IBM

Field Engineering
Theory of Operation
(Manual of Instruction)

1130 Computing System
Features

227-3670-0

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Theory of Operation
(Manual of Instruction)

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1130 Computing System
Features

PREFACE

This manual (Form 227-3670) contains information on the theory of operation of the attachment circuits for the feature devices of the IBM 1130 Computing System.

The theory of operation of the IBM 1130 Computing System is described in the IBM Field Engineering Theory of Operation (Manual of Instruction), 1130 Computing System. (See Bibliography, Appendix A.)

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- Provides 120 positions of output printing for the system.
- Prints numeric or alphameric information.
- Maximum rate of printing; 82 lines per minute for alphameric and 110 lines per minute numeric.
- Prints 48 alphabetic, numeric, and special characters.
- Provides for forms control.
- See IBM Field Engineering Manual of Instruction, 1132 Printer for details of the printer.
- Reference to Maintenance Diagrams: AA101, AA231, AA611, AA621, XP401, XP501, XP511, XP701, XP711.

The 1132 Printer (Figure 1-1) provides printed output for the 1130 Computing System at maximum rates of 82 lines per minute (lpm) for alphameric printing and 110 lpm for numeric printing. Actual print speeds are dependent on the program and the output format required. The print line is 120 print positions long; horizontal spacing is 10 characters per inch. Vertical spacing of six or eight lines per inch can be selected by the operator.

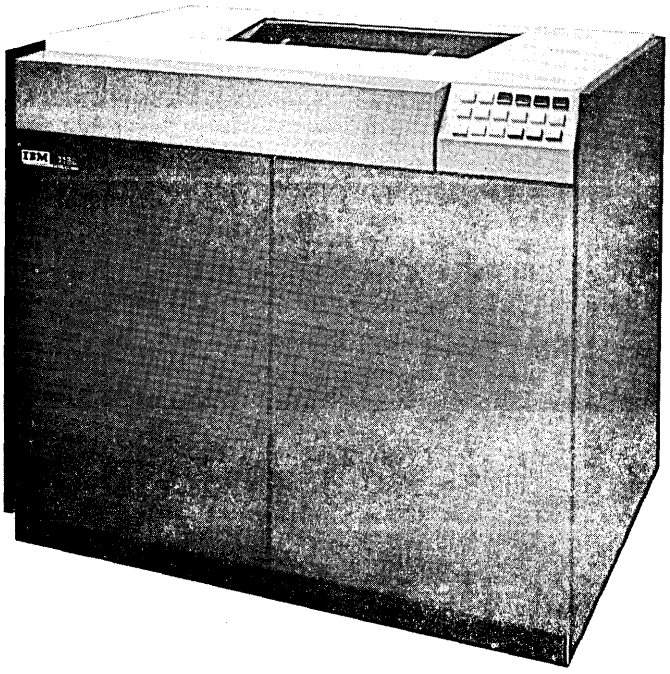


Figure 1-1. IBM 1132 Printer

1.1 FUNCTIONAL DESCRIPTION

The 1132 contains a printwheel (Figure 1-2) with 48 alphabetic, numerical, and special characters for each of the 120 printing positions. Special (FORTRAN) characters are as follows:

& - / . $, * ( ) ' + =

Each wheel rotates continuously and moves forward to print when the data in the output record specifies that the character to be printed is in the print position. Thus, all similar characters for the entire line are printed on the same cycle. Forty-eight cycles are required to print a complete line with any character capability.

Forms control is provided through a tape-controlled carriage that uses the standard IBM carriage tape. Channels 1 through 6, 9, and 12 are available to the stored program.

The 1132 uses interrupt circuitry and responds on level 1. The core storage address related to the

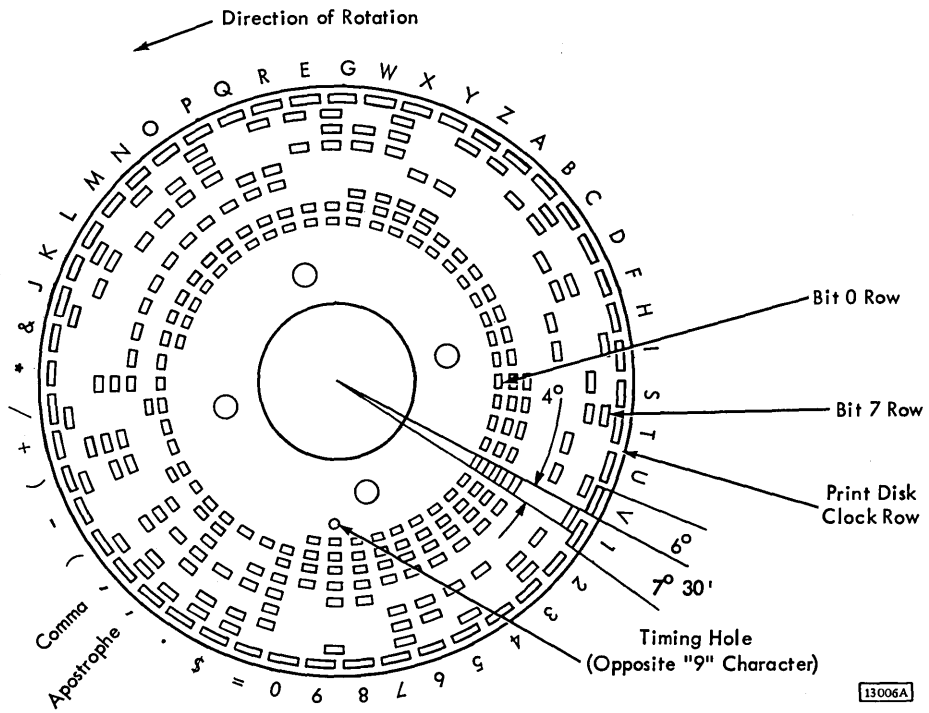


Figure 1-2. Print Disk and Typewheel Schematic

interrupt level is 0009; the device code of the printer is 00110 (Area 6). When an interrupt occurs, the device status word (Figure 1-3) for the printer can be sensed directly because the 1132 is the only device on interrupt level 1.

The data to be printed is assembled (in any unassigned storage area) in core storage in the same order (including spaces) as the line that is to be printed. The printer scan field is located in core storage locations 0032 through 0039. The 16 bits of each of the first seven words and bits 0 through 7 of the eighth word represent the 120 printwheels. During each of the scanning sequences necessary to print all 48 characters, the character next in position to print is read from the character emitter and is compared (by the printer sub-routine) with each character of the output record. Table 1-1 shows the bit code of the read emitter characters.

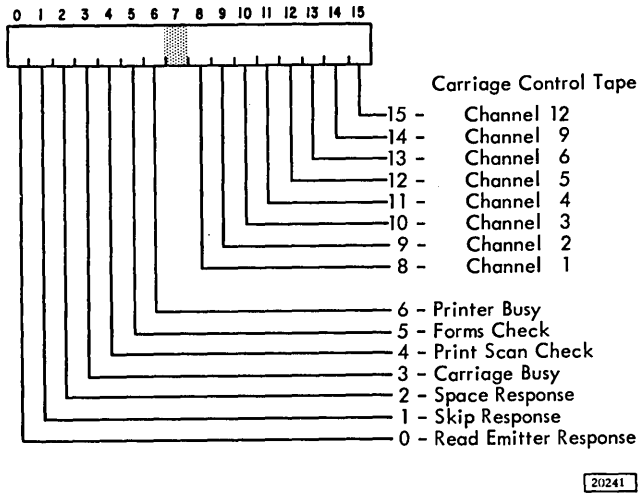


Figure 1-3. 1132 Device Status Word

Table 1-1. Printer Code

	I/O Bus Bits							
	0	1	2	3	4	5	6	7
A	1	1	0	0	0	0	0	1
B	1	1	0	0	0	0	1	0
C	1	1	0	0	0	0	1	1
D	1	1	0	0	0	1	0	0
E	1	1	0	0	0	1	0	1
F	1	1	0	0	0	1	1	0
G	1	1	0	0	0	1	1	1
H	1	1	0	0	1	0	0	0
I	1	1	0	0	1	0	0	1
J	1	1	0	1	0	0	0	1
K	1	1	0	1	0	0	1	0
L	1	1	0	1	0	0	1	1
M	1	1	0	1	0	1	0	0
N	1	1	0	1	0	1	0	1
O	1	1	0	1	0	1	1	0
P	1	1	0	1	0	1	1	1
Q	1	1	0	1	1	0	0	0
R	1	1	0	1	1	0	0	1
S	1	1	1	0	0	0	1	0
T	1	1	1	0	0	0	1	1
U	1	1	1	0	0	1	0	0
V	1	1	1	0	0	1	0	1
W	1	1	1	0	0	1	1	0
X	1	1	1	0	0	1	1	1
Y	1	1	1	0	1	0	0	0
Z	1	1	1	0	1	0	0	1
0	1	1	1	1	0	0	0	0
1	1	1	1	1	0	0	0	1
2	1	1	1	1	0	0	1	0
3	1	1	1	1	0	0	1	1
4	1	1	1	1	0	1	0	0
5	1	1	1	1	0	1	0	1
6	1	1	1	1	0	1	1	0
7	1	1	1	1	0	1	1	1
8	1	1	1	1	1	0	0	0
9	1	1	1	1	1	0	0	1
=	0	1	1	1	1	1	1	0
$	0	1	0	1	1	0	1	1
.	0	1	0	0	1	0	1	1
'	0	1	1	1	1	1	0	1
,	0	1	1	0	1	0	1	1
(	0	1	0	0	1	1	0	1
-	0	1	1	0	1	1	0	1
)	0	1	0	1	1	1	0	1
+	0	1	0	0	1	1	1	0
/	0	1	1	0	0	0	0	1
*	0	1	0	1	1	1	0	0
&	0	1	0	1	0	0	0	0

22267

For each equal comparison, a 1-bit is put into the printer scan field (0032-0039) in the position corresponding to the printwheel to be fired. The printer attachment scans the field, in a cycle-steal mode, and fires each printwheel magnet whose position contains a 1-bit.

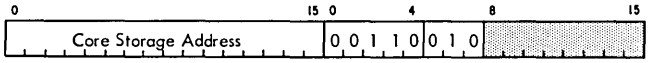
1.2 PROGRAMMING

- The IBM 1132 Printer operates under direct program control of the CPU.

1.2.1 Printer Control Instructions

- The 1132 Printer is addressed by the binary device code of 00110 (Area 6).

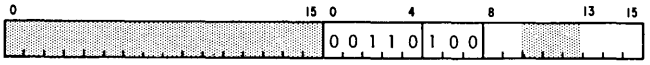
Read Emitter (010)



20239

This instruction causes the 8-bit code of the next character which may be printed to be read into the 8 high-order bit positions of the word at the core storage location specified. This data is generated by the 1132 print disk emitter.

Control (100)



202404

This command causes the execution of the function specified by the modifier bit. In the following description a 1-bit in the position indicated in parentheses after each instruction causes the operation described.

