UNIVERSITY OF PITTSBURGH
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PITTSBURGH, PENNSYLVANIA 15213

February 20, 1967

Grants and Research Contracts
Code SC
Office of Space Sciences
National Aeronautics and Space Administration
Washington, D.C. 20546

FACILITY FORM 602
N67 19048 (ACCESSION NUMBER)
(THRU) 1
11 (PAGES)
(CODE)
CR-82522 (NASA CR OR TMX OR AD NUMBER)
04 (CATEGORY)

Dear Sir:

This is the twelfth quarterly progress report submitted in accordance with the requirements of NASA Contract NASr-169, covering the period from 1 October 1966 through 31 December 1966.

Automatic Microscope: A meeting was held with the Perkin-Elmer engineering group on 13 September 1966 to assure that the final system design for the automatic microscope was acceptable. A clarification resulted concerning the lens transfer mechanisms. The Perkin-Elmer Company subsequently reevaluated its time and funding requirements and discovered an impending overrun due to work resulting from the September 13 clarification as well as an underestimate of the complexity of the total design, the administrative requirements for material control, and an overhead rate adjustment at the Perkin-Elmer Company. Negotiations between the company, the University and NASA resulted in an arrangement which shared the cost of the overrun between the sub-contractor and the contractor. A work stoppage during the negotiation period has resulted in a change in delivery date to March 8, 1967.

Computer Interface: The major effort of the engineering group at the University of Pittsburgh has been directed toward preparation of the PDP-7 computer for its functions as the control system for the automatic microscope and the flying spot scanner. The following is the design plan and the summary of the status of this work.

I. PDP-7 Real-Time Connection Expansion (Figure 1)

In order to control a device by means of a PDP-7 program, it is necessary to provide some means of sending control signals to the device and (usually) accepting response signals from it. The PDP-7 Real-Time Connection, type KA71A, provides hardware for accomplishing these tasks. A simplified block diagram of its components is shown in Figure 1 A. The program's method of communication is via a special instruction, called the IOT operation. The bit structure of this instruction is shown in Figure 1 B.

By means of this instruction, control pulses may be sent to a specific device or position thereof. The nature of the device dictates what is then done with these pulses. For example, one pulse may be used to indicate that a device (e.g., Paper Tape Reader) is to be started, another one to inquire as to the status of a device (e.g., Has the Paper Tape Reader located a punched character), and yet another to retrieve information from a device (e.g., Gate the character just read by the Paper Tape Reader into the accumulator). The function of these control pulses is called out in the logical design of the device and its interface.

The diverse range of auxilliary equipment which is available for PDP-7 has resulted in the pre-definition of most of the 64 available device numbers. In order to circumvent this problem, keeping in mind the possibility of later addition of some of this equipment, it was necessary to construct an expanded I/O Interface for the PDP-7. The heart of this Interface lies in the decoding of bits 4, 5, 12, and 13 to provide sixteen selectable sub-devices, using only one Device number. We have chosen three of these numbers, 50, 51, and 52, which are sufficient for the current devices being contemplated for the PDP-7.

The Information Distributor (ID) provides the means of sending data from a program to a device. It is usually necessary to have a register in the device whose inputs are connected to the ID and the gate input to the register driven from an IOT pulse. In our expansion, both the assertion and negation levels of the accumulator bits are available.

Reading of data from a device requires use of the Information Collector(IC). The IC consists of several channels of input sources, each having 18 two-input AND gates, with one gate per bit of the Accumulator. (See Figure 1 C) The data input consists of a negative (-3v) level for a "1" bit, and a negative IOT pulse, as decoded by the device, is applied to the Gate Pulse input. When this occurs, the corresponding "1" bits from the input data are OR'ed into the Accumulator. If bit 14 of the IOT Instruction is a "1", the Accumulator will be cleared to all zeros before generating the IOT pulses.

The I/O Facility provides the means whereby the program may check on the status of a device. If the IOT pulse is applied to the "P" input of a Skip Facility channel, while simultaneously the device supplies a -3v level to the "L" input, the computer will skip over the instruction which follows the IOT instruction.

