The 162-1 and 162-2 select 556 density by a 210X code, 200 density by a 110X code. The 2XXX code sets the Assembly/Disassembly FF, the 1XXX code does not (figure 4-5). The state of this FF is passed to the tape handler by circuits enabled by the XX0X code.

The 162-3 has a Density switch that is manually set to determine which of the three available densities is to react to the high or low setting of the Assembly/Disassembly FF.

Lines R and S to the tape handler signal 556 and 200 densities in the 162-1, 162-2, and 162-3. Both signals present in a 162-3 indicate 800 density.

FFs in the tape handler are set or cleared by the signals (R and S). Signals from the tape handler to the synchronizer indicate the state of these FFs. Certain delay circuits are altered in the Synchronizer according to these signals.

Word Format

The word format (12-bit or 6-bit) is determined from the code that selects the operation to be performed. A 2XXX code sets the Assembly/Disassembly FF, a 1XXX code does not (figure 4-5). The FF controls the data transfers in loading and unloading. If the 12-bit mode (Assembly mode) is selected, the Assembly/Disassembly FF enables the word counter. The counter determines whether the 6-bit word passing through the 162 is the upper or the lower part of the 12-bit computer word. The 6-bit mode (Character mode) passes only the lower 6 bits of the computer word.

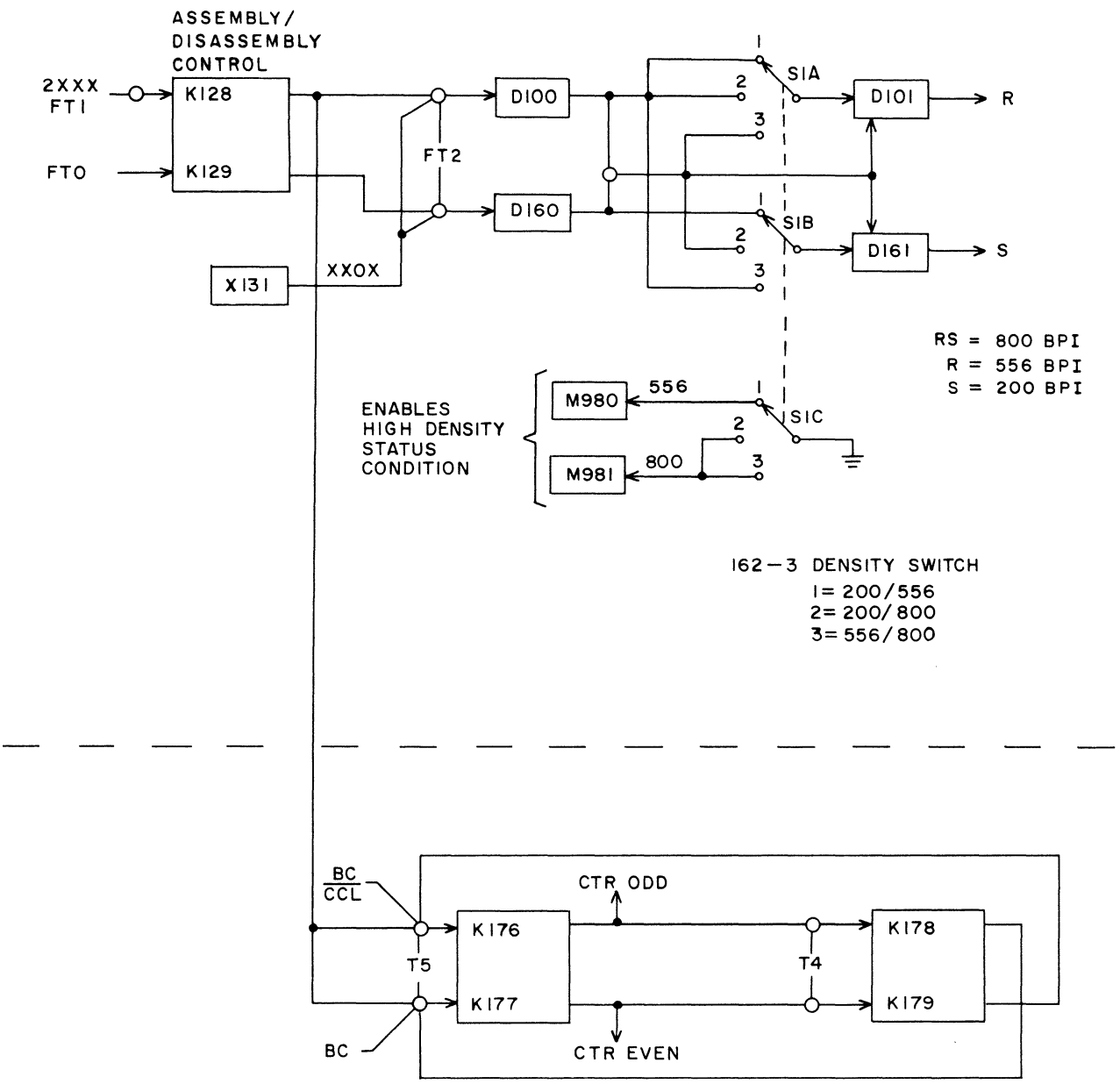


Figure 4-5. Density - Word Format

Parity Mode

BCD mode is selected by a XX72 code; binary mode by a XX71 code. A XX72 code sets the Code FF; a XX71 code clears it (figure 4-6). This FF controls the parity generation and the Binary/Coded indicator switch on the front panel.

The Parity mode may also be changed manually by pressing either the Binary or Coded indicator switch. The selected switch illuminates. Selecting either switch removes the input ground to M196 and grounds the input to M195.

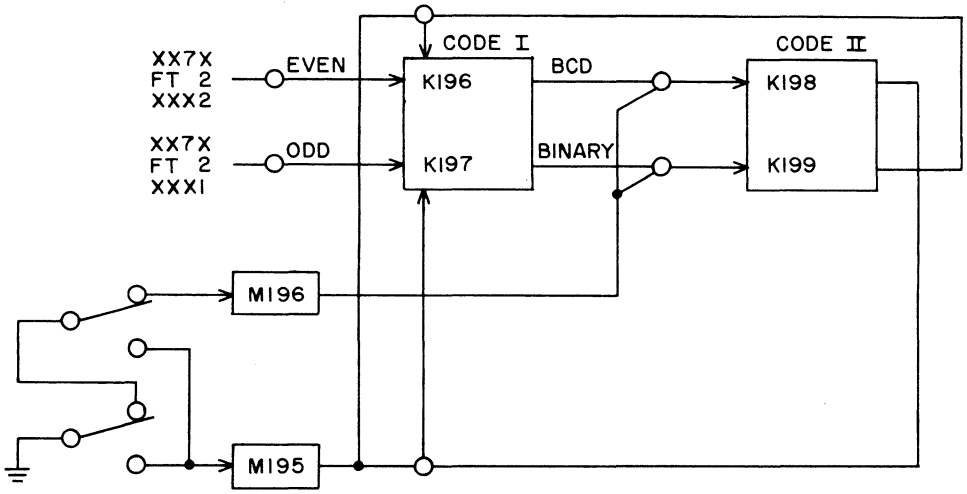


Figure 4-6. Parity Mode

OPERATION

The operation that the 162 is to control is determined by the value of n in the function code XXnX, and in certain operations by that code in conjunction with the presence or absence of computer I/O signals.

In the example shown in figure 4-7 the External Function code is XX3X. This code followed by an Input Request signal selects a Read operation. This code without an Input Request signal selects a Search Forward to File Mark operation.

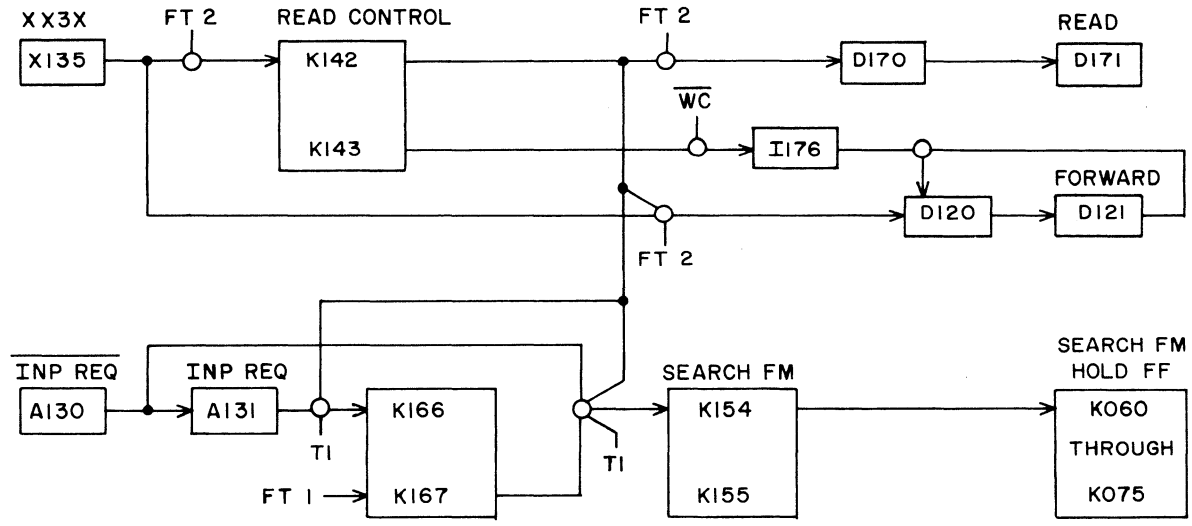


Figure 4-7. Read/Search Forward Select

The XX3X code sets the Read Control FF. If no Input Request follows, the Search FF is set, thereby sending a Search File Mark signal to the tape handler. If an Input Request signal follows, the Search FF is not set and only the Forward signal and the Read signal are sent. These signals to the tape handler allow the selected operation to proceed automatically.

CONTROL CIRCUITS

The 162 performs its control function in the following manner:

1) The function timing chain sequences the acceptance of the function codes from the computer and the transmission of the control signals to the tape handler and the computer.
2) The Control FFs in the 162 enable the circuits necessary for the selected operation.
3) The main timing chain sequences the information and register transfers necessary for the operation.
4) The End of Record circuit terminates the operation, preparing the 162 for other operations.

TIMING

The synchronization functions of the 162 are accomplished by two timing chains. The function timing chain sequences selection and the main timing chain sequences Write, Read, and Status operations.

Function Timing

The Function Timing circuit sequences selection and transmission of the control signals to the tape handler. A detailed outline of the circuits may be found in table 5-5 and the command timing charts in appendix C.

The function timing chain (figure 4-8) is triggered by the Function Ready signal accompanying a 162 selection. The four function times (FT) follow automatically in most selections.

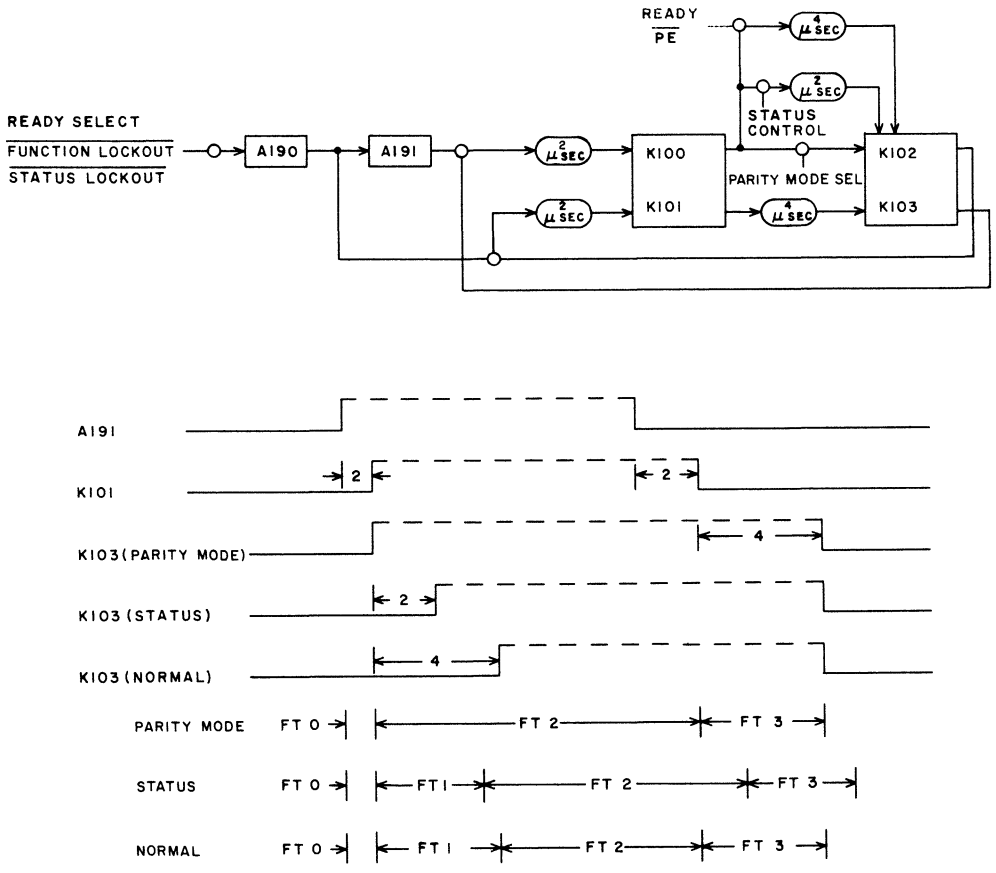


Figure 4-8. Function Timing Chain

FT	Duration	Comment
0	2 usec	
1	During Parity Mode selection: lasts long enough for translation of function code.	Not affected by conditions in tape handler
	During a Status selection: 3 usec	Not affected by conditions in tape handler
	During other selection: 4 usec	If tape handler is ready
2	Lasts 2 usec from drop of Function Ready signal (approximately 4 + usec)	
3	4 usec	

FT2 controls the transmission of the Output Resume signal to the computer, the setting of the Control FFs, and the transmission of the control signals to the tape handler. It cannot occur if the tape handler is not ready for a new operation (figure 1-9). (This is not true for a Status or a Parity Mode selection as they do not concern the tape handlers.) If any other selection is made but the tape handler is not ready, the computer program is halted until the tape handler is ready.

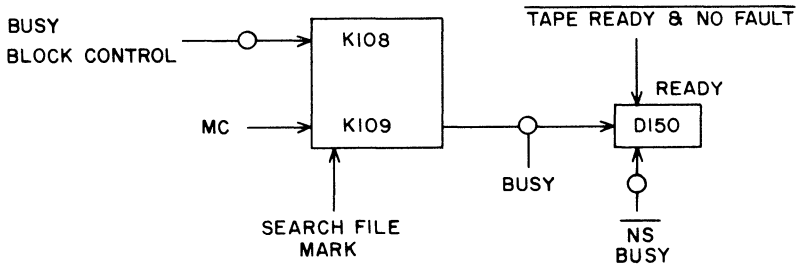


Figure 4-9. Ready Circuit

Main Timing

The main timing pulses are generated by a five-stage timing chain. The chain is enabled for one loop by the following conditions (figure 1-10):

1) each character written on the tape (enabled by the Sync pulse)
2) each character read from the tape (enabled by the Sprocket pulse)

3) each of the three gaps and the check character at the end of a Write operation (the Enable Oscillator FF remains set in a Write operation until the check character is enabled)

4) each status response

5) in the event that an odd number of characters are read in the Assembly mode

The functions of the timing pulses are shown in the command timing charts (appendix C) and in the main timing chart (table 5-6).