Start Printer (Bit 8): This causes the 1132 attachment to gate the 1132 emitter. When the next 1132 emitter clock timing pulse occurs, the print scan field is transferred to the printer with level 1 cycle-steal cycles and a level 1 interrupt is initiated. When the central processing unit (CPU) program services this interrupt the printer sub-routine reads the device status word (DSW) and a read emitter command is initiated. The printer sub-routine sets up the printer scan field. The printer attachment under control of the print emitter, starts a scan of the printer scan field.

Each position that contains a 1-bit causes the corresponding printwheel to print the character in position on that cycle. After the field of eight words has been scanned, a 1-bit is placed in bit position 0 of the 1132 device status word (Figure 1-3). A level 1 interrupt is signaled, causing an interrupt when level 1 is the highest level waiting. The start printer control command is given only once per print line.

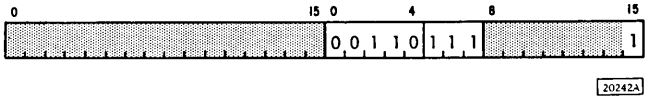
Stop Printer (Bit 9): This instruction causes the printer to be put in a ready (not-busy) state and inhibits subsequent printer interrupts. In order to allow the mechanical operations to be completed, the stop printer instruction should not be given until 18 scan cycles have been completed after the command to print the last character.

Start Carriage (Bit 13): This command initiates a skip operation, which is halted by a stop carriage instruction.

Stop Carriage (Bit 14): This command stops the carriage at the end of a skip operation. A punch in the carriage control tape channel 1, 2, 3, 4, 5, 6, 9, or 12 initiates an interrupt request, which is identified by bit 1, (skip response) of the DSW. The tape channel punch is compared by the program with the corresponding bit position (8 through 15) of the DSW to determine if a stop carriage command should be given.

Space (Bit 15): This command is given to space the carriage one line after a line is printed. After the space operation, an interrupt is initiated and a 1-bit is put in bit position 2 of the DSW to indicate spacing is completed. Another space can now be initiated.

Sense Device (111)



This instruction causes the DSW of the 1132 Printer to be placed in the ACC. The functions of the bit positions of the DSW are shown in Figure 1-3.

Interrupts

- The printer attachment interrupts on level 1.
- Printer interrupt is the only interrupt on level 1.

Read Emitter Interrupt: This interrupt occurs when the emitter CB makes after a printer start command has been given and a printer scan cycle has been completed. This interrupt indicates to the CPU that the read emitter is ready to be read.

Carriage Skip: This interrupt occurs when any carriage tape hole is sensed following, a start carriage control command. The CPU program checks the DSW to see if this is the channel to which the skip is being made.

Carriage Space: This interrupt occurs as each line is spaced. The CPU program may then give another space control command if more spaces are needed.

Indicators

- The following indicators are entered into the accumulator by a sense device command.

Read Emitter Response: This indicator in the DSW is turned on when the read emitter is ready with a character.

Skip Response (1): This indicator in the DSW is turned on when any carriage channel is read.

Space Response (2): This bit in the DSW is turned on when a line space is completed.

Carriage Busy (3): This bit in the DSW is turned on at the start of a skip or space and remains on until the action is finished.

Print Scan Check (4): This bit in the DSW is turned on when the printer attachment addresses word 0039 and there is no 1-bit in position 15. A zero in bit 15 indicates that the printed sub-routine did not finish setting up the print scan field.

Forms Check (5): This bit in the DSW is turned on when approximately 14 inches or less of paper remain to be fed into the print position.

Printer Busy (6): This bit in the DSW is turned on from the time the printer start control command is initiated, until the stop printer control command occurs.

Carriage Control Channels (8-15): As each hole in the carriage tape is read after a start carriage control command, one of these bits is turned on in the DSW.

Programming Notes

The status of the 1132 indicators should be checked before the first line of a record is printed. This is accomplished by transferring the printer DSW into the ACC with a sense device instruction. The modifier bits of the sense device instruction should be set to zeros to prevent reset of the DSW responses and indicators. Bits 3, 5, and 6 (Figure 1-3) of the DSW are tested and if all three positions are set to zero, the printer is ready to print the next line. A printer start control command is then given to start the timing sequence. A scan field transfer, using cycle steal level 1 cycles, takes place under control of the printer. Therefore the scan field must be clear and have a one bit set in bit 15 of word 0039 by the program before the printer start command is given.

After the code of the next character has been emitted by the printer, a level 1 interrupt is given and the character is read into core storage by a read emitter instruction. There are 11.2 ms (milliseconds) available to test each position of the output record with the character read and set up the 1-bits in the printer scan field. At the end of 11.2 ms, the printer attachment begins its scan and fires each printwheel with a corresponding 1-bit in the printer scan field. If the program has been interrupted for a considerable period by level 0, the programmed scan may not have been completed. To ensure that the program detects this condition, the first steps of the printer sub-routine for each character should clear the printer scan field to zeros and, upon completion of the programmed scan, place a one bit in position 15 of the eighth word (0039). When the printer attachment scans the field it checks this position. If it is zero, the print scan check indicator (bit 4 of the DSW) is turned on. The program can test this indicator and branch to an error routine that provides 47 idle scan cycles and resumes programmed scanning at the point where the scanning was interrupted. This results in over printing of the characters that were printed unless the error routine keeps track of the positions that were printed and does not set them up again on this scan.

After the final scan cycle for a line of printing, 16 idle scan cycles must be taken before spacing or skipping is started to allow time for completion of the mechanical operation of printing the last character. If the operation is a single or double space, the next scan cycle can be started two scan cycles after the last space command is given.

During an idle scan cycle the printer scan field should be set to zeros, except for bit 15 of the eighth word (0039), to prevent the print scan check indicator from being turned on.

1.3 PRINTER OPERATIONS

1.3.1 Read Emitter Command

- Given after a read emitter response interrupt.
- Transfer the 8-bit code of the next character to be printed to core storage.
- The character is read into the 8 high-order bits of the word.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XP401, XP511, XP711.

E-1 Cycle. An XIO instruction effective address (EA) which has been loaded into the accumulator is an even address. This address is transferred to the M register and the M15 bit output line is made active to Address EA + 1. The word at EA + 1, which is the IOCC control word (area and function), is placed into the U register.

E-2 Cycle. The M15 bit line is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word is read from core storage and loaded into the B register and the accumulator.

E-3 Cycle. The U register decode of XIO read and area 6, gates the print disk solar cells to the I/O in bus, B register, and core storage at the address specified in the IOCC.

1.3.2 Control Commands

- Execute functions specified by the modifier bit.

Start Printer

- Modifier bit 8 sets the printer run latch.
- Conditions the cycle steal request FF and printer buffer register output.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XP401, XP511, XP711.

E-1 Cycle: An XIO instruction effective address (EA) which has been loaded into the accumulator is an even address. This address is transferred to the M register and M15 output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area and function), is placed in the U register.

E-2 Cycle: The forced M15 bit line is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator. The U register decode of XIO control, area 6 and modifier bit 8 turns on the printer run latch. This gates the cycle steal request FF. Balance of the print operation is covered in the section on print scan control.

E-3 Cycle: Not used.

Stop Printer

- Modifier bit 9 resets the printer run latch.
- Prevents printer cycle steal requests.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XP401, XP511, XP711.

E-1 Cycle: An XIO instruction effective address (EA) which has been loaded into the accumulator is an even address. This address is transferred to the M register and the M15 bit output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area and function), is placed in the U register.

E-2 Cycle: The forced M15 bit line is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator. The U register decode of XIO control and bit 9 resets the printer run latch. This drops the gate to the cycle steal request latch to prevent further print scans.

E-3 Cycle: Not used.

Start Carriage

- Modifier bit 13 sets the skip start latch.
- The interposer magnet is energized.
- The carriage magnet is energized.
- The carriage skips at high speed.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XP401, XP511, XP711.

E-1 Cycle: An XIO instruction effective address (EA) which has been loaded into the accumulator is an even address. This address is transferred to the M register and the M15 bit output line is made active to address EA + 1. The word EA + 1, which is the IOCC control word (area and function), is placed in the U register.

E-2 Cycle: The forced M15 bit line is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator. The U register decode of XIO control, area 6 and bit 13 turns on the skip start latch which energizes the interposer magnet in the 1132. The interposer transferring closes the interposer contact and energizes the carriage magnet. The carriage is now moving the paper at high speed.

E-3 Cycle: Not used.

Carriage Functions: As each hole in the carriage tape is read the carriage skip interrupt FF is turned on to initiate a level 1 interrupt. The CPU program services this interrupt by checking the DSW to see if this is the channel at which to stop the carriage. When the hole to which the carriage is to skip is read, the printer sub-routine gives a stop carriage command.

Stop Carriage

- Modifier bit 14 turns on the skip stop latch.
- Skip start latch is turned off by the next carriage CB pulse.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XP401, XP511, XP711.

E-1 Cycle: An XIO instruction effective address (EA) which has been loaded into the accumulator is an even address. This address is transferred to the M register and the M15 bit output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area and function), is placed in the U register.

E-2 Cycle: The forced M15 bit line is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator. The U register decode of XIO control, area 6, and bit 14 turns on the skip stop latch.

E-3 Cycle: Not used.

Carriage Functions: When the carriage CB makes the skip start latch and skip stop latch are turned off and the carriage and interposer magnets are de-energized to stop the paper and printing can again take place.

Space

- Modifier bit 15 turns on the line space latch.
- Energize the carriage magnet.
- Move the paper one space.
- Set the carriage space interrupt FF for a level 1 interrupt.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XP401, XP511, XP711.

E-1 Cycle: An XIO instruction effective address (EA) which has been loaded into the accumulator is an even address. This address is transferred to the M register and the M15 bit output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area and function), is placed in the U register.

E-2 Cycle: The forced M15 bit line is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator. The U register decode of XIO control, area 6, and modifier bit 15 sets the line space latch energizing the carriage magnet.

Carriage Functions: The paper starts to move. When the carriage CB makes the carriage space interrupt FF is turned on, and the line space latch is turned off. A level 1 interrupt request is signaled. Programmed interrogation of the interrupt request determines if more spaces or skips are needed. The carriage magnet de-energizing allows the carriage to stop.

1.3.3 Print Scan Control

- Start printer control command must have been given.
- Printer run latch is on.
- With first Printer CB pulse set the cycle steal request latch.
- Set read emitter response FF for a level 1 interrupt.
- Hold up interrupt until end of the scan field transfer.
- Set cycle steal level 1.
- Gate print group counter to address core storage print scan field word one.
- Set print buffer register with word one and select the print magnets.
- At end of the first cycle, turn on the cycle steal control FF and advance the print group counter.
- At the end of the second cycle turn off the cycle steal control FF.
- Address the second word.
- Repeat the sequence until the eighth word is addressed.
- Turn off the cycle steal request FF.
- All cycle steal levels off allows the level 1 interrupt to be serviced by the CPU.
- The number of scans taken are controlled by the program.
- Reference Maintenance Diagrams: AA101, AA231, AA611, AA621, XP401, XP501, XP701.