By proper inter-connection to these facilities, virtually any device may be controlled. Although the Real-Time Connection is usually referred to as the "I/O Interface," we will consider an "interface" to be the logic which is required to process the signals and route the data to and from some device. Thus, we will speak of the "Scanner Interface" and the "Microscope Interface," bearing in mind that these interfaces consist of various gates, flip-flop register, counter, delays, etc.

Digital Equipment Corporation publication F-78A, "PDP-7 Interface and Installation Manual," contains an excellent description of these facilities for the standard PDP-7.

The expanded Real-Time Connection has been designed and constructed, and is undergoing check out.

II. Interface to the Automatic Microscope (Figure 2)

There are two primary portions of the interface required to drive the microscope, Input Signals and Control Signals.

The Input Signals are:

1. Platen Shaft Encoder- 17 bits + Inhibit flag
2. Radial Encoder- 12 bits + Inhibit flag
3. Focus Encoder- 13 bits
4. End of Film
5. Slide Photograph Mode Signal
6. CRT Photograph Mode Signal
7. Scan Mode Signal
8. Viewing Eyepiece In Signal
9. Analog Signals for:
   a) High Spatial Frequency Photomultiplier
   b) Low Spatial Frequency Photomultiplier
   c) Reference Photomultiplier
   d) Data Photomultiplier

The Control Signals are:

1. Interogate Focus Encoder
2. Lock Rotating Platen
3. Lock Radial Arm
4. Step Motor Pulser
   a) Platen CW
   b) Platen CCW
   c) Radial In
   d) Radial Out
   e) Focus Down
   f) Focus Up
5. Open Spatial Freq. PMT Shutters
6. Open Flying Spot Scanners PMT Shutters
7. Open Laser Shutter
8. Open Photographic light Source Shutter
9. Set Slide Photograph mirror
10. Set CRT Photograph mirror
11. Set Coarse motion
12. Set Fine motion
13. Activate Camera Shutter
14. Enable Double-exposure

The Input Signals, except for number 9, the Analog Signals, take up three Information Collector Channels. The Analog Signals are processed by the Analog-to-Digital Converter (ADC). This consists of two 8-bit resolution converters, with common timing and control logic. It converts a pair of 0-to-10 volt input signals to 8-bit binary numbers representing the input level. A mode flip-flop in the converter logic allows one of the converter channels to convert its input signal to a 12-bit number.

The ADC multiplexor contains control flip-flops and mercury-wetted-contact relays to switch inputs to the ADC. It permits the use of the ADC for several input signals.

The Control Signals break down into two categories - pulses and levels. The pulses will be generated by R302 delay modules, driven by appropriate IOT pulses. The levels will be supplied by an 18-bit control register and appropriate drivers. By means of a pair of IOT commands, any single bit of the register will be cleared or set, the particular bits to be specified by the contents of the Accumulator.

The entire automatic microscope Interface should require no more than one double mounting panel (64 modules capacity). Of the necessary units, the ADC has been built and tested. No more than a week should be necessary to design the balance of these controls, and another three weeks for construction and installation in the PDP-7.

In order to connect the microscope to the Interface, three cables will be required. The specifications for these cables (length, type and size of wire,etc.) have not yet been determined.

III. Flying Spot Sub-System (Figure 3)

A. Description of the System by blocks

1. Intensity Logic- converts a 3-bit number supplied by the PDP-7 program into one of eight levels of intensity of the CRT spot when the spot is unblanked.

2. Character Generator Logic- accepts two 18-bit numbers from the PDP-7 program, and decodes them into a 5 x 7 matrix of intensified or non-intensified spots. By proper choice of these words, letters or other symbols may be displayed on the CRT face.

3. Point-Plot Logic- consists of 12-bit Horizontal Vertical position registers, corresponding digital-to-analog conversion networks, and control logic necessary to position the CRT spot to any of 4096 x 4096 points.

4. Deflection Correction Logic- generates necessary analog signals to correct the inherent pin-cushion distortion of flat-faced CRT's.

5. Spot-Size Logic- converts a 6-bit number supplied by the PDP-7 program into one of 64 sizes for the CRT spot.

6. Horizontal Analog Interface- matches the high-impedance output of the Horizontal deflection ladder network to the low-impedance input of the CELCO deflection driver. It also acts as analog summer to combine the deflection correction voltages.

