of the IO Register at this time should contain the address specifications concerning the number of computer words to be transferred via the High Speed Channel Control Type 19. In addition, Memory Buffer Register bits 6 through 8 are transferred to the Device Register. These bits should specify he direction of data transfer and the device to be connected to the Data Control.

MB Bit	State	Description
6	0	Data is to be transferred into the computer
6	1	Data is to transferred out from the computer
7 and 8	00	No device connected
7 and 8	10	Connect Tape Control, Type 510
7 and 8	01	Connect device 2
7 and 8	11	Connect device 3

Set Initial Address
sia Address 0346

Transfers the contents of the IO Register into the Initial Location Counter in the Data Control. The contents at this time should be the address specifications concerning the location of the initial computer data word to be transferred from or put into core memory.

Stop Data Flow
sdf Address 0146

Disconnects all devices from the Data Control.

Read Location Counter
rlc Address 0366

Transfers the contents of Initial Location Counter to the IO Register of the computer. This instrucion can be executed twice to compare the results before accepting the location as a check of synchronism. The asynchronous nature of this instruction makes it useful to examine the contents of the Initial Location Counter at any time. In addition, this instruction transfers two status bits into the IO Register.

IO Bit	State	Description
0	0	Transfer in progress
0	1	Word counter equals zero; transfers complete
1	0	Data Transfer is on time
1	1	Data transfer is later. This signifies that the computer did not take the data in and new data was transferred in over old in the Data Control buffers.

NOTE: The data late condition can exist with the Tape Control on the third priority high speed channel if simultaneous request on all channels is preceeded by multiply or divide, when operating the Tape Control at a density of 800 cpi.

Set High Speed Channel Request
shr Address 0446

Forces a high speed channel cycle request to transfer data.

In the sequence break mode of operation the Word Count Equal to Zero (WC = 0) output signal of the Data Control is assigned to a particular channel on the Type 120 Sequence Break System. Therefore, programming to synchronize on the completion of the issued transfer instruction varies according to the channel assignment. To synchronize on the completion of the transfer with the standard Single Channel Sequence Break System the

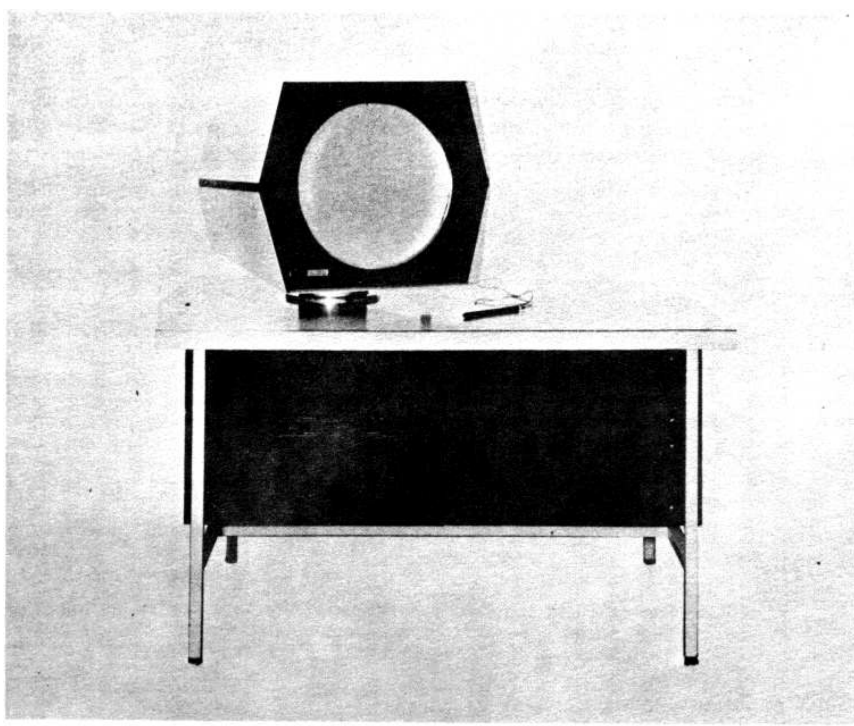
WC = 0 signal is sent to bit 8 of the computer Status Register.