1.4 MANUAL OPERATIONS

1.4.1 Manual Printer Start

- Ready the printer for operation.
- Reference Maintenance Diagrams: XP511, XP711.

Pressing the start key turns off the stop FL, if on, and turns on the ready FL if the printer motor switch is on and forms are in position.

1.4.2 Manual Printer Stop

- Remove the printer from ready status.
- Reference Maintenance Diagrams: XP511, XP711.

Pressing the printer stop key sets the stop FL and this turns off the ready FL. The ready FL going off turns off the printer run FL. The program is signaled the new status by reading the DSW.

1.4.3 Manual Space

- Move the carriage one space.
- Reference Maintenance Diagrams: XP511, XP711.

Pressing the space key on the printer turns on the manual space FL selecting the carriage magnet and the paper starts to move. When the carriage CB makes, the manual space FL is turned off and the carriage stops.

1.4.4 Manual Restore

- Restore key causes a skip to channel one.
- Reference Maintenance Diagrams: XP511, XP711.

Pressing the restore key on the printer turns on the restore FL and the skip start FL. The skip start FL selects the interposer magnet. When the interposer contact transfers, the carriage magnet is selected and the carriage starts to move paper.

When the carriage brush for channel 1 makes, the skip stop FL is turned on. The restore FL and skip start FL are turned off when the carriage CB makes.

1.4.5 Manual Carriage Stop

- Stop the carriage movement.
- Reference Maintenance Diagrams: XP511, XP711.

Pressing the carriage stop key turns on the skip stop FL turning off the skip start FL and restore FL, if on.

- Provides card input to the system.
- Provides card output from the system.
- Two models of the 1442 (Model 6 and 7) are available (Figure 2-1).
- Speeds are

	Reading	Punching
Model 6:	300 cards per minute	80 columns per second
Model 7:	400 cards per minute	160 columns per second

- Provides for loading of programs.
- Information is read into the B register one column at a time on program load (Figure 2-2).
- Information is read into the B register one column at a time, 12 hole to bit 0, 11 hole to bit 1, etc., on programmed read (Figure 2-3).
- Information is punched out from the B register one column at a time, bit 0 to 12 hole, bit 1 to 11 hole, etc.
- Reading is initiated by a control command, area 2, with modifier bit 13 on.
- Transfer of information one column at a time to the B register is controlled by a read command.
- Timing of the read commands is controlled by a read response interrupt.
- End of card reading is indicated by an operation complete interrupt after column 80.
- Punching is initiated by a control command, area 2, with modifier bit 15 on.
- Transfer of information, one column at a time, from the B register is controlled by a write command.
- Timing of the punch commands is controlled by the punch response interrupt.
- End of card punching is indicated by a 12 bit in the data word and an operation complete level 4 interrupt.
- Only one group of columns may be punched per card. Punching can not be restarted after the operation complete interrupt.

2.1 FUNCTIONAL CHARACTERISTICS

Cards are placed in the hopper face down, 9-edge first (Figure 2-4). The hopper holds approximately 1200 cards. Figure 2-4 illustrates the path the cards follow during reading and/or punching operations.

2.1.1 Card Reading

Card reading is initiated by a program read command. The card is fed through the reading station during the second card feed cycle (first card read cycle). This causes columns 1-80 of the card to be read in one continuous motion of the card. The card is read serially, that is, column by column, beginning with column one. Reading is accomplished through the principle of photocell sensing. Figure 2-5 illustrates the path of the card through the photocell reading mechanism. While each card column is read by the photocells, the output is sampled twice and the readings are compared for agreement and then sampled a third time to set the data into the attachment buffer register. This read-check-read process continues until all 80 columns have been read.

After a read operation is completed, the card is registered in column 1 at the punch station.

2.1.2 Card Punching

If a punch command is initiated, an incremental punch drive causes the card to be moved through the punch station. The attachment compares the punch data register with a signal from the punch magnets selected to verify punching accuracy.

The card motion and punching process continues until a signal from the program (data bit 12) indicates the last column to be punched. Upon this signal, the 1442 punches and generates an operation complete interrupt. Once punching is terminated in this manner it cannot be restarted in this card.

