Reference/Instruction Manual

CONTROL DATA®
162-1 / 162-2
MAGNETIC TAPE
SYNCRONIZER

CONTROL DATA

CORPORATION

Record of Revisions

REVISION	NOTES
D	Change order 9058 (which did not advance the Product Designation). This change was written at Product Designation 162-1/162-2 - A21. This manual obsoletes all previous editions together with Pub. No. 60026600, the information from which is now included with this manual.

CONTENTS

APPENDIXES

FIGURES

TABLES

162 MAGNETIC TAPE SYNCHRONIZER

CHAPTER 1

DESCRIPTION

The CONTROL DATA* 162-1/162-2 Magnetic Tape Synchronizer is an input/output device for the CONTROL DATA 160-A Computer System. The tape synchronizer allows the computer to communicate with up to eight CONTROL DATA 606 Magnetic Tape Handlers. The synchronizer also provides a communication channel between one tape handler and a CONTROL DATA 166-2 Line Printer.

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 FF codes generated by the printer select switches. The pseudo EF codes select the following functions:

* Registered trademark of Control Data Corporation

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 1-1. 162-1/162-2 EXTERNAL FUNCTION CODES AND STATUS RESPONSES

	162-1/162-2 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

162 STATUS RESPONSES	
0000	Odd parity select - 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, high density, mode illegal for 162-2
when used with 160 or 160A Computer System.

1-3

PHYSICAL DESCRIPTION

The 162 is constructed of standard Control Data logic cards mounted on three hinged chassis. The chassis and their independent power supplies are mounted in a cabinet 18 inches wide, 30 inches deep, and 28 inches high. The unit weighs 350 pounds and generates 4200 BTUs. Connectors are available for the following cables:

> 4 on-line logic cables*
> 16 logic cables for the tape handlers
> 2 logic cables for the printer
> 1 power cable

FUNCTIONAL DESCRIPTION

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 1 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.

---

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

SEARCH BACKWARD TO FILE MARK (Cont'd)	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 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.

WRITE (Cont'd)	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 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 and 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 transfers 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.
	When the end of record is sensed, the longitudinal parity check character is inspected for error, the operation is terminated, and the units are cleared for future operation.
	Tape motion continues until the end of record is sensed, even if the computer stops requesting input. Data, however, is not passed to the computer.
STATUS	Initiated by the select code Y14X (Y = word length, X = tape handler). Completed at any later time by an INA instruction.
	Circuits are enabled in the 162 which generate a pseudo input word. The word reflects conditions existing in the tape handler and the 162. The computer receives the input word when an INA instruction is sent to the 162. Translations of the status response word are shown in table 1.

OFF-LINE RECORDING* MODE

TAPE HANDLER	Selected by manually setting Tape Handler Select switch to "7".
PARITY	Selected by manually setting the Binary/Coded switch on the 162.
DENSITY	Selected by manually setting the Density switch on the tape handler.
WORD LENGTH	Always 12-bit.

OFF-LINE MOTION CONTROL

SEARCH FORWARD TO FILE MARK	Initiated by pressing the following printer switches:
	    Tape/Print
	    Tape/Card
	    Master Clear (Press and hold before pressing Step or Continuous, continue holding until motion stops.)
	    Step or Continuous
	The tape moves forward until a file mark is sensed.

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.

*The term "recording" does not apply to "writing" on tape. The table is a list of preliminary mode selections for the off-line read.

READ	Initiated by pressing the following printer switches:
	Tape/<u>Print</u>
	Tape/Card
	<u>Step</u> or <u>Continuous</u>
	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.

60X 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; track 6 holds the parity bit (figure 1).

In Control Data systems, data is recorded in: binary or binary coded decimal (BCD) format. Tape is binary if data is recorded as it is represented in core storage. In

BCD format, digits, characters and special symbols are represented in core storage by 6-bit binary numbers.

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

Recorded data on the tape is arranged in groups called records and files. A minimum of one line of information constitutes a record. Adajcent 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. Adajcent 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 2). This marker is placed with its one-inch dimension parallel to, and not more than 1/32 inch from the edge of the tape nearest the operator when the file reel is mounted.

The end of tape marker should be placed not less than 18 feet from the end of the tape attached to the takeup reel hub. This space includes approximately ten feet of tape trailer and enough tape to hold a record of 20,000 characters after the end of tape marker is sensed. 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 case to avoid dust accumulating on the tape while attaching markers.

556 bpi=.0018 (.0036)
200 bpi=.005 (.01)

(READ) .032   TRACK
DETAIL   048

BINARY TRACK
NOTATION

TAPE MOTION

BCD TRACK
NOTATION

← RECORD →|← RECORD GAP →|← RECORD →

LONGITUDINAL
CHECK CHAR GAP
200 bpi= .02 (.04)
556 bpi= .0074 (.0148)
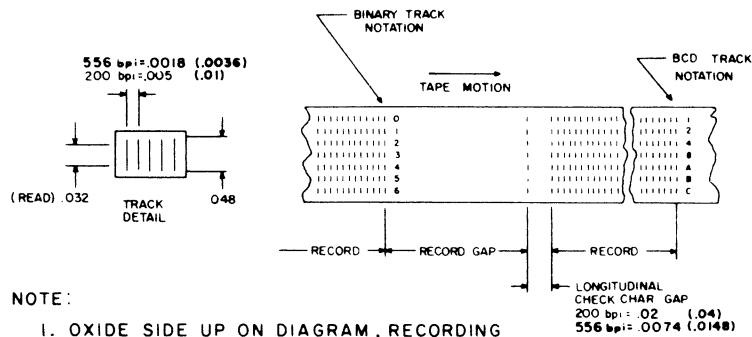
NOTE:

1. OXIDE SIDE UP ON DIAGRAM, RECORDING HEAD ON SAME SIDE AS OXIDE.

2. WRITE FREQUENCY 606-30 KC ± 1% OR 83.4 KC ± 1%
603-15 KC ± 1% OR 41.7 KC ± 1%

3. AVERAGE STEADY STATE TAPE SPEED
150 in/sec ± 1% in 606
75 in/sec ± 1% in 603

Figure 1-1.   Bit Assignments on Tape

10 1/2" DIA. REEL

END OF TAPE REFLECTIVE SPOT

LOAD POINT REFLECTIVE SPOT

TAKEUP REEL (LEFT)

SUPPLY REEL (RIGHT)

FORWARD DIRECTION

PHYSICAL BEGINNING OF TAPE   10' MINIMUM   USABLE PORTION OF MAG. TAPE 2400 MAX.   18' MINIMUM   PHYSICAL END OF TAPE
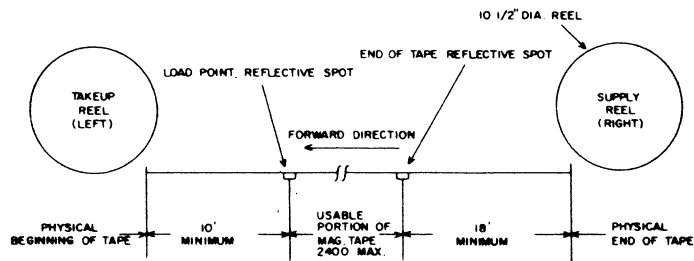
Figure 1-2.   Physical Layout of Tape

1-11

FILE PROTECTION RINGS

The back of the file reel has a slot near the hub which accepts a plastic file protection ring (figure 3). Writing on a tape is possible only when the reel contains this ring but the tape may be read with or without the ring. Presence of a ring on a reel of tape is 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.
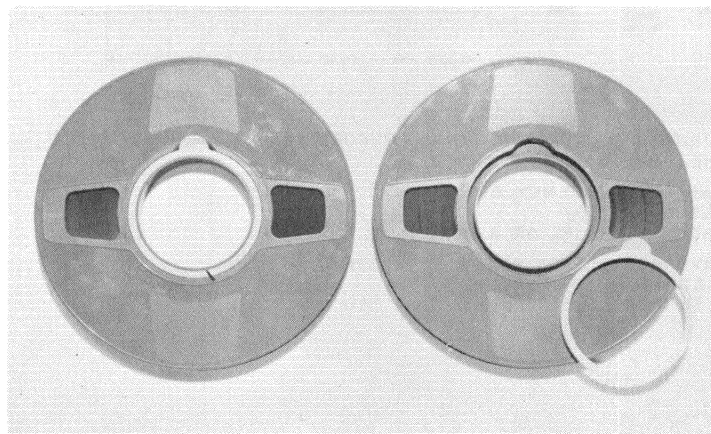
Figure 1-3. File Protection Ring

TABLE 1-2. DETAILED 60X SPECIFICATIONS

RECORDING FORMAT	Method	NRZ1 (non-return-to-zero - change-on-ones)
	Seven-Track Recording	Data six bits, parity one bit, self-clocking
	Inter-Record Gap	Three-fourths inch
	Tape Markers	End of tape and load point reflective spot
	Recording Density	200 frames per inch - 556 frames per inch
	Compatibility	Compatible with IBM 727 and 729 I, II, III and IV Tape Units
TAPE SPEED	Read/Write	606 - 150 inches per second ± 1% 603 - 75 inches per second ± 1%
	Reverse Search	606 - 150 inches per second ± 1% 603 - 75 inches per second ± 1%
	Rewind and Unload	Over 320 inches per second
	606 Start Time	3 ms (2.75 ms ± 0.5 ms)
	603 Start Time	3 ms (2.75 ms ± 0.5 ms)
	606 Stop Time	2 ms (1.75 ms ± 0.5 ms)
	603 Stop Time	3 ms (2.75 ms ± 0.5 ms)
	606 Start Distance	0.100 inch ± 30%
	603 Start Distance	0.150 inch ± 30%
	606 Stop Distance	0.225 inch ± 30%
	603 Stop Distance	0.225 inch ± 30%
CHARACTER RATE	606 High Density	83,400 per second
	606 Low Density	30,000 per second
	603 High Density	41,700 per second
	603 Low Density	15,000 per second
TAPE	Width	One-half inch
	Length	2400 feet with 1-1/2 mil base Mylar tape
	Reels	10-1/2 inch IBM hub with file protect ring
PHYSICAL	Size and Weight	Height - 72 inches, Width - 28 inches, Depth - 33 inches, Weight - 800 pounds
	Construction	Steel frame on casters with removable front and side panels and hinged rear doors

TABLE 1-2. (Cont'd)

PHYSICAL (Cont'd)	Environment	60° to 90°F, humidity 10° above dew point, dust free (typical computer room environment)
	Heat Dissipation	7500 BTU per hour
ELECTRICAL	Power Source (single phase)	115v ± 10%, 60-cycle, single-phase, 30 amp circuit. Average load at 120v; 25 amps and 2.2 KW
	(three phase)	208v ± 10%, 60-cycle, three-phase, 15 amp circuit. Average load at 208v
		Unloaded - 1 amp Loaded/Ready - 8 amps Operation - 11 amps

CHAPTER 2
OPERATION

162 ON-LINE OPERATING INSTUCTIONS

Make certain necessary cables are connected:

> 2 cables to the computer
>
> 2 cables to each tape handler
>
> 1 power cable

Press Power On switch (table

162 OFF-LINE OPERATING INSTRUCTIONS

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)

Press Power On switch (table 2-1)

Select parity mode (table 2-1)

TABLE 2-1. 162 CONTROLS

Binary/Coded	S/I-I*	Press to change parity mode. If the binary indicator lights, binary mode (odd parity) is selected; if the coded indicator lights, coded mode (even parity) is selected.
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.
Power On	S/I	Press to supply power - lights when power is on.
Power Off	S	Press to turn off power.

*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.

60X 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 2-1).

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

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

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

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

6) Slide tape under head assembly.

7) Snap tape load arms down.

8) Set Unit 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 takeup 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 takeup 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.

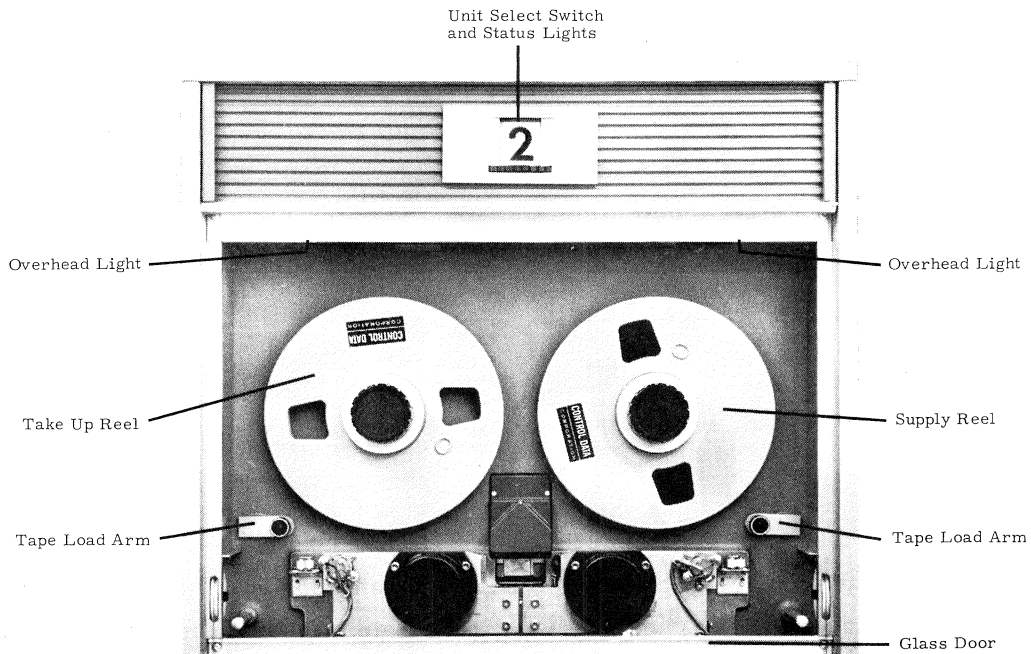5) Check if reel needs to be file-protected and if it is labeled adequately prior to storage.

Figure 2-1. 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 2-2). The functions of the controls are described in table 2-2.

TABLE 2-2. 60X MANUAL CONTROLS AND INDICATORS

Name	S/I*	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.

*S = Switch
 I = Indicator

2-5

TABLE 2-2. (Cont'd)

Name	S/I	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.
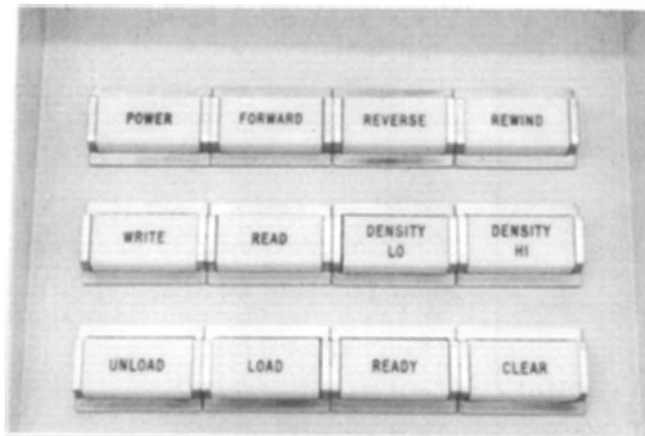
Figure 2-2. 60X Operator Control Panel

SPECIAL INSTRUCTIONS

To simulate an unload condition without removing all tape from the takeup 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 takeup 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
RNI at (P+1) 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
RNI at P+2 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 6 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.
BACKSPACE TO FILE MARK	Y12X starts tape motion reverse - without input instruction the tape unit recognizes only the longer 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 be read from the tape.
SEARCH 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 permits 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 tape motion in reverse at high speed - motion continues until tape has completely rewound off reel - 162 free for other operation after initial selection.
REWIND LOAD	Y16X starts tape motion in reverse at high speed - motion continues until load point reflective spot is sensed - 162 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 non-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	

PROGRAMMING TIME CONSIDERATIONS

Certain durations occur in a 162 operation that may be used for other computer operations. These durations are graphically shown in figures 3-1 and 3-2. This information is intended only as a guide to more efficient programming; the times are approximate, dependent on differences in variable delay settings and circuit responses.

Also shown in figures 3-1 and 3-2 are the approximate times that the 162 is available for selection.

An explanation of these durations for a 606 Write and a Write File Mark selection is outlined below. For a more precise understanding of these considerations, see Chapter IV.

WRITE
The XX1X select code enables the write circuits and initiates tape motion. Other operations may be performed in the time after the computer has received the Output Resume signal from the 162 (indicating that the selection has been accepted) and before it is necessary for the computer to issue its first output word. During this 3.5 ms period the tape attains operating speed and the tape moves forward 3/4 inches to assure a clean record gap.

Once output is started, the computer is not available for other operation until a record of information is processed.* Upon reception of the Output Resume signal from the 162 (indicating the acceptance of the last word in the record), the computer is again available for other operations.