Synchronization for transfer completion can be accomplished out of the sequence break mode by use of the rlc instruction. In this manner, WC = 0 when a ZERO is transferred to bit 0 of the IO Register.

Input-Output Equipment Options

PRECISION CRT DISPLAY (TYPE 30)

This sixteen-inch cathode ray tube display is intended to be used as an on-line output device for the PDP-1. It is useful for high speed presentation of graphs, diagrams, drawings, and alphanumerical information. The unit is solid state, self-powered and completely buffered. It has magnetic focus and deflection.



Precision CRT Display with Light Pen

Display characteristics are as follows:

- Random point plotting
- Accuracy of points ±3 per cent of raster size
- Raster size 9.25 by 9.25 inches
- 1024 by 1024 addressable locations
- Fixed origin at center of CRT
- Ones complement binary arithmetic
- Plots 20,000 points per second

Resolution is such that 512 points along each axis are discernable on the face of the tube.

One instruction is added to the PDP-1 with the installation of this display:

Display One Point On CRT
dpy Address 0007

> This instruction clears the light pen status bit and displays one point using bits 0 through 9 of the AC to represent the (signed) X coordinate of the point and bits 0 through 9 of the IO as the (signed) Y coordinate.

Many variations of the Type 30 Display are available. Some of these include hardware for line and curve generation.

Precision CRT Display Type 30

SYMBOL GENERATOR (TYPE 33)

The Type 33 Symbol Generator automatically translates digital computer words into format information for rapid display on a Type 30 CRT. The Type 33 plots symbols on a 5 x 7, 35-dot matrix in one of four sizes. Individual symbols are displayed by intensifying spots within the matrix under program control. Character and symbol information is received from the computer in the form of two 18-bit words.

The Type 33 greatly increases the Type 30's capacity for character and symbol generation. Plotting rate is increased approximately ten times: a total of 220 characters (based on an average character of 16 points) can be displayed flicker free. Any symbol compatible with a 5 x 7, 35-dot matrix can be displayed. The Type 33 includes a subscript control with adjustable offset and an increment control which spaces successive symbols one position to the right.

Generator Plot Left
gpl Address 2027

> Transfers the contents of the IO Register to the shift register of the Symbol Generator and initiates plotting of the first 17 dots. Bit 17 of this word sets or resets the subscript control if the bit is a one or a zero, respectively.

Generator Plot Right
gpr Address 0027

> Transfers the contents of the IO register to the shift register of the symbol generator and initiates plotting of the last 18 dots. The "Clear" is inhibited by MD bit 7 = 0 to prevent losing the count contained in the horizontal and vertical counters which control dot position.

Reset
gcf Address 0127

> Clears the light pen status flip-flop in the display. The light pen status will also be cleared when a normal point plot (iot 07) is performed.

Load Format
glf Address 2026

> Reads the three least significant bits of the IO Register to the two character-size control flip-flops .Bits 16 and 17 are used to specify one of the four symbol sizes. Bit 15, if a 1, specifies automatic spacing between symbols. A completion pulse will not be generated by the display when this instruction is performed.

Space
jsp Address 0026

> Increments the X buffer-counter to position the beam one character position to the right. Since the contents of the IO Register are transferred to the Shift Register by this instruction, the IO Register should be cleared before performing the jsp instruction. The Increment control must be set before performing the jsp instruction by loading bit 15 with the glf instruction.

Intensify
dpy Address 0007
No Intensify
sdb Address 2007

By use of the MB bit 12, the normal point plotting instruction dpy can be used to load the position co-ordinates of the first character to be displayed without illuminating that point. When the “No Intensify” instruction is performed the display will not generate a completion pulse, therefore the programmer must allow at least 25 usec before executing a gpl instruction.

Except for the gcf, glf and sdb instructions, which do not cause the generation of a completion pulse, the preceding iot instructions can be coded to perform the in-out wait operations.