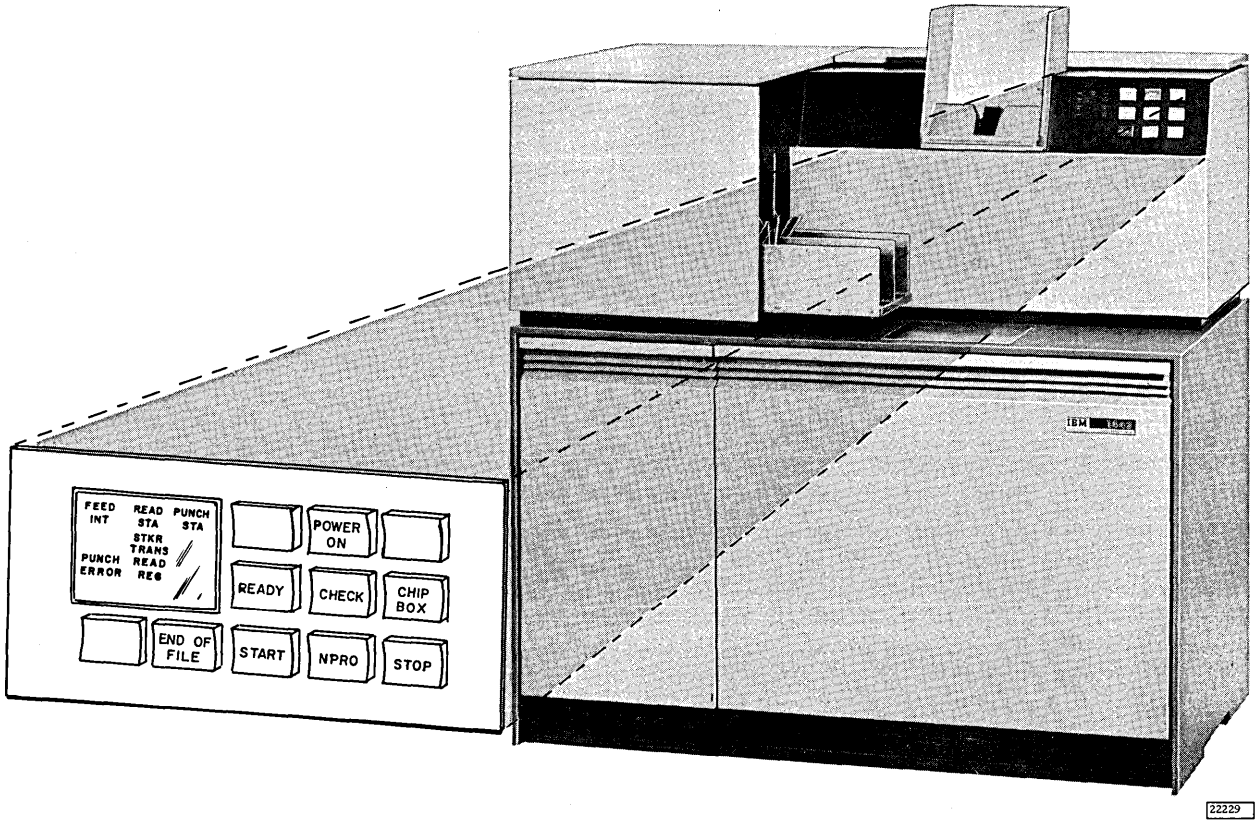


Figure 2-1. 1442 Card Read-Punch

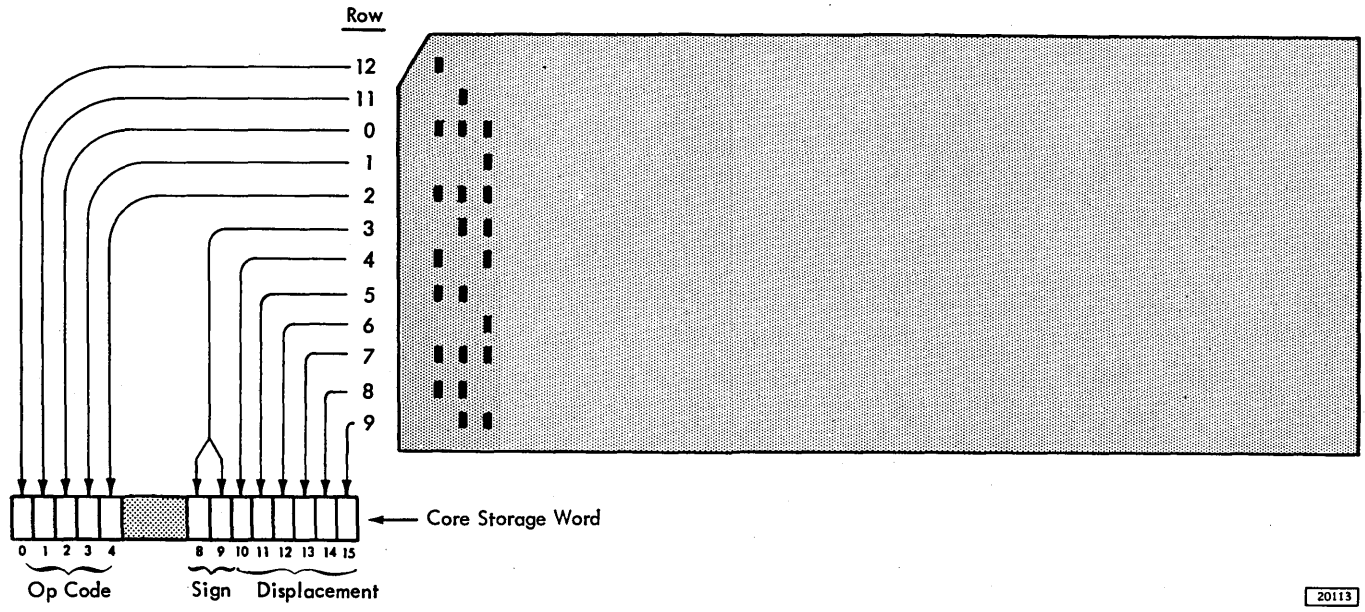


Figure 2-2. Load Program Mode Read

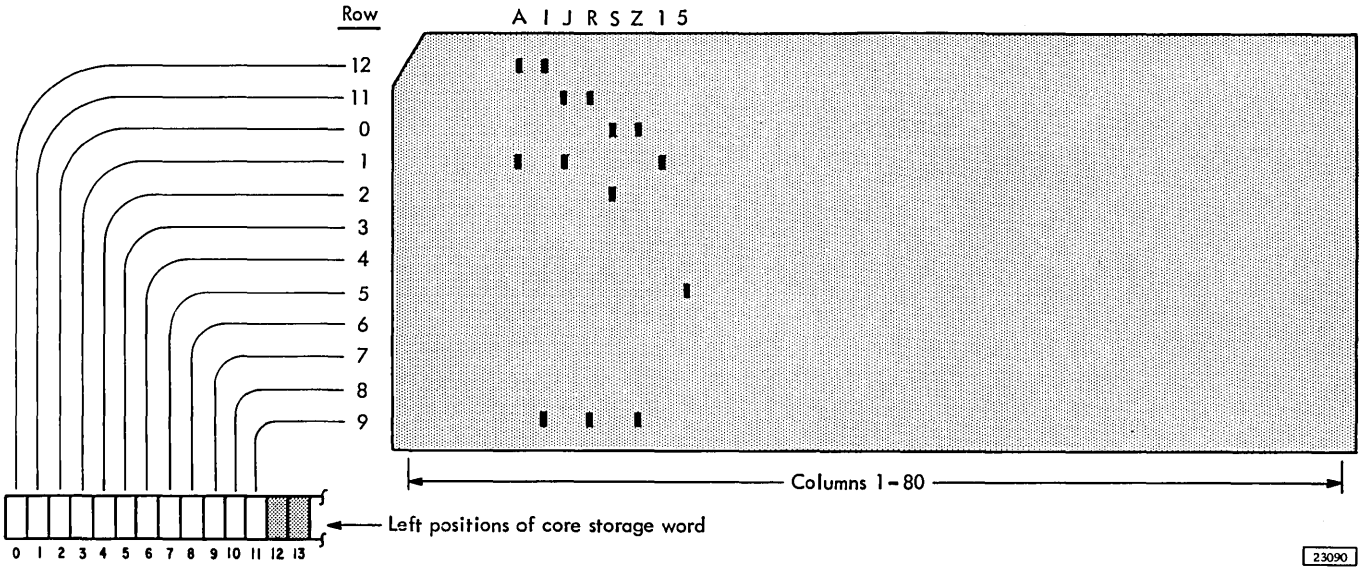


Figure 2-3. Card Code/Core Storage Transfer

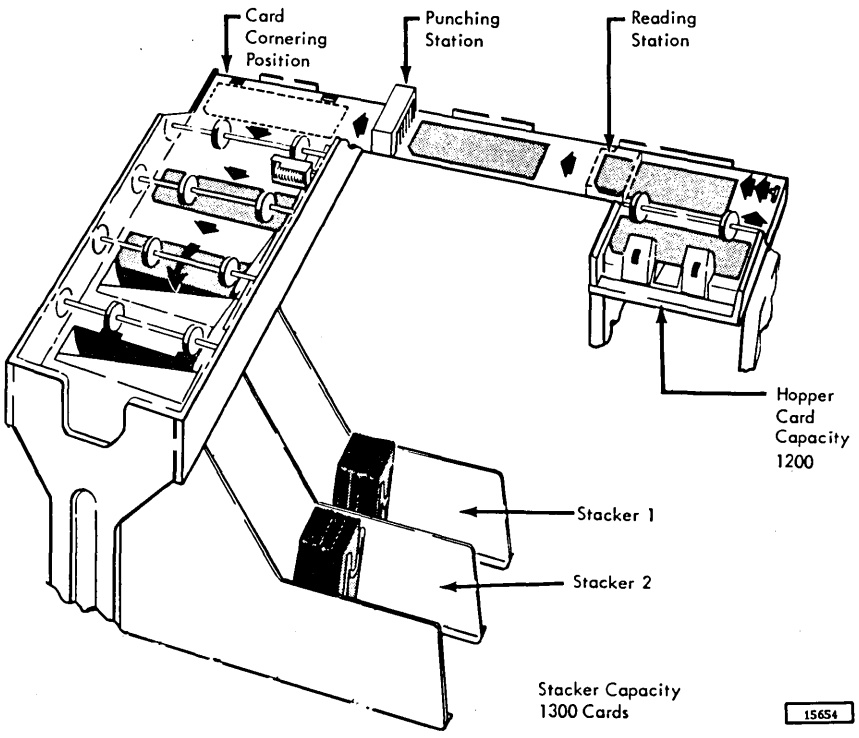


Figure 2-4. IBM 1442 Card Feed Path

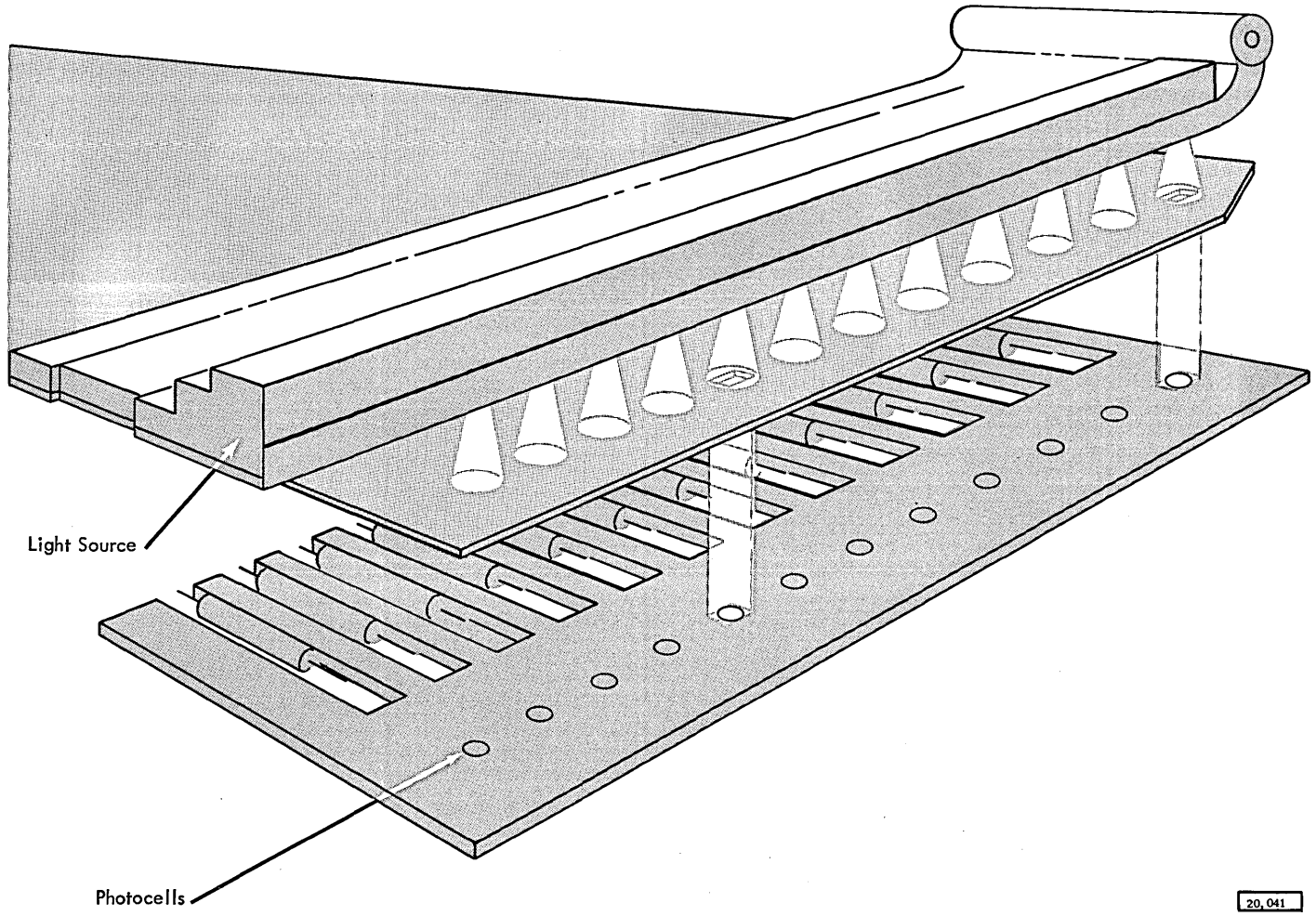


Figure 2-5. Photocell Reading

NOTE: All cards pass through the read and punch stations, but reading and/or punching occurs only by program instruction.

When the hopper becomes empty during a feed cycle, the 1442 is taken out of ready status. The operator may continue processing cards by loading more cards into the hopper and pressing the start key or he may initiate a last card sequence by pressing the start key without loading more cards in the hopper. For further information, see the IBM Field Engineering Manual of Instruction, 1442 Models 6 and 7.

2.1.3 Programming Considerations

Read

Data transfer begins with the data read from column one of the card and continues until all 80 columns are transferred from the reader. The instruction specifies the core storage location to which the character read is transferred. Card reading is initiated by a control (start read) command. This causes columns 1-80 of the card to be read in one continuous motion of the card. Each column of data is read, checked, read again and placed in a buffer register.

A read response interrupt is given for each column read. Checking is accomplished automatically by reading each column twice and comparing the results bit-by-bit. This read-check-interrupt process continues until all 80 columns have been read. An operation complete interrupt is given after all 80 columns have been read. The last card indicator will be on if the card read was the last card in the hopper.

NOTE: The start read instruction causes a card at the punch station to be transported through the punch station to the stacker. The card read moves from the preread station to the punch station as the following card feeds from the hopper to the read station.

Maximum reading rates can be attained if following feed and read commands are given within 35 milliseconds (25 ms in the model 7) after the end operation interrupt (operation complete) is given by the 1442. If a read-cycle command does not occur within this time, the maximum reading rate becomes 285 cards per minute (cpm) for the model 6 and 375 cpm for the model 7.

Less time is required of the CPU for servicing the 1442 when less than 80 columns of the card are read into core storage, thereby leaving more time available for computing.

Punch

Punching rates depend on the number of columns spaced and punched, that is, the position of the card when the last column is punched. The punching speed ranges are

Model 6: 49 cpm to 255 cpm (12.5 ms per column spaced or punched)

Model 7: 90 cpm to 340 cpm (6.5 ms per column spaced or punched)

Table 2-1 shows approximate punch cycle times and cards per minute rates based upon the last column punched.

The write instruction specifies the core storage location from which the character is to be transferred to the 1442. The punch operation is terminated by the end punch bit (12) contained in the data word of the last column to be punched.

Combined Reading and Punching

It is important to consider card design when the operation calls for reading a card, processing the information, and then punching the results into the same card. A significant increase in card throughput results from punching into the beginning columns of the card.

2.1.4 Data Coding

The 1442 reads and punches any combination of holes in any card column. Any code translation required must be done by the stored program. During normal read operations the twelve rows (12-9) in a card column correspond to the 0-11 bits, respectively, in the core storage word (Figure 2-3).

Card punching is initiated by a control (start punch) command. As each column passes the punch station a punch response interrupt is given.

Automatic checking is accomplished by comparing the punch check echo data with the single-character data register, which contains the character from the CPU. Checking of each column punched is done at the same time that the punch response interrupt is given for the data of the next column to be punched.