7. Vertical Analog Interface- same as No. 6, but for the vertical deflection channel.

8. Focus Analog Interface- same purpose as No. 6 above, but for the Focus Driver.

9. CRT Unblanking- accepts an input pulse to unblank (intensify) the CRT spot. The spot remains intensified for the duration of the input pulse.

A. Description of the System by blocks (cont.)

10. CRT Overcurrent Monitor- monitors the cathode current of the CRT. Should this current exceed a pre-set limit, the spot is defocussed and all power removed from the CRT.

11. CELCO Deflection Driver- supplies sufficient current to drive the CRT deflection coils.

12. Same as No. 11.

13. Same as No. 11, but for the Focus Coil.

14. Power Sequencer- turns on the various power supplies in the sub-system in a pre-set order, which is designed to minimize the danger of damage to the CRT and amplifiers.

15. Beam Centering and Static Focus Supplies and Controls- provides necessary constant current to operate the CELCO Beam Centering and Static Focus Coils.

16. CRT Power Supplies- provide the -125 volt GI bias, +2000 volt G2 bias, and CRT filament voltage.

17. Walden 30KV Power Supply- provides the 30,000 volts necessary for the CRT second-anode.

18. Litton L-4123/P11 CRT and Coils- This is the CRT sub-assembly which is controlled by the above items. It is to supply the flying-spot of light which is to be used in the automatic micro-scope being completed by the Perkin-Elmer Co.

B. Status of the System by block number

1. Intensity Logic- designed and wired. Final connection to the PDP-7 and checkout are currently being done.

2. Character Generator Logic- same as No. 1 above.

3. Point-Plot Logic- same as No. 1 above.

4. Deflection Correction Logic- This has been deferred due to in-complete specification of what is required. It was decided to build the balance of the system and determine what corrections are necessary, and attempt them by using the computer. Provisions have been made to incorporate this logic at a later time.

5. Spot-Size Logic- same as No. 1, except that the spot range is unspecified at this time. It is planned to have a range suffi-cient to permit some degree of correction for off-center de-flection. (This would eventually be taken care of by the De-flection Correction Logic.)

B. Status of the System by block number (cont.)

6. Horizontal Analog Interface- This has been designed by Miss Carol Freshman, Research Electronics Technician for this project. Tests indicate that the design is sufficiently stable and precise for their intended application. One of these has been completed, and another is awaiting some special components, which have been ordered.

7. Vertical Analog Interface- see No. 6 above.

8. Focus Analog Interface- This remains to be designed. A print from Mr. Bernie Wodsworth of MIT has been received, which shows his design. However, there seem to be several incompatabilities with our system which are under investigation. We may use a duplicate of No. 6 for this application. Miss Freshman is currently investigating this matter.

9. CRT Unblanking- same state as No. 8 above.

10. CRT Overcurrent Monitor- same state as No. 8 above.

11. CELCO Deflection Driver-(Horizontal)- This has been purchased from CELCO, and is a stock item. However, it has not been checked out due to the need for the balance of the system.

12. CELCO Deflection Driver (Vertical)- same as No. 11 above.

13. CELCO Focus Driver- same as No. 11 above.

14. Power Sequencer- A print is available from MIT, and may be used as is. For interim testing, it may be feasible to do the power sequencer function manually.

15. Beam Centering and Static Focus Supplies- These cannot be specified until it is known what range of currents is needed to do the job. During initial testing of the system, simple variable resistances across a constant voltage source will be used.

16. CRT Power Supplies- These have been purchased and checked.

17. Walden 30KV Power Supply- purchased and checked. Also, a high-voltage connector box is being constructed to permit location of the CRT remotely from this power supply, and provide maximum protection of personnel from the high potential used.

18. Litton L-4123/P11 CRT and Coils- These have been purchased and partially checked. Final checkout cannot be done until the balance of the system is completed.

B. Status of the System by block number (cont.)

18. Litton L-4123/P11 CRT and Coils (cont.)- A P11 phosphor was chosen primarily because of its ruggedness, although it has a 200-300 micro-second decay time. It is also less grainy and has greater light output than the P16 phosphor, the alternate under consideration.

Respectfully submitted,

Niel Wald

Niel Wald, M.D.
Professor of Radiation Health