In a start-stop operation the 162 is not available for additional selection from the time it is selected until 6 ms after it accepts the last output word in the record. This 6 ms delay is necessary so that: the tape can move from the write heads to the read heads; the end of record condition can be sensed by the read heads; and the end of record condition can terminate the write and the motion circuits.

---

*This statement does not apply if the 160-A buffer channel is used. However, because of relatively small percentage of computation time available when using buffered I/O, particularly in character mode, this statement is essentially correct. The greater speed of the 160-A allows more computation time than I/O time, percentage depends on mode and density.

In a non-stop operation (another record to follow immediately) reselection is possible during the last 400 usec of the 2.5 ms period after the computer has received the last Output Resume signal in the previous record. Reselection during this period permits initiation of the new operation without stopping the tape motion. The computer is available for other operations during the first 2.1 ms after the Output Resume and for 3 ms after the Output Resume signal for the new select code. The 3 ms duration is used to assure the 3/4 inch record gap.

During a non-stop write operation the 162 is available for selection only during the 400 usec mentioned above. It is available at this time for any selection that uses the same tape motion.

WRITE FILE MARK

The computer is available for other operations after it has received the Output Resume signal for the select code.

The 162 is available for other selections 45 ms after the initial selection. This 45 ms period allows time for write tape motion initiation, tape to move six inches for the file mark gap, and write circuit termination.

INITIATE WRITE

NON STOP WRITE

TERMINATE WRITE

WRITE FILE MARK

BACKSPACE ONE RECORD

SEARCH BACKWARD OR FORWARD TO FILE MARK

F. R. — FUNCTION READY
O.R. — OUTPUT RESUME
I.R. — INFORMATION READY
I.Rq. — INPUT REQUEST
I.Rd. — INPUT READY

TIMES IN PARENTHESIS FOR 162-1

TIMES NOT IN PARENTHESIS FOR 162-2

XX1X AND XX2X
SELECTIONS
AVAILABLE TIME

Figure 3-1.   XX1X and XX2X Selections Available Time

INITIATE READ

```
160-A        SELECT          4 (6) M.S.          FIRST WORD
             15
162          μ SEC

             F.R.  O.R.                          I.Rq.  I.Rd.
```

TERMINATE READ (END OF RECORD)

```
                          LAST WORD
160-A                                    1(1) M.S.    25
                                                      μSEC
162

                          I.Rq.  I.Rd.              INPUT
                                                    DISCONNECT
```

TERMINATE READ (NO MORE INPUT REQUESTS)

```
             LAST INPUT
                WORD
160-A                                               300 (400) μSEC

162

             I.Rq.  I.Rd.                    LAST WORD
                                             ON TAPE
```

STATUS

```
160-A        SELECT                                  INPUT STATUS
             15
162          μ SEC      MAXIMUM - INDEFINITE
                        MINIMUM  10 μ SEC

             F.R.  O.R.                              I.R.   I.R.
```

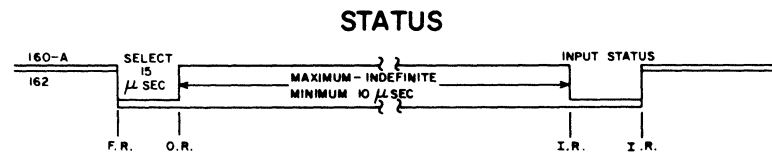## REWIND UNLOAD

```
160-A        SELECT
162          15
(SAME TAPE)  μ SEC

             F.R.  O.R.
```

REWIND LOAD

```
160-A        SELECT
162          15
(SAME TAPE)  μ SEC        MAXIMUM 90 (90) SEC

                                                    LOAD POINT
             F.R.  O.R.
```

F.R. — FUNCTION READY   XX3X
O.R. — OUTPUT RESUME   XX4X
I.R. — INFORMATION READY   XX5X
I.Rq. — INPUT REQUEST   XX6X
I.Rd. — INPUT READY   SELECTION
                                                         AVAILABLE TIME

Figure 3-2. XX3X, XX4X, XX5X, XX6X Selections Available Time

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 text 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

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 1-1).

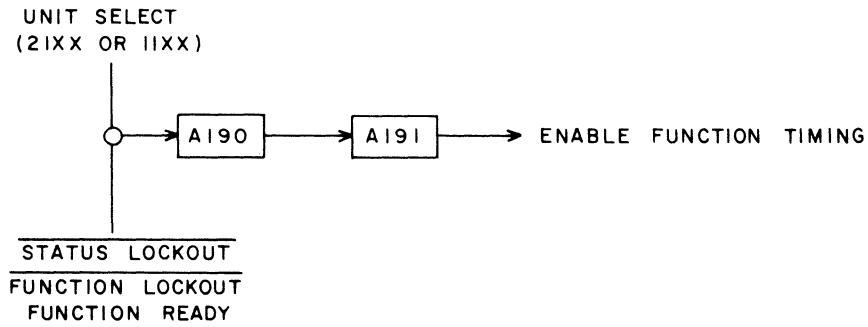* Certain operations are also dependent on the presence or absence of additional computer I/O signals.

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. 25 usec after the end of record circuit is enabled, the Function Lockout II FF is cleared, allowing further selection.
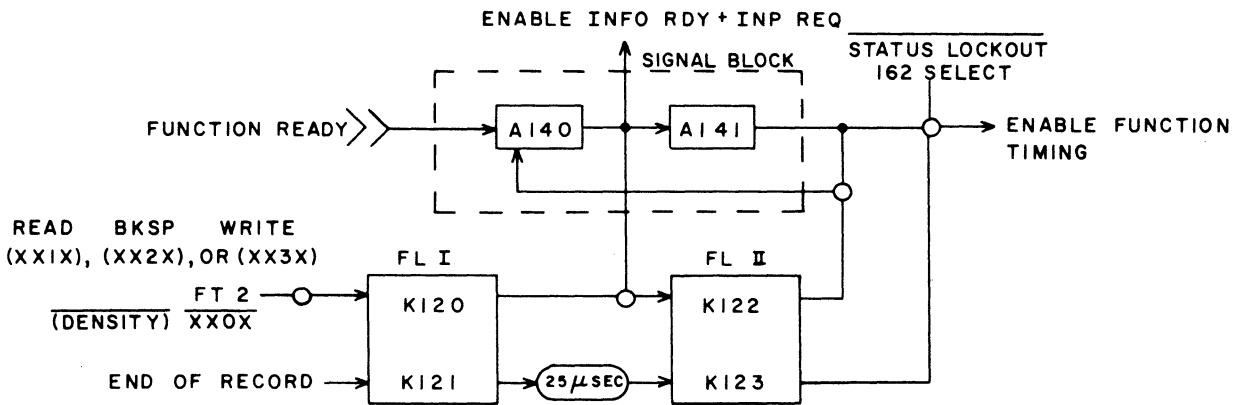

Figure 4-2. Function Lockout

If the computer issues another function ready signal while the Function Lockout II FF 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 the Function Lockout II FF is set.

Status Lockout

The Status Lockout FF (figure 1-3) is set by a status selection. It blocks further selection until the status reply is sent to the computer.
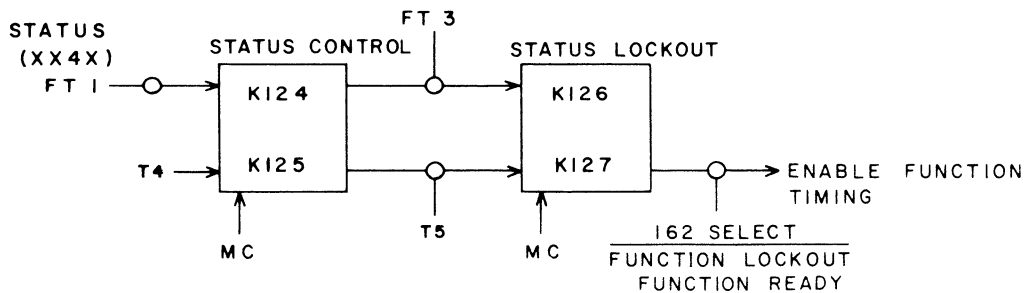
Figure 4-3. Status Lockout

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.
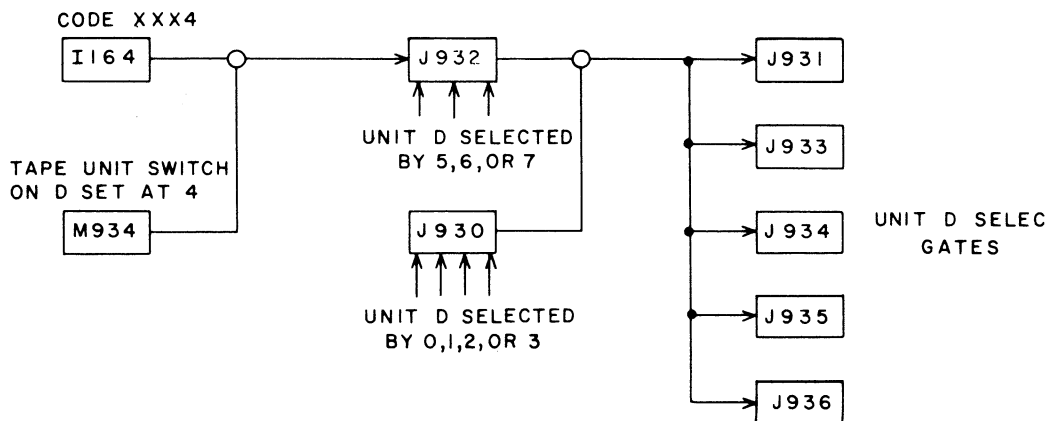
Figure 4-4. Tape Handler Select

RECORDING MODE

Density

High density is selected by a 210X code; low density by a 110X code. The 2XXX code sets the Assembly/Disassembly FF, the 1XXX code does not (figure 1-5). The state of this FF is passed to the tape handler by circuits enabled by the XX0X code. The Density FF in the tape handler is set or cleared by these signals. Signals from the tape handler to the 162 indicate the state of the Density FF. Certain 162 delay circuits are altered according to these signals.

A manual switch on the tape handler control panel may also determine the density.
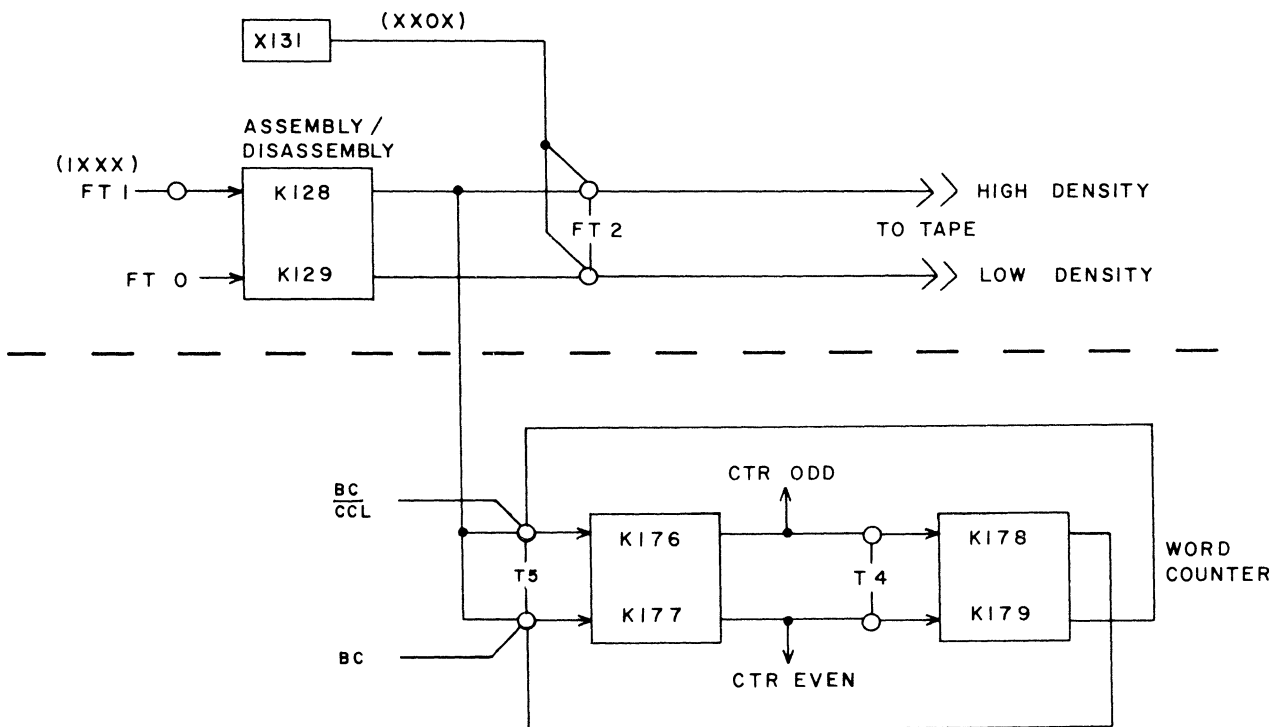
Figure 4-5. Density - Word Format

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.

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 the Binary/Coded indicator switch. The neutral position of the switch allows Code II FF to duplicate the setting of Code I FF. Pressing the switch grounds the input to inverter M196; this allows Code II FF to toggle Code I FF, thereby changing the mode.
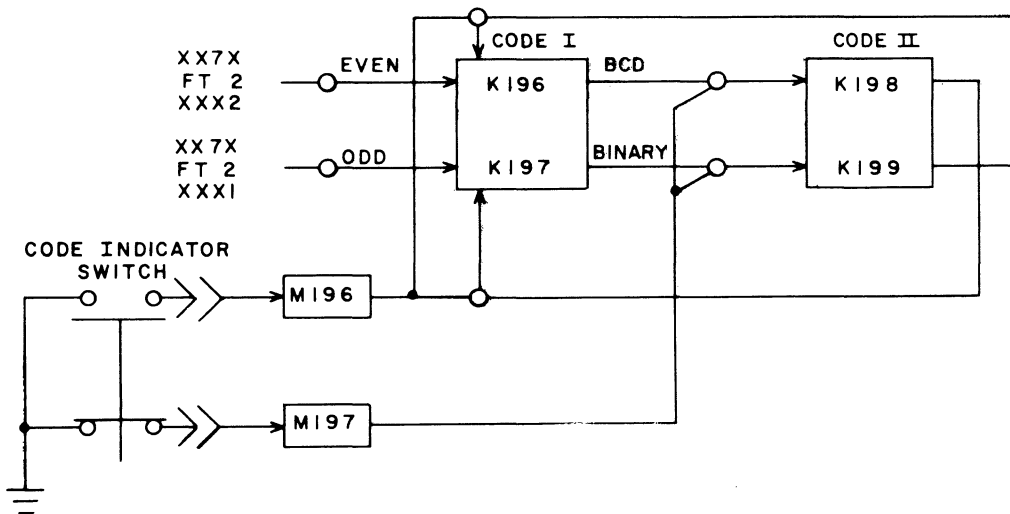
Figure 4-6. Parity Mode

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.
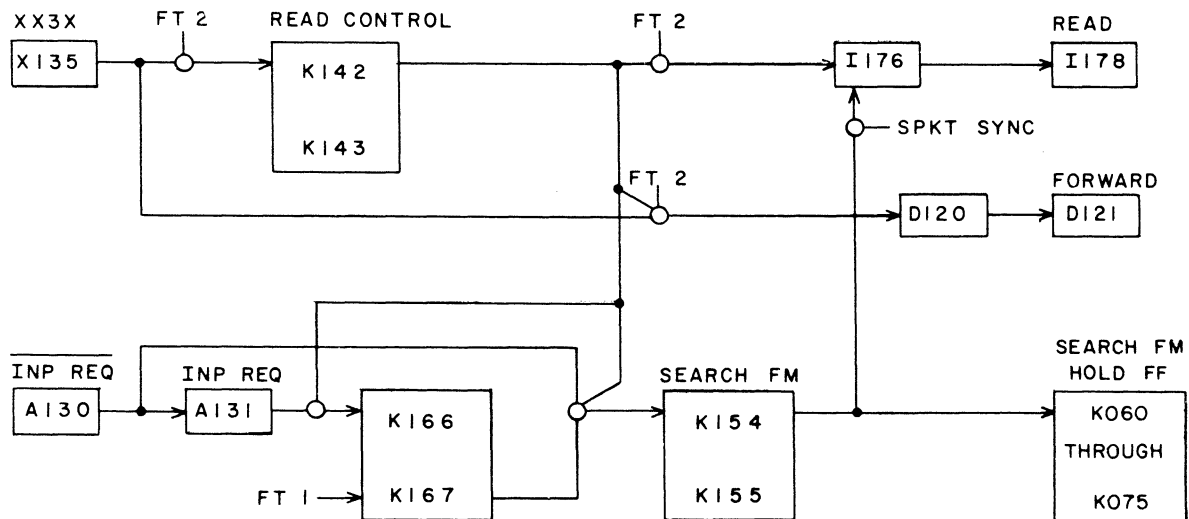
Figure 4-7. Read/Search Forward Select