The card motion and punching process continues until the punch data word contains a one in the 12-bit position (punch data is in bits 0-11). When this end-punch bit is detected, the 1442 punches that column, moves to the next column, and gives an operation complete interrupt. No more punch response inter-

Table 2-1. Punch Cycle Times and Cards Per Minute Rates (Approximate)

Last Column Punched	Punch Time (ms)		Total Punch Cycle Time (ms)		Cards per Minute	
	Model 6	Model 7	Model 6	Model 7	Model 6	Model 7
1	13	6	229	169	202	355
10	125	63	341	226	176	265
20	250	125	466	288	127	208
30	375	188	591	351	102	171
40	500	250	716	413	84	145
50	625	313	841	476	71	126
60	750	375	966	538	62	112
70	875	438	1091	601	55	100
80	1000	500	1216	663	49	91

23095

rupts are given. All punching on the card must be completed at one time.

To eject a punched card to the stacker, a control (feed cycle) or a control (start read) command must be given. These control commands advance all the cards in the serial path.

2.1.5 Program Load

After a system reset and the run in cycle of a load card, program load can be initiated by pressing the program load key on the 1130 console. This load mode operation causes the load card data to be placed in 80 consecutive memory positions beginning at memory position 00000 (Figure 2-2) then causes the CPU to go to memory position 0000 for its next instruction.

2.1.6 Selective Stacker

The selective stacker is a standard feature of models 6 and 7. The feature allows stacker number 2 to be selected under program control. If a stacker is not specified by the program, the cards eject to stacker number 1.

2.1.7 Last Card Sequence

When the hopper becomes empty during a feed cycle, the card read-punch is taken out of ready status. The operator may continue processing cards by loading more cards into the hopper and pressing the start key or he may initiate a last-card sequence by pressing the start key without loading more cards in the hopper.

If the last-card sequence is to be entered, the program determines this through the last card indicator in the device status word. This indicator is turned on when the last card passes the read station.

When the start key is pressed without cards in the hopper, the 1442 is placed in the ready condition and allows two more feed cycles to be taken.

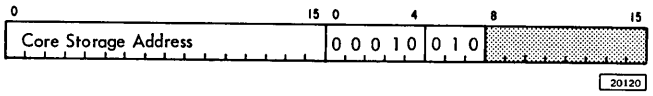
2.2 PROGRAMMING

- The IBM 1142 Card Read-Punch operates under the direct program control of the CPU.

2.2.1 I/O Control Commands

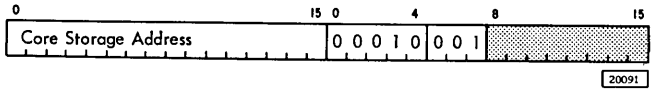
- The card read-punch is addressed by the 5-bit device code, 00010 (Area 2).

Read (010)



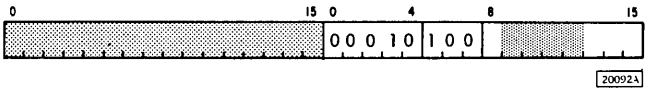
This command causes a card column image to be entered from the card read-punch into the core storage location specified by the address.

Write (001)



This command causes the data in the memory location specified by the address of the IOCC to be transmitted and punched as a card column image in the card.

Control (100)



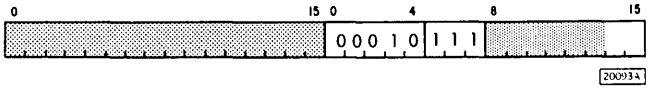
This command causes the card read-punch to accomplish the function specified by the modifier.

Modifier bits that have significance are:

- B8 Stacker Select--causes the card leaving the punch area to enter the alternate stacker. This control applies only to the next card leaving the station.
- B13 Start Read--causes the card to move through the read station. As each column is read and checked, the card read-punch initiates a read column response interrupt.
- B14 Feed Cycle--causes all cards in the feed path to advance one station. There are no read column response interrupts.
- B15 Start Punch--starts the punching operation and initiates a punch column request interrupt. If a card is not at the punch station, a card feeds past the read station without data entering the system.

Modifier bits B13, B14, and B15 of a control command should not be used in combination with each other, as conflicting commands would result.

Sense Device (111)



This command directs the card read-punch to place its device status word (Figure 2-6) into CPU ACC. Modifier B15 resets responses for level 0; B14 for level 4.

2.2.2 Interrupts

The three interrupts associated with the card read-punch are divided into two levels.

Level 0

Read Response: This interrupt signals that a column of data is ready to be entered into core storage. This interrupt is on interrupt level zero, which guarantees service of the request within 800 usec for the 1442 model 6 and 700 usec for the model 7. Time from start read to first read column request interrupt is 28.4 ms on model 6 and 23.8 on model 7.

Punch Response: This interrupt signals that a column of data must be transmitted from CPU within 1000 usec for the 1442 model 6 and 500 usec for the model 7. Times from start punch to first punch column response interrupt varies from 1.22 ms to 12.5 ms on the model 6 and 1.56 ms to 6.25 ms on the model 7.

Level 4

Operation Complete: This interrupt occurs after a card has been read. It indicates that column 80 of the card has passed the read station. This interrupt occurs 20.6 ms after column 80 for the model 6 and 15.4 ms after column 80 for the model 7.

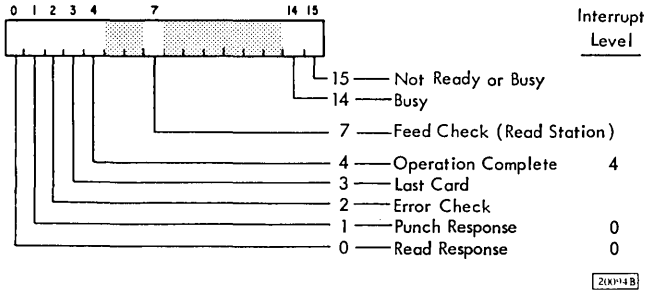


Figure 2-6. 1442 Device Status Word

This interrupt also occurs after the last column to be punched has been punched and checked with the punch drive stopped. This occurs 12.5 ms after the terminating write function for the model 6 and 6.25 ms after the terminating write function for the model 7.

2.2.3 Indicators (DSW)

Not Ready or Busy: This indicator (Figure 2-6) shows that the 1442 is not in a ready condition. Except when the 1442 is busy, manual intervention is required to ensure that the following conditions are met.

1. Power On.
2. Card registered at read station (initially).
3. Cards are in hopper or last-card sequence is in progress.
4. Stacker not full.
5. Feed-check light off (no card jam or feed failure conditions).
6. If the stop key has been pressed, the start key must have been subsequently pressed.
7. Chip box not full or removed.

Busy: The Busy indicator indicates that a start read, feed cycle, or a start punch control command cannot be initiated because one of these functions is already in progress.

Last Card: This indicator shows that column 80 of the last card has passed the read station and the hopper is empty, or that the last card in the deck has been punched.

Feed Check (Read Station). This indicator comes on as a result of a feed check detected at the read station.

Error Check: This indicator comes on as a result of a read error, punch error, or feed check. Punch response, read response and operation complete indicators are also interrupt levels and are explained under interrupts.

2.3 CIRCUIT DESCRIPTION

The 1442 models 6 and 7 are designed so that a minimum of circuitry is contained within the 1442 unit. Figure 2-7 shows the circuit components within the 1442 box.

The balance of the circuits needed to control the 1442 operations are contained in 1131 gate A, board B1 of the 1131.

Data flow of the 1130-1442 operations is shown in Maintenance Diagram XR401. Data read by the solar

Lamps	Switches	CB's	Magnets and Relays
Read Error	Start	Feed CB 1	Incremental Drive Magnet A
Punch Error	Stacker Full	Feed CB 2	Incremental Drive Magnet B
CPU Stop	Non Process Runout	Feed CB 3	Stacker Select Magnet
Power On	Stop	Feed CB 4	12 Punch Magnets
Ready	Box Full	Punch CB 1	Motor Relay
Chip Box	Box Out	Punch CB 2	Clutch Relay
Feed Clutch	Cover Interlock	Incremental Drive CB A	15 Second Delay Relay
Check	Hopper Empty	Incremental Drive CB B	Process Meter
Misfeed	Stacker Jam		
Punch Station	Idle Relay Contact		
Read Station			
Transport			
Read Column			
Punch			

22230

Figure 2-7. 1442 Circuit Components

cells is placed in the read-punch data register. With the read response interrupt the data is transferred to the B register with a read command. Data to be punched is transferred from the B register, following the punch response interrupt, by a write command to the read-punch data register then to the punch magnets.

More detailed data flows are shown in the Maintenance Diagrams, AA101, AA231, and XR401. A data flow of the 1442 read circuits is shown in the I/O operation chart 1442 read punch-read operation diagram XP511.

A data flow of the 1442 Punch circuits is shown in the I/O operation chart-1442 read-punch-punch operation diagram XP501.

2.3.1 Control Operations

- Used to control card feeding.
- Used to control card stacking.
- Reference Maintenance Diagrams: AA101, AA231, AA621, XR401, XR531, XR541, and XR721.

Before a read or a write command may be given the program must initiate a card feed cycle by giving a control command.

The control IOCC contains the device code (00010) for selecting the 1442, the operation code (100) for control, and one or more modifiers:

Modifier bits that have significance are:

B8 Stacker Select--causes the card leaving the punch area to enter the alternate stacker. This control applies only to the next card leaving the punch station.

B13 Start Read--causes the card to move through the read station. As each column is read and checked, the card read-punch initiates a read column response interrupt.

B14 Feed Cycle--causes all cards in the feed path to advance one station. There are no read column response interrupts.

B15 Start Punch--starts the punching operation and initiates a punch column request interrupt. If a card is not at the punch station, a card feeds past the read station without data entering the system.

Modifier bits B13, B14, and B15 of a control command should not be used in combination with each other.

Stacker Select: A control command with a modifier bit 8 sets the XIO stacker select FF. When feed CB 1-2 pulse falls, the stacker select trigger is turned on and the XIO stacker select FF is turned off. The stacker select FF energizes the stacker select magnet until feed CB 1-2 makes again. The feed CB timing is needed because the selection is made after punching but before the card reaches the stacker.

Start Read: A control command with a modifier bit 13 sets the XIO feed FF. The XIO read FF is also turned on allowing the card to be read. (I/O operation chart--read operation XR511).

When the XIO feed FF comes on the feed clutch FL is turned on, energizing the clutch magnet. The XIO feed FF is turned off when feed CB 1-2 pulse drops. When feed CB 2 makes, the feed clutch FL is turned off and the clutch mechanics compete the feed cycle.

Feed Cycle: A control command with a modifier bit 14 sets the XIO feed FF the same as bit 13 and causes a feed cycle but does not set the XIO read FF. This allows the advancing of the cards without reading or punching.

Start Punch: A control command with a modifier bit 15 sets the XIO punch FF. This sets the feed clutch

FL if a card is not in the punch station. At the same time it sets up the control for the incremental drive as shown in I/O control chart-punch operation XR501. (See Punch Operation section.)

2.3.2 Read Operation

- Read one column of data.
- Check one column of data.
- Provide read response interrupt.
- Transfer one column of data to core storage.
- Reference Maintenance Diagrams: AA101, AA231, AA611, AA621, XP402, XP511, XP711.