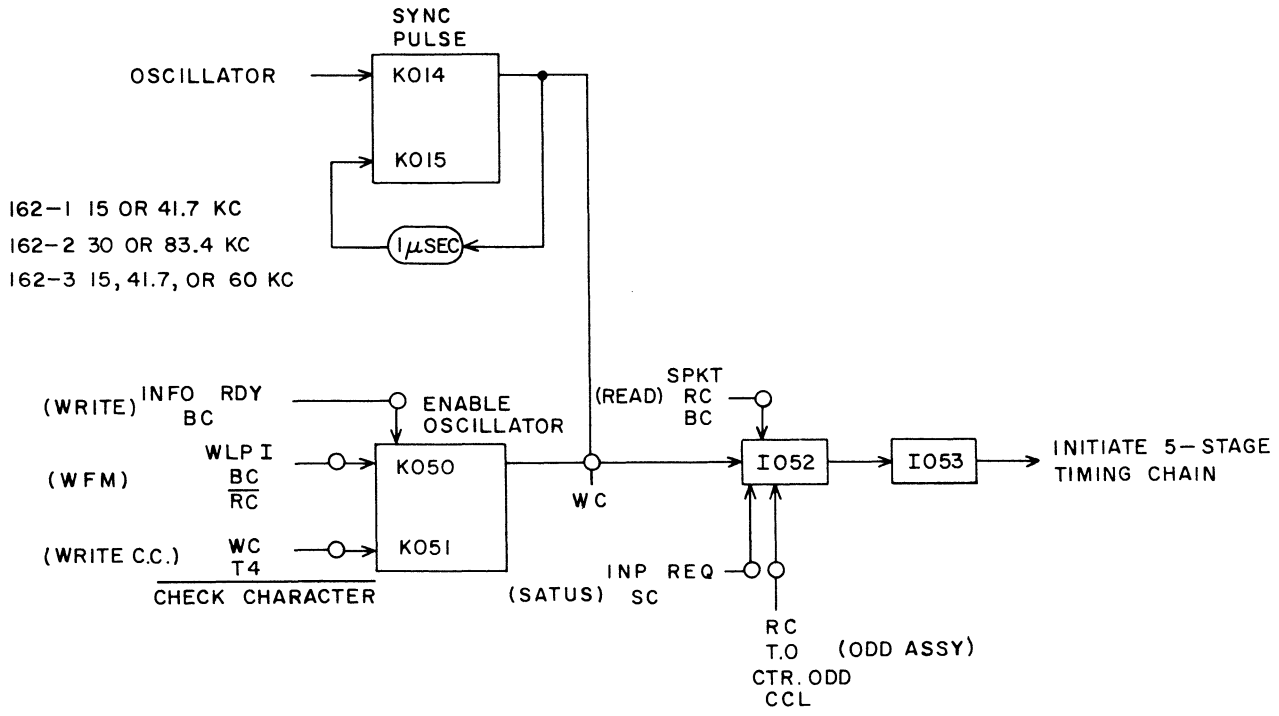


Figure 4-10. Main Timing

CONTROL FFs

Read Control (RC)

The Read Control FF is set at FT 2 when a Read, Search Forward to File Mark, Backspace One Record, or Search Backward to File Mark selection is made (figure 4-11). It controls the circuits used in these selections. The FF is cleared by the 162 End of Record circuits. These circuits are enabled when the tape handler senses an End of Record or when a Search operation has been selected.

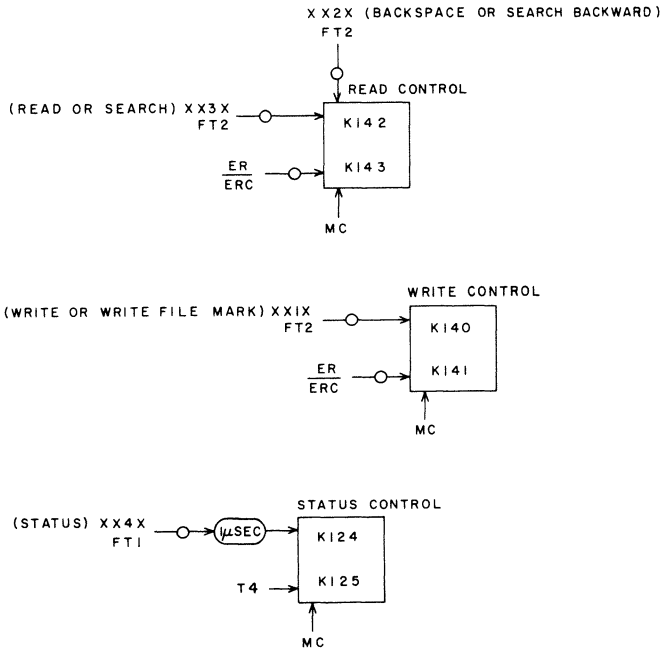


Figure 4-11. Read, Write, and Status Control

Write Control (WC)

The Write Control FF is set at FT 2 when a Write or Write File Mark selection is made (figure 4-11). It controls the circuits used in these selections. The FF is cleared by the 162 End of Record circuits when the End of Record is sensed by the tape handler in the Write Reply.

Status Control (SC)

The Status Control FF is set at FT 1 when a Status selection is made (figure 4-11).

It controls the circuits used in a Status Response (see Status operation and command timing charts, appendix C).

Block Control (BC)

The Block Control FF is set during the time that information transfer is required. It is set for the following selections:

1) Read
2) Backspace One Record
3) Search Forward to File Mark
4) Search Backward to File Mark
5) Write
6) Write File Mark

In a Read or Backspace One Record selection it remains set until one record of information has been read. In a Search selection it remains set only long enough to ascertain that a request for information is not forthcoming. In a Write selection it remains set until there is no more information to write. In a Write File Mark selection it remains set long enough to trigger the main timing chain for the file mark transfer.

For a Read, Backspace One Record, Search Forward to File Mark, or Search Backward to File Mark selection, the Block Control FF (figure 4-12) is set by the Read Control FF and the Read Sprocket pulse from the tape handler. (The Read Sprocket is a pulse corresponding to each frame read.)

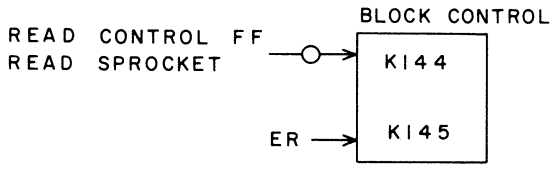


Figure 4-12. Block Control (Read)

For a Write File Mark selection, the Write Control FF and the Busy signal from the tape handler set the WLP I FF (figure 4-13). Forty ms (eighty ms) later (time for the tape to move 6 inches) WLP II FF is set; WLP I and WLP II set the Block Control FF.

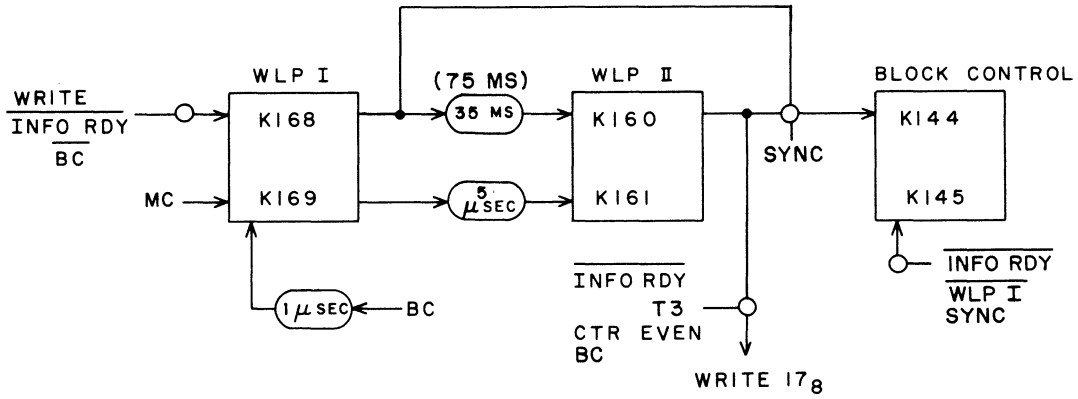


Figure 4-13. Block Control (WFM)

For a Write selection made while the tape is at load point, the Write Control FF and the Busy signal from the tape handler set WLP I FF (figure 4-14). Forty ms (eighty ms) later (time for the tape to move approximately 6 inches) WLP II FF is set; WLP I and WLP II set the Block Control FF.

For a Write selection made while the tape is not at load point, the Write Control FF and the Busy signal from the tape handler set the Block Control FF via the delay path I113 through I110 (figure 4-14). The adjustable delay in this delay path assures a 3/4 inch clean record gap.

For continuous writing, the Non-Stop circuits (see motion description) give I110 a "1" output after allowing time for the 3/4 inch record gap, thereby re-setting Block Control.

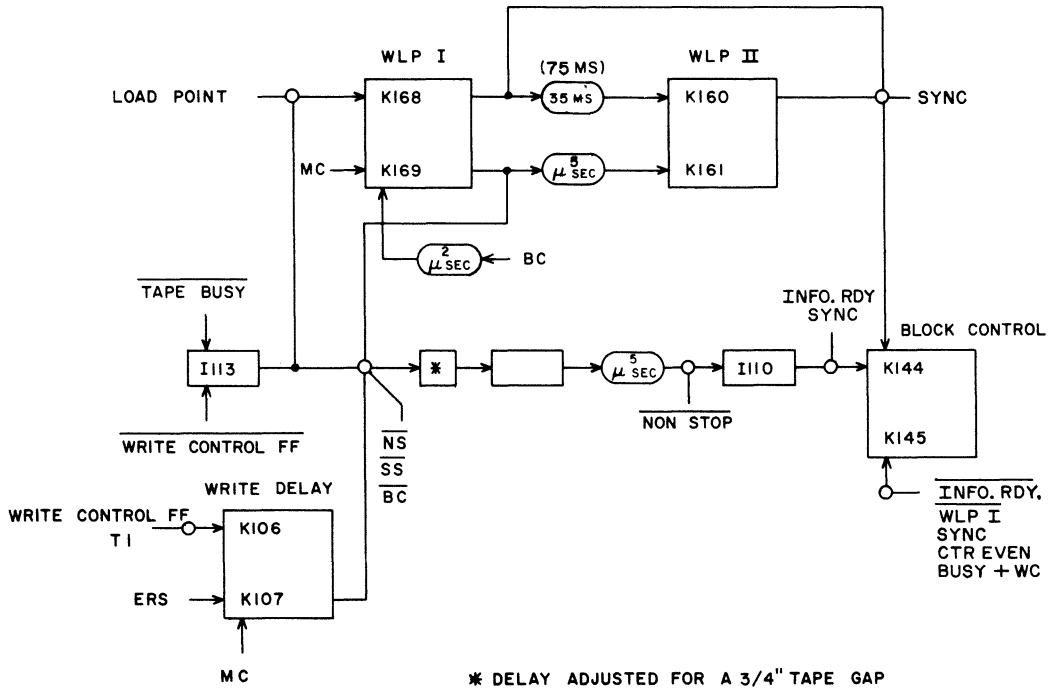


Figure 4-14. Block Control (Write)

MOTION CONTROL

Forward

These selections initiate a Forward signal to the tape handler (figure 4-15):

1) Write
2) Write File Mark
3) Read
4) Search Forward to File Mark

The feedback from D121 to D120 maintains the signal, allowing tape motion and the return of the Busy signal to the 162. The Busy signal is used in the 162 Read circuit and Write circuit. When the Write Control FF or the Read Control FF (whichever controls the operation) is cleared, the feedback to D120 is disabled, thereby terminating the signal.

The Forward Store FF is set by D121 when the Block Control FF for the selection is set. The Forward Store FF is used in the Non-Stop circuits. It is cleared by the End of Record circuit which is delayed 400 usec (time necessary to determine if the Non-Stop mode is possible).

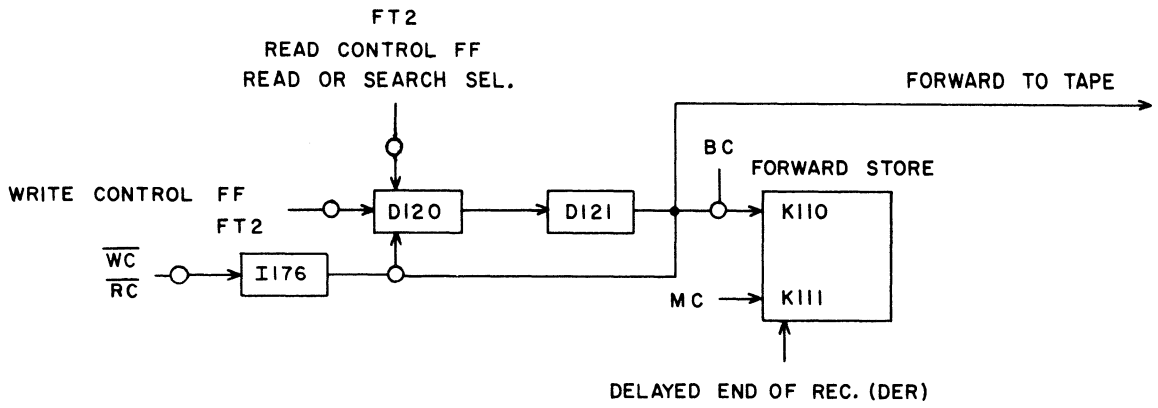


Figure 4-15. Forward Signal

Reverse

A Backspace One Record or Search Backward to File Mark selection enables a 4 usec Reverse signal to the tape handler and sets the Reverse FF (figure 4-16).

The pulse to the tape handler initiates reverse tape motion and the return of the Busy signal to the 162. Motion continues until an End of Record or a File Mark is sensed (whichever was selected). Motion also stops if a Load Point is sensec.

The Reverse FF sets the Reverse Store FF when Block Control is set for the selection. The Reverse Store FF is used in the Non-Stop circuit.

The Reverse Store FF is cleared by the End of Record circuits (delayed 400 usec to determine if the Non-Stop mode is possible). The Reverse FF is cleared by FT 0 of a new selection or by a Load Point signal from the tape handler.

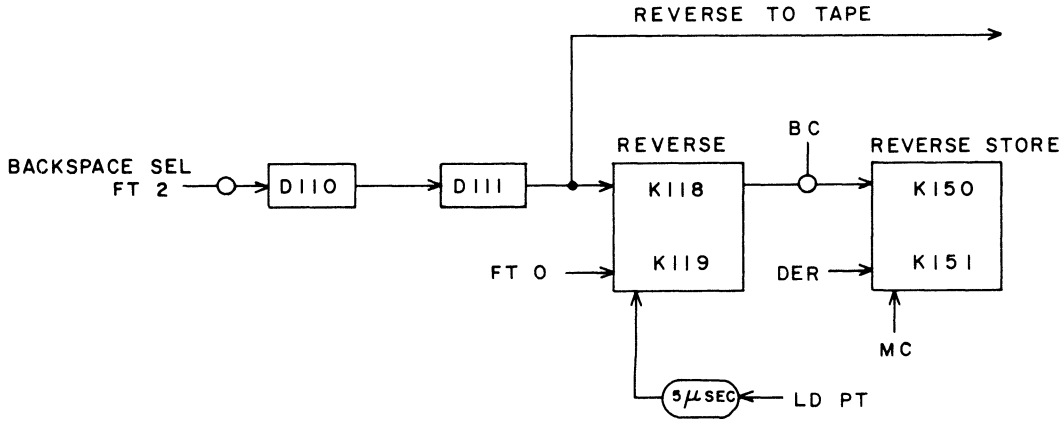


Figure 4-16. Reverse Signal

Non-Stop

The Non-Stop circuit (figure 4-17) permits constant tape motion if these conditions are met:

1) A new selection is made within 400 usec after the End of Record Clear FF is set.
2) The same tape handler is selected in the new selection.
3) The new selection requires the same tape motion.*

The Non-Stop circuit controls the setting of the Block Control FF in a Write selection. This permits a new selection to be made by blocking the Not Ready signal which otherwise would stop the function timing chain.

The selection of the same tape handler is determined by the comparison of rank I with rank II of the Unit Select FFs. Each selection is stored in rank II until the next selection can be compared with it. The new selection is in rank I until the determination is made. It is then passed to rank II to be compared with the next selection. The new selection is compared with the Forward Store FF or the Reverse Store FF to determine if the same tape motion is required.