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 2-5 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.
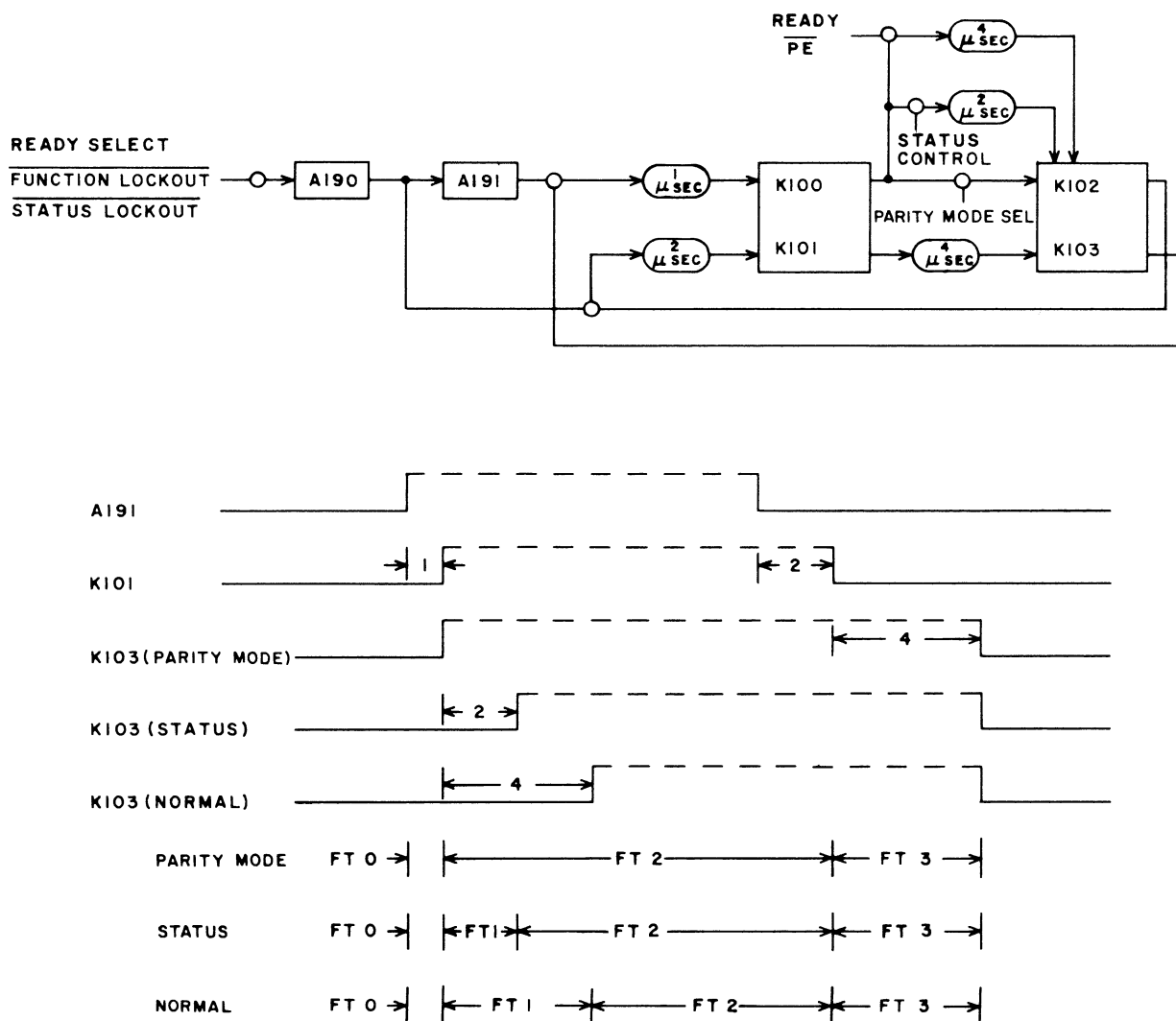
Figure 4-8. Function Timing Chain

FT	Duration	Comment
0	1 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: 2 usec	Not affected by conditions in tape handler
	During other selection: 4 usec	If tape handler is ready
2	Lasts until drop of function ready signal (approximately 2 + 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 4-9). (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.
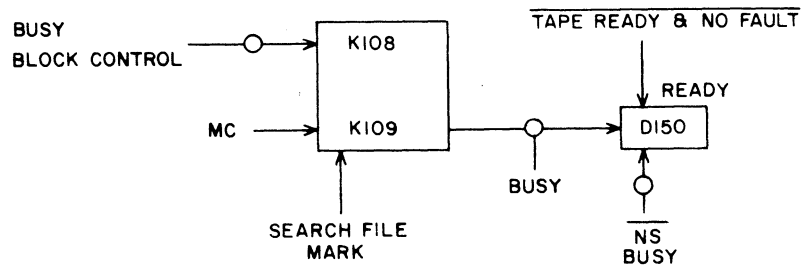
Figure 4-9. Ready Circuit

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 4-10):

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 2-6).
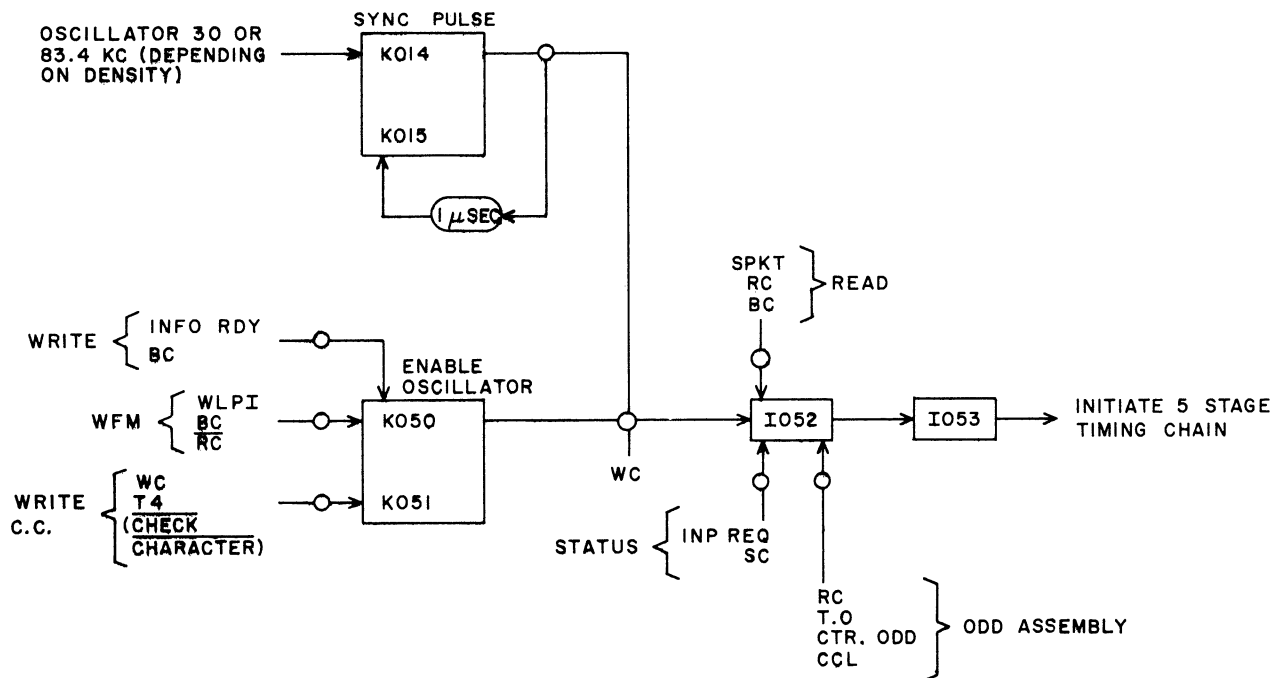
Figure 4-10. Main Timing Chain

CONTROL FFs

Read Control (RC)

The Read Control FF is set at FT2 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.
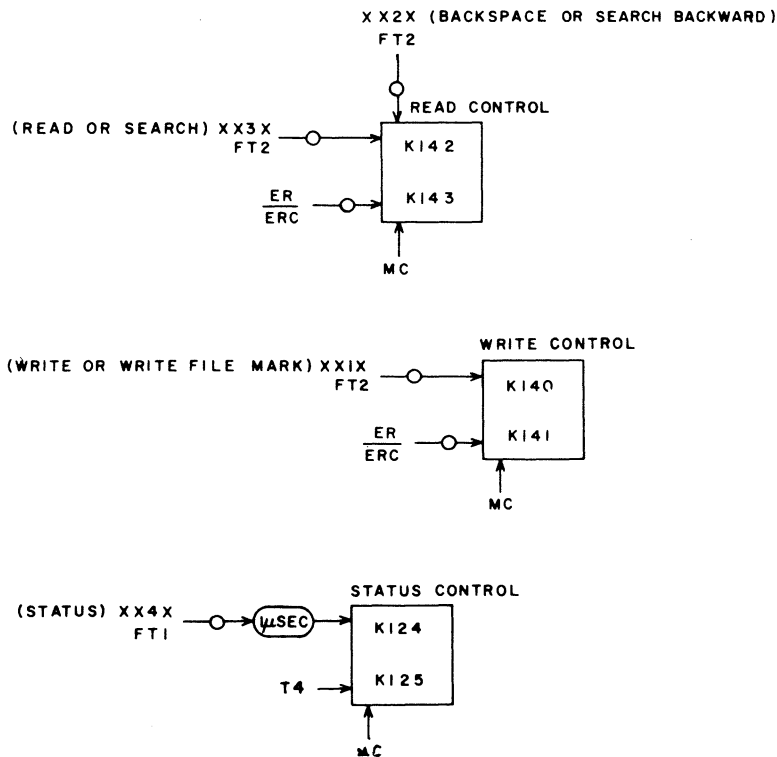
Figure 4-11. Read, Write, and Status Control

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 information 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.)
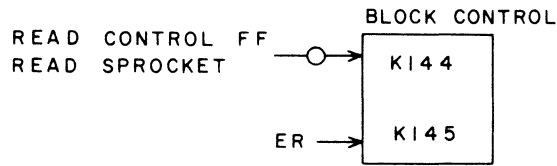
Figure 4-12. Block Control (Read)

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.
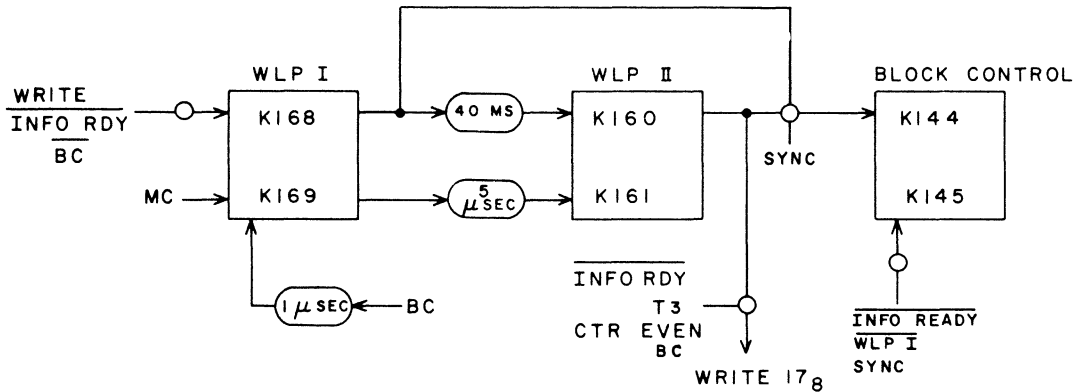
Figure 4-13. Block Control (WFM)

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.

4-13
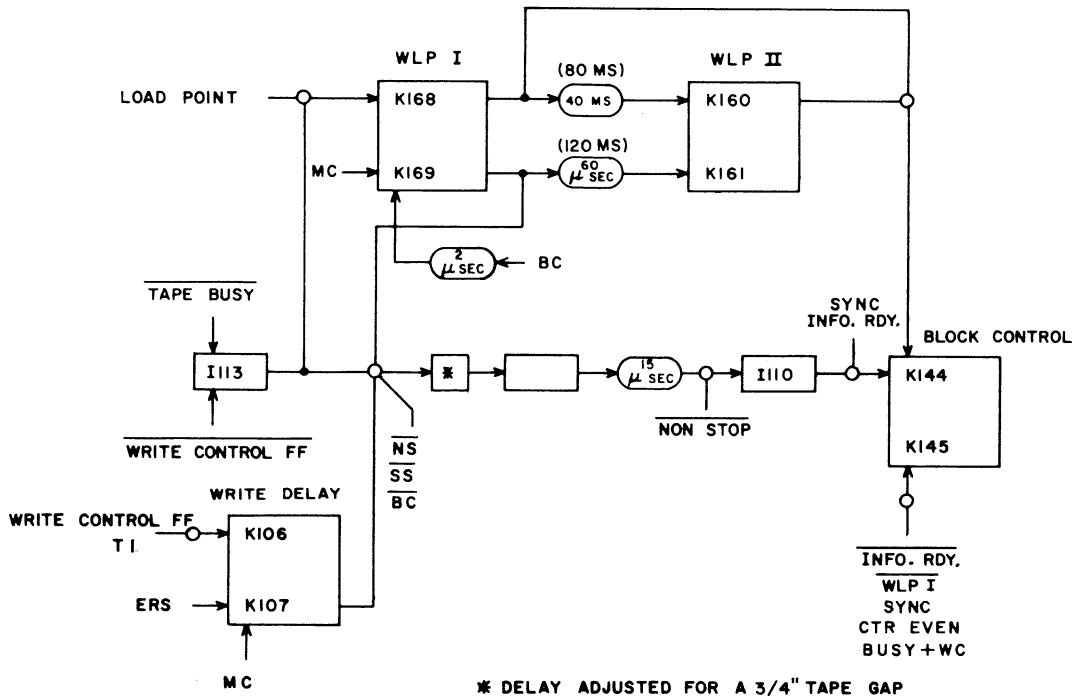
Figure 4-14. Block Control (Write)

MOTION CONTROL

Forward

The following selections require forward tape motion:

1) Write

2) Write file mark

3) Read

4) Search forward to file mark

These selections initiate a forward signal to the tape handler (figure 4-15). 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 ready 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).

4-14
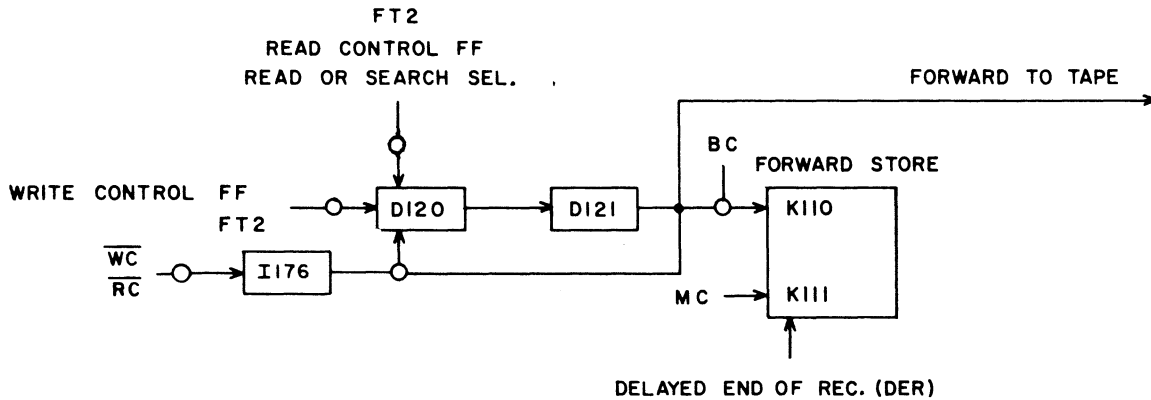
Figure 4-15. Forward Signal

Reverse

A backspace one record or search backward to file mark selection enables a 4 usec reversal 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 sensed.

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.
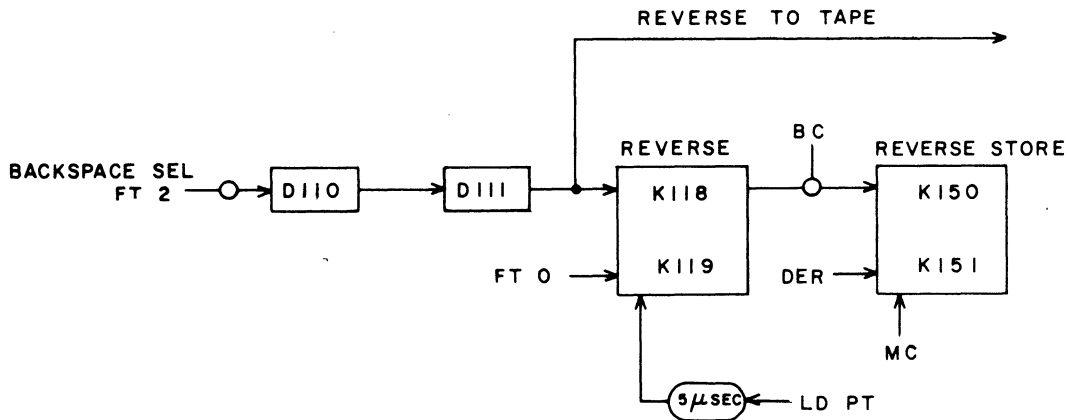
Figure 4-16. Reverse Signal

4-15

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 (logically this is true; however normal non-stop operation assumes repetitive select codes).