The read IOCC contains the core storage address of the high-order of the data field, the device code (00010) (Area 2) for selecting the 1442, and the operation code (010) for read. The XIO read and XIO feed FF are on from the start read control command.

When the read emitter makes for column one, it starts the read single-shot timing starting the time 1-time 2 FF sequence, and causing the data register FF's to be turned off. When time 2 FF comes on, the register complement SPD sets the output of the read solar cells into the data register.

When the read single shot stops timing, the time 1-time 2 sequence is started again. At time 2, the register complement SPD resets the data register bits that are now being read. If any of the data register bits are left on, the data error FF is turned on at the fall of time 2, by the read-interrupt-and-error-sample single shot. This single shot also turns on the read interrupt FF and causes a level 0 interrupt.

With the fall of time 2, the register complement SPD sets the data from the solar cells into the data register again. The program answers the level 0 interrupt by a sense device command to read the DSW into the accumulator. This also turns off the read response FF if B15 is on in the sense command. The program decodes the read response DSW and gives a read command to transfer the data word to core storage.

This sequence is repeated for each column until after column 80 has been read. Then feed CB 2 makes and turns off the XIO read and XIO feed FF. The XIO feed FF drops busy and turns on the end operation FF giving a level 4 interrupt. The program then gives a sense device command turning off the end operation FF if B14 is on in the sense command. The program decodes the DSW, determines that end operation was on and returns to the main line routine, or issues a command to read the next card.

2.3.3 Punch Operation

- Transfer one column of data to the read-punch data register for punching.
- Reference Maintenance Diagrams: AA101, AA231, AA611, AA621, XP401, XP501, XP701.

The punch IOCC contains the core storage address of the high-order of the data field, the device code (00010) (Area 2) for selecting the 1442, and the operation code (001) for write.

The XIO punch FF is on from the start punch control command. The card feeds into the punch station, registering at column 1, and incremental drive A FF is turned on to bring up the punch gate line permitting the next punch CB 1 pulse to turn on the punch single shot.

The punch single shot timing starts the time 1-time 2 sequence. When time 2 comes on, the register complement SPD gates the responses (at this time there are none) from the punch magnets to turn off the data register FF's which were already turned off by the start punch command.

When time 2 goes off, the punch-interrupt-and-error-sample single shot times to check the output of the data register. The punch response FF is also turned on to give a level 0 interrupt to start the sequence for the first column.

The program answers this interrupt with a sense device control command. The program decodes the DSW as punch response interrupt and answers with a write command.

The write command sets the load punch data sample SPD to set the data (first column) on the I/O out bus into the data register. At the same time the punch data FF is set to gate the data register to the punch magnets. The 1442 starts the punch operation.

When the next incremental drive CB makes the punch single shot times and starts the time 1-time 2 sequence. When time 2 comes on, the register complement SPD gates the responses from the punch magnets to turn off the data register FF's, which contain the data just punched.

When time 2 goes off, the punch interrupt FF is set (second column) and the error sample tests the data register for any bits on. If any bits are on, the punch error FF is turned on.

When the punch CB 2 makes, the punch data FF is turned off to drop the gate to the punch magnets. The incremental drive moves the card into column 2. The incremental drive FF's remain on until the punch gate is turned off at the end of the operation.

The sequence continues for each column until a column is punched that has a 12 bit in the data word. This sets the last punch FF to turn off the XIO punch FF at punch CB 2 time.

NOTE: If all 80 columns are being punched the bit 12 must be on in the 80th column not the 81st column.

The punch response is inhibited during the last cycle. After the last column has been error checked the punch gate drops turning off busy and turning on the end operation FF to give a level 4 interrupt to signal the CPU that the punch routine is complete.

The XIO punch FF going off also turns off the card-in-punch-station FL causing a feed cycle if another punch command is given on the same card.

2.3.4 Program Load

- Provides a means of loading a one card program into core storage which will load the rest of the program.
- Starts the card reading.
- Reads all 80 columns.
- Sets read response causing a CPU cycle, but program load blocks the normal interrupt addressing controls.
- Reads each column as a single word instruction (Figure 2-2).
- Starts the program at location 0000.
- Reference Maintenance Diagrams: AA101, AA231, AA611, XR401, XR521.

The cards to be loaded into core are placed into the 1442 hopper. When the program load key is pressed the program load FL is turned on setting the motor clutch FL and energizing the motor relay. When the motor is up to speed the feed clutch FL is turned on and a card is fed to the preread station and to the read station.

As each column is read the read response FF is set to give a CPU cycle. The normal level 0 interrupt is blocked by program load. The normal incrementing of the instruction register advances the addressing from 0000 through 0079, one at a time.

The information read and checked in the data register is set onto the I/O input bus and transferred to core storage.

After column 80 is transferred the program load FF is turned off and the I register is turned off (0000) and the run FF is allowed to function. This starts program execution at location 0000.

3.1 FUNCTIONAL DESCRIPTION

- The IBM 1134 Paper Tape Reader and IBM 1055 Paper Tape Punch provide paper tape input/output for the IBM 1130.
- One of each can be connected to the system.
- The 1134 and 1055 operate on the IBM 1130 under direct program control.
- The 1134 Paper Tape Reader reads one-inch eight-track paper tape at a maximum rate of 60 columns per second (cps).
- The 1055 Paper Tape Punch punches one-inch eight track paper tape at a maximum punching rate of 15 cps.
- For additional 1055 information, see the IBM Field Engineering Manual of Instruction, 1054 Paper Tape Reader and 1055 Paper Tape Punch.
- For additional 1134 Paper Tape Reader information, see the IBM Field Engineering Manual of Instruction, 1134 Paper Tape Reader.

The 1134 Paper Tape Reader reads input data into the core storage as an image of the holes in the tape. One paper tape character is read into each addressed core storage location. Any code translation must be made by programming.

Figure 3-1 indicates which bits of the word correspond to the respective holes in the paper tape read by the 1134.

The 1055 Paper Tape Punch punches data as an image of the data contained in the core storage word on a character-to-character basis as shown in Figure 3-1.

Special data-character and control-character (feed code, etc.) coding and recognition must be handled by the stored program.

3.2 PROGRAMMING

The IBM 1134 Paper Tape Reader and the IBM 1055 Paper Tape Punch operate on the IBM 1130, under direct program control.

3.2.1 I/O Control Commands (IOCC)

The 1134 and 1055 are addressed by the 5-digit area code (00011).

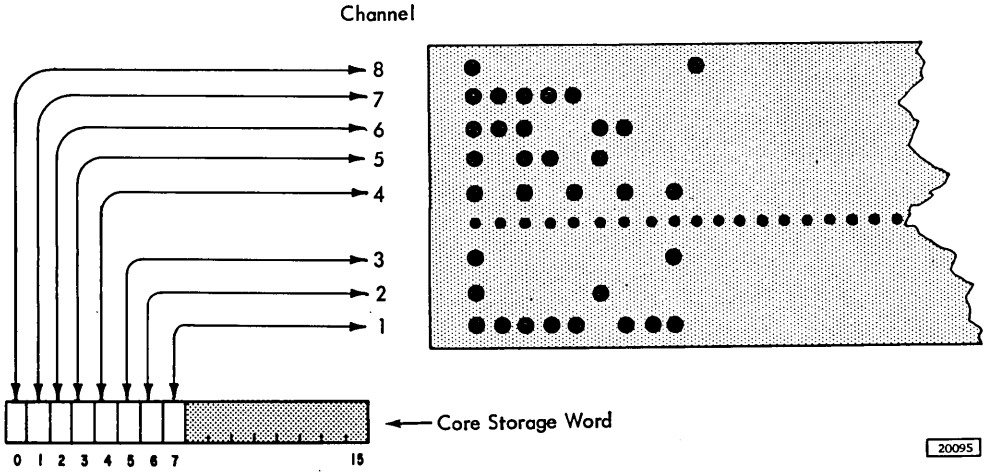
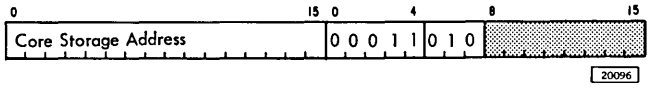


Figure 3-1. 1134/1055 Word Format

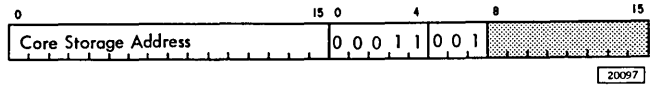
Read (010)



This command reads one character from paper tape into core storage.

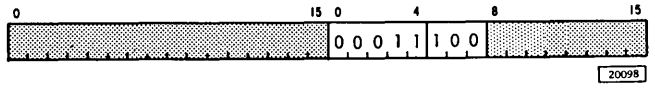
The address word specifies the location in core storage where the tape character is to be stored.

Write (001)



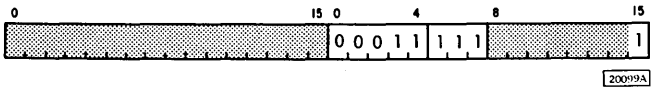
This command writes one character from core storage to the paper tape punch. The address word specifies the location in core storage where the tape character is stored that is to be transferred to the paper tape punch.

Control (100)



This command must be given prior to each character to be read from the 1134. Execution of this command causes: one character to enter the paper tape reader buffer and the tape to be advanced one column; and a reader-service-response interrupt to be initiated to indicate that a character from paper tape can be read into the core storage location specified by a subsequent read (paper tape) command.

Sense Device (111)



This command is used to enter the device status word (Figure 3-2) into the accumulator. B15 on indicates that the responses are to be turned off.

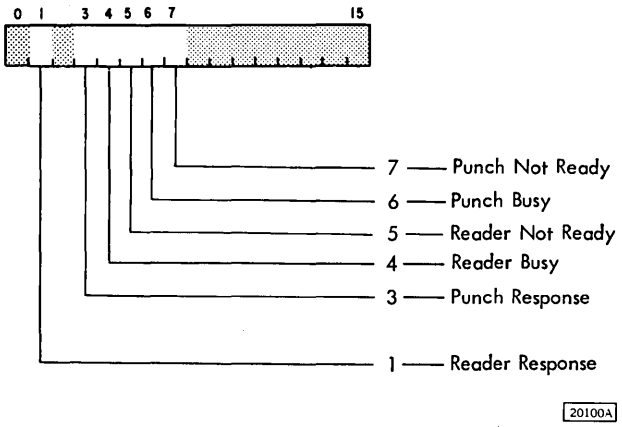


Figure 3-2. 1134/1055 Device Status Word

Interrupts - Level 4

Reader Response: This interrupt occurs when the reader has completed the execution of a control command. This interrupt indicates to the CPU that a character is available to be entered into core storage.

Punch Response: This interrupt occurs when the punch has completed punching as directed by the execution of a write command, and indicates that the punch can accept the next command.

Indicators (DSW)

The following indicators can be entered into the accumulator by a sense device command (Figure 3-2).

Punch Not Ready: This indicator is turned on when tape is not feeding freely from the tape spool, when the tape pressure roll holder is not down and holding the tape against the feed wheel, or when tape is not present. Manual intervention is required to clear these conditions. The indicator is also on if the punch is busy. (See punch busy indicator.)