LIGHT PEN (TYPE 32)

The Light Pen is designed to be used with the CRT Display Type 30. By “writing” on the face of the CRT, stored or displayed information can be expanded, deleted or modified. Specifically, each time a light-pulse strikes the pen, the Light Pen status bit is set to one (see definition of Check Status Instruction) and Program Flag 3 is set to one. At the time the status bit is set, the x-y coordinates of the point just “seen” by the pen are in bits 0 through 9 of the AC and bits 0 through 9 of the IO, repsectively (if the Display Instruction was given the optional in-out wait). A program designed to accept Light Pen input would periodically check the Light Pen status bit and when found to be set, would store the C(AC) and the C(IO) thereby defining the point just “seen” by the pen.

ULTRA-PRECISION CRT DISPLAY (TYPE 31)

The operation of this high resolution, five-inch cathode ray tube display is similar to that of the Type 30. Its resolution, accuracy, and stability, however, are such that it is much more suitable for the accurate, photographic recording of data. The specifications differ as follows:

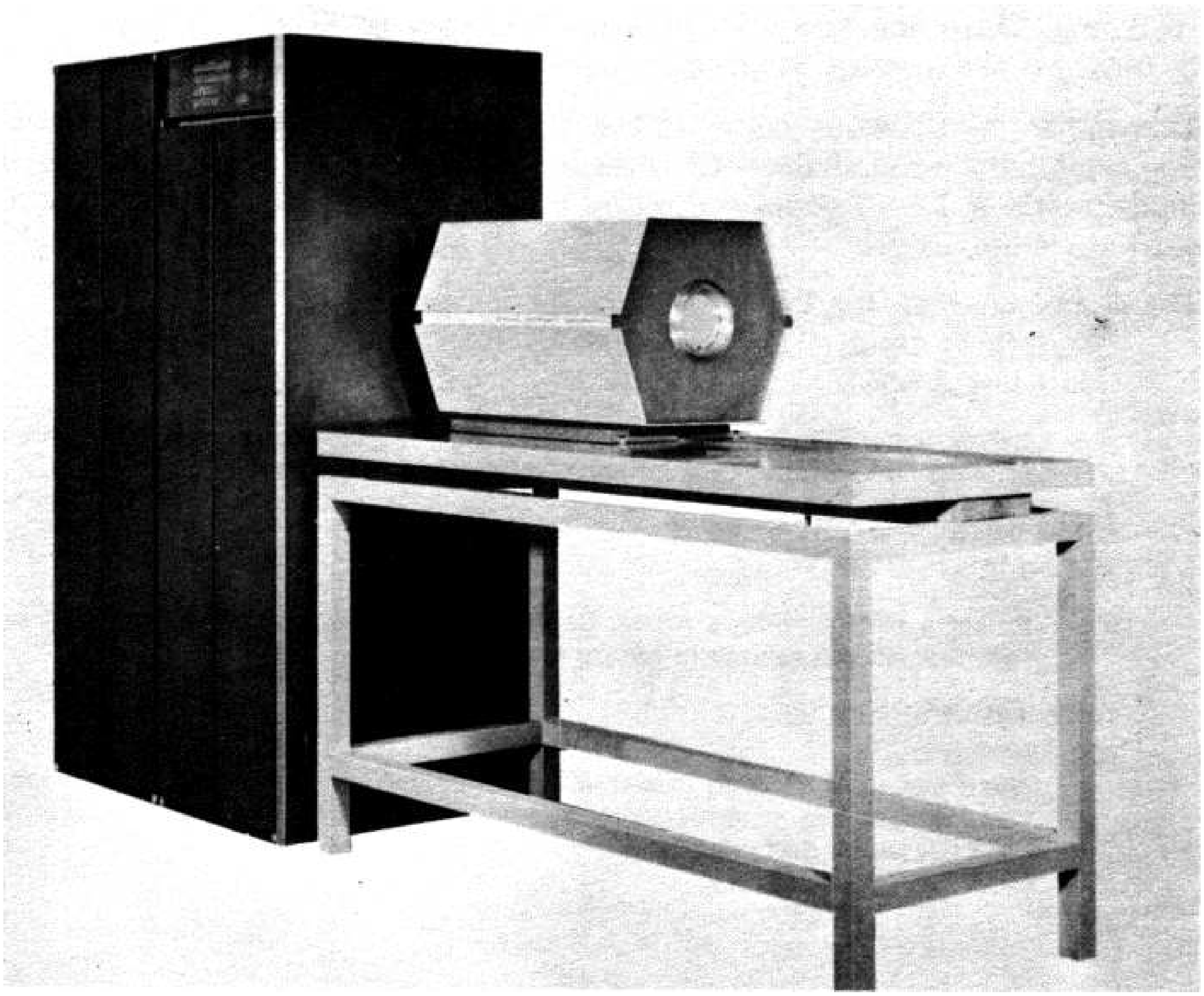
Raster Size 3 by 3 inches
Accuracy of points is ±1/2 percent of raster size
4096 by 4096 addressable locations