The non-stop circuit controls the setting of the Block Control FF in a write selection. They permit 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.
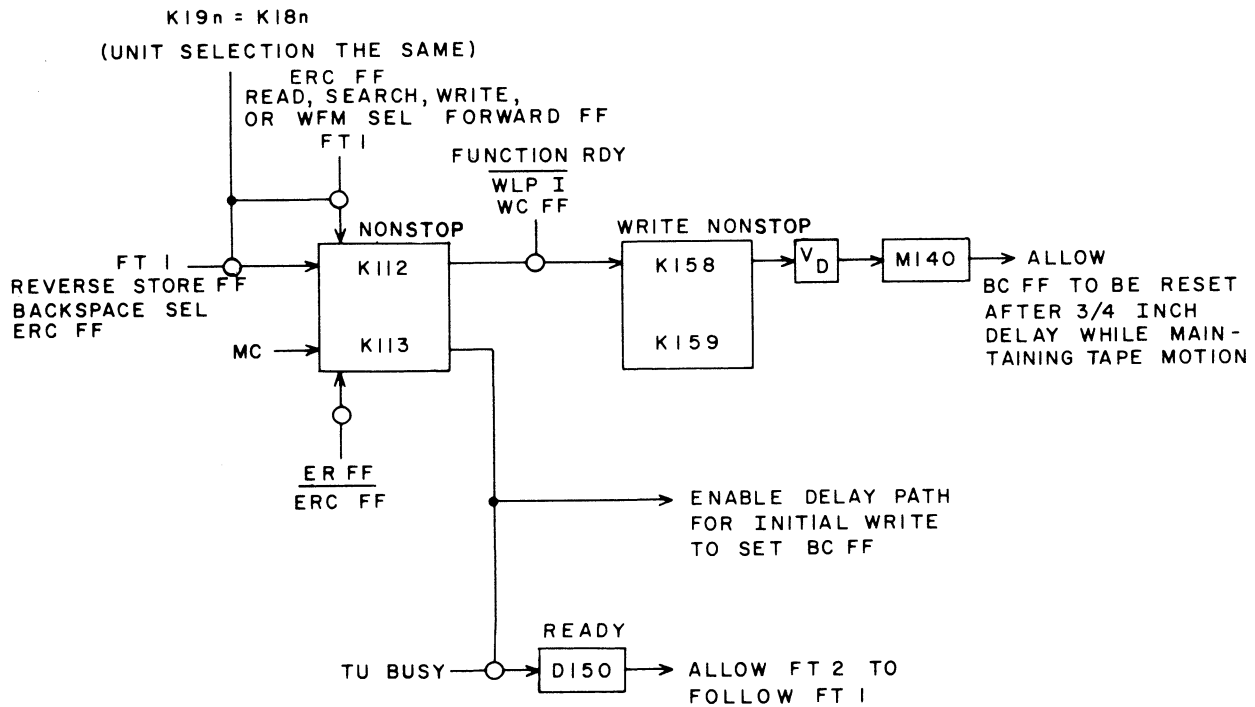
Figure 4-17. Non-Stop Circuit

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 record 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 it 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".
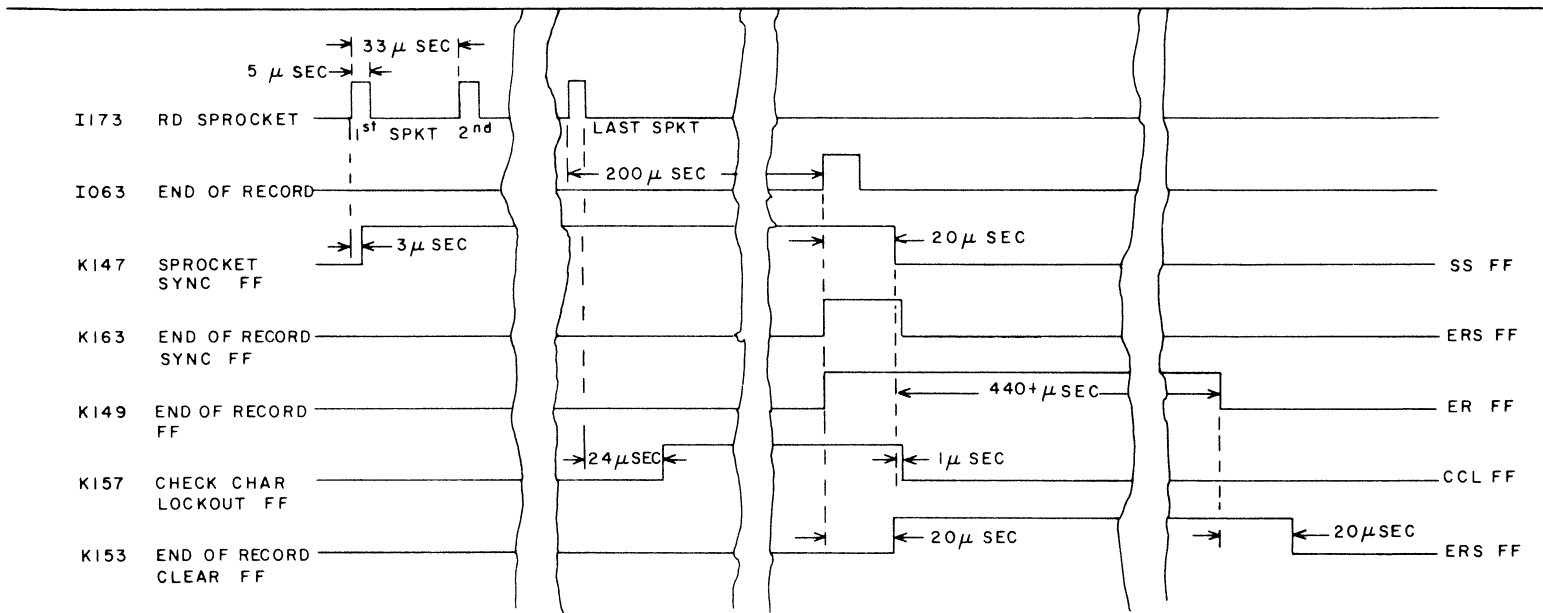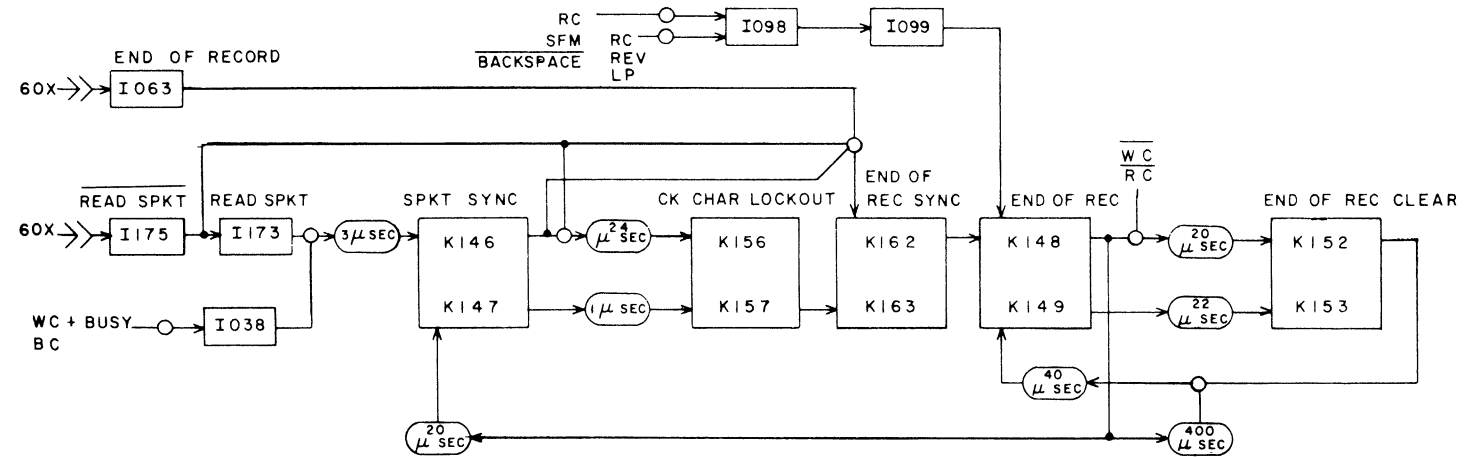
Figure 4-18. End of Record

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 [80 usec (160 usec) - low density, 24 usec (48 usec) - high 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

T 2	M register (12 bits) is passed to the X register
T 3	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 exists 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 exists and binary mode is selected, a "0" is generated; if even and binary, a "1".
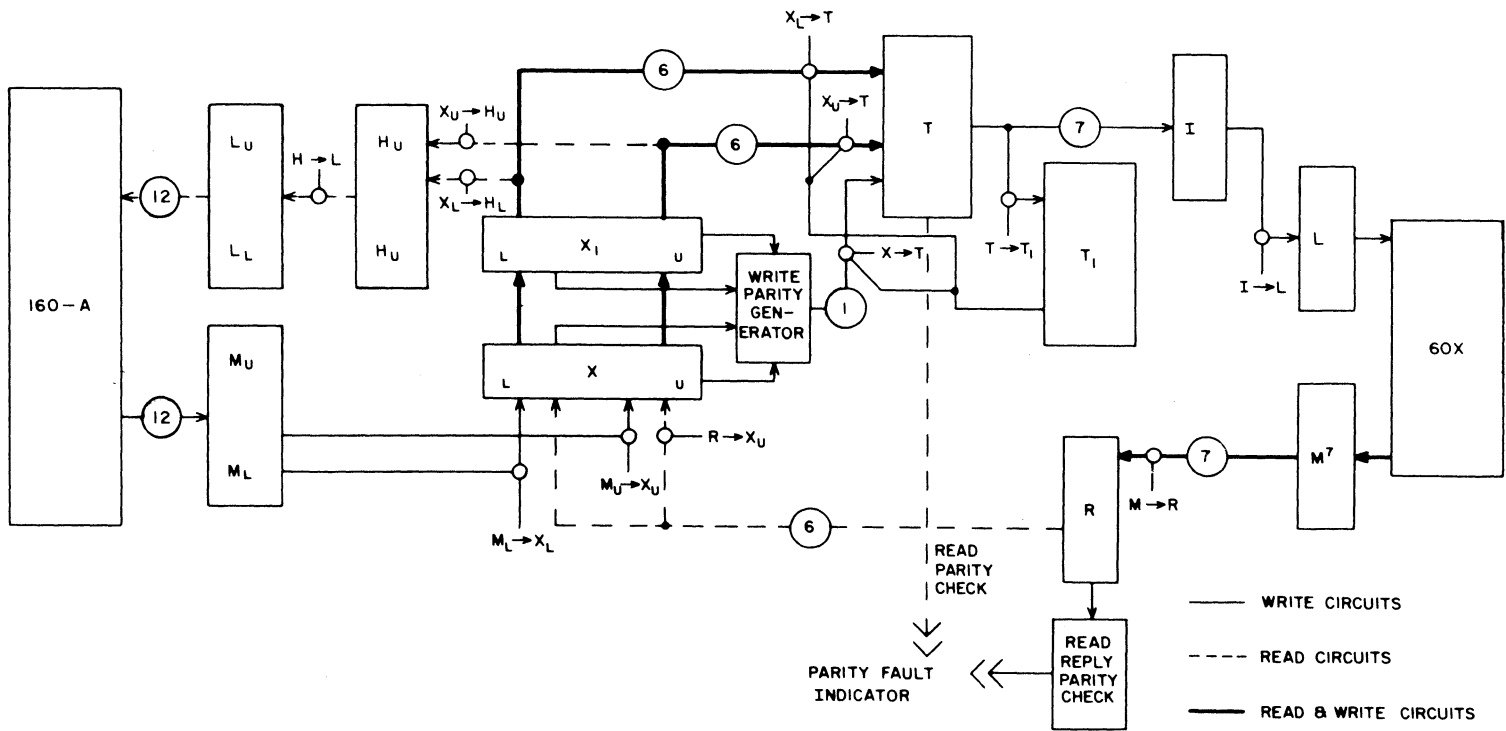
Figure 4-19. 162 Block Diagram

4-20

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 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.
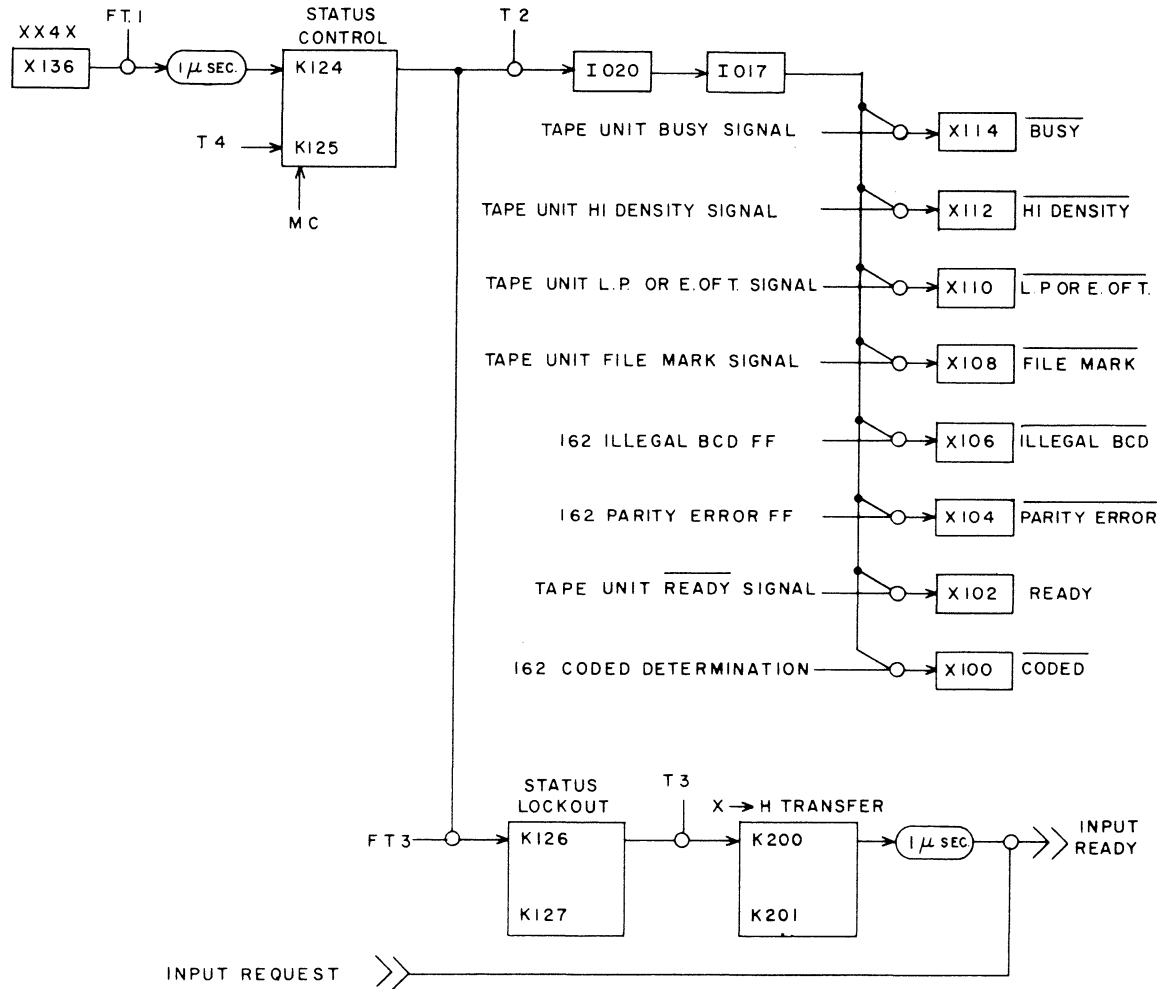
Figure 4-20. Status