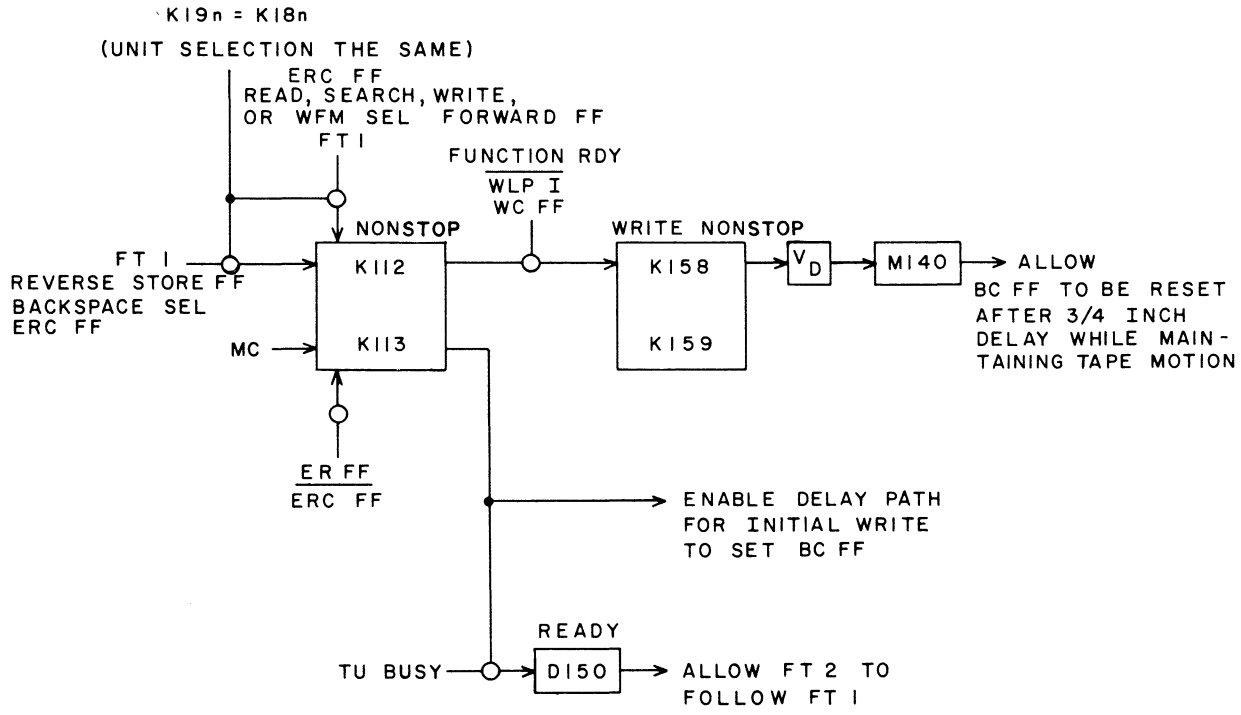


Figure 4-17. Non-Stop Circuit

*Logically this is true, however, normal Non-Stop operation assumes identical repetitive Select codes.

If the Non-Stop FF is not set, the initial write delay path to set the Block Control FF is enabled, thereby allowing time for tape acceleration. If the Non-Stop FF is set, the Function Ready signal accompanying the new selection sets the Write Non-Stop FF. This FF permits the Block Control FF to be set after time for the 3/4 inch record gap while maintaining tape motion.

END OF RECORD CIRCUIT

The End of Record circuit (figure 4-18) terminates the 162 Control circuits when they are no longer needed for one of the following selections:

1) Write
2) Write File Mark
3) Read
4) Search Forward to File Mark
5) Backspace One Record
6) Search Backward to File Mark

In a Read or Backspace One Reocrd selection, the End of Record FF is set by the halt of the Read sprockets and an End of Record signal from the tape handler. The tape handler sends the End of Record signal 200 usec (400 usec) after it has sensed the end of the record. During a Backspace One Record selection, the End of Record FF will also be set if a Load Point is recognized by the tape handler.

In a Write or Write File Mark selection, the End of Record FF is set by the halt of the Read sprockets from the Write Reply and an End of Record signal from the tape handler indicating that is has sensed the end of the record on the Write Reply [the End of Record signal is delayed 200 usec] (400 usec) .

In a Search Forward to File Mark or Search Backward to File Mark selection, the End of Record FF is set by a pseudo End of Record signal from the Search FF. This feature permits the 162 to perform other operations while a search is in progress.

The halt of the Read sprockets (necessary in a Write, Write File Mark, Read, or Backspace One Record selection) is determined by the absence of sprocket pulses after the Sprocket Sync FF is set. The Sprocket Sync FF is set 3 usec after the first Read sprocket is received from the tape handler in all selections except Write. In a Write selection the Sprocket Sync FF is set 3 usec after inverters I114 and I038 are both "1".

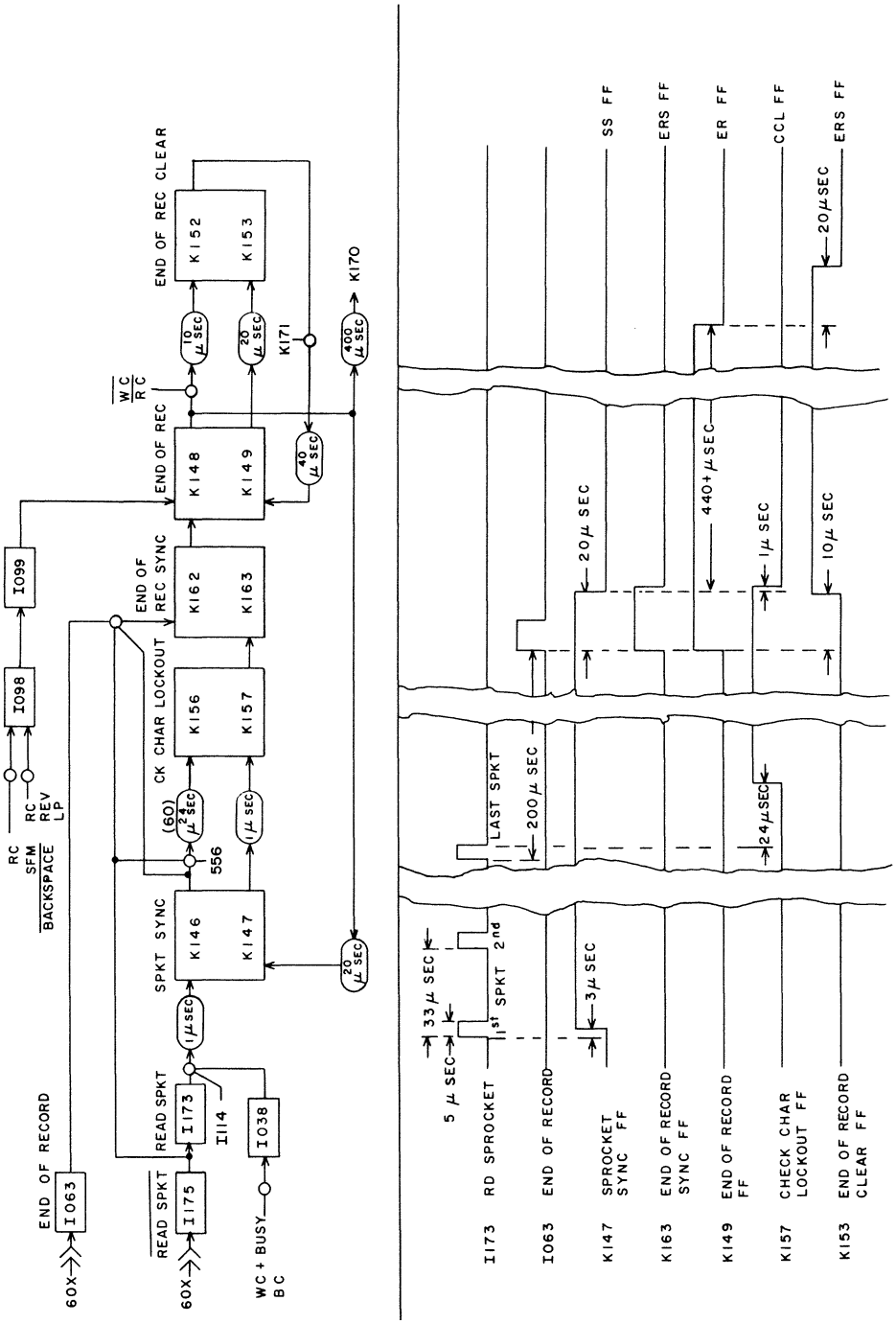


Figure 4-18. End of Record

I114 will be "1" 3.75 ms (7.5 ms) after the selection is made; this prevents the gap, formed by the 3 ms (6 ms) distance between the Write and Read heads if operation is started in the middle of a record, from being misinterpreted as a record gap. I038 will be "1" only after the Block Control FF is cleared by the stop of computer output; this prevents gaps caused by poor tape from being misinterpreted as a record gap.

The Check Character Lockout FF prevents the 162 from sending a check character (horizontal parity check) to the computer as a data word. As long as the FF is set, generation of an Input Ready signal to the computer is blocked. The FF is set by the Sprocket Sync FF through a delay path determined by the density selected [66 usec (132 usec) - 200 density, 24 usec (48 usec) - 556 density, 40 usec - 800 density] . The FF is cleared 21 usec after the End of Record FF is set.

REGISTER TRANSFER

As the data format passes through the 162 registers, functional changes occur. These functions (assembly/disassembly, change-on-ones conversion, parity generation and parity error detection) can be seen in the 162 block diagram (figure 4-19).

WRITE

The computer 12-bit output word is received by the 162 M register.

Assembly Mode

T2 M register (12 bits) is passed to the X register

T3 X register (upper 6 bits only) is passed to:

- T_1 register
- Parity generator
- Illegal BCD detector (if BCD mode selected)

Any bit that is "1" toggles its channel in the T_1 register (the previous quantity is stored in the T_2 register).

The parity generator determines whether an even or odd number of "1's" exist. If an odd number exist and BCD is selected, a "1" is passed to the seventh channel of the T_1 register; if even and BCD, a "0". If an odd number exist and binary mode is selected, a "0" is generated; if even and binary, a "1".

If BCD is selected, the 6 bits are sent to the illegal BCD detector which checks for an illegal BCD (all "0's"). If an illegal BCD is sensed, the Parity Error FF is set and

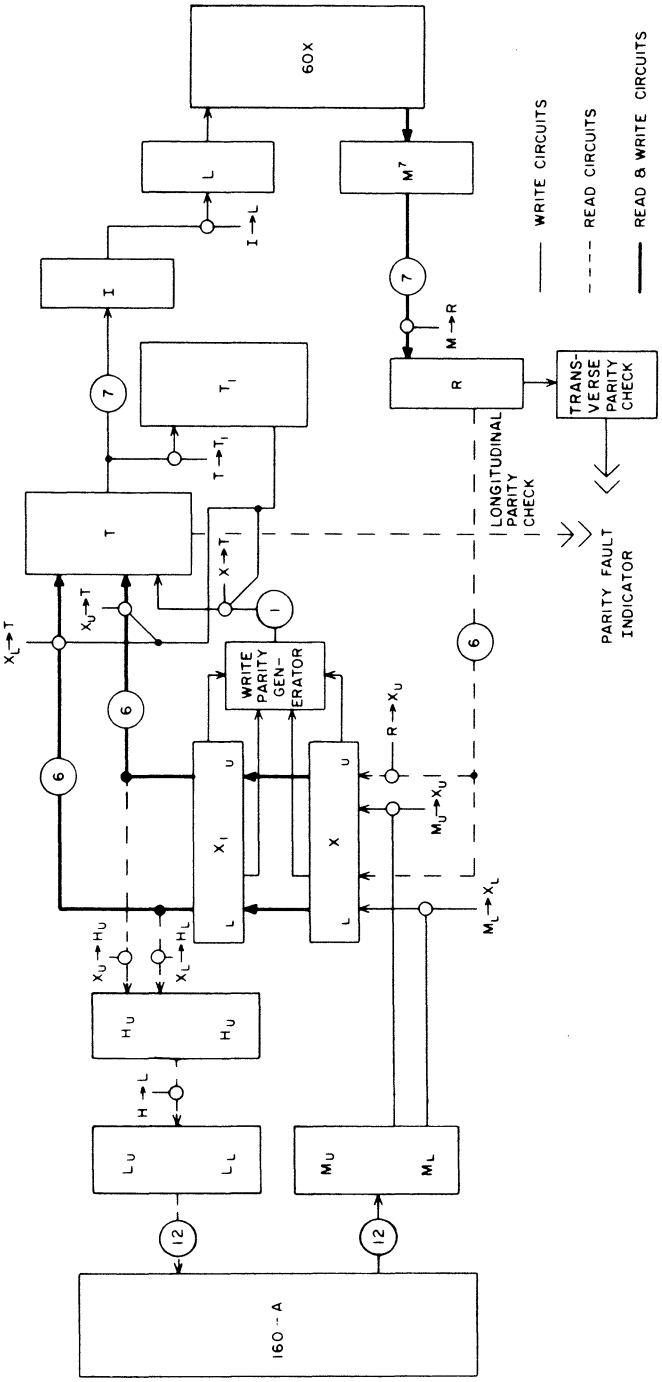


Figure 4-19. 162 Block Diagram

both the Parity Error indicator and the Program Error indicator light.

T 3	T_1 register (7 channels) to I register
	I register to L register (L register for selected tape handler)
T 4	T_1 to T_2 (stored for the next toggle function)
next T 3	X register (lower 6 bits only) follow same steps as upper 6 bits above

Character Mode

T 2	M register (lower 6 bits) is passed to X lower
T 3	X register (lower 6 bits) follow same steps as the upper 6 bits in the Assembly mode above

CHECK CHARACTER

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

During Read, as each 7-bit frame passes through the synchronizer, the bits in the frame toggle their corresponding FFs in the T_1 register. After all the frames in the record and the record check character have been toggled, the T_1 register should be clear (indicating an even number of "1's" in each channel).

WRITE REPLY

As each 7 bits are written on the tape they are also read back to the 162.

Tape handler to 162 M register
M register to R register
R register to transverse parity detector

The transverse parity detector determines what the parity should be for the 6 bits of data and compares it to the recorded parity bit. If they differ, the Parity Error FF is set and the Parity Error indicator lights.

WRITE FILE MARK

A 17_8 and its check character are generated by the T register and pass through the I register to the L register of the selected tape handler. The file mark and its check

character are read back to the 162 in sequence similar to the Write Reply.

READ

The tape handler reads a 7-bit word from the tape and sends the data to the 162.

Tape handler to 162 M register
M register to R register
R register to transverse parity detector

The transverse parity detector determines the parity for the 6 bits of data and compares it to the recorded parity bit. If they differ, the Parity Error FF is set and the Parity Error indicator lights.

Assembly Mode

T 2	R register (6 bits of data) passes to X upper
	R register (1 parity bit) passes to the Parity Hold FF
T 3	X register (upper 6 bits) is passed to T_1 register
	State of the Parity Hold FF is passed to channel 7 of T_1 register

The T_1 register toggles the 7 channels and inspects for longitudinal parity error (T_1 being "0") when the end of record is determined.

next T 2	R register (6 bits of data) passes to X lower
	R register (1 parity bit) passes to the Parity Hold FF
next T 3	X register (12 bits) is passed to T_1 register
	State of the Parity Hold FF is passed to channel 7 of T_1 register

The T_1 register toggles the 7 channels and inspects for longitudinal parity error (T_1 being "0") when the end of record is determined.

X register (lower 6 bits)is passed to H lower
H register (12 bits) is passed to L register
L register to computer

The H register holds the input word, keeping the input available to the computer until the next request for input. The Check Character Lockout FF blocks the transmission of H lower to the computer when it contains the check character.

Character Mode

T 2	R register (6 bits of data is passed to X lower

R register (1 parity bit) is passed to the Parity Hold FF

T 3 X register (lower 6 bits) is passed to T_1 register

State of the Parity Hold FF is passed to channel 7 of T_1 register

The T_1 register toggles the 7 channels and inspects for longitudinal parity error (T_1 being "0") when the end of record is determined.

X register (lower 6 bits relevant, upper 6 bits "0's") is passed to H register

H register to L register

L register to computer

The H register holds the input word, keeping the input available to the computer until the next request for input. The Check Character Lockout FF blocks the transmission of H lower to the computer when it contains the check character.

OPERATION

The four types of selection -- status, preliminary, information transfer, and motion directive -- occur under the control of the circuits mentioned previously and in this section. Further information concerning these selections is found in the command timing charts in appendix C.

STATUS SELECTION

The status selection allows the computer to determine the conditions of the 162 and the selected tape handler. The Status code (figure 4-20) sets the Status Control FF. This FF enables the transfer of the condition signals to the X register inverters and enables the Status Lockout and X to H Transfer FFs. The FFs generate an Input Ready signal to the computer when the computer issues an input to A (7600) instruction.

PRELIMINARY SELECTION

The preliminary selections, Parity Mode and Density, are explained earlier in this chapter.