Resolution is such that 1024 points along each axis are discernable on the face of the tube.

One instruction is added to the PDP-1 with the installation of this display:

Display One Point on Precision CRT
dpp Address 0407

This instruction displays one point using bits 0 through 11 of the AC to represent the (signed) X coordinate of the point and bits 0 through 11 of the IO as the (signed) Y coordinate.



Ultra-Precision CRT

CARD PUNCH CONTROL (TYPE 40-1)

This control allows for on-line, buffered operation of standard card punch equipment. It contains an 80-bit buffer, loaded from the IO Register using one iot five times for each card row punched. Since any or all punching positions may be used, the standard IBM format is not a restriction and any format may be used. Maximum speed of the punch is 100 cards per minute. The instructions for the Type 40-1 are:

Load a Group
lag Address 0044

Loads 18 bits into the Control buffer. Five lag instructions are required to load the 80-bit buffer.

Punch a Card
pac address 0043

Starts the punching operation.

CARD READER AND CONTROL (TYPE 421)

The Type 41 provides on-line reading of standard punched cards. Cards are read length-wise and sensed optically. They may be read in the alphanumeric or binary mode at rates of up to 200 cards per minute. Output is 6 parallel bits.

The alphanumeric mode converts the 12-bit Hollerith code of one column into the 6-bit binary-coded decimal code with code validity checking. The binary mode reads a 12-bit column directly into the computer. Hopper and stacker capacity is 500 cards.

The instructions for the Type 421 Card Reader are:

Read Card Alpha
rac Address 0041

> Select a card in alphanumeric mode. Select the card reader and start a card moving. Information will appear in alphanumeric form.

Read Card Binary
rbc Address 0042

> Select a card in binary mode. Select the card reader and start a card moving Information will appear in binary form.