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

4-24

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 handler, allowing the handler to accept the data.
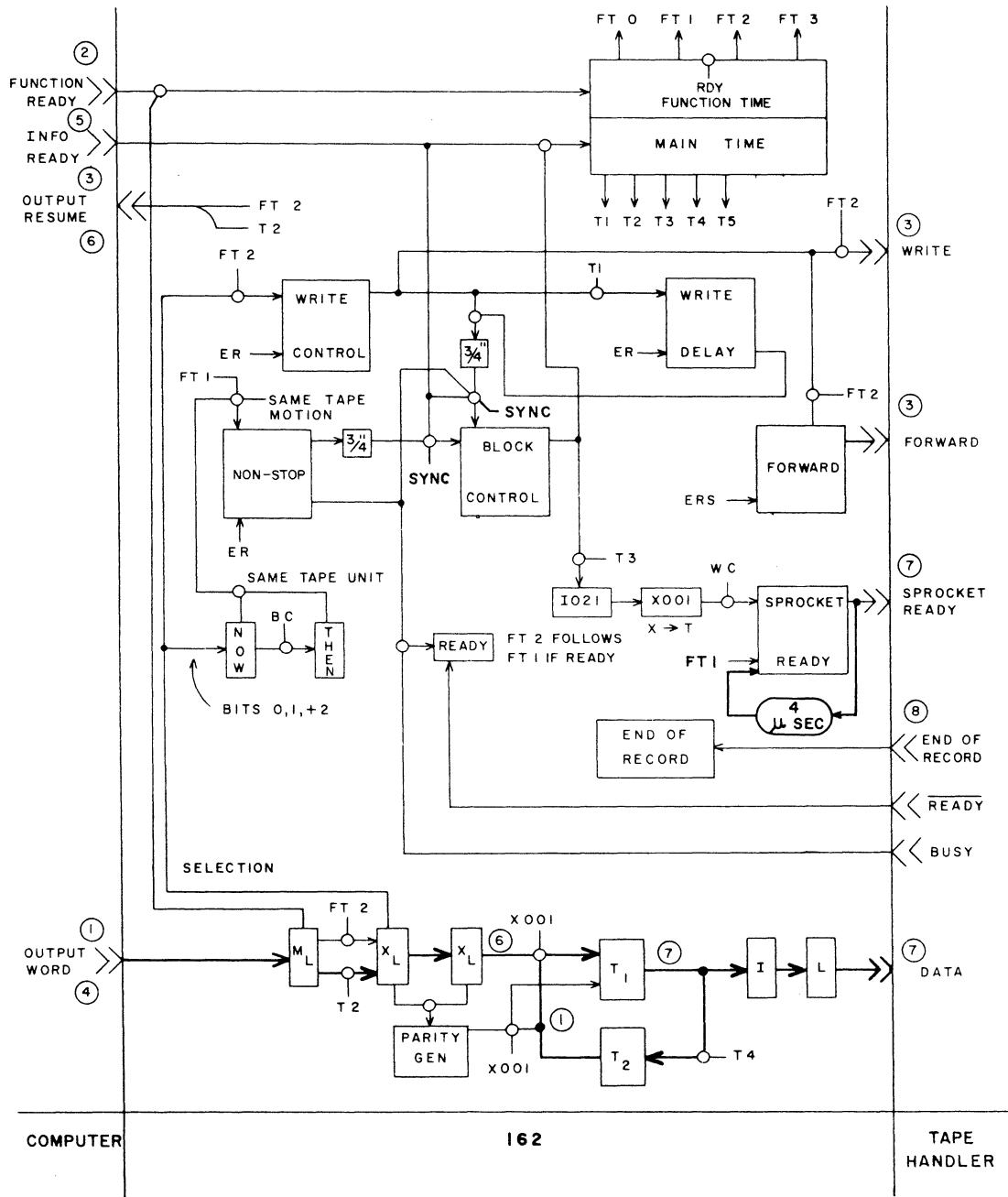
Figure 4-21. Write

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 horizontal 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).
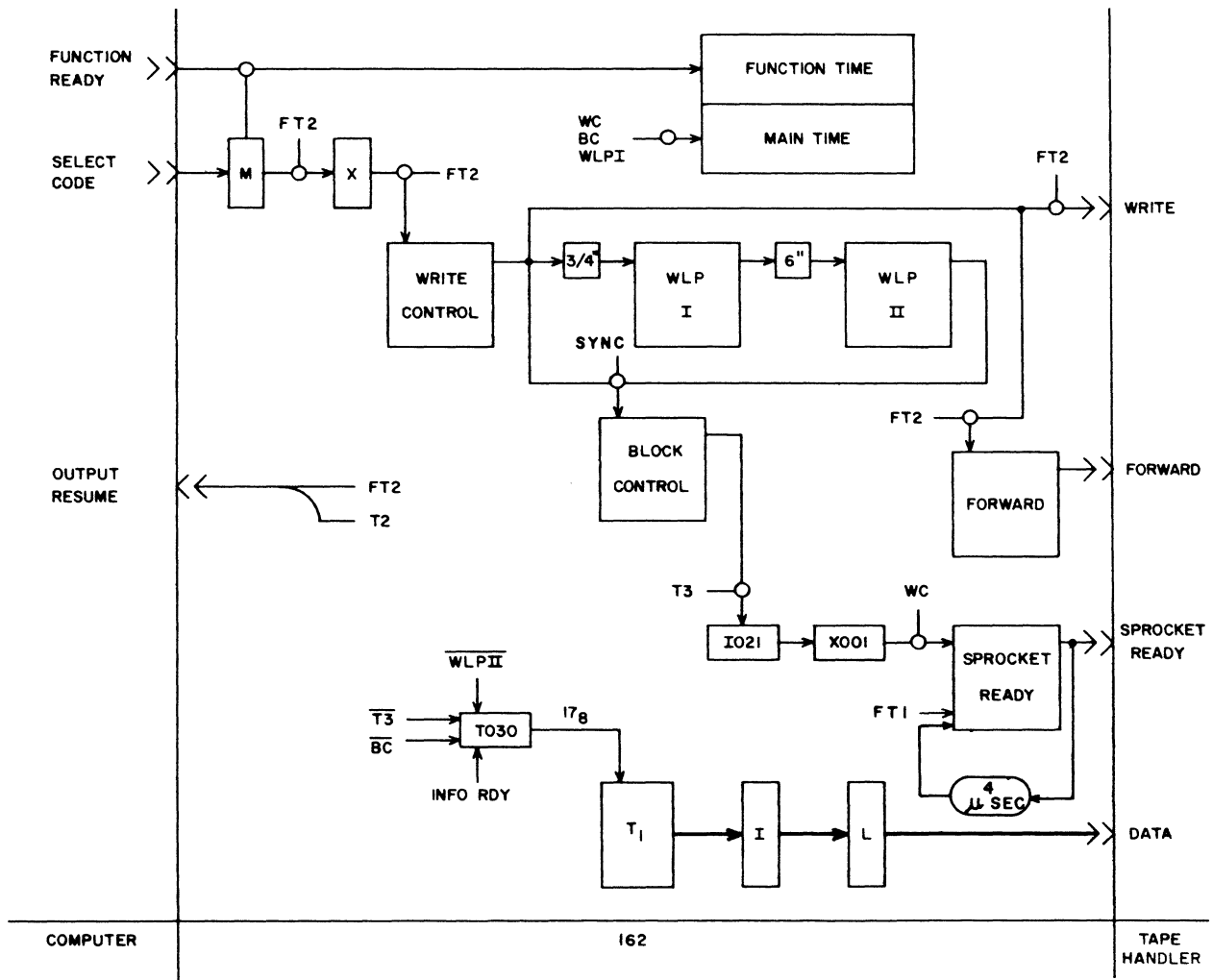
Figure 4-22. Write File Mark

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 4-23). 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

4-28
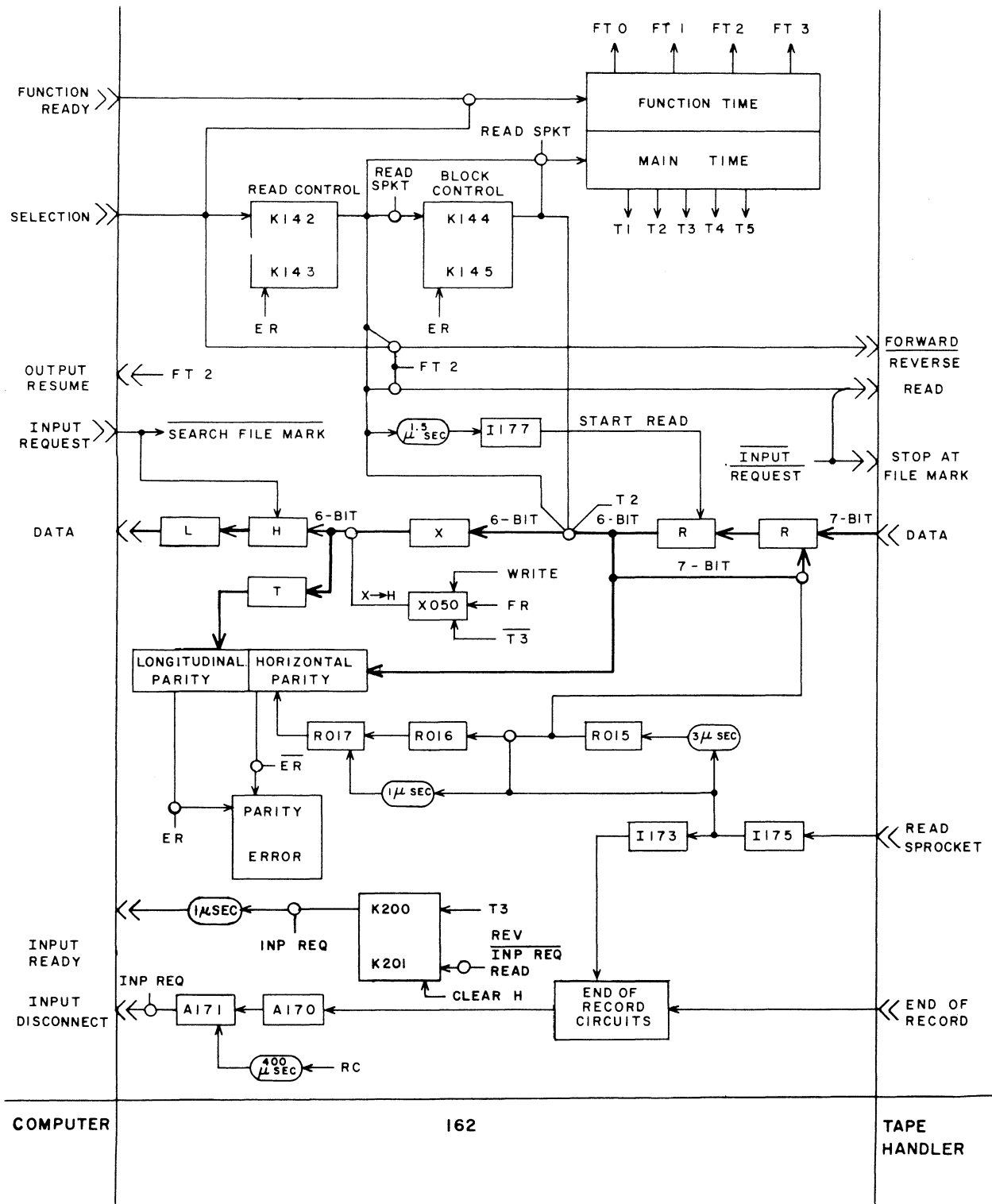
The select code sets the Read Control FF; this generates the read and the forward signals to the tape handler. These signals enable tape motion and the read heads. After a 1.5 ms delay, the Read Control FF releases the read register block to prepare the input transfer path.

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 horizontal 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 $(T_1 = "0")$.

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.
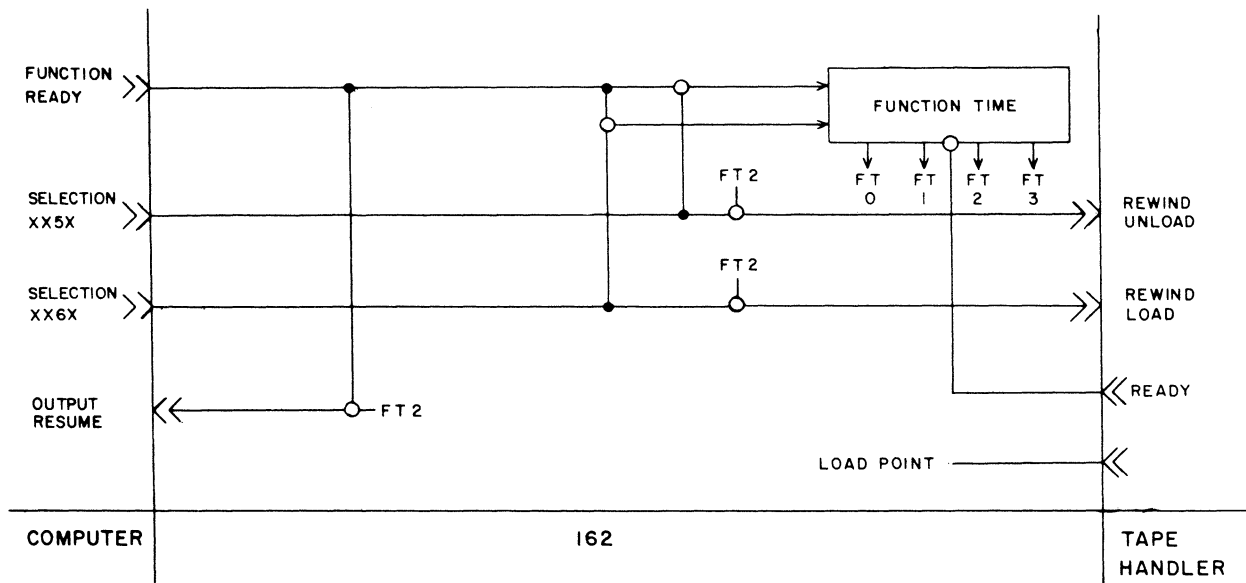
Figure 4-24. Rewind Load/Unload

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 (figure 5-1).

If the unit is overheated, the thermostat cuts off power when the temperature of the exhaust air reaches 100°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 on the bottom and side of chassis 220100 (figure 2-2). 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)
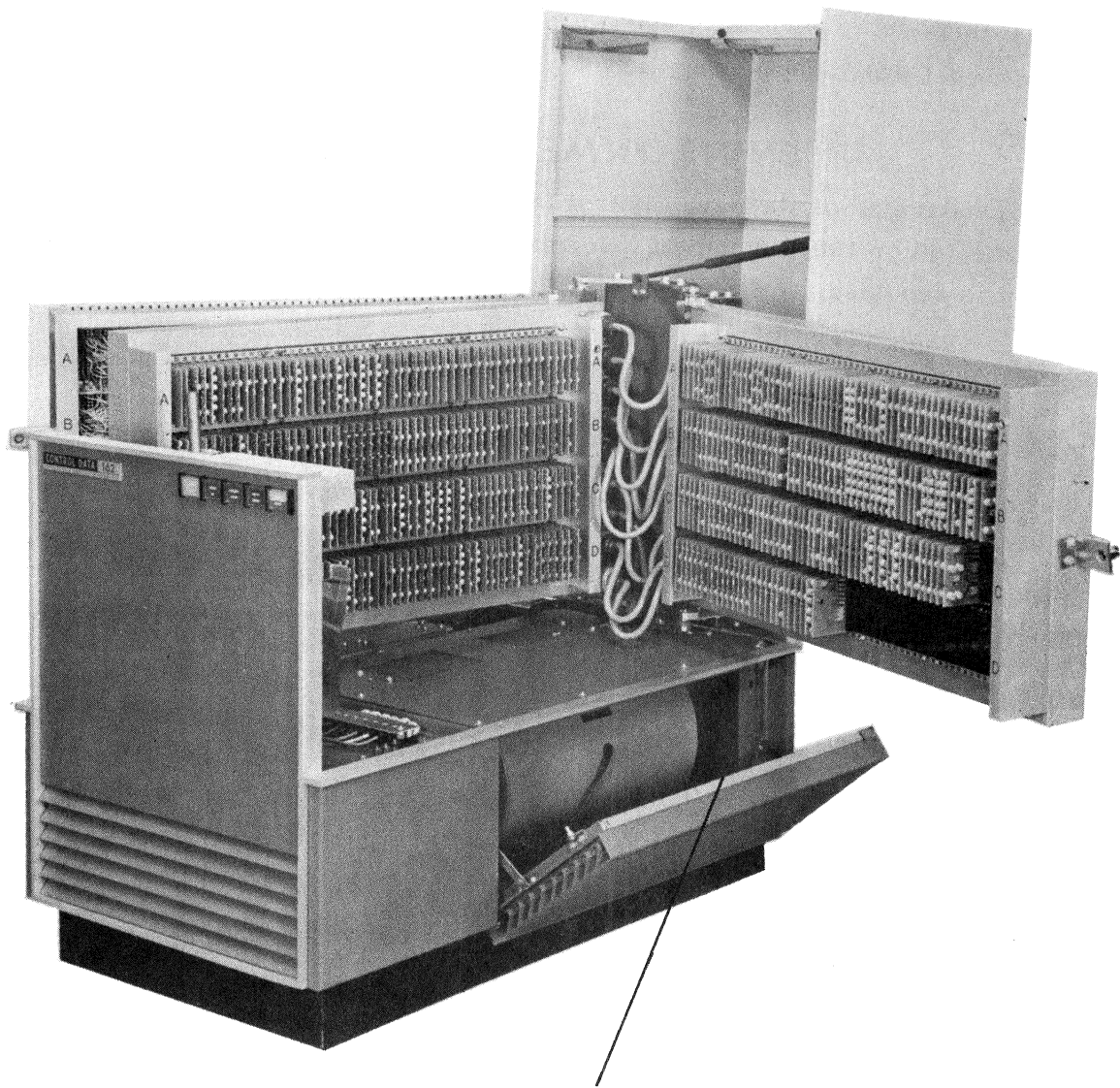
Blower Filter