This indicator should always be tested by the program before a write command is given. If a write command is given while this indicator is on, loss of information occurs. No indication is given of this loss.

Reader Not Ready: This indicator is turned on when the tape tension switch is open. This condition exists when the paper tape is broken or not feeding freely. Manual intervention is required to clear these conditions. This indicator is also on if the reader is busy. (See reader busy indicator.)

This indicator should be tested by the program before a read command is given. If a read command is given while this indicator is on, erroneous data can be read into core storage. No valid indication can be given as to whether the data read is correct or incorrect.

Punch Busy: This indicator is turned on for the total time the punch is mechanically engaged and punching a character (68 ms). During this time the punch is not able to accept another write command.

Reader Busy: This indicator is on from the time a control command (start paper tape reader) is given until data is available. Availability of data is signaled by a reader-service interrupt.

3.3 CIRCUIT DESCRIPTION

3.3.1 Paper Tape Reader Operation

- Initiated by XIO instruction with IOCC function of control.
- The control command loads the read buffer and moves paper tape one character position.
- When the read buffer is loaded, interrupt request is sent to the CPU.
- Branch is forced to XIO with IOCC function of read.
- The read command transfers a character from the read buffer to the core storage location specified by the IOCC address word.
- A control command must precede each read command.
- Tape movement is in the forward direction only.
- Reference Maintenance Diagrams: AA101, AA231, AA611, AA621, XT401, XT501, XT701.

Ready Reader

- Make sure that reader contacts are seated in the holes in a column.

When tape is placed in the read head and the head cover is locked, reader ready comes up. This sets the inhibit paper tape (PT) response FF. This FF holds the reader single shot output at the active level preventing a PT-reader-response interrupt.

This is used to give one dummy feed cycle on the first control command.

The inhibit-PT-response FF is turned off by the PT control FF after the first cycle, and is off for the balance of the operation.

Control Command

A control command must precede each read command to perform the following functions:

- Energize reader clutch to read a character into the buffer.
- Load tape image into read buffer.
- Move the tape one character position.
- Initiate an interrupt request.

E-1 Cycle: An XIO instruction effective address (EA), which has been loaded into the accumulator, is an even address. This address is transferred to the M register and M15 bit output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area, function, and modifier), is placed in the U register.

E-2 Cycle: The area bits in the control word (00011) specify the 1134/1055 (Area 3), the U register decodes XIO Control (100), and the paper tape reader busy FF is turned on.

This gates the PT control FF.

E-3 Cycle: Not used.

Reader Functions: The PT control and osc FF's are turned on by the 120 cps oscillator. These FF's gate the reader contacts and the drive pulse to the reader drive clutch. The PT control FF times the read single shot that turns off the reader buffer FF. When the read single shot times out the read buffer is set with the image of the tape character, and the PT-reader-response FF is set on, and the PT-reader-busy FF is turned off. The PT reader response FF gives a level 4 interrupt and a DSW bit 1.

Sense Command

- Transfer the DSW to the accumulator.

E-1 Cycle: Same as the control E-1 cycle.

E-2 Cycle: The area bits in the IOCC (00011) specify the 1134/1055, the U register decodes XIO sense (111). This turns off the reader-response FF after gating the DSW to the I/O in bus.

Read Command

- Transfer the paper tape read data to core storage.

When the CPU services the interrupt, a branch is forced to a subroutine containing an XIO instruction with an IOCC specifying a read function.

E-1 Cycle: The E-1 cycle is the same as for the control command except the U register decodes an XIO read function. No reader action takes place during this cycle.

E-2 Cycle: No reader action. The CPU reads the address word of the IOCC from core storage and loads it into the accumulator.

E-3 Cycle: The content of the read buffer is gated, by XIO read and area 3, on to the I/O in bus, transferred to the B register, and stored in core storage at the location specified by the address word of the IOCC.

The operation is terminated and the CPU proceeds with the program. To read subsequent characters from tape, another control-sense command and read command must be executed.

3.3.2 Paper Tape Punch Operation

- Each character to be punched requires an XIO instruction with an IOCC specifying a write function.

- The write command punches the character specified by the IOCC address word and advances the paper tape.

- After a delay to advance tape and reset circuits a punch-response interrupt request is initiated.

- Reference Maintenance Diagrams: AA101, AA231, AA611, AA621, XT401, XT511, XT711.

XIO Write Execution

The addressing, punching, and tape advancing are all accomplished by the write command. An XIO instruction effective address (EA) is loaded into the accumulator during the I cycle(s).

E-1 Cycle: EA is the location of the IOCC word; it must be an even address. EA is loaded into the M register and M15 bit output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area, function and modifier) is placed in the U register.

E-2 Cycle: The forced M15 bit condition is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator.

E-3 Cycle. The IOCC address word is loaded into the M register to address the data word. The data word is read from core storage, set into the B register, and placed on the I/O out bus.

The U register decode of XIO write, and area 3 turns on the busy FF. The busy FF coming on sets the data word (bits 0-8) into the punch buffer, and gates the punch timing ring FFs. The punch magnets are energized under control of the punch buffer to punch the character in eight-bit paper tape code into paper tape. The XIO execution is complete; the CPU continues with the next sequential program instruction.

The first (1) paper tape oscillator pulse (120 cps) turns on the timing ring A FF. The A FF coming on with the C FF off turns on the clutch drive FF to start the tape punch and feed cycle. The next pulse (2) turns the A FF off and the B FF on.

The next oscillator pulse (3) turns on the A FF. The next pulse (4) turn off the A FF and the B FF. The B FF going off, while the C FF is off turns off the clutch drive FF. The B FF going off turns on the C FF. The C FF on and the B FF off turns off the punch buffer FF's.

The next oscillator pulse (5) turns on the A FF. The next pulse (6) turns off the A FF and turns on the B FF.

The next oscillator pulse (7) turns on the A FF. The next pulse (8) turns off the A FF to turn off the B

FF which turns off the C FF. The C FF going off turns off the busy FF. The busy FF going off turns on the punch response FF to send an interrupt request level 4 to the CPU.

3.3.3 Paper Tape Reader-Punch Sense Operation

- Initiated by an XIO instruction with IOCC specifying sense interrupt (011) or sense device (111).
- The sense interrupt command transfers the interrupt level status word to the accumulator for analysis by the program.
- The sense device command transfers the device status word to the accumulator for analysis by the program.

Sense Command Execution

Both sense-interrupt and sense-device command operations are the same except for the information that is transferred and the resetting of indicators by the sense-device command.

E-1 Cycle. This cycle is the same as for the control, read, or write commands; the IOCC control word is analyzed by the paper tape reader punch adapter.

E-2 Cycle: (Sense interrupt.) If the U register decodes a sense interrupt (001) and the 1134/1055 caused the interrupt, the ILSW bit 0 assigned to the paper tape reader-punch is set to a one on the I/O in bus. The ILSW is stored in the accumulator.

E-2 Cycle (Sense device): If the U register decodes a sense device (111), the DSW bits assigned to the various indicators are set to a one for those indicators that are on. The DSW is stored in the accumulator.

Bit 15 and 14 of the IOCC specify which interrupt indicators turned off by the sense device command:

Bit 15 is a one, highest interrupt level indicators within the device are turned off.
Bit 14 is a one, second highest interrupt level indicators within the device are turned off.
If neither bit 15 nor 14 is a one, no indicators are turned off.

E-3 Cycle: There is no E-3 Cycle in the sense commands.

3.3.4 Paper Tape Program Load

- Provides a means of loading a program into core storage when card input is not installed.
- Start tape movement.
- Read four columns.
- Set the paper-tape-reader-response to cause a CPU cycle. Program load blocks the normal interrupt addressing controls.
- Read a 16 bit word to core storage starting with location 0000.
- Repeat until a channel 5 punch is read.
- Start program at location 0000.
- Reference Maintenance Diagrams: AA231, XT401.

Pressing the program load key starts the PT control oscillator sequence and gates the PT reader contacts and the reader clutch. The read single shot times. This resets the reader buffer FF's. When the read single shot times out, it turns on the program load 1 FF. This sets the first column into the program load buffer 1. When the read single shot times out for column 2, the program load 2 FF is turned on, and the data is set in to the reader buffer. When the read single shot times out for column 3, the program load 1 FF is turned off, and the data is set into the program load buffer 2. When the read single shot times out for column 4, the program load 2 FF is turned off, the reader response FF is turned on to force a CPU cycle. During this cycle, column 1 data from the program load buffer 1, column 2 data from the read buffer, column 3 data from the program load buffer 2 and column 4 data from the 1134 data lines are gated to the I/O input bus. The instruction counter is advanced to address the next word in core storage.

Characters	First	Second	Third	Fourth
Tape Channels	4321	4321	4321	4321
Bits	0,1,2,3	4,5,6,7	8,9,10,11	12,13,14,15

The sequence is started over for the next four columns.

When a punch in column 5 is read the instruction counter is reset to 0000, and the cycle timer is started to begin the program.

4.1 FUNCTIONAL DESCRIPTION

- The IBM 1627 Plotter provides graphic output of system data.
- One 1627 may be attached to the system.
- Operates under direct program control.
- For information on the plotter see the IBM Field Engineering Instruction-Maintenance manual, 1627 Plotter (See Bibliography).

The IBM 1627 Plotter provides an exceptionally versatile, reliable, and easy-to-operate plotting system for the IBM 1130 Computing System. The plotter converts tabulated digital information into graphic form. Bar charts, flow charts, organization charts, engineering drawings, and maps are among the many graphic forms of data which can be plotted on the 1627 Plotter.

Two models of the 1627 are available and the major characteristics are:

Model 1 -- Plotting area: 11 inches by 120 feet, 1/100-inch incremental-step size, 18,000 steps/minute.

Model 2 -- Plotting area: 29-1/2 inches by 120 feet, 1/100-inch incremental-step size, 12,000 steps/minute.

More information on both models is given in Figure 4-1.

		Model 1	Model 2
Speed	X, Y Increments Pen Status Change	18,000 Steps/Min 600 Operations/Min	12,000 Steps/Min 600 Operations/Min
Increment Size		1/100 Inch	1/100 Inch
Chart Paper	Width Plotting Width Length Sprocket Hole Dimensions	12 Inches 11 Inches 120 Feet .130 Inch Dia on 3/8 Inch Centers	31 Inches 29 1/2 Inches 120 Feet .188 Inch Dia on 1 Inch Centers

15667

Figure 4-1. Operating Characteristics (1627)

Data from core storage is transferred serially to the 1627 under direct program control, where it is translated into 1627 actuating signals. These signals are then converted into drawing movements by the 1627 Plotter.

The actual recording is produced by incremental movement of the pen on the paper surface (y-axis) and/or the paper under the pen (x-axis). The pen is mounted in a carriage that travels horizontally across the paper as viewed from the front of the plotter. The vertical plotting motion is achieved by rotation of the pin feed drum, which also acts as a platen (Figure 4-2).