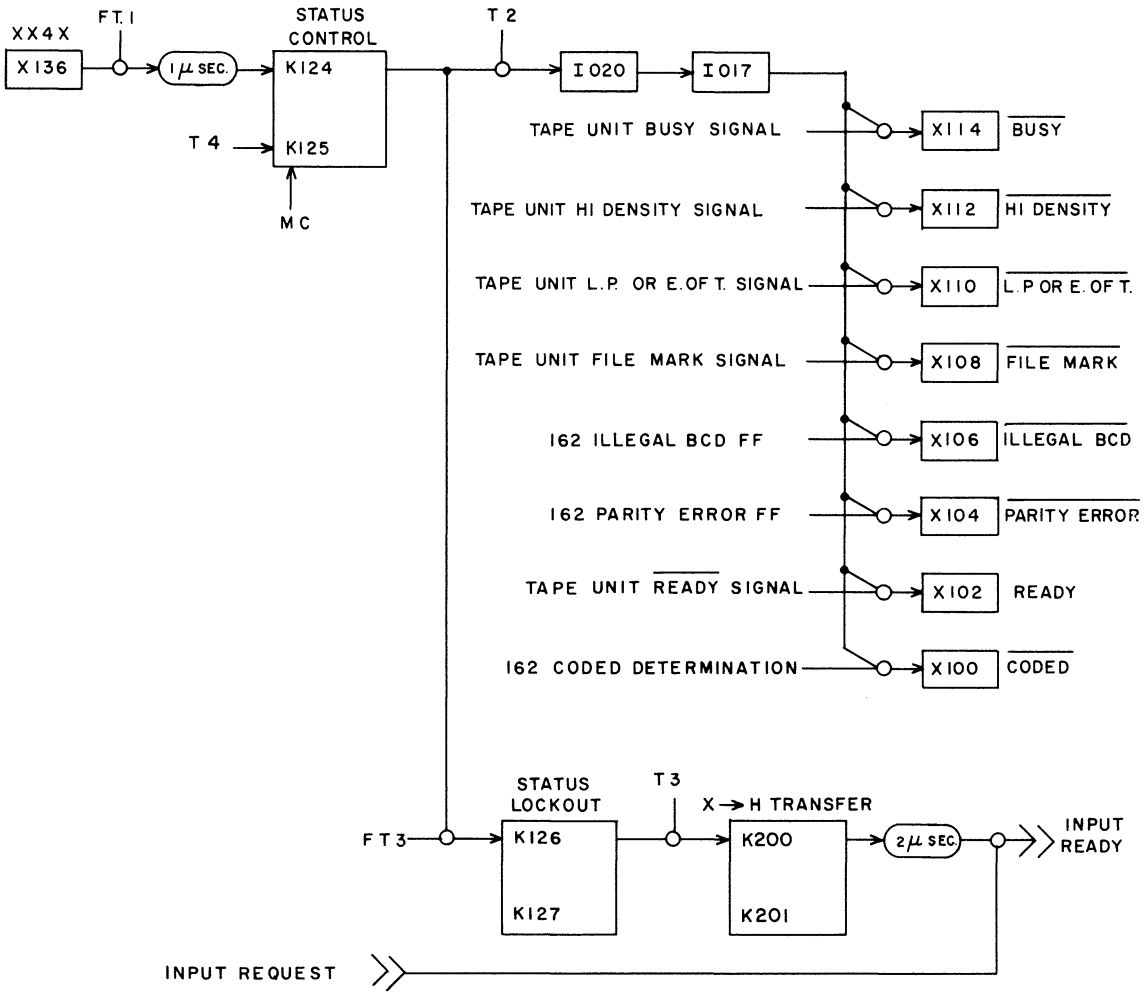


Figure 4-20. Status

INFORMATION TRANSFER SELECTIONS

Write

A Write selection is made by a XX1X code followed by an Information Ready signal. The Function Ready signal (figure 4-21) accompanying the Select code initiates the function timing chain. The function timing chain sequences the setting of the Control FFs in the 162 and transmission of the control signals to the tape handler. The Write Control FF, which is set by the Select code, initiates Write and Forward signals to the tape handler.

The Information Ready signal accompanying the first output word sets the Block Control

FF after a delay that allows a 3/4 inch gap on the tape (see Block Control description for special cases). The Block Control FF enables the main timing chain which sequences the register transfers in the 162 and the transfer of data to the tape handler. The Block Control FF also enables the X to T Transfer circuit which sets the Sprocket Ready FF. This FF sends the Sprocket pulse to the tape hanlder, allowing the handler to accept the data.

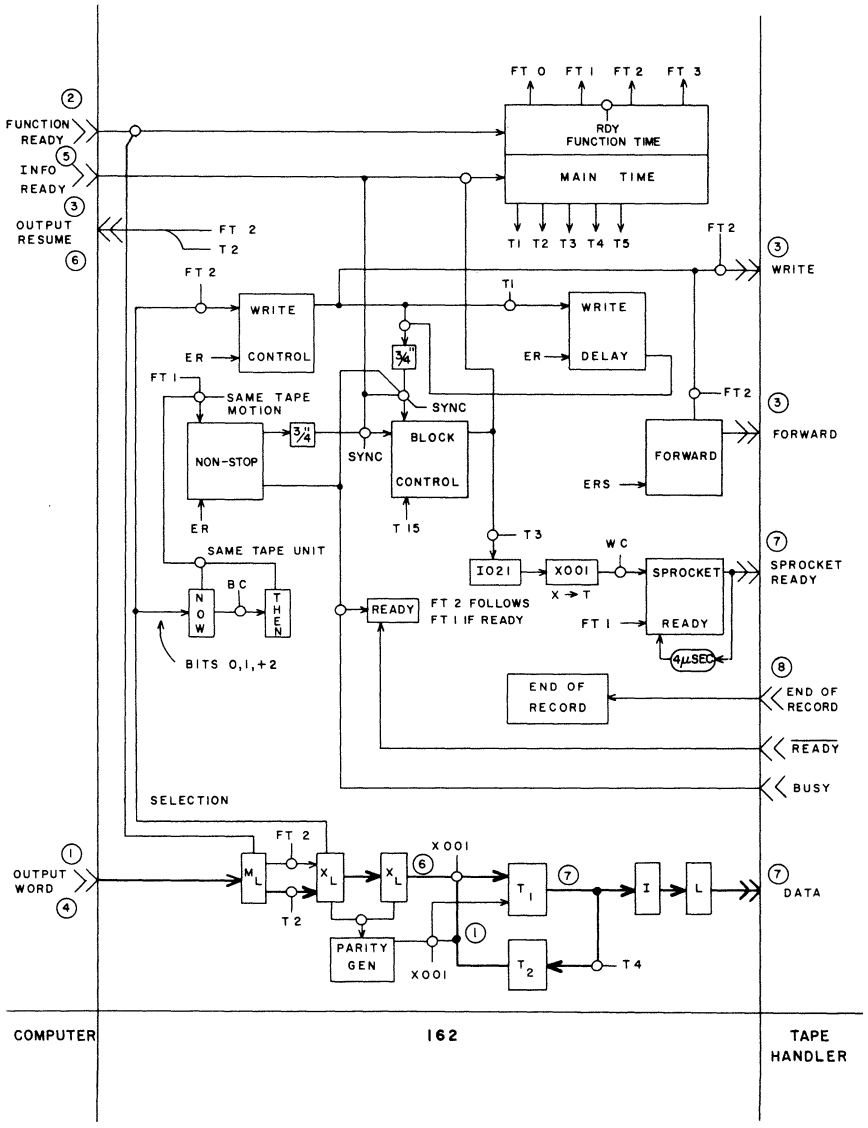


Figure 4-21. Write

Each frame of data written on the tape is also sensed by the tape handler Read heads. This data is transferred back to the 162 (Write Reply) and checked for transverse parity error.

In both Character mode (6-bit) and Assembly mode (12-bit) an Output Resume signal is sent to the computer as the first word is transferred to the tape handler. The Output Resume signal allows the computer to issue another output word.

If the computer does not issue another word (no Information Ready Signal) the Block Control FF is cleared. This enables the check character gap counter to count four main timing chain excursions. During the fourth cycle, the check character passes to the tape handler to be written and the Initiate Oscillator FF is cleared. Tape motion continues until a 3/4 inch gap is sensed by the Write Reply circuit. This enables the End of Record circuit in the tape handler and in the 162. These circuits clear both units for the next operation (see Non-Stop description for special Non-Stop operation).

Write File Mark

A Write File Mark selection is made by a XX1X code which is not followed by computer output. The Function Ready signal accompanying the Select code initiates the function timing chain (figure 4-22). The function timing chain sequences the setting of the Control FFs in the 162 and the transmission of the control signals to the tape handler. The Write Control FF, which is set by the Select code, initiates Write and Forward signals to the tape handler.

At the end of the delay allowing a 3/4 inch gap on the tape, the absence of an information Ready signal sets the WLP I FF. (The presence of an Information Ready signal would set the Block Control FF in a Write selection.) This FF initiates the file mark delay path which determines the 6-inch file mark gap on the tape. At the end of the delay path WLP II FF is set, setting the Block Control FF. The Block Control FF starts the main timing chain which permits transmission of the file mark to the tape handler. The file mark (17_8) is generated by the WLP II FF. The file mark is followed by the check character gap and the check character for the file mark (same as in Write).

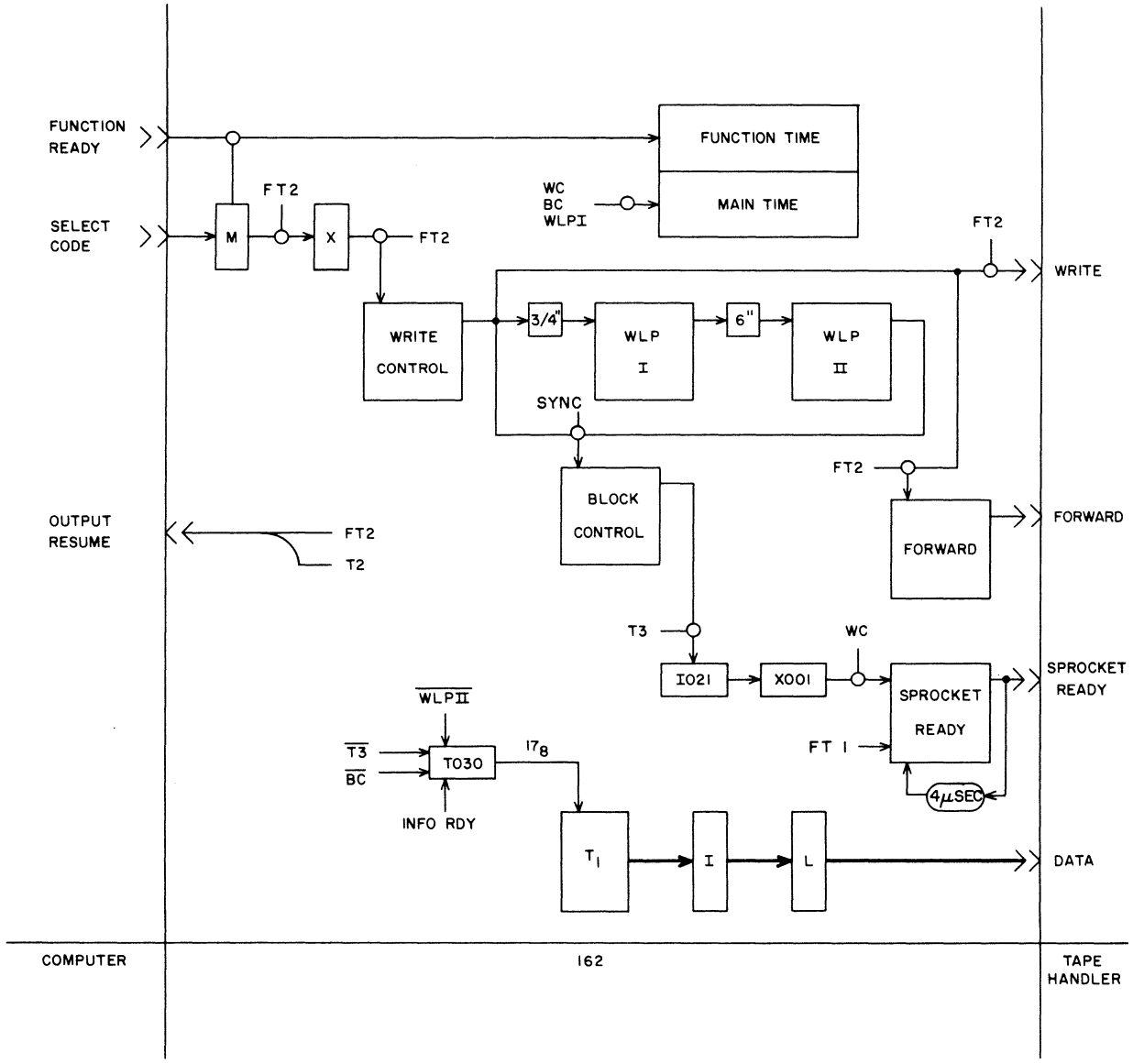


Figure 4-22. Write File Mark

Read

A Read selection is made by a XX3X code followed by an Input Request signal. The Function Ready signal and the Select code initiate the function timing chain (figure 1-23). The function timing chain sequences the setting of the Control FFs and transmission of the control signals to the tape handler.

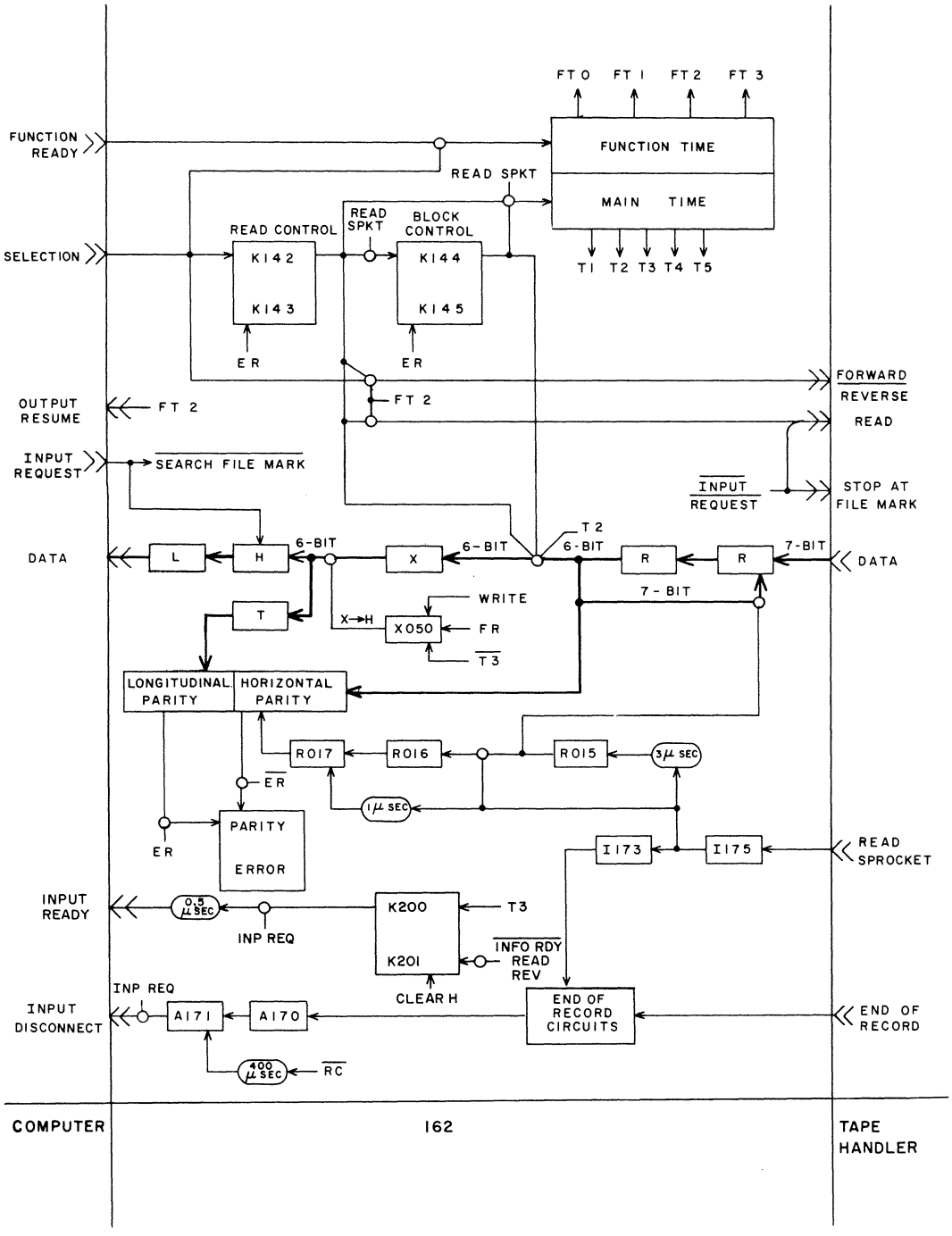


Figure 4-23. Read

The Select code sets the Read Control FF; this generates the Read and the Forward signals to the tape handler. These signals enable tape motion and the Read heads.

The tape handler sends the 162 a Read Sprocket (a pulse corresponding to each frame read from the tape) which enables the Read register feedback and permits the Read Control FF to set the Block Control FF. The Block Control FF enables the main timing chain that sequences the data transfer. The inverter that gates the X to H transfer also enables the Input Ready signal to the computer. This signal allows the computer to accept the input word.