Figure 5-1. Cabinet Open
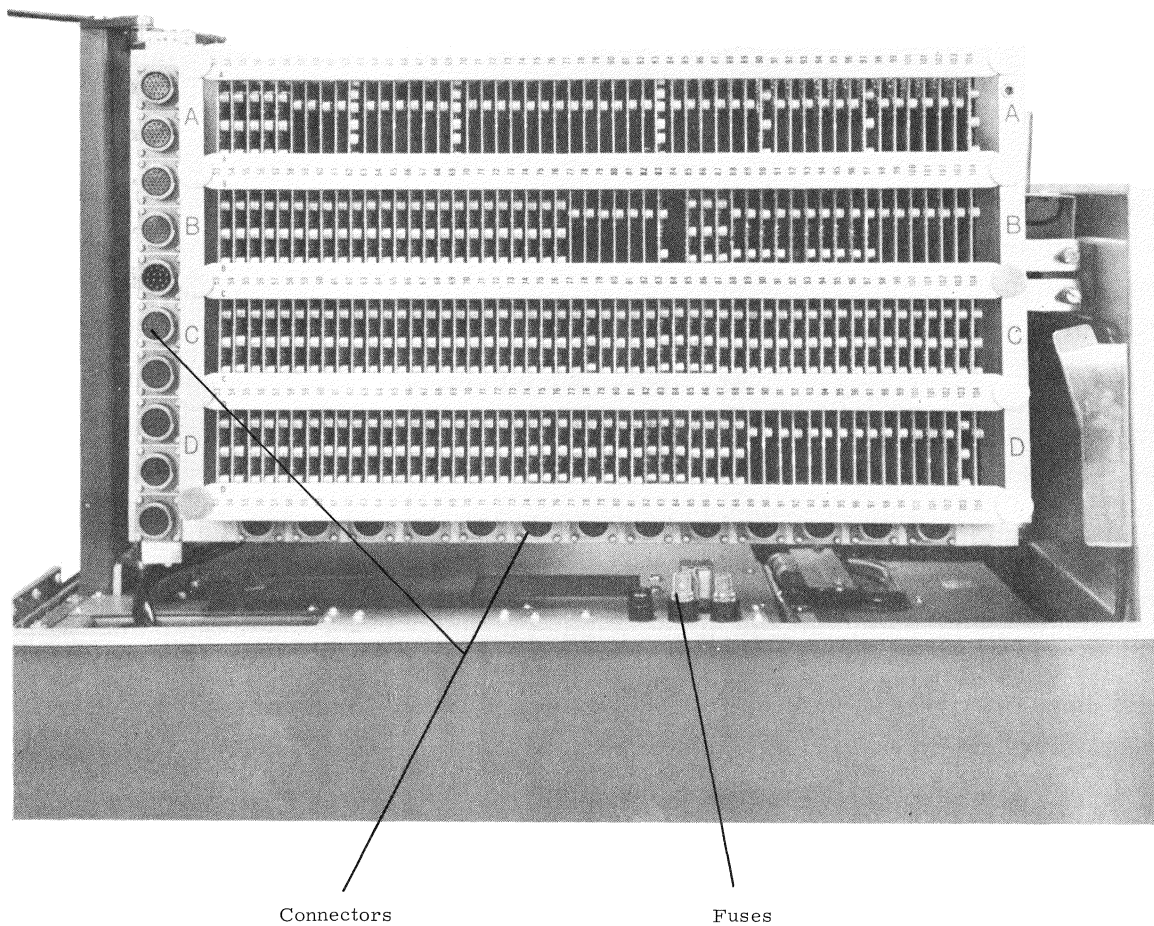
Figure 5-2. Chassis 220100

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

FUSES

The fuses are on fuse panel 220400 on the side of the unit (figure 5-2).

Fuses: two 1/2 amp slo-blo for the blower
           one 15 amp for the main power
           one 12 amp for the negative
           one 6 amp for the positive

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 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 2-4, 2-5, and 2-6 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
	J03, J04 (Computer Input Cable)	J01, J02 (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 J06, J08, J10, J12 (J14, J16, J18, J20)		Connectors J07, J09, J11, J13 (J15, J17, J19, J21)	
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
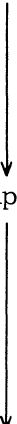
PIN	Connector J22	Connector J23
A	Bit 0	
B		
C		
D		Bit 3 Output
E		
F	Input Data	
H		
J		
K		
L		
M		
N	Bit 11	
P		
R	Input Ready Input	
S	Input Request Output	Output Resume Input
T		Function Ready Output
U		Master Clear Output
V	Input Disconnect Input	
W		
X		
Y		Tape → Printer Output
Z	Parity Error Input	
a		
b	GRD	GRD

TABLE 5-4. PRELIMINARY TIMING CHECKS

	Location	162-1	162-2
Main Timing			
High Density	2C15B	.75 usec leading edges	.375 usec
Low Density	2C15B	2.06 usec leading edges	1.03 usec
Function Timing			
FT 0	B03B	1 usec	1 usec
FT 1	B04B	4 usec +	4 usec +
FT 2	B05A	4.5 usec +	4.5 usec +
FT 3	B07A	4 usec	4 usec
Check Character Lockout			
High Density	2A17C	48 usec	24 usec
Low Density	2A17C	160 usec	80 usec
		Ascertain that FF set after 3/8 inches of tape motion.	
Sprocket Pulse	C46A	4 usec	4 usec
Stop-Start Gap Y016	2A08-1, 2, 3	Adjust for 3/4 inches of tape motion.	
Non-stop Gap Y017	2A21-1, 2, 3	Adjust for 3/4 inches of tape motion.	
Off-Line			
Clear A T1	2B41	2 usec	2 usec
R → A T2	2B40	2 usec	2 usec
T3	2B06C	4 usec	4 usec
T4	2A52C	2 usec	2 usec

TABLE 5-5. MAIN TIMING TABLE

Function	Condition	Jack
T0 J020 (2C06B)		
enable timing	assembling odd number of words in a read operation	2C14A
T1 J021 (2C01B)		
disable X register feedback	all operations	A13B
enable Search FF	search operations	2B14
enable Read/Backspace Record FF	read and backspace record	2B13
enable Write Delay FF	write and write FM	2B24
T2 J022 (2C02B)		
send Output Resume to computer	all operations	C37C
enable X to parity generator		B16A
enable M to X	write	C18C
enable R to X	read	$A15B_1$
enable status to X	status	$A25A_1$
T3 J023 (2C03B)		
enable X to H	operations that input	D43C
enable X to T	all operations	2D20C
$\overline{T3}$ J030 ($2C13A_2$)		
disable check character counter		2C40B
disable $T_1 = 17_8$		2A01B
T4 J024 (2C04B)		
disable X to parity generator		B17B
		B18B
enable T_1 to T_2	all operations	$2D25A_1$
advance A/D counter	all operations	C01
T5 J025 (2C05A)		
clear Status Control FF		C24
enable A/D counter	assembly mode	C01
clear Status Lockout FF		C25
advance check character counter		2C42
		2C44

TABLE 5-6. FUNCTION TIMING TABLE

FT 0 (I106) [B03] 1 usec duration after counter enable (A191) [A08A]

Clear Unit Select Register	all selections		B35
Clear Assembly/Disassembly FF	all selections		C17
Clear X Register Feedback	all selections	A13	A14B
Clear Reverse FF	all selections		2B27

FT 1 (I101) [B04] 4 usec duration after end of FT 0*

Set Unit Select Register	all selections except numeric designation	B35
Set Assembly/Disassembly FF	all selections except numeric designation	C17
Clear Read/Backspace One Record FF	all selections except numeric designation	2B13
Clear Sprocket Ready FF	all selections except numeric designation	2B12
Set Status Control FF	Status selection	C24
Clear T Register	all selections except numeric designation	2D21 2D22
Set Non-stop FF	Non-stop reselection	2B26

FT 2 (I103, I107, I109) [B06, B05A, B05C] the duration from the end of FT 1 until 4 usec after the Function Ready signal drops

Set Record Control FF	Read, Search, Backspace Record, and Search Backward	2B11
Set Write Control FF	Write and Write File Mark	2B09
Set Code FF	Parity Mode	2B21
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	D27

FT 3 (I105) [B07A] 4 usec duration after the end of FT 2

Set Status Lockout FF	Status selection	C25
Clear Parity Error FF	all selections except status	C30

* FT 1 lasts 2 usec during a status operation.

APPENDIX A
PRINCIPLES OF 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/<u>Print</u>
> <u>Tape</u>/Card
> <u>Continuous</u> or <u>Step</u>

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

A-2
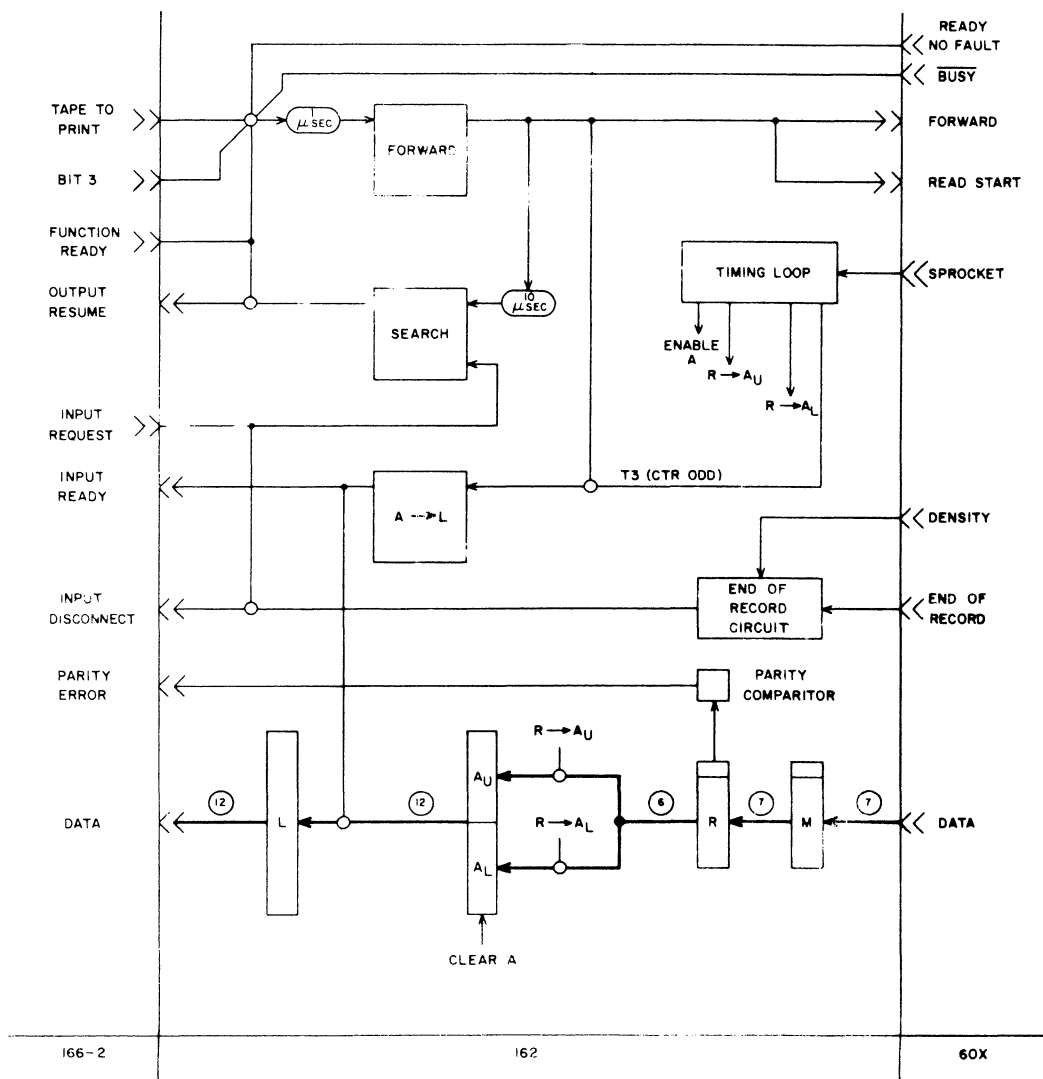
SEARCH FORWARD TO FILE MARK

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.
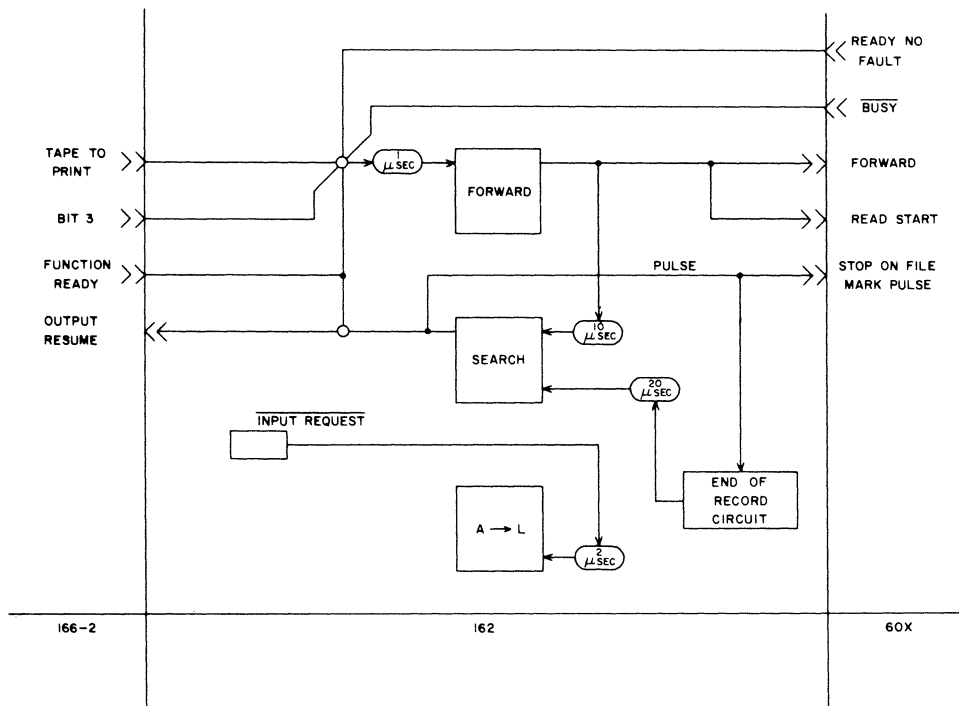
Figure A-2. Search Forward to File Mark

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:

<div align="center">

Tape/<u>Print</u>

Tape/<u>Card</u>

<u>Backspace</u>

</div>

These switches generate the following signals:

<div align="center">

tape to printer

function ready

input request

</div>

The tape to printer signal and the function ready signal set the Reverse FF if the tape handler is signalling 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.
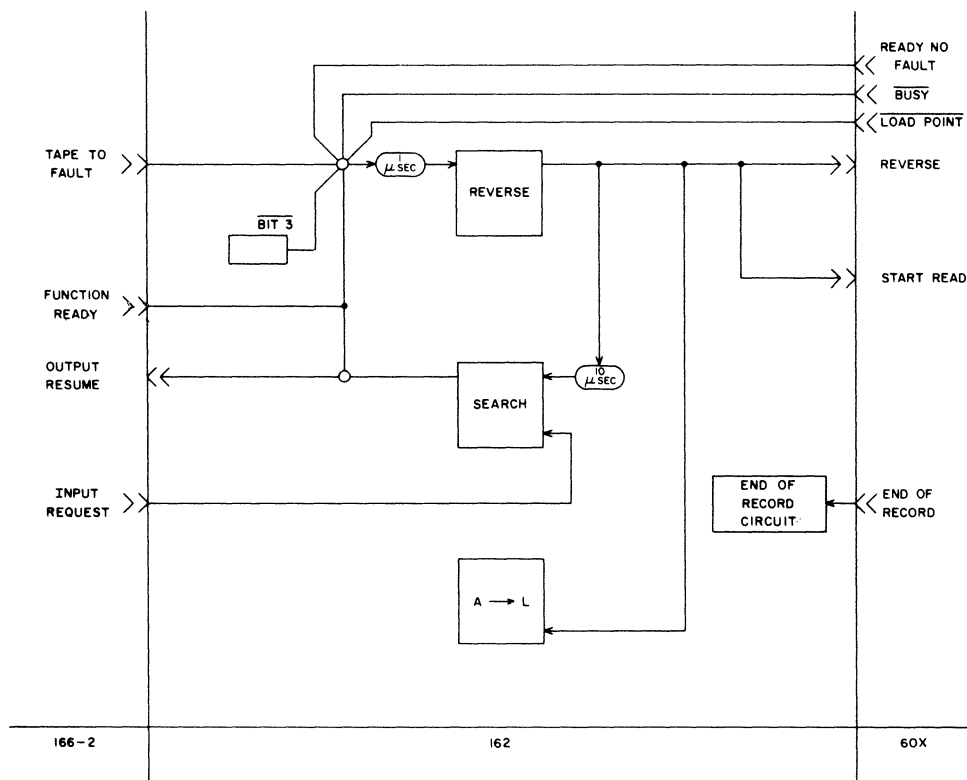
Figure A-3. Backspace One Record

SEARCH BACKWARD TO FILE MARK

The search backward to file mark operation (figure A-4) is selected by pressing the following printer switches:

> Tape/<u>Print</u>
>
> <u>Tape</u>/Card
>
> <u>Master Clear</u>
>
> <u>Backspace</u>

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

A-5

on file mark signal to the tape handler and a pseudo end of record signal to the
162 end of record circuit.