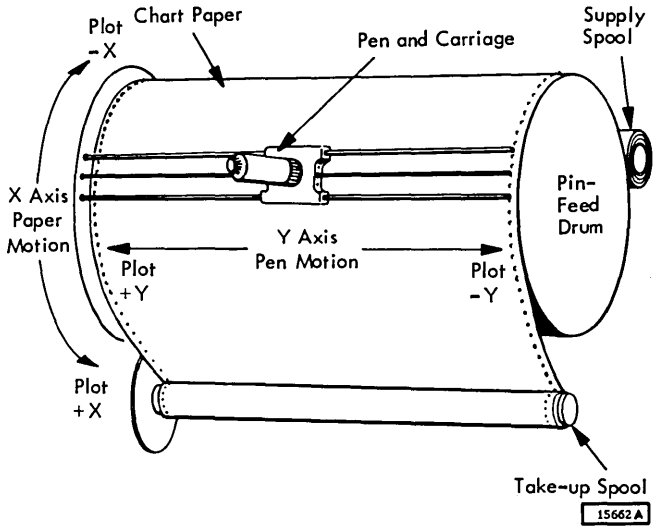


Figure 4-2. Paper and Pen Motions

The drum and the pen carriage are bi-directional; that is, the paper moves up or down, and the pen moves right or left. Control is also provided to raise or lower the pen from or to the paper surface. The pen remains in the raised or lowered position until directed to change to the opposite status.

The drum and pen-carriage and the pen status are controlled by digits transferred to the 1627. Each output word is decoded into a directional signal which causes a 1/100 inch incremental movement of the pen carriage (Figure 4-3) and/or paper, or a raise-pen or a lower-pen movement. The motion or action resulting from each word in the output record is shown in Figure 4-4.

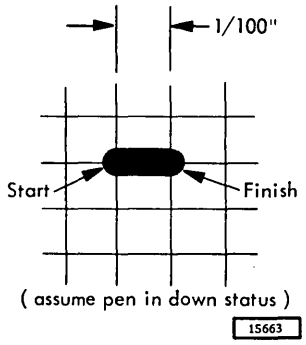


Figure 4-3. Plotter Result for One Horizontal (y-axis) Movement

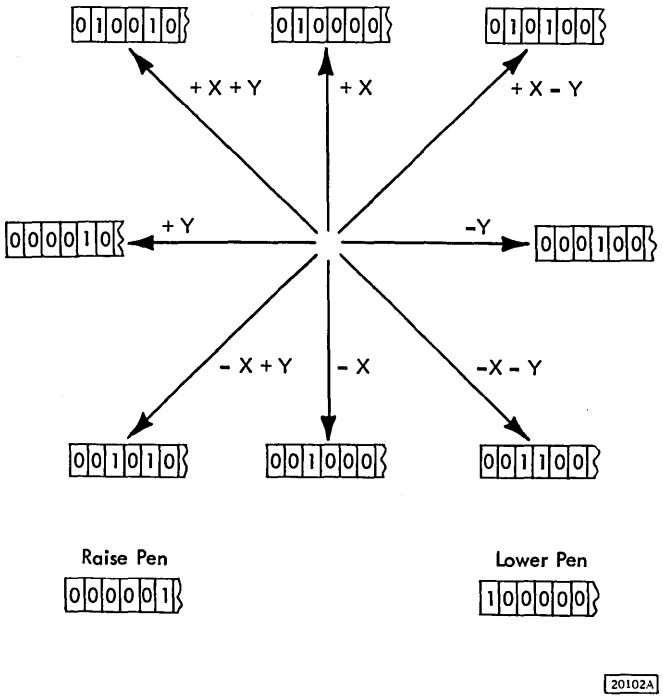


Figure 4-4. Output Record Control

The time required for execution of raise-pen and lower-pen commands is 100 ms. The time to plot a point is approximately 5 ms (3.3 ms for 300 steps/sec).

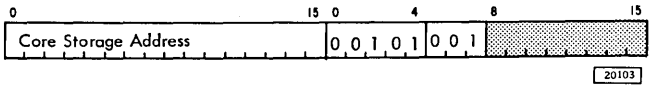
4.2 PROGRAMMING

- The IBM 1627 Plotter operates under direct program control of the IBM 1130 Computing System.

4.2.1 I/O Control Commands (IOCC)

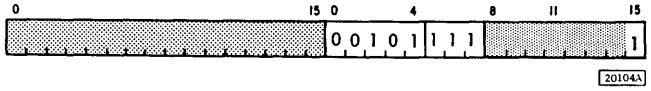
The 1627 is addressed by the 5-bit area code of the IOCC (area 5).

Write (001)



This command causes the six-high order bits of the word in the core storage location specified by the address to be sent to the 1627 to control the movement of the pen or drum (Figure 4-4).

Sense Device (111)



This command causes the 1627 device status word (Figure 4-5) to be placed in the accumulator and resets the interrupt level addressed. Modifier B15 specifies the turn off of the plotter response.

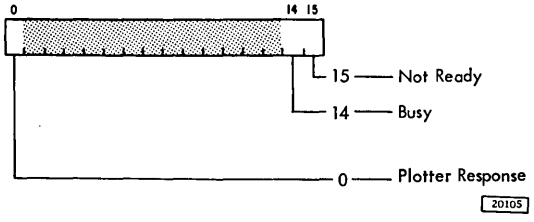


Figure 4-5. 1627 Device Status Word

Interrupt

A level 3 interrupt is the only one associated with the 1627 attachment.

Plotter Response: This interrupt occurs when the 1627 has completed the action specified by the last character transmitted by the write command.

Indicators (DSW)

Not Ready: When this indicator is off, it indicates that the 1627 has power on.

Busy: This indicates that the 1627 is in a busy status and cannot accept a character. After the first write command the program should wait for succeeding plotter interrupts to initiate write commands. If a write command is given while busy is on, loss of information will probably occur. No indication is given of this loss.

4.3 CIRCUIT DESCRIPTION

4.3.1 Plotter Operation

Write Command

- Transfers data to the IBM 1627 to control pen and paper movement.
- Reference Maintenance Diagrams: AA101, AA231, AA611, AA621, XG401, XG501, XG701.

E-1 Cycle: EA is the location of the IOCC word; it must be an even address. EA is loaded into the M register and the M15 bit output line is made active to address EA + 1. The word at EA + 1, which is the IOCC control word (area and function) is set into the U register.

E-2 Cycle: The forced M15 bit is dropped, causing EA to be addressed. The word at EA, which is the IOCC address word, is read from core storage and loaded into the accumulator.

E-3 Cycle: The IOCC address word is loaded into the M register to address the data word. The data word is read from core storage, set into the B register, and placed on the I/O out bus.

The 1627 adapter sets the six-high order bits into the controlling FF's.

Plotter Functions

Any of the drum or carriage FF's coming on starts the busy single shot 1 timing. Either pen FF coming on starts the busy single shot 3 timing. When busy single shot 1 times out, busy single shot 2 times and turns off the carriage and drum FF's. The busy single shot 3 timing out starts the busy single shot 4 timing. This turns off the pen FF's.

When the busy single shot 2 (or 4 if timing) times out the plotter response FF is turned on, giving an interrupt level 3 request.

Sense Command

- Transfers information on the status of the plotter to the CPU.
- Must precede each write command.

E-1 Cycle: This cycle is the same as for the write command.

E-2 Cycle: The U register decodes XIO sense device and area 3 and gates the sense information onto the I/O in bus. The DSW is stored in the accumulator. If bit 15 of the IOCC is on, the plotter response FF is turned off.

E-3 Cycle: There is no E-3 Cycle in the sense commands.

This is a list of manuals that contain information that is of value in servicing the IBM 1130 Computing System.

Manual Name	Type	Form Number
IBM 1130 Computing System Functional Characteristics	SRL	A26-5881
IBM 1130 Computing System	FETO	227-5978
Includes: IBM 1131 Central Processing Unit		
IBM Disk Storage Feature		
IBM 1130 Computing System-Features	FETO	227-3670
Includes: IBM 1442 Card Read Punch Feature		
IBM 1132 Printer Feature		
IBM 1627 Plotter Feature		
IBM 1134/1055 Paper Tape Reader-Punch Feature		
IBM 1130 Computing System	FEMM	227-5977
IBM 1130 Computing System	PC	127-0808
I/O Printer (Modified IBM SELECTRIC ®)	FEMI	225-6595
I/O Printer (Modified IBM SELECTRIC ®)	FEMM	225-1726
IBM 1130 Reference Card		X26-3566
Solid Logic Technology Packaging	FEIM	223-2800
Tektronix Oscilloscopes	FEMI	223-6725
Transistor Component Circuits	FEMI	223-6889
Transistor Theory Illustrated	FEMI	223-6794
Transistor Theory and Application	FEMI	223-6783
SLT Power Supplies	FEMI	223-2799
IBM Serial Reader-Punch	FEMM	231-0026
IBM Serial Reader-Punch	FEMI	231-0025
IBM 1442 Card Read-Punch	PC	121-0518
IBM 1442 Models 6 and 7	FEMI	231-0101
IBM 1442 Models 5, 6, and 7	FEMM	231-0098
IBM Single Disk Storage (Serial Numbers 00001 through 39999)	FEMM	227-3668
IBM Single Disk Storage (Serial Numbers 00001 through 39999)	FETO	227-3669
IBM 1134 Paper Tape Reader	FEIM	227-3662
IBM 1134 Paper Tape Reader	PC	123-0452
IBM 1132 Printer	FEMM	227-3621
IBM 1132 Printer	PC	127-0806
IBM 1132 Printer	FEMI	227-3622
IBM 1627 Plotter	FEIM	227-5980
IBM 1627 Plotter	PC	127-0780
IBM 1055 Paper Tape Punch	FEMM	225-3178
IBM 1055 Paper Tape Punch	PC	124-0062
IBM 1055 Paper Tape Punch	FEMI	225-3082

FEMI = Field Engineering Manual of Instruction
FEMM = Field Engineering Maintenance Manual (Formerly Reference Manual)
FEIM = Field Engineering Instruction - Maintenance
FEISD = Field Engineering Instructional System Diagrams
PC = Parts Catalog
FIELD = Field Engineering Intermediate Level Diagrams
FES = Field Engineering Manual Supplement
FESI = Field Engineering Service Index
FEDM = Field Engineering Diagram Manual
FETO = Field Engineering Theory of Operation

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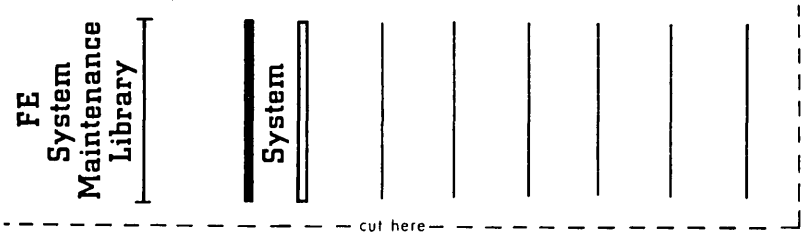

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