Read Column Register
rcc Address 0032

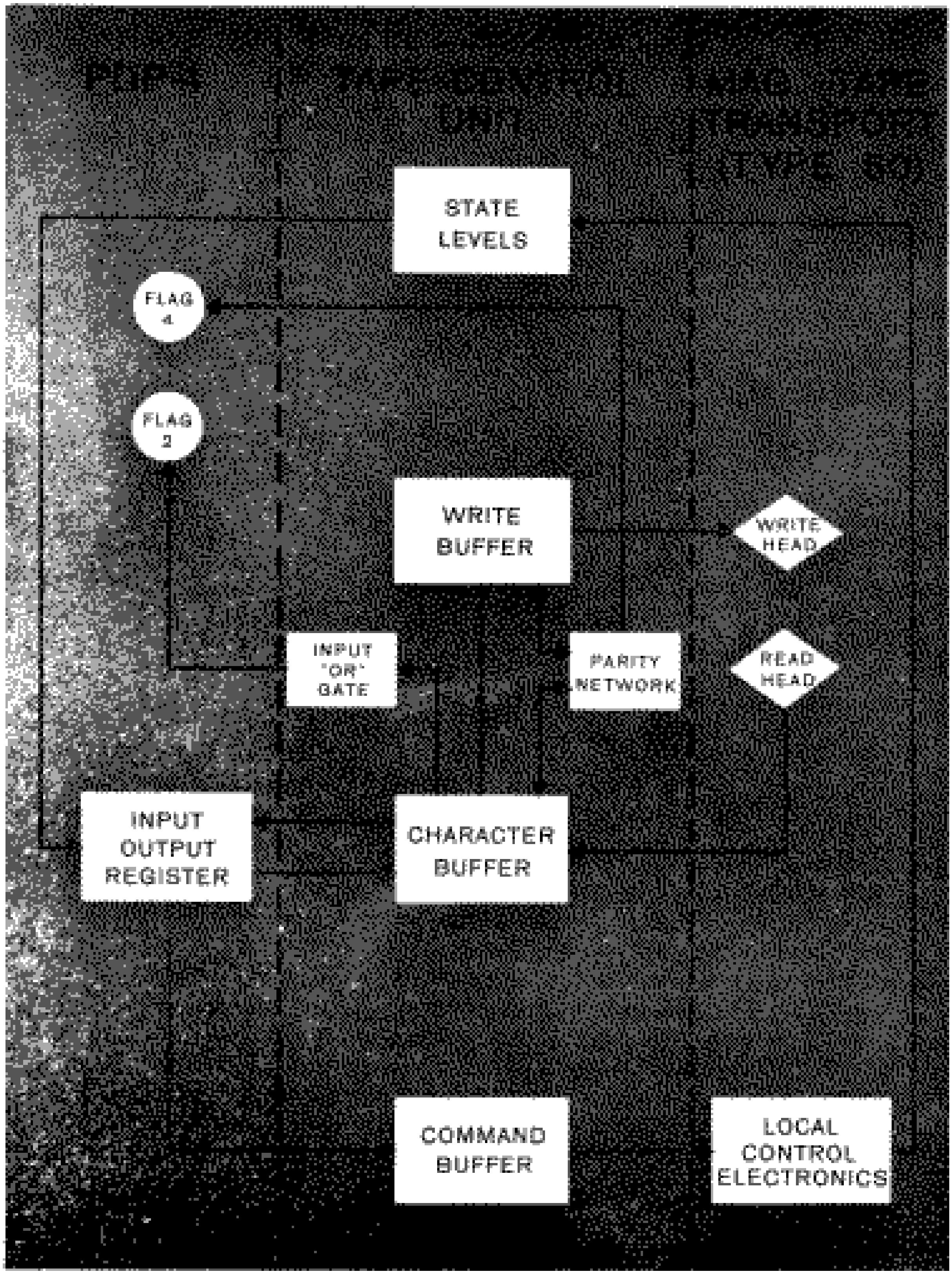
> Read the card column buffer information into the IO Register and the clear the Card Reader flag. One rcc reads alphanumeric information Two rcc instructions read the upper and lower column binary information.

TAPE TRANSPORT (TYPE 50)

This transport is compatible with IBM tape formats with a recording density of 200 7-bit characters per inch, an inter-record gap of 3/4 inches, and an interfile gap of 3-1/2 inches. The read-write speed of 75 inches per second provides for a 15,000 character per second transfer rate. Rewind speed is 225 inches per second. The method of recording is non-return to zero. Standard IBM reels with the “file-protect ring” feature are used. A maximum of 24 tape transports may be connected to the PDP-1.

PROGRAMMED MAGNETIC TAPE CONTROL (TYPE 51)

This control transfers information between the computer and the tape one character at a time. All transfer operations, including timing, formatting, error checking and assembly of characters into computer words are performed by stored programs. The Type 51 allows a choice of tape format, including the standard IBM format described under Tape Transport Type 50. A maximum of three Tape Transports Type 50 can be connected to the PDP-1 through the Type 51 Control.



Magnetic Tape Control Block Diagram