As the 7-bit data word passes through the Read register it is checked for transverse parity error. While the 6-bit word (parity bit not included) is in the X register it is shunted to the T register which toggles with each "1". When the end of record is determined, the final state of the T_1 register is inspected for longitudinal parity error ($T_1 \neq$ "0").

Once a Read operation is started tape motion continues until the end of record. If the computer does not issue input requests, the 162 continues to accept data from the tape handler but does not input the data to the computer. If the computer issues another input request after the end of the record, the 162 sends it an Input Disconnect signal.

MOTION DIRECTIVE SELECTIONS

Search Forward to File Mark

The Search File Mark selection is made by a XX3X code without a request for input. The Function Ready signal accompanying the Select code initiates the function timing chain (figure 4-23). The function timing chain sequences the setting of the Control FFs and transmission of the control signals to the tape handler. The Read and Forward signals to the tape handler are generated by the Read Control FF which is set by the Select code.

When the tape handler reads the first word, it sends the 162 a Read Sprocket (a pulse corresponding to each frame read). The Read Sprocket allows the Read Control FF to set the Block Control FF. This triggers the main timing chain which sets the Search FF at T 1 if there is no Input Request signal from the computer. The Search FF sets the Search Hold FF for the selected tape handler. This FF generates the Search File Mark signal which permits the tape handler to ignore the record gap and start the end of record procedure only when the file mark is sensed.

The Search FF also generates a pseudo End of Record signal to the End of Record FF. This clears the 162 for other selections while the initially selected tape handler is searching. The only circuit in the 162 that remains activated with the tape handler is the Search Hold FF which blocks the Read signals coming from the searching tape handler.

Backspace One Record

The Backspace One Record selection is made by a XX2X code followed by a request for input (INA). The circuits used are the same as in a Read selection (figure 4-23) except that the Select code initiates a Reverse rather than a Forward signal to the tape handler. The INA instruction is used to easily dispose of the irrelevant input word in the computer A register.

Search Backward to File Mark

The Search Backward to File Mark selection is made by a XX2X code without a request for input. The circuits used are the same as those in a Search Forward to File Mark selection (figure 4-23_ except that the Select code initiates a Reverse signal rather than a Forward.

Rewind Load

The Rewind Load selection is made by a XX6X code. The Function Ready signal accompanying the code initiates the function timing chain which sequences the transmission of the Rewind Load signal to the tape handler (figure 4-24). The tape handler performs the operation automatically upon reception of the signal and returns the Load Point signal to the 162 when it is sensed. The function timing chain also returns an Output Resume signal to the computer allowing it to proceed with other operations. The 162 is available for other operations with a different tape handler once the Output Resume signal is sent to the computer.

Rewind Unload

The Rewind Unload selection is made by a XX5X code. The Function Ready signal accompanying the Select code initiates the function timing chain which sequences the transmission of the Rewind Unload signal to the tape handler (figure 4-24). The tape handler performs the operation automatically. The function timing chain sends an Output Resume signal to the computer, freeing it for other operations. This also frees the 162 for other operations with a different tape handler. The tape handler is no

longer available for computer control once this selection is made. The tape must be manually loaded before operation is again possible.

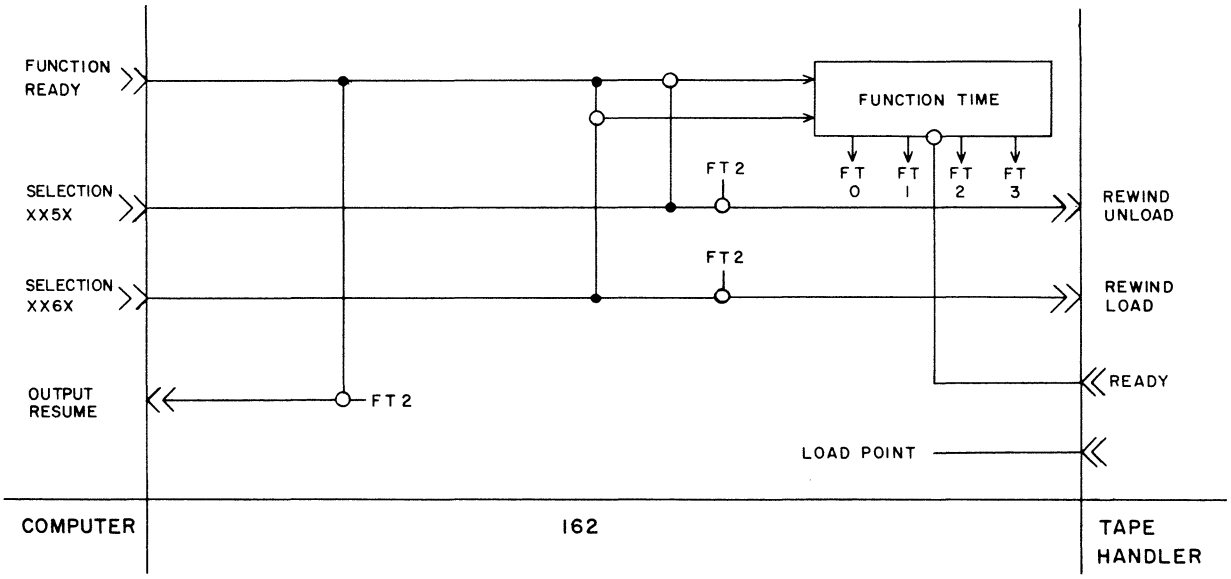


Figure 4-24. Rewind Load/Unload

CHAPTER 5

MAINTENANCE

Maintenance of the 162 primarily involves the following:

1) Fuse replacement
2) Checking circuit malfunctions
3) Checking delay periods
4) Testing power supply operation

ENVIRONMENTAL CARE

The 162 is constructed of standard Control Data components with properties identical to those of the 160 or 1604 computer. Normal dust-free, air-conditioned computer environment is required.

A blower cools the unit by drawing air through a reuseable filter at the bottom of the cabinet. The blower filter should be cleaned weekly.

If the unit is overheated, the thermostat cuts off power when the temperature of the exhaust air reaches $100^{o}F$.

Temperature requirements for the 162 are the same as those for the computer. The unit generates 4200 BTUs.

POWER

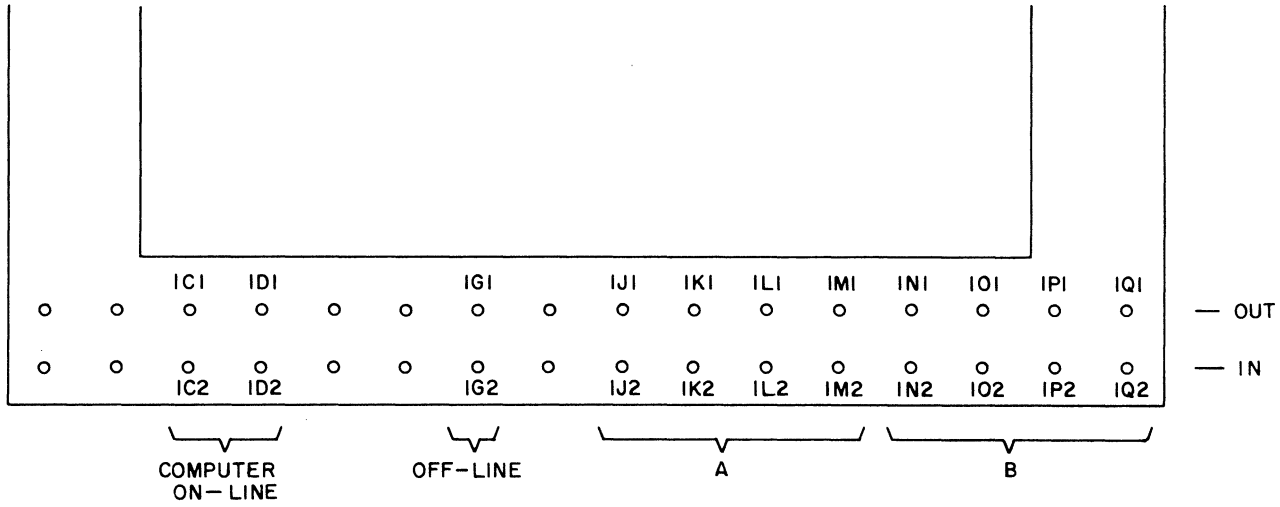
The Amp 851266 power supply provides ±20v. Power supply maintenance is explained in appendix B. The 162 requires 1230 watts of 117v, 60 cycle power.

CABLE CONNECTIONS

The cable connectors are located at the bottom of the back of the cabinet (figure 2-1). Connector assignments are as follows:

J01, J02	computer output
J03, J04	computer input
J05	power
J06 through J13	four tape handler I/O
J14 through J21	optional four tape handler I/O
J22, J23	simultaneous off-line I/O (printer)

Pin assignments of the logic cables are shown in tables 5-1, 5-2, and 5-3.



Synchronizers with four tape handler capacity use A above.

Synchronizers with eight tape handler capacity use A and B.

Figure 5-1. Bottom of Chassis From Rear Cable Connections

FUSES

Fuse values are marked on the fuse panel on the rear of the cabinet. These values may vary with different power supplies.

CIRCUIT CARDS

All cards in the 162 are standard Control Data printed circuit cards. Schematic drawings of the cards are available from the company and in the Control Data 151 Card Tester instruction manual (publication 60018400, Rev A). A Control Data 151 Card Tester is helpful in maintaining the 162.

DELAY PERIODS

One of the vital functions of the 162 is to supply timing synchronization in the information transfers. If any malfunction of the 162 occurs, checking the delay periods may be advantageous. Checking aids may be found in tables 5-4, 5-5, and 5-6 and in the command timing charts (appendix C).

CIRCUIT MAINTENANCE

Success in maintaining circuit operation, while dependent upon the skill and experience of the maintenance man, will be facilitated by a thorough examination of the theory of operation. This information is found in chapter 1 of this manual, in the Diagrams manual, and in the File of Equations manual.

TABLE 5-1. 162 - COMPUTER I/O CONNECTORS

PIN	CONNECTORS	CONNECTORS
	1C2, 1D2 (Computer Input Cable)	1C1, 1D1 (Computer Output Cable)
A	Bit 00	Bit 00
B	01	01
C	02	02
D	03	03
E	04	04
F	05	05
H	06	06
J	07	07
K	08	08
L	09	09
M	10	10
N	11	11
P		
R	Input Ready	Information Ready
S	Input Request	Output Resume
T		Function Ready
U		External Master Clear
V	Input Disconnect	
W		
X		
Y		
Z		
a		
b	GRD	GRD

TABLE 5-2. 162 - TAPE HANDLER I/O CONNECTORS

Connectors 1J1, 1K1, 1L1, 1M1 (1N1, 1Ø1, 1P1, 1Q1)		Connectors 1J2, 1K2, 1L2, 1M2 (1N2, 1Ø2, 1P2, 1Q2)	
Pin		Pin	
A	Bit 0	A	Bit 0
B	|	B	|
C	Output Data	C	Input Data
D	|	D	|
E	|	E	|
F	Bit 5	F	Bit 5
H	Parity Write	H	Parity Read
J	Write Sprocket	J	Read Sprocket
K	Address 6	K	Write Ready
L	Address 7	L	Address 4
M	Forward	M	End of Record
N	Reverse	N	File Mark
P	Stop on File Mark	P	Address 0
R	Select Hi Density	R	Address 1
S	Select Lo Density	S	Address 2
T	Write Select	T	Address 3
U	Read Start	U	Busy
V	Master Clear	V	Hi Density Selected
W	Rewind Unload	W	Load Point
X	Rewind	X	End of Tape
Y	Address 5	Y	Ready
Z	Unit Select Light 1	Z	
a	Unit Select Light 2	a	
b	Ground	b	Ground

TABLE 5-3. 162 - 166-2 PRINTER CONNECTORS

PIN	Connector 1G1	Connector 1G2
A	Bit 0	
B		
C		
D		Bit 3 Output
E		
F	Input Data	
H		
J		
K		
L		
M		
N	Bit 11	
P		
R	Input Ready Input	
S	Input Request Output	Output Resume Input
T		Function Ready Output
U		Master Clear Output
V	Input Disconnect Input	
W		
X		
Y		Tape → Printer Output
Z	Parity Error Input	
a		
b	GRD	GRD

TABLE 5-4. PRELIMINARY TIMING CHECKS

		Location	162-1, 162-3	162-2
Main Timing				
556 Density		F85A	.75 usec leading edges	.375 usec
200 Density		F85A	2.06 usec leading edges	1.03 usec
800 Density		F85A	(162-3 only) .515 usec	
Function Timing				
FT 0		D44B	1 usec	1 usec
FT 1		D43B	4 usec +	4 usec +
FT 2		D42A	4.5 usec +	4.5 usec +
FT 3		D40A	4 usec	4 usec
Check Character Lockout				
556 Density		B60	48 usec	24 usec
200 Density		B60	132 usec	66 usec
800 Density			40 usec (162-3 only)	
			Ascertain that FF set after 3/8 inches of tape motion.	
Sprocket Pulse		F41C	3 usec	3 usec
Stop-Start Gap	Y016	B51A	Adjust for 3/4 inches of tape motion.	
Non-Stop Gap	Y017	B39C	Adjust for 3/4 inches of tape motion.	
Off-Line				
Clear A	T1	G61B	2 usec	2 usec
R → A	T2	G60B	2 usec	2 usec
	T3	I77C	4 usec	4 usec
	T4	I77A	2 usec	2 usec

TABLE 5-5. MAIN TIMING TABLE

Function	Condition	Jack
T0 J020 (D81B)		
Enable Timing	Assembling odd number of words in a Read Operation	2C14A
T1 J021 (D80B)		
Disable X register feedback	All operations	D34B
Enable Search FF	Search operations	B34
Enable Read/Backspace Record FF	Read and Backspace Record	B36
Enable Write Delay FF	Write and Write FM	B46
T2 J022 (D79B)		
Send Output Resume to computer	All operations	C86C
Enable X to parity generator		G84C
Enable M to X	Write	D39A
Enable R to X	Read	$D38B_1$
Enable status to X	Status	$D38C_1$
T3 J023 (D78B)		
Enable X to H	Operations that input	C39C
Enable X to T	All operations	D40C
T3 J030 ($F85B_1$)		
Disable check character counter		B28B
Disable $T_1 = 17_8$		C26B
T4 J024 (D77B)		
Disable X to parity generator		C88B
		C89B
Enable T_1 to T_2	All operations	$D33B_1$
Advance ^{1}A/D ^{2}counter	All operations	D32
T5 J025 (D76B)		
Clear Status Control FF		C62
Enable A/D counter	Assembly mode	D32
Clear Status Lockout FF		C61
Transfer check character counter		B30
		B32

TABLE 5-6. FUNCTION TIMING TABLE

FT 0 (I106) [D44B] 1 usec duration after counter enable (A191) [A08A]			
Clear Unit Select Register	All selections		H71
Clear Assembly/Disassembly FF	All selections		C49
Clear X Register Feedback	All selections	D34B	C34B
Clear Reverse FF	All selections		C67
FT 1 (I101) [D43B] 4 usec duration after end of FT 0*			
Set Unit Select Register	All selections except numeric designation		H71
Set Assembly/Disassembly FF	All selections except numeric designation		C49
Clear Read/Backspace One Record FF	All selections except numeric designation		B36
Clear Sprocket Ready FF	All selections except numeric designation		B37
Set Status Control FF	Status selection		C62
Clear T Register	All selections except numeric designation		C41B C40B
Set Non-stop FF	Non-stop reselection		C69
FT 2 (I103, I107, I109) [D41B, D42A, D42C] the duration from the end of FT 1 until 4 usec after the Function Ready signal drops			
Set Read Control FF	Read, Search, Backspace Record, and Search Backward		D28
Set Write Control FF	Write and Write File Mark		B40
Set Code FF	Parity Mode		C70
Send control signals to tape handler			
Send Output Resume signal to computer			
Set Function Lockout I FF	Read, Search, Backspace Record, Search Backward, Write, and Write File Mark		C57
FT 3 (I105) [D40A] 4 usec duration after the end of FT 2			
Set Status Lockout FF	Status selection		C61
Clear Parity Error FF	All selections except status		D54

*FT 1 lasts 3 usec during a Status operation

APPENDIX A
PRINCIPLES OF OPERATION

TAPE TO PRINTER SIMULTANEOUS OFF-LINE

The four simultaneous off-line operations (Read, Search Forward to File Mark, Backspace One Record, and Search Backward to File Mark) are controlled by an exchange of signals between the printer and the tape handler. The printer signals are generated by switches on the printer control panel. The tape handler signals are generated by conditions within the tape handler. The 162 circuits which control the off-line signal exchange are independent of the 162 on-line circuits.

READ

The Read operation (figure A-1) is selected by pressing the following printer switches:

Tape/Print
Tape/Card
Continuous or Step

These switches generate the following signals:

Tape to Printer
Bit 3
Function Ready
Input Request

The Tape to Printer signal, the Bit 3 signal, and the Function Ready signal set the Forward FF if the tape handler is signaling Read-No Fault and Not Busy. The Forward FF sends the tape handler a Forward signal and a Read signal, starting tape motion and enabling the Read heads. The Forward FF also sets the Search FF which sends the printer an Output Resume signal. The Output Resume signal allows the printer to issue the Input Request signal which clears the Search FF.

As the tape handler reads each word on the tape, it sends the 162 a Read Sprocket pulse, enabling the timing loop. The timing loop and sequencer gate the register transfers -- the first tape frame into A upper, the second tape frame into A lower, and the assembled 12-bit words to L and the printer. The A to L FF is set by the timing loop, sending an Input Ready signal to the printer. This allows the printer to accept the input word.

As each 7-bit frame passes through the R register, a parity bit is generated from the 6 bits of information and compared with the recorded parity bit. If they do not compare, a Parity Error signal is sent to the printer.

When the tape handler senses the end of record it sends the End of Record signal to the 162. This signal enables the 162 End of Record circuit which sends the printer an Input Disconnect signal, blocks the transmission of the check character to the printer, and clears the 162 for another operation.

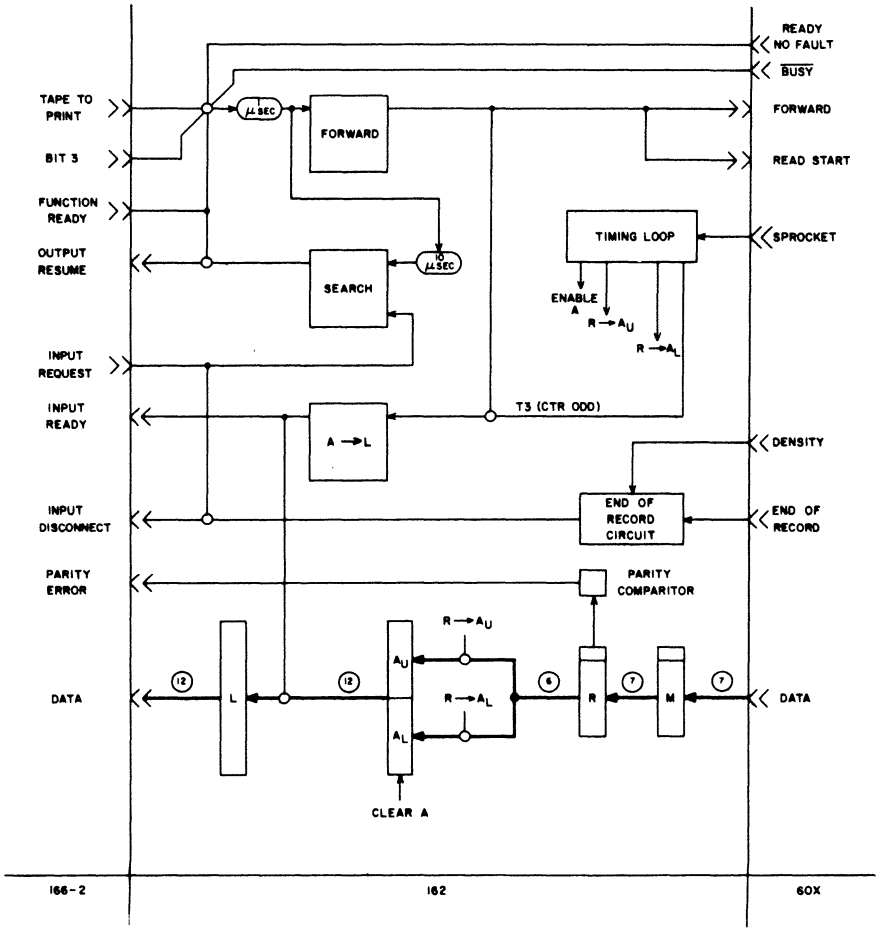


Figure A-1. Read

SEARCH FORWARD TO FILE MARK

The Search Forward to File Mark operation (figure A-2) is selected by pressing the following printer switches:

Tape/Print
Tape/Card
Master Clear
Step or Continuous

These switches generate the following signals:

Tape to Printer
Bit 3
Function Ready

The circuits that control a Search Forward to File Mark operation are the same as those for a Read operation except that the Search Forward does not include a request for input. The absence of an Input Request signal from the printer leaves the Search FF in the set state. This allows the FF to generate a Stop on File Mark signal to the tape handler and a pseudo End of Record signal to the 162 End of Record circuit.

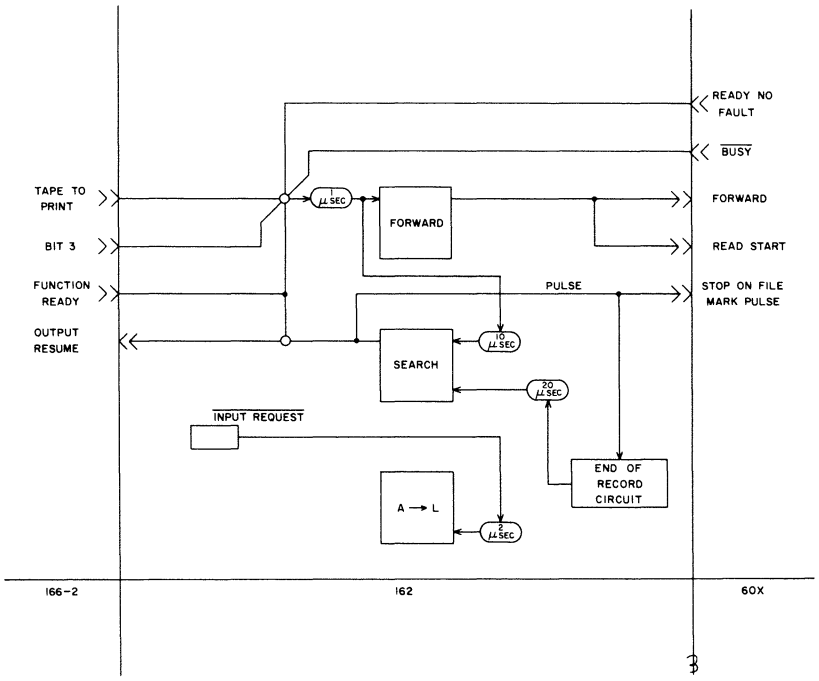


Figure A-2. Search Forward to File Mark

The Stop on File Mark signal modifies the End of Record circuit in the tape handler so that the circuit senses the file mark but not the end of record gap.

The pseudo End of Record signal allows the 162 End of Record circuit to clear the Search FF (this terminates the Output Resume signal to the printer).

This system is available for other operations when the tape handler is again in the Not Busy state.

BACKSPACE ONE RECORD

The Backspace One Record operation (figure A-3) is selected by pressing the following printer switches:

Tape/Print
Tape/Card
Backspace

These switches generate the following signals:

Tape to Printer
Function Ready
Input Request

The Tape to Printer signal and the Function Ready signal set the Reverse FF if the tape handler is signaling Ready-No Fault, Not Busy, and Not Load Point. The Reverse FF sends the Reverse signal and the Read signal to the tape handler. The Reverse FF also sets the Search FF which sends the Output Resume signal to the printer. The Output Resume signal to the printer allows the printer to issue the Input Request signal; this clears the Search FF. The Reverse FF also blocks the setting of the A to L FF, blocking any information transfer to the printer.

The Reverse signal and the Read signal allow the tape handler to start tape motion and enable the Read heads. Motion continues until the Read heads sense an end of record gap. The End of Record signal sent to the 162 enables the 162 End of Record circuit which clears the unit for other operations. This terminates the Reverse signal to the tape handler, stopping the tape motion.

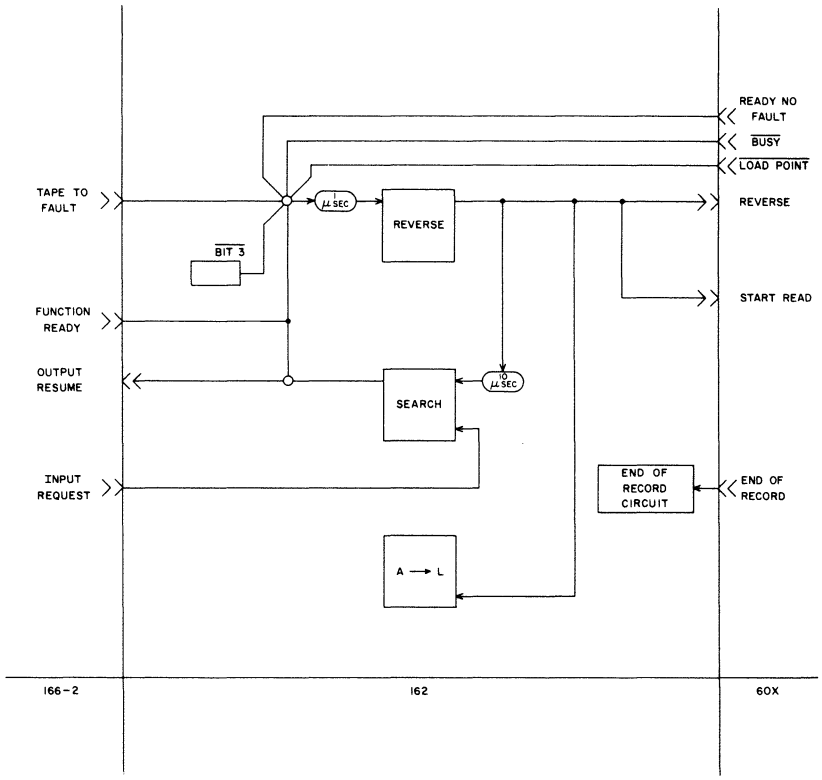


Figure A-3. Backspace One Record

SEARCH BACKWARD TO FILE MARK

The Search Backward to File Mark operation (figure A-4) is selected by pressing the following printer switches:

Tape/Print
Tape/Card
Master Clear
Backspace

These switches generate the following signals:

Tape to Printer
Function Ready

The circuits that control a Search Backward to File Mark operation are the same as those for a Backspace One Record operation except that the Search Backward operation

does not include a request for input. The absence of an Input Request signal from the printer leaves the Search FF in the set state. This allows the FF to generate a Stop on File Mark signal to the tape handler and a pseudo End of Record signal the the 162 End of Record circuit.

The Stop on File Mark signal modifies the End of Record circuit in the tape handler so that it senses the file mark but does not sense the end of record gap.

The pseudo End of Record signal allows the 162 End of Record circuit to clear the Search FF (this terminates the Output Resume signal to the printer).

The system is available for other operations when the tape handler is again Not Busy.

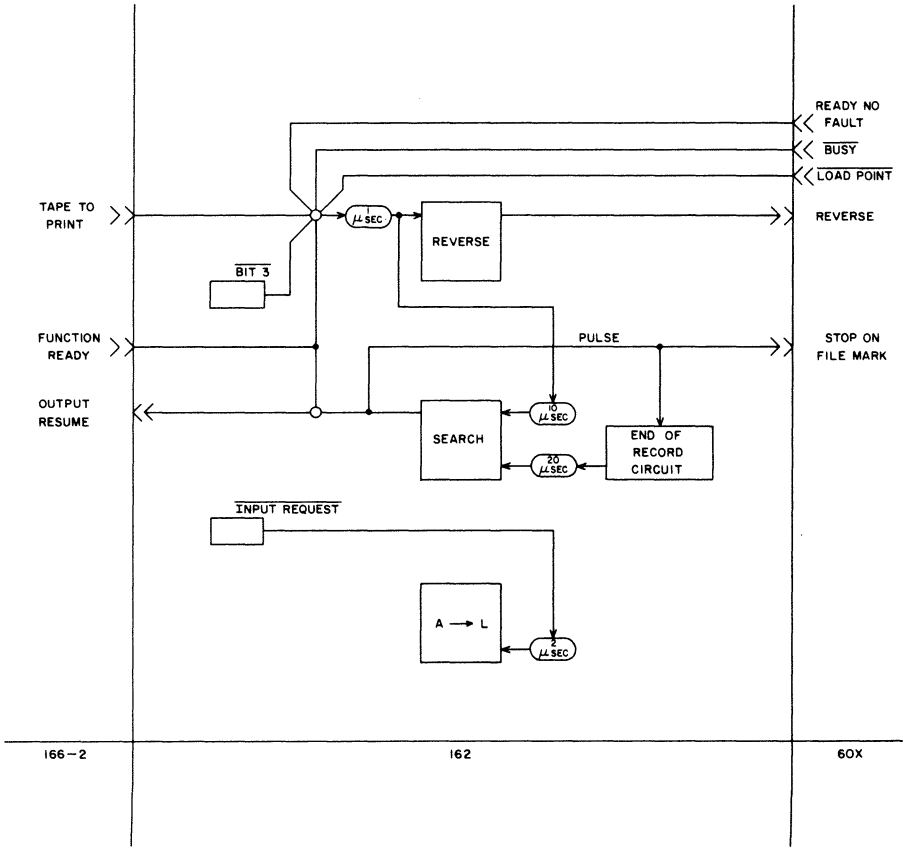


Figure A-4. Search Backward to File Mark

CONTROL CIRCUITS

TIMING

Transfer of information through the 162 is sequenced by a timing loop and a timing sequencer (figure A-5). The timing loop is activated by each Sprocket pulse received from the tape handler. The Sprocket pulse is generated by each frame read on the tape. The only Sprocket pulse that does not activate the timing loop is the one generated by the check character frame. The frame is blocked to prevent the check character from being read by the printer.

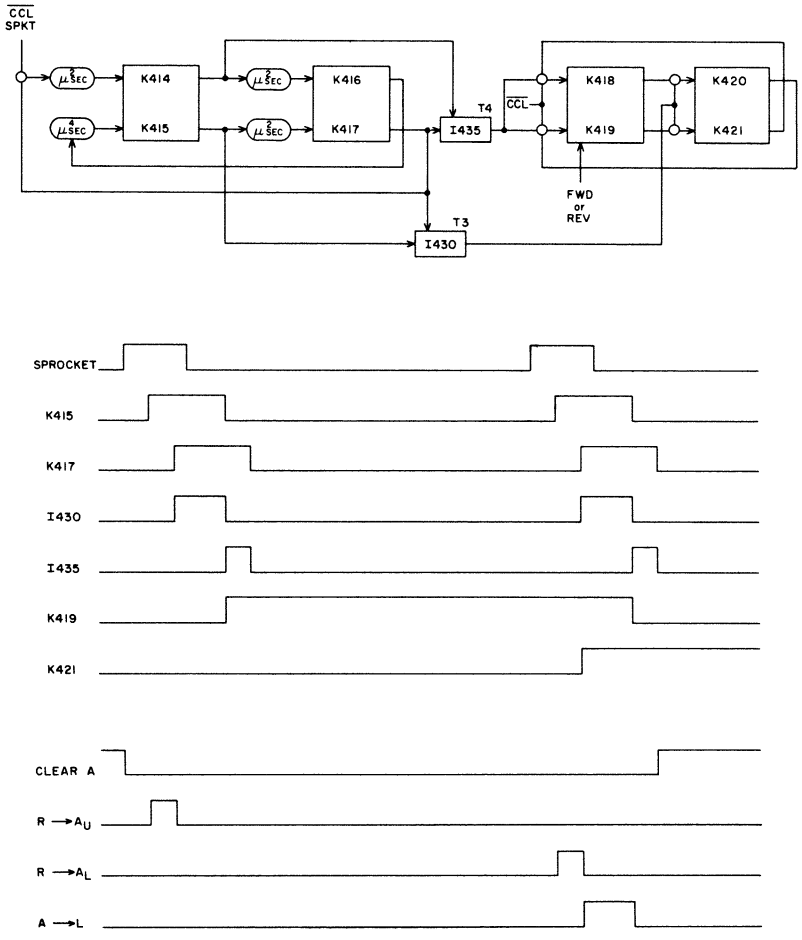


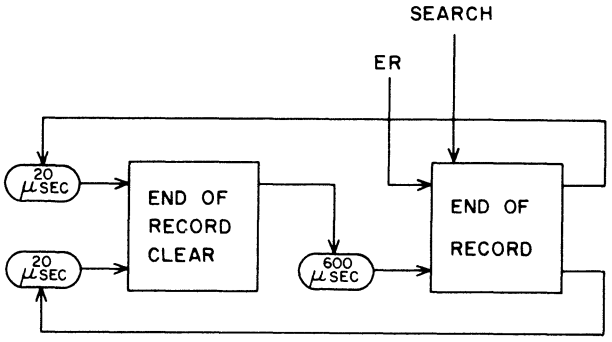
Figure A-5. Timing Loop and Sequencer

Each Sprocket pulse during an odd phase of the timing sequencer enables the R to A upper transfer. Each Sprocket pulse during an even phase of the sequencer enables an R to A lower transfer followed by setting the A to L FF (this gates the transfer to the printer).

END OF RECORD

When the 162 End of Record circuit (figure A-6) receives the End of Record signal from the tape handler, it determines that the End of Record of information has been read from the tape and clears the 162 for new operation. The circuit is also used in a Search operation to generate a pseudo Completion signal to clear the Search FF; this terminates the Output Resume signal to the printer.

The Check Character Lockout FF is used to prevent the check character from being read by the printer.



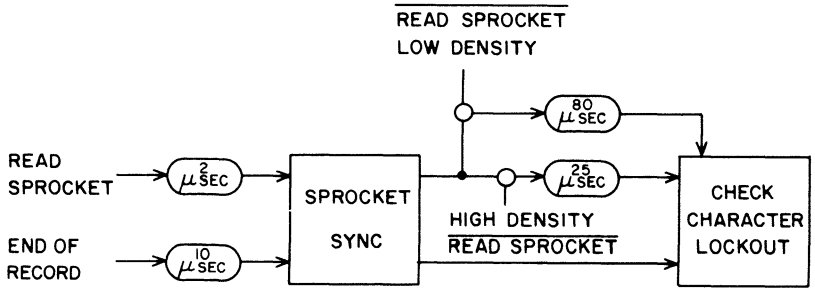


Figure A-6. End of Record

APPENDIX B
POWER SUPPLY

The AMP 851266 power supply in the 162 furnishes d-c for the printed circuit cards.

ADJUSTMENT

Three adjustment controls are adjacent to the terminal strip (4E01). Only two of the three controls are used -- plus and minus 20 volts. Each time the 162 undergoes routine maintenance, check these voltages with a VOM and adjust the controls to correct any existing error. If the error is beyond the range of the controls, remove the power supply and repair it.

REPAIR NOTES

The following is taken from Repair Notes, AMP 851266, AMP Incorporated, Capitron Division, Elizabethtown, Pennsylvania.

Introduction

The instructions contained in the following paragraphs are intended to aid in trouble-shooting AMP 851266 power supplies in case of component failure. These instructions are not intended as a complete maintenance manual, because it is very difficult to anticipate all possible failures that can occur. Since the Regulator circuits are the most intricate areas of the supply, failures are more likely to occur there. Consequently, the following instructions primarily concern the Regulator circuits.

Regulator Operation (figure B-1)

The regulator receives 24 to 29 vdc at its input terminals A and K with about 2v P-P ripple. To obtain -20 ± 0.2 vdc output at terminals C and K, excessive voltage is dropped through the 2N1557 series transistors. A ripple suppression factor of about 25:1 is achieved through the regulator. In the Series Regulator circuit, several 2N1557 transistors are placed in parallel to handle the current requirements of the supply.

The 2N555 transistors provide a current gain of about 1000. This gain in addition to the gain of the series transistors reduces the regulating current variation requirement to about 200 ua at point F.

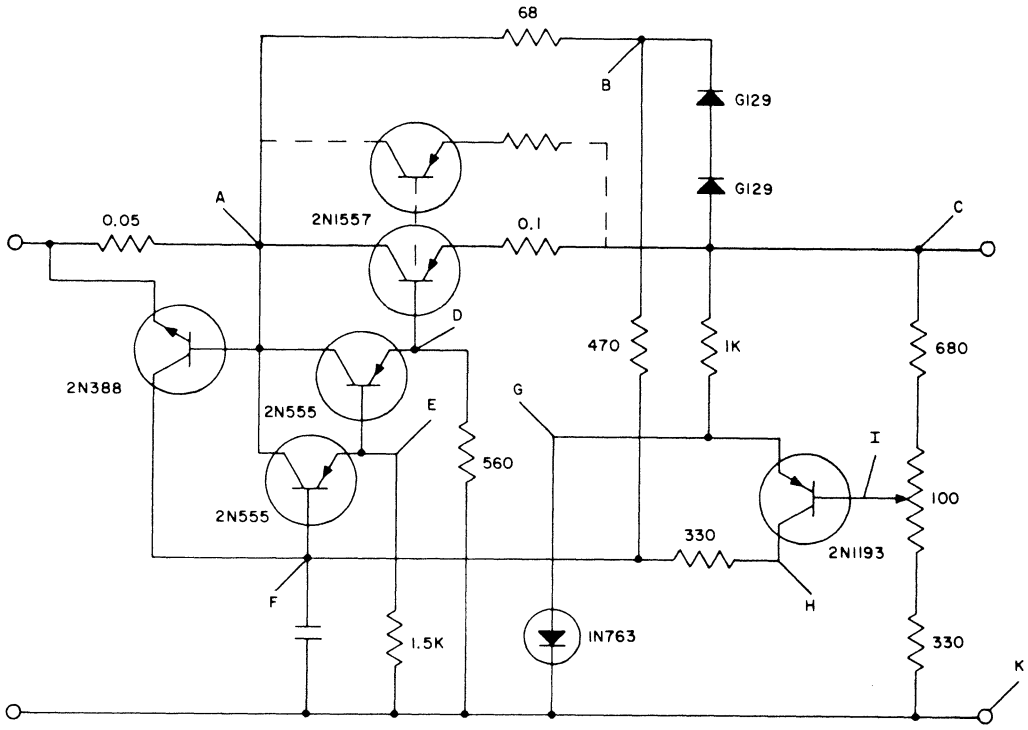


Figure B-1. Power Supply

The 2N1193 transistor compares the Voltage Feedback signal at point I to a reference voltage supplied by the 1N763 zener diode at point G. The Error signal is amplified and fed into point F. From there, the 2N555 transistors amplify the signal and control the voltage drop across the 2N1557 series transistors.

Transistor 2N388 saturates the series transistors under short circuit conditions. It also helps to regulate the output voltage during load changes.

Diodes G-129 provide a constant reference voltage at point B and improve both the ripple suppression and the regulation.

Each regulated side of the power supply, when operating correctly, provides 50 mv regulation against specified line and load changes, and about a 100 mv ripple at full load. If these limits are exceeded by an appreciable amount, a component has failed and the supply should be repaired.

Normal Operating Voltages

When the supply is operating properly, voltages throughout the Regulator circuit should have certain values. These values may vary slightly from supply to supply due to transistor gain, transconductance, saturation resistance and zener voltage variations, but these variations should not exceed a volt.

Following is a list of voltages at certain points in the Regulator circuit, relative to positive side at about half load.

Point	Voltage	Point	Voltage
A	-26v*	F	-20.9v
B	-21.4v	G	-6.6v**
C	-20v	H	-20.5v
D	-20.5v	I	-6.8v**
E	-20.7v	K	-v

If a power supply failure has occurred, measurements of these voltages will quickly locate the faulty component, since all these voltages can be measured on the component board.

Probable Failures

A) Failure - Series transistor 2N1557 V_{CE} short.

1) Symptoms:
   a) High output voltage (C to K).
   b) No regulation.
   c) No adjustment.
   d) Excessive ripple.
2) Abnormal Circuit Voltages:
   a) Point C, approximately -25v.
   b) Point F, approximately -10 to -15v.
   c) Point H, approximately -6.6v.
3) Other Observations:
   a) One of the 0.1 ohm series-transistor emitter resistors gets very hot.

---

* This voltage may vary from -24 to -30 volts at half load without any detrimental effects.

** These voltages may vary from -6.2 to -7.8 volts; however, their mutual relationship must remain as shown on the list.

b) Zener diode 1N763 gets hot.

4) Remedy: Replace the 2N1557 transistor the emitter resistor of which gets hot.

B) Failure: Series transistor 2N1557 V_{CB} short.

This failure will have similar symptoms to failure "A"; however, it will not be possible to locate the fault transistor by the over-heating 0.1 ohm emitter resistor. In this case all the series transistors should be removed and checked in a transistor tester. When this is not feasible remove one series transistor and turn the power supply on. If the regulating circuit still does not operate, replace the transistor and remove another. Repeat the procedure until the fault transistor is located. The power supply will not suffer any damage if one of the series transistors is removed for a short operating period. It is impossible, however, to determine the fault by this method if two transistors are bad.

C) Failure: The 2N388 transistor V_{CE} or V_{CB} short.

1) Symptoms:
   a) High output voltage (C to K).
   b) No regulation.
   c) No adjustment.
   d) High output ripple.
2) Abnormal Circuit Voltages:
   a) Points C-D-E-F are at same voltage point as A.
   b) Point H is at -6.6v.
3) Other Observations:
   a) Zener diode 1N763 gets very hot.
   b) Transistor 2N1193 gets warm.
   c) 330 ohm collector resistor for 2N1193 gets warm.
4) Remedy: Replace 2N388 transistor. If short has existed for a long period of time the 1N763 zener diode may also have to be replaced.

D) Failure: Shorted 2N555 transistor.

Same symptoms as in failure "B", except the good 2N555 will exhibit a high V_{BE} voltage.

Remedy: Replace 2N555 transistor.

E) Failure: Short circuit anywhere in the circuit.

1) Symptoms: No output voltage and very little voltage (about 1 volt) throughout the circuit.

2) Remedy: Disconnect Regulator circuits at point "A", and also disconnect filter capacitors. If short still persists, return supply to vendor for replacement of transformer.

The failures outlined previously are the most likely to occur in that order. Other failures may happen, but it is impossible to discuss all possibilities. With some understanding of transistor d-c amplifier operation it should not be difficult for the average technician to trouble-shoot the circuit.

Transistor Substitution

Although this practice is not recommended on a permanent basis, the transistors in the AMP 851266 power supply may be replaced temporarily by equivalent transistors. Since the transistors used in the power supply are readily available, an effort should be made to get the correct replacement as soon as possible.

Cautions

1) Do not operate the power supply for long periods of time with the lid removed.
2) Do not obstruct openings on both ends of the power supply.
3) Do not obstruct fan outlet.
4) Do not operate supply off 400 cps line. The unit is designed for 115v, 60 cps only.

Warranty

This unit is warranted to be free from defects in workmanship and materials for a period of 90 days or 720 hours, whichever occurs first. In the event this unit is serviced by the customer, we reserve the right to void this warranty, and replace only those parts which we have determined to have failed through defects prior to such servicing.

A) Substitutes for 2N1557 transistors:
2N1549, 2N1550, 2N1551, 2N1553, 2N1554, 2N1555, 2N1556, 2N1558, 2N1559, 2N1560, 2N667-A-C-C, 2N1146-A-B-C, 2N512-A-B-C, 2N1120, 2N1162, 2N1164, 2N1166, CTP-1508, CTP-1504, CTP-1503, CTP-1500.

B) Substitutes for 2N388 transistors:
2N78, 2N78A, 2N167, 2N167A, 2N169, 2N377, 2N524, 2N525, 2N526, 2N527, 2N634, 2N635, 2N636.

C) Substitutes for 2N555 transistors:
Any 3 or 5 amp diamond shaped germanium PNP power transistor.

D) Substitutes for 2N1193 transistors:
Any germanium PNP small signal transistor with V_{CEs} of 20v or more.

APPENDIX C
COMMAND TIMING CHARTS

STATUS SELECTION

Step	Event	Comment
	XX4X	Status Code
	Function Ready signal	
FT 0	Disable X register feedback	(2 usec) translates EF code
FT 1	Set Status Control FF	(3 usec)
	$M_L \rightarrow X_L$	
FT 2	Output Resume to computer	(2 usec from termination of Function Ready)
FT 3	Set Status Lockout FF	(4 usec) locks out further Function Ready
	Input Request signal	Enables main timing chain
T 1	Disable X register feedback	
T 2	Status condition to X	
T 3	X to H transfer	
	Input Ready signal to computer	
T 4	Clear Status Control FF	
T 5	Clear Status Lockout FF	

PARITY MODE SELECTION

	XX71 or XX72	Parity Mode code
	Function Ready signal	
FT 0	Disable X register feedback	(2 usec)
FT 1	$M_L \rightarrow X_L$	
FT 2	Set Code FF	
	Output Resume to computer	(FT 2 lasts 2 usec from termination of the Function Ready signal)

DENSITY SELECTION

Step	Event	Comment
	210X or 110X	Density code
	Function Ready signal	
FT 0	Clear A/D FF	(2 usec)
	Disable X register feedback	
FT 1	Set A/D FF	(4 usec) store Density selection
	$M_L \rightarrow X_L$	
FT 2	Density signal to tape handler	(2 usec from termination of Function Ready) Signal recorded in tape handler and returned to the 162 to alter certain delay paths
	Output Resume signal to computer	

WRITE SELECTION

Character Mode

I.	111X	Write, Character Mode EF code
	Function Ready signal	
FT 0		(2 usec)
	Clear Unit Select FFs	
	Disable X register feedback	
FT 1	$M_L \rightarrow X_L$	(4 usec)
	Set Unit Select FFs	Store selection
	Clear Sprocket Ready FF	
FT 2		(Duration from end of FT1 until 2 usec after Function Ready signal drops)
		(Blocked if unit is Not Ready or if an error exists)
	Set Write Control FF	
	Control signals to tape handler	(Forward and Write Enable)

Step	Event	Comment
	Set Function Lockout FF	Locks out further Function Ready signal until operation complete
	Output Resume signal to computer	
FT 3		(4 usec)
	Clear Parity Error FF	
II.	Information Ready signal	
	12 bits of data	Output word 12 bits, Character mode uses only the lower 6 bits.
	Set Block Control FF	Delayed for a duration equal to 3/4 inch of tape motion
	Set Initiate Oscillator FF	Wait for Sync pulse
T 1	Disable X register feedback	
	Set Write Delay FF	Disables the Block Control FF enable
T 2	M lower to X lower	
	Parity generation from X	
	Output Resume signal to computer	
T 3	X lower to T_1	T_1 changes on "1's" stored in T_2 (data sent from T_1 to selected tape handler)
	Set Sprocket Ready FF	Sprocket pulse sent to tape handler
T 4	T_1 to T_2	Records change on "1's" for next frame
T 5		
	Sprocket Ready FF set	Clear Sprocket Ready FF
	+ 4 usec	Halts Sprocket pulse to tape handler

Step II cycles as long as the computer issues output words.

When the computer stops issuing output words, the 162 begins an end of record procedure. This involves leaving a check character gap on the tape, writing the longitudinal parity check character, and leaving a 3/4 inch record gap.

Step	Event	Comment
III.	Sync Pulse	No Information Ready signal
	Clear Block Control FF	
	T 1 through T 5	Check character counter enabled at T 3
	T 1 through T 5	Check character counter enabled at T 3
	T 1 through T 5	Check character counter enabled at T 3
	T 1 through T 3	Check character counter enabled at T 3
	T 4	Set Sprocket Ready FF
		Send signal to tape handler
		Clear Initiate Oscillator FF
IV.	End of Record signal	Tape handler sends signal 200 (400) usec after it has sensed 3/4 inch gap
	Set End of Record FF	
	Clear Sprocket Sync FF	(20 usec delay)
	Clear Check Character	
	Lockout FF	(1 usec delay)
	Clear End of Record Sync FF	
	Disable Forward signal to tape handler	

If the computer did not issue another output word at step II, the above end of record procedure is initiated. If another similar selection is issued after step III starts, but within 400 usec after the End of Record FF is set in step IV, a Non-Stop operation ensues.

Step	Event	Comment
Last word in record		
FT 0	Clear Unit Select FFs	
FT 1	Set Unit Select FFs	Advances to Rank II
	$M_L \rightarrow X_L$	
IV.	Clear Block Control FF	
First word of new record		
FT 0	Clear Rank I Unit Select FFs	
FT 1	Set Rank I Unit Select FF	Compare with Rank II of previous selection
	$M_L \rightarrow X_L$	

Step	Event	Comment
	Set Non-Stop FF	
	Set Write Non-Stop FF	
	Set Block Control FF	3/4 inch delay

During a Write operation every frame written on the tape is read back to the 162 transverse parity detector. The distance between the Write and the Read heads of the tape handler (0.3 inch) causes the Write Reply for each frame to trail its Write output by 2 ms (4 ms).