The stop on file mark signal modifies the end of record circuit in the tape handler
so that is 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.
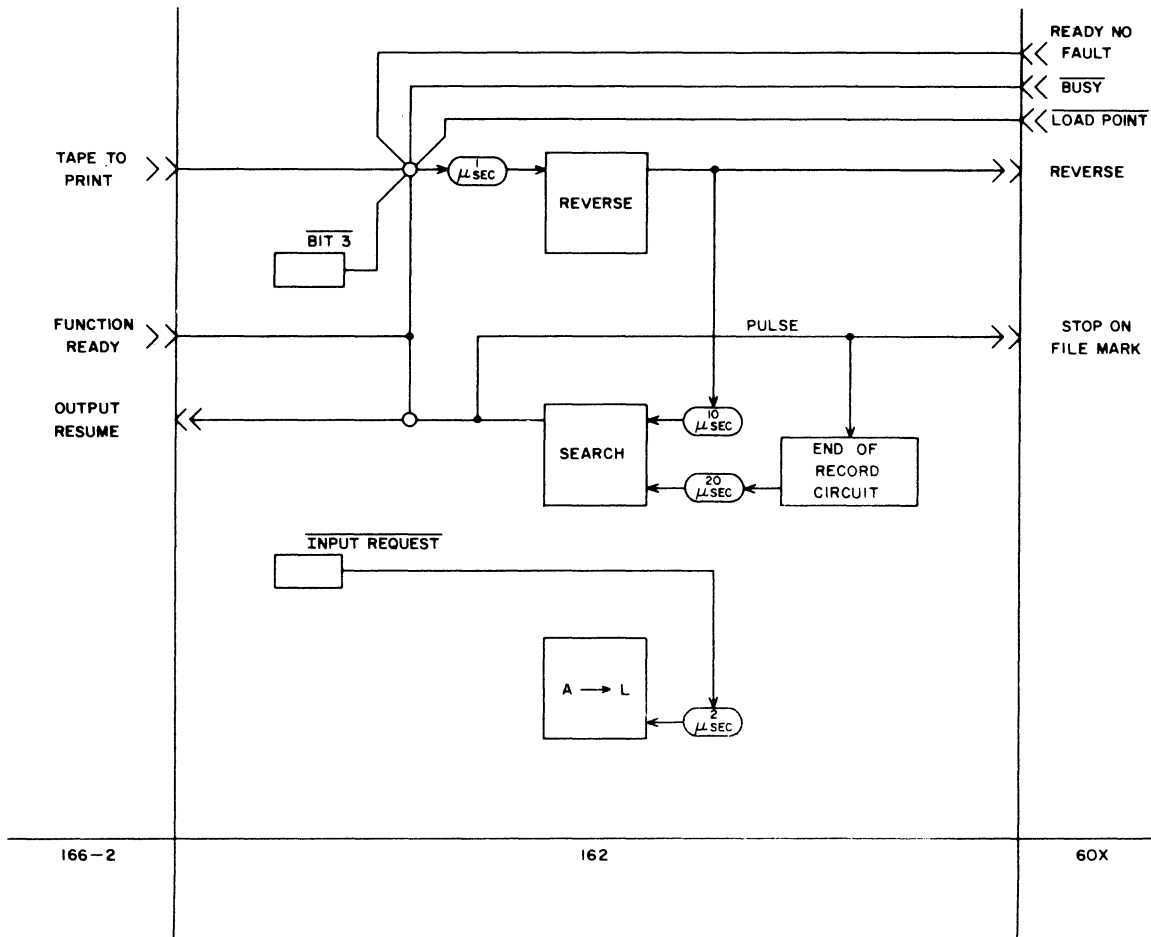
Figure A-4. Search Backward to File Mark

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.
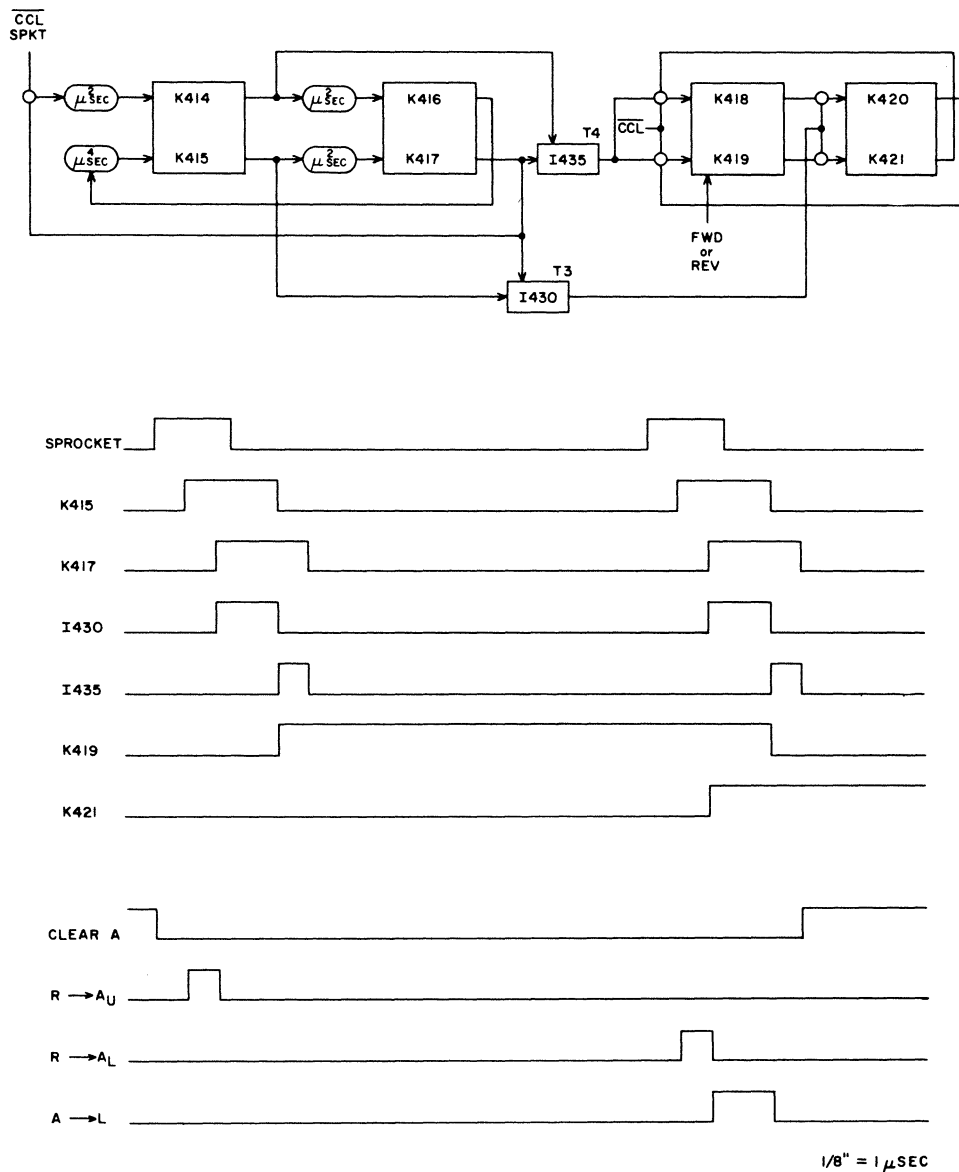
Figure A-5. Timing Loop and Sequencer

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.
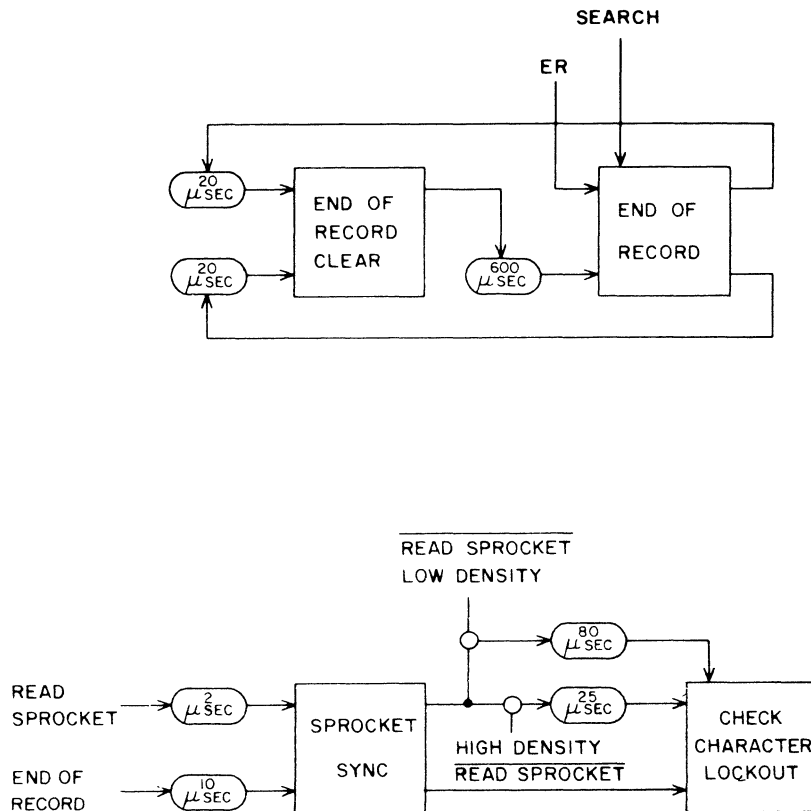
Figure A-6. End of Record

APPENDIX B
POWER SUPPLY

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.
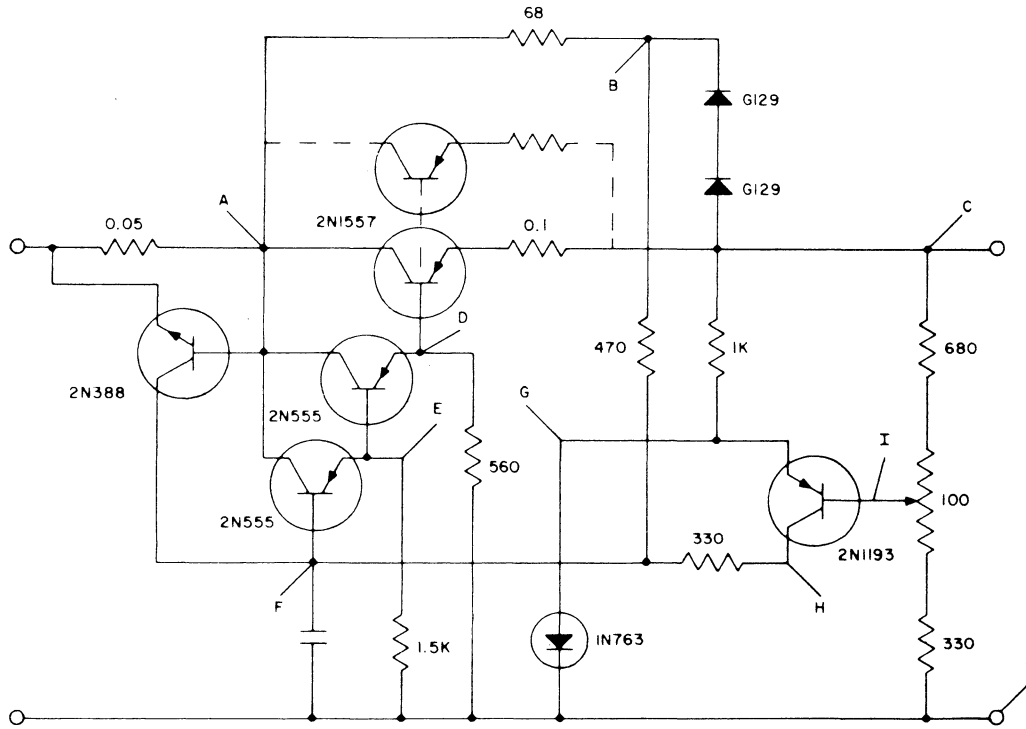
Figure B-1. Power Supply

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.

---

*   This voltage may vary from -24 to -30 volts at hald 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.

3. Other Observations:
    a. One of the 0.1 ohm series-transistor emitter resistors gets very hot.
    b. Zener diode 1N763 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 faulty 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 faulty transistor is located. The power supply will not suffer any damage if one of the series transistors is removed for a short operating period. However, by this method it is impossible to determine the fault 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 CHART

APPENDIX C
COMMAND TIMING CHARTS

STATUS SELECTION

Step	Event	Comment
	XX4X	Status code
	Function ready signal	
FT 0	Enable X register feedback	(2 usec) translates EF code
FT 1	Set Status Control FF	(2 usec)
	$M_L \rightarrow X_L$	
FT 2	Output resume to computer	(Terminates at termination of function ready)
FT 3	Set Status Lockout FF	(4 usec) locks out further function ready signals until status response is issued
	Input request signal	Enables main timing chain
T 1	Enable X register feedback	
T 2	Status condition to X	
T 3	X to H transfer	
	Input ready signal to computer	
T 4		
T 5	Clear Status Control FF	
	Clear Status Lockout FF	

PARITY MODE SELECTION

	XX71 or XX72	Parity mode code.
	Function ready signal	
FT 0	Enable X register feedback	(2 usec)
FT 1	$M_L \rightarrow X_L$	
FT 2	Set Code FF	
	Output resume to computer	(FT 2 lasts until termination of the function ready signal)

DENSITY SELECTION

	210X or 110X	Density code
	Function ready signal	

Step	Event	Comment
FT 0	Clear A/D FF	(2 usec)
	Enable 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	(Terminates at 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

Step	Event	Comment
I.	111X	Write, character mode EF code
	Function ready signal	
FT 0		(2 usec)
	Clear Unit Select FFs	
	Enable 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 2 usec after end of FT 1 until 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)
	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

Step	Event	Comment
T 1	Enable 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		
T 6		
T 7	Sprocket Ready FF set + 4 usec	Clear Sprocket Ready FF 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
	$M_L \to X_L$	
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
	$M_L \to X_L$	
	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 (except the check character). 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 $\boxed{40 \text{ ms (80 ms)}}$ 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	
	Enable 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	$\boxed{\text{Duration from 2 usec after the end of FT 1 until function ready signal drops (blocked if unit is not ready or if an error exists)}}$

Step	Event	Comment
	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
	Enable delay path to start read inverter	1.5 ms delay
FT 3	Clear Parity Error FF	(4 usec)
<u>II.</u>	Read sprocket signal from tape handler	
	Set Block Control FF	
	Initiate Oscillator Counter	
T 1	Enable X register feedback	
	M to R transfer	(7 bits)
	R to parity comparitor	
<u>III.</u>	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 approx. 5 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
<u>II.</u>	No read sprocket	
	Input request from computer	
<u>III.</u>	End of record signal from tape handler	
	Set End of Record Sync FF	
	Set End of Record FF	
	Clear Read Control FF	
	Clear Block Control FF	

Step	Event	Comment
	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	(1 usec)

Step	Event	Comment
FT 1	$M_L \rightarrow X_L$	(4 usec)
FT 2	Rewind load signal to tape handler	[Duration from 2 usec after the end of FT 1 until 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
162 INSTALLATION

APPENDIX D
162 INSTALLATION

The CONTROL DATA 162 Magnetic Tape Synchronizer controls up to four (eight) CONTROL DATA 60X Magnetic Tape Handlers. The 162 is connected to a CONTROL DATA 160-A computer's Input/Output lines 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 supply which uses 15 amp, 120v, 60 cycle power.