Step	Event	Comment
	Read Sprocket signal	
	M to R transfer	
	R to Write Reply parity comparitor	(Determines parity of the 6 bits of data and compares it with the parity bit written on the tape)
	Set Parity Error FF	(Lights parity error indicator and stores error determination for status)

The Write Reply steps occur for each frame written on the tape. When the tape handler senses the end of record gap, it sends the 162 an End of Record signal. This signal enables the End of Record circuits in the 162. The 162 End of Record circuits clear the Write Operation Control circuits.

WRITE FILE MARK

Step	Event	Comment
I.	Same as the step I of a Write operation	

The above steps store the Write request, start the tape motion, and initiate the Write delay path. At the end of the Write delay path, the absence of an Information Ready signal sets WLP I FF. This initiates the load point delay path [40 ms *80 ms)] which permits the 6 inch blank space on the tape. At the end of the load point delay path WLP II FF is set, setting the Block Control FF.

Step	Event	Comment
II.	Set WLP I FF	Set after the usual Write delay (3/4 inch)
	Set WLP II FF	Set 40 ms (80 ms) after WLP I FF
	Set Block Control FF	
	Set Initiate Oscillator FF	
T 1		
T 2		
T 3	Set lower 4 FFs of the T register = 17_8	
	Set Sprocket Sync FF	
III.	Same as step III of a Write operation	

READ

Character Mode

Step	Event	Comment
I.	113X	
	Function Ready signal	
FT 0	Clear A/D FF	(2 usec)
	Clear Unit Select FFs	
	Disable X register feedback	
FT 1	Set Unit Select FFs	(4 usec)
	$M_L \rightarrow X_L$	
	Clear Read FF (K166/167)	
FT 2	Set Read Control FF	[Duration from the end of FT 1 until 2 usec after Function Ready signal drops (blocked if unit is not ready or if an error exists)]
	Send signals to tape handler	(Forward and Read)
	Set Function Lockout circuit	Locks out further Function Ready signals until operation complete
	Send Output Resume to computer	Drops Function Ready signal

Step	Event	Comment
FT 3	Clear Parity Error FF	(4 usec)
II.	Read Sprocket signal from tape handler	
	Set Block Control FF	
	Initiate Oscillator counter	
T 1	Disable X register feedback	
	M to R transfer	(7 bits)
	R to parity comparitor	
III.	Input Request signal from computer	
	Set Read FF (K166/167)	Blocks Search FF
T 2	R to X transfer	(6 bits)
T 3	X to H transfer	Holds data in H until next Input Request
	X to T transfer	Horizontal parity check made on contents of T at the last word in record
	Input Ready signal to computer	1 usec after X to H Input Ready signal allows computer to drop the Input Request signal
	Sprocket signal lasts approximately 3 usec	When sprocket drops, disable oscillator counter

Steps II and III are repeated for each frame read to the computer. If the end of record occurs and the computer is still requesting information, an Input Disconnect signal is sent to the computer.

Step	Event	Comment
II.	No Read sprocket	
	Input request from computer	
III.	End of Record signal from tape handler	
	Set End of Record Sync FF	
	Sent End of Record FF	

Step	Event	Comment
	Clear Read Control FF	
	Clear Block Control FF	
	Disable Forward signal to tape handler	
	Send Input disconnect signal to computer	

Information transfer stops whenever the computer stops requesting information. Tape motion is still maintained however, until the end of the record on the tape.

SEARCH FORWARD TO FILE MARK

Step	Event	Comment
I.	Same as steps I and II in the Read selection	
II.	No input request	
	Set Search FF (K154/155)	
	Send Search File Mark signal to the tape handler	Causes the tape handler to recognize only the file mark rather than the record gap
	Set 162 End of Record FF	Pseudo End of Record frees 162 for operation with other tape handler
III.	Tape handler recognizes file mark	
	Tape handler sends BUSY to 162	Reselection of tape handler legal

BACKSPACE ONE RECORD

Circuits the same as for the first word in a Read operation except for the reverse motion rather than forward. Motion continues until the end of record is sensed. The first word is actually read into the computer.

SEARCH BACKWARD TO FILE MARK

Circuits the same as for a Search Forward to File Mark operation except for the reverse motion rather than the forward.

REWIND LOAD

Step	Event	Comment
I.	XX6X	
	Function Ready signal	
FT 0	Enable X register feedback	(2 usec)
FT 1	$M_L \rightarrow X_L$	(4 usec)
FT 2	Rewind Load signal to tape handler	[Duration from the end of FT 1 until 2 usec after the Function Ready signal drops (blocked if the unit is Not Ready or if error exists)]
	Output Resume to computer	Drops function ready
II.	When tape has reached load point it is again available for selection (during a Rewind Load the 162 is available for operation with other tape handlers)	

REWIND UNLOAD

Rewind Unload uses the same circuits as Rewind Load except for the actual signal to the tape handler. This selection removes the tape handler from computer control until the tape is manually threaded back on the take-up reel.

APPENDIX D

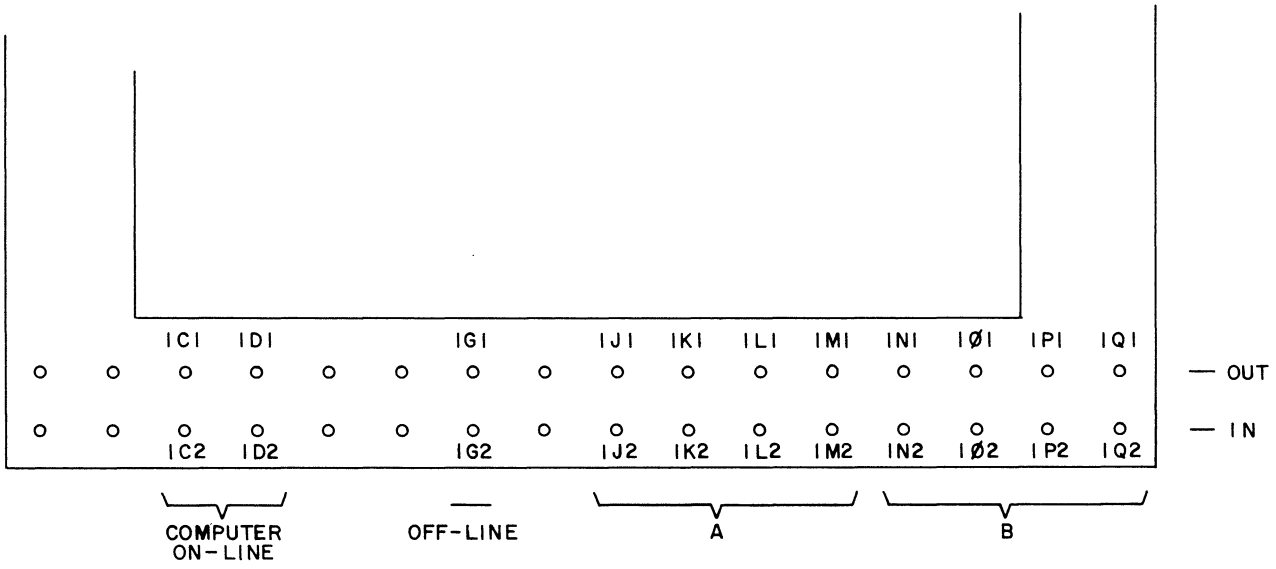
INSTALLATION

APPENDIX D
INSTALLATION

The Control Data 162 Magnetic Tape Synchronizer controls up to four (eight) Control Data 60X Magnetic Tape Handlers. The 162 is connected to the input/output lines of a Control Data 160-A Computer as a peripheral equipment. The unit is constructed of standard Control Data components. Cooling requirements are identical to those for the computer. The unit generates 4200 BTUs and is powered by an independent power supply which uses 15 amp, 120v, 60-cycle power.

The (B-1) cabinet is 56 7/8 inches high, 42 inches wide, and 20 1/2 inches deep. There must be enough clearance front and back to allow access. Weight of the 162 is approximately 350 pounds.

Logic cables enter the unit at the bottom of the rear of the cabinet (figure D-1).



Note: Synchronizers with four tape handler capacity use A above.
Synchronizers with eight tape handler capacity use A and B.

Figure D-1. Bottom of Chassis from Rear, Cable Connections

APPENDIX E
PARTS LIST

APPENDIX E
PARTS LIST
INTRODUCTION

The parts list provides the identification and ordering data necessary for the replacement of electrical and mechanical parts for the 162-1-B, 162-2-B, 162-3-B Magnetic Tape Synchronizer. The 162-1-G, 162-2-G, 162-3-G Modifications are also included.

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

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

All Control Data assemblies are listed and are broken down into individual parts (with the exception of printed circuit card assemblies) but are listed in alphabetical rather than disassembly order.

For the breakdown of printed circuit card assemblies refer to Control Data Pub. No. 60040800, Volumes I and II.

For the breakdown of the "B" type peripheral cabinet into which the chassis fits, refer to Control Data Pub. No. 60097300, Appendix A.

For the breakdown of the power supply, refer to Control Data Pub. No. 60097300, Appendix A and 60120700.

ORDERING OF PARTS

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

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

162-1-B Magnetic Tape Synchronizer, CDC Drawing Number 25175403
162-2-B Magnetic Tape Synchronizer, CDC Drawing Number 25175402
162-3-B Magnetic Tape Synchronizer, CDC Drawing Number 25175401

PARTS LIST

DATEX

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
	The following parts are common to the 162-1, -2, -3 unless otherwise indicated.	
25153000	Bar, Mounting, Connector, 01-90	
30008700	Bracket, Angle, Chassis	
25177900	Bracket, Control Panel, 162-2-B, 162-1-B	
30116600	Bracket, Mounting, Shield	
25184100	Bracket, Terminal Strip	
25187301 Thru 25187318	Cable Assembly, 24 Pin Connector (LJI Thru 1Q2, 1G1, 1G2)	
25188801	Cable Assembly, 24 Pin Connector (1C1, 1D1)	
25188901	Cable Assembly, 24 Pin Connector, (1C2, 1D2)	
25186900	Card Placement, 162-3-B	
25187000	Card Placement. 162-2-B	
25187100	Card Placement. 162-1-B	
25159501	Card Spacer Assembly	
25159601	Card Spacer Assembly	
25175401	Chassis Assembly, 162-3-B	
25175402	Chassis Assembly, 162-2-B	
25175403	Chassis Assembly, 162-1-B	
00863705	Clamp, Loop,	
30093502	Clip, Spring Tension	
10001800	Connector, Receptacle, 30 Socket	
24512001	Connector Receptacle, 24 Socket	
30093614	Cover, Terminal Board	
25177800	Cover, Control Panel, 162-2-B, 162-1-B	
30104800	Hinge, Connector Panel	
00815800	Knob, Bar Type, 162-3-B	
24515807	Lamp, Incandescent, 24V	
24511501	Lampholder, Pushbutton	
24511601	Lampholder	
25159701	Latch Assembly, Connector Panel	
24511739	Lens, Indicator Light, 'Coded'	
24511740	Lens Indicator Light, 'Binary'	
24543547	Lens, Indicator Light, 'Program Error'	

PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
24543548	Lens, Indicator Light, 'Parity Error'	
25153800	Member, Frame, Chassis, RH	
25153900	Member, Frame, Chassis, LH	
25154501	Member, Frame, Chassis, Bottom	
25154502	Member, Frame, Chassis, Top	
25177700	Panel, Control	
24548101	Plate, Identification	
25156801	Plate, Retainer, Connector	
30103800	Plate, Retainer, Cable	
25175501	Power Supply	
25157702	Sheet, Panel Filler, Chassis	
25166204	Shield, Connector Panel	
25166205	Shield, Connector Panel	
30013802	Spacer, Marker Strip	
00841101	Stud Assembly, Turnlock Fastener, Latch, Connector Panel	
30103900	Stud, Extension	
30104600	Support, Connector Assembly	
22901201	Strip, Marker, Narrow, 01-14	
22901202	Strip, Marker, Narrow, 39-52	
22901203	Strip, Marker, Narrow, 53-66	
22901401	Strip, Marker, Narrow, 15-38	
22901402	Strip, Marker, Narrow, 67-90	
22901101	Strip, Marker, Wide, 01-14	
22901102	Strip, Marker, Wide, 39-52	
22901103	Strip, Marker, Wide, 53-66	
22901301	Strip, Marker, Wide, 15-38	
22901302	Strip, Marker, Wide, 67-90	
24501214	Strip, Terminal Board, 14 Terminals	
24502214	Strip, Marker, Characters 1-14	
24521300	Switch, Push, Alternate, 2 PDT	
24507502	Switch, Rotary, 6 Pole, 8 Position	
00856604	Thumbscrew	
25186601	Wire Listing, Chassis	

PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
25186801	Wire Listing, Power Panel	

Printed Circuit Card Assemblies PARTS LIST

DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
10242401	Printed Circuit Card Assembly, Type 03	
10242701	Printed Circuit Card Assembly, Type 04	
10243001	Printed Circuit Card Assembly, Type 05	
10243601	Printed Circuit Card Assembly, Type 07	
10201801	Printed Circuit Card Assembly, Type 11	
10201901	Printed Circuit Card Assembly, Type 12	
10202001	Printed Circuit Card Assembly, Type 13	
10202501	Printed Circuit Card Assembly, Type 14	
10202601	Printed Circuit Card Assembly, Type 15	
10202701	Printed Circuit Card Assembly, Type 16	
10202801	Printed Circuit Card Assembly, Type 21	
10203401	Printed Circuit Card Assembly, Type 22	
10203501	Printed Circuit Card Assembly, Type 23	
10203601	Printed Circuit Card Assembly, Type 24	
10232501	Printed Circuit Card Assembly, Type 28	
10232801	Printed Circuit Card Assembly, Type 29	
10334401	Printed Circuit Card Assembly, Type 30	
10203701	Printed Circuit Card Assembly, Type 31	
10203801	Printed Circuit Card Assembly, Type 32	
10203901	Printed Circuit Card Assembly, Type 33	
10339201	Printed Circuit Card Assembly, Type 50	
10005901	Printed Circuit Card Assembly, Type 62	
10210201	Printed Circuit Card Assembly, Type 67	
10335201	Printed Circuit Card Assembly, Type 73A	
10337001	Printed Circuit Card Assembly, Type 87	
24407001	Printed Circuit Card Assembly, Type 97	
24414101	Printed Circuit Card Assembly, Type 141	
10206401	Printed Circuit Card Assembly, Type 00	

FORM CA 108

162-1-G Magnetic Tape Synchronizer, CDC Drawing Number 17657600
PARTS LIST
162-2-G Magnetic Tape Synchronizer, CDC Drawing Number 17657500
162-3-G Magnetic Tape Synchronizer, CDC Drawing Number 17657300 DATE: _____

CDC - DRAWING NUMBER	DESCRIPTION	QUANTITY EACH MACHINE
	The following parts are common to the 162-1, -2, -3(G Mod) unless otherwise indicated	
25175403	Chassis Assembly, 162-1-G	
25175402	Chassis Assembly, 162-2-G	
25175401	Chassis Assembly, 162-3-G	
24500707	Pin, Taper	
10202801	Printed Circuit Card Assembly, Type 21	
24410601	Printed Circuit Card Assembly, Type 244106 (DIODE)	
24415601	Printed Circuit Card Assembly, Type 99	
24414701	Printed Circuit Card Assembly, Type 108	
10005901	Printed Circuit Card Assembly, Type 62	
10337201	Printed Circuit Card Assembly, Type 87	

COMMENT SHEET

MANUAL TITLE 162-1-B/162-2-B/162-3-B MAGNETIC TAPE SYNCHRONIZER Reference Instruction Manual

PUBLICATION NO. 60100200 REVISION B

FROM: NAME: _____

BUSINESS ADDRESS: _____

COMMENTS:

This form is not intended to be used as an order blank. Your evaluation of this manual will be welcomed by Control Data Corporation. Any errors, suggested additions or deletions, or general comments may be made below. Please include page number references and fill in publication revision level as shown by the last entry on the Record of Revision page at the front of the manual. Customer engineers are urged to use the TAR.

CUT ALONG LINE

AA3419 REV. 11/69 PRINTED IN U.S.A.

NO POSTAGE STAMP NECESSARY IF MAILED IN U. S. A.

FOLD ON DOTTED LINES AND STAPLE

STAPLE

STAPLE

FOLD

FOLD

FIRST CLASS
PERMIT NO. 8241

MINNEAPOLIS, MINN.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN U.S.A.

POSTAGE WILL BE PAID BY

CONTROL DATA CORPORATION
Technical Publications Department
4201 North Lexington Avenue
Arden Hills, Minnesota 55112

CUT ALONG LINE

FOLD

FOLD