The cabinet is 29 inches high, 18 inches wide, and 30 inches deep. There must be enough clearance to allow the top of the cabinet and the chassis to be opened (figures D-1 and D-2). Weight of the 162 is 350 pounds.

Logic cables enter the unit through the cable openings near the bottom of chassis 220100. Cable connections are made to the connector panels on chassis 220100 (figure D-3).
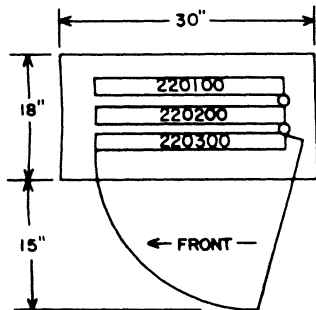
Figure D-1. Top View

Figure D-2. Side View

```
         ┌  O J0I              220100
   OUT ⟨  
         └  O J02      ┌──────────────────────────────────┐
160-A⟨        O J03    │                                  │
     IN ⟨              │                                  │
         └  O J04      │                                  │
                       │                                  │
 POWER      O J05      │                                  │
         ┌  O J06      │                                  │
         │  O J07      │                                  │
     A ⟨  │  O J08      │                                  │
         │  O J09      └──────────────────────────────────┘
         │           JII JI2 JI3  JI4 JI5 JI6 JI7 JI8 JI9 J20 J2I  J22 J23
         └  O JIO     O   O   O    O   O   O   O   O   O   O   O    O   O

                      ⟍__⟋   ⟍_____⟋   ⟍_⟋
                        A                 B                 C
```
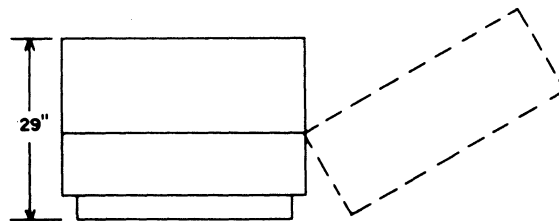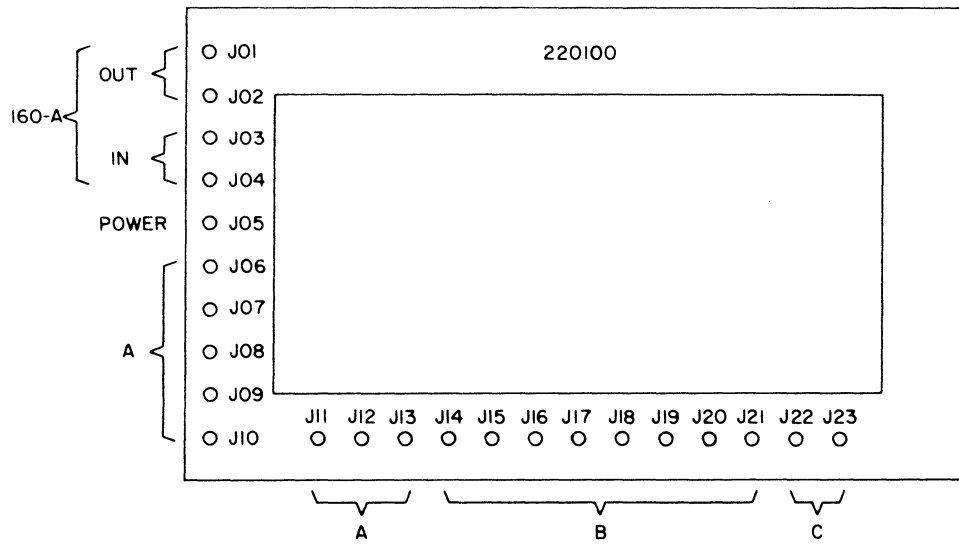
I/O Connectors for Tape Handlers

162(S)	A
162-1	A and C
162-2	A, B, and C

Figure D-3.   Cable Connections - Chassis 220100

APPENDIX E

CONTROL DATA 162-2
Magnetic Tape Synchronizer
(with 162G-2 Modification Kit)

PARTS LIST

INTRODUCTION

The Parts List provides the identification and ordering data necessary
for the replacement of electrical and mechanical parts for the 162-2 Magnetic
Tape Synchronizer and the 162G-2 Modification Kit.

Electrical Contents: All items are included except jumper wires and wire.
Quantities are per one Magnetic Tape Synchronizer. Quantities on printed
circuit card assemblies are per one Magnetic Tape Synchronizer.

Hardware Content: All items are included except standard hardware such
as screws, nuts, bolts, washers and raw material. Quantities are per one
Magnetic Tape Synchronizer.

All CDC 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.

For the breakdown of Amp Power Supply, refer to amp model number 851266.

ORDERING OF PARTS

When ordering CDC parts include the following information: Item number
or CDC drawing number (both if listed), description, quantity needed,
equipment used on.

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

PARTS LIST

162-2 Magnetic Tape Synchronizer 229235 Final Assy. Dwg. No. (with 162-2G Modification 229293 Dwg. No.)

Section No. _____   Date: __2/7/64__

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229015-1	Bar mounting, connector, 01-52	
	229015-2	Bar mounting, connector, 53-104	
	229221	Bar mounting, connector, top	
	229222	Bar mounting, connector, bottom	
	8551-35	Bearing, sleeve, flange	
	8551-50	Bearing, sleeve, flange	
	229275	Block, pawl	
	229247-1	Bracket, bottom	
	229247-2	Bracket, bottom	
	229156	Bracket, filter catch	
	229248	Bracket, grill	
	229076	Bracket, hood, top	
	229077	Bracket, hood, bottom	
	229050	Bracket, hood, guide, left	
	229052	Bracket, hood, guide, right	
	229080	Bracket, thermostat	
	8218-2	Bumper rubber screw (white)	
	8222-2	Bumper, rubber, 5/32" x 13/32 (black)	
	229260-1	Cable assembly, chassis (2P01)	
	229260-2	Cable assembly, chassis (2P02)	
	229260-3	Cable assembly, chassis (2P03)	
	229260-4	Cable assembly, chassis (2P04)	

		PARTS LIST	
		Section No. _____ Date: _____	

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229260-5	Cable assembly, chassis (2P05)	
	229260-6	Cable assembly, chassis (2P06)	
	229260-7	Cable assembly, chassis (2P07)	
	229260-8	Cable assembly, chassis (2P08)	
	229260-9	Cable assembly, chassis (2P09)	
	229245	Cable assembly, chassis power (P220105)	
	229246	Cable assembly, chassis power (P220309)	
6619		Cap, clear, plastic	
	8530	Catch, spring, receptacle	
	229237	Chassis assembly, wired	
	229239	Chassis assembly, wired	
	229058-1	Card spacer assembly (A)	
	229058-2	Card spacer assembly (BC)	
	229058-3	Card spacer assembly (D)	
	229059-1	Card spacer assembly (AB)	
	229059-2	Card spacer assembly (CD)	
	229060-1	Card spacer assembly (A)	
	229060-2	Card spacer assembly (BC)	
	229060-3	Card spacer assembly (D)	
	229061-1	Card spacer assembly (AB)	
	229061-2	Card spacer assembly (CD)	
	8637-3	Clamp, loop, 1/4" I.D.	

PARTS LIST

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	8637-7	Clamp, loop, 1/2" I.D.	
	8637-9	Clamp, loop, 5/8" I.D.	
	8637-11	Clamp, loop, 3/4" I.D.	
6148	245302-5	Clamp, cable, (used w/6145, 6147)	
	229033	Clamp, wire retainer, chassis	
	245181-1	Connector, cable, 1/2 dia., w/cable clamp	
6145	245301-1	Connector, plug, 5 socket	
5467		Connector, plug, 5 socket	
6147	245301-3	Connector, plug, 5 socket	
6135	245316	Connector, plug, 3 pin	
6114	245154	Connector, plug, 14 pin	
6110	245139	Connector, plug, 24 pin	
6111	245120	Connector, receptacle, 24 socket	
6115	245155	Connector, receptacle, 14 socket	
6101	100018	Connector, receptacle, 30 socket	
	229256-1 thru 229256-12	Connector, receptacle, wired, 24 socket (1J01-1J13)	
	229257-1 thru 229257-10	Connector, receptacle, wired, 24 socket (1J14-1J23)	
	229258-1 thru 229258-9	Connector, receptacle, wired, 24 socket (2J01-2J09)	
	229259-1	Connector, receptacle, wired, 14 socket (1J05)	

PARTS LIST

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229259-2	Connector, receptacle, wired, 14 socket (3J10)	
6196		Connector, twistlock, single phase socket	
6199	245152	Connector, twistlock, three phase	
	229197	Cover, end, hood stop	
	229111	Cover, switch, long capacitor, 35 MF, 25 VDC, sprague #TE1208	
	229230	Emblem	
	229184	Fall, stop, modified	
	8167	Fan, centrifugal, 523 CFM	
	8411-2	Fastener, turnlock, screw type	
	8154-18	Filter, air, washable, 18 x 7 1/4 x 1/2 x 1/2	
	229161	Frame, 162	
	229223	Frame, chassis	
	229225	Frame, chassis, center	
	229224	Frame, chassis, right	
	229157	Frame, grill	
6710	245086	Fuseholder, HKL	
6713	245135	Fuseholder, HKP	
6720	245130=10	Fuse, cartridge, 12 Amp, 250 v	
6709	245362-3	Fuse, cartridge, 6 Amp, 150 v	
6724	245217-25	Fuse, cartridge, 2.5 Amp, 125 v	
6702	245130-1	Fuse, cartridge, 15 Amp, 250 v	
	229227	Grill, exhauset, lower	

PARTS LIST

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229079	Grill, hood, exhause	
	8396-4	Grommet, rubber, 5/8" I.D.	
	8134	Grommet, rubber, 1/4" I.D.	
	229273	Guard assembly, power panel	
	229050	Guide, hood, LH	
	229053	Guide, hood, RH	
	229193-1	Handle, power supply	
	229193-2	Handle, power supply	
	229155	Hinge, filter frame	
	229162	Hinge, hood	
	8454-4	Hinge, continuous	
	229165	Hinge, top	
	229166	Hinge, bottom	
	229163	Hood	
	229190	Hood assembly	
	229056-1	Insert, lens, "power off"	
	229056-2	Insert, lens, "power on"	
	229056-11	Insert, lens, "program error"	
	229056-12	Insert, lens, "parity error"	
	229056-13	Insert, lens, "binary/coded"	
6608	245425	Insulator, Barrier	
	8279	Jack, banana, tip	

PARTS LIST

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
6802	245123-2	Lamp, incandescent	
6606	245424	Lamp holder	
6605	245423	Lamp holder - pushbutton	
	229043	Latch assembly, chassis, hinged	
	229178	Latch assembly, chassis, left	
	229179	Latch assembly, chassis, center	
6613	245425-3	Lens, indicator light, white	
6611	245426-2	Lens, indicator light, green	
6609	245426-1	Lens, indicator light, red	
6614	245426-5	Lens, indicator light, blue/white	
	229231	Panel, front	
	229232	Panel assembly, front	
	229244-2	Panel assembly, power	
	229234-1	Panel, power	
	229160	Panel, blower	
	229274	Pawl, chassis stop	
6214	245185	Pin, ground, (used on y201-socket)	
	229023	Pin, hinge, chassis	
	232005	Pin, pivot	
	229168	Plate, chassis, to P, right	
	229169	Plate, chassis, to P, left	
	229167	Plate, chassis, lower, left	

PARTS LIST

Section No. _____   Date: __ _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229170	Plate, chassis, lower, right	
	229199-1	Plate, hood stop	
	229199-2	Plate, hood stop	
	229189	Plate, striked, chassis stop	
1147	229110	Power supply (amp incorp. #851266)	
6200	245132	Relay, 24 VDC, 2 PDT	
6209	245329-1	Relay, 115 VAC, 4 PDT	
	229196	Rod, hood stop	
6201	245196	Socket, relay	
	8622-85	Spring, compression, 0.240 OD	
6206	245197	Spring, relay (for 6201 relay)	
	229198	Spring, hood stop	
	229019	Stand off, channel	
	229020	Stand off, channel	
	229200-1	Stop assembly, hood	
	229277-1	Stop assembly, chassis	
	229047	Stop, ridged, chassis	
	229048	Stop, hinged, chassis	
	8529-1	Stop, catch, used with 8530	
	229012-1	Strip, marker, narrow 01-14	
	229012-2	Strip, marker, narrow 39-52	
	229012-3	Strip, marker, narrow 53-66	

PARTS LIST

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229012-4	Strip, marker, narrow 91-104	
	229014-1	Strip, marker, narrow 15-38	
	299014-2	Strip, marker, narrow 67-90	
	229011-1	Strip, marker, wide, 01-14	
	229011-2	Strip, marker, wide 39-52	
	229011-3	Strip, marker, wide 53-66	
	299011-4	Strip, marker, wide 91-104	
	229013-1	Strip, marker, wide 15-38	
	229013-2	Strip, marker, wide 67-90	
6160	245022-8	Strip, marker, (characters 1-8)	
6166	245022-2	Strip, marker, (characters 1-2)	
6157	245012-2	Strip, terminal, 2 terminals	
6159	245012-8	Strip, terminal, 8 terminals	
	229026	Support assembly, lower, hinged chassis	
	229027	Support assembly, lower, rigid chassis	
	229028	Support assembly, upper, rigid chassis	
	229029	Support assembly, upper, hinged chassis	
	8460	Support, fall, brass	
6607	245090	Switch, push, SPDT	
10957		Tape, magnetic (used on Magnetic Tape Units)	
6963	300923-3	Thermostat, 100° F	
	229297	Temperature reduction kit	

PARTS LIST

Section No. ——————   Date: ——————

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	229112	Top plate, switch cover	
	229036	Trim, top	
	229037	Trim, bottom	
	229038	Trim, vertical, left	
	229039	Trim, vertical, right	
	229040	Trim, horizontal, right	
	229041	Trim, horizontal, left	
	229194	Tube, outer, hood stop	
	229195	Tube, center, hood stop	
	229078	Vane, hood top	
	229228	Vane, lower, grill	
	241081	Wire tabulation, chassis 1 & 2	
	241080	Wire tabulation, chassis 162	
	241194-2	Wire tabulation, power panel	

PARTS LIST

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
1303	102424	Card assembly, type 03	
1304	102427	Card assembly, type 04	
1305	102430	Card assembly, type 05	
1311	102018	Card assembly, type 11	
1312	102019	Card assembly, type 12	
1313	102020	Card assembly, type 13	
1314	102025	Card assembly, type 14	
1315	102026	Card assembly, type 15	
1316	102027	Card assembly, type 16	
1321	102322	Card assembly, type 21	
1322	102028	Card assembly, type 22	
1323	102034	Card assembly, type 23	
1324	102035	Card assembly, type 24	
1328	102325	Card assembly, type 28	
1329	102328	Card assembly, type 29	
1330	103344	Card assembly, type 30	
1331	102037	Card assembly, type 31	
1332	102038	Card assembly, type 32	
1333	102039	Card assembly, type 33	
1350	103392	Card assembly, type 50	
1362	100059	Card assembly, type 62	
1367	102102	Card assembly, type 67	
1373	103352	Card assembly, type 73A	
1377	102135	Card assembly, type 77 (used on 162-1)	
1387	103372	Card assembly, type 87	
1397	244069	Card assembly, type 97	
1426	244141	Card assembly, type 244141	

PARTS LIST

#229293   162G-2 Modification Kit

Section No. _____   Date: _____

Item Number	CDC-Drawing Number	Description	Quantity Each Machine
	110611	Serial Plate	
	245007-2	Pin, taper	
	245460	Diode - 1N2071	
1423	244147-1	Long line driver, type 108	
1393	244156-1	Long line receiver, type 99	

COMMENT SHEET

161-1/161-2 MAGNETIC TAPE SYNCHRONIZER
Reference - Instruction Manual
Pub. No. 60025800

FROM   NAME : _____

        BUSINESS
        ADDRESS : _____

COMMENTS :   (DESCRIBE ERRORS, SUGGESTED ADDITION OR
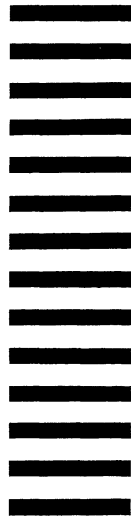   DELETION AND INCLUDE PAGE NUMBER, ETC.)

CUT ALONG LINE

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

8100 34TH AVENUE SOUTH

MINNEAPOLIS 20, MINNESOTA

ATTN: TECHNICAL PUBLICATIONS DEPT.
COMPUTER DIVISION
PLANT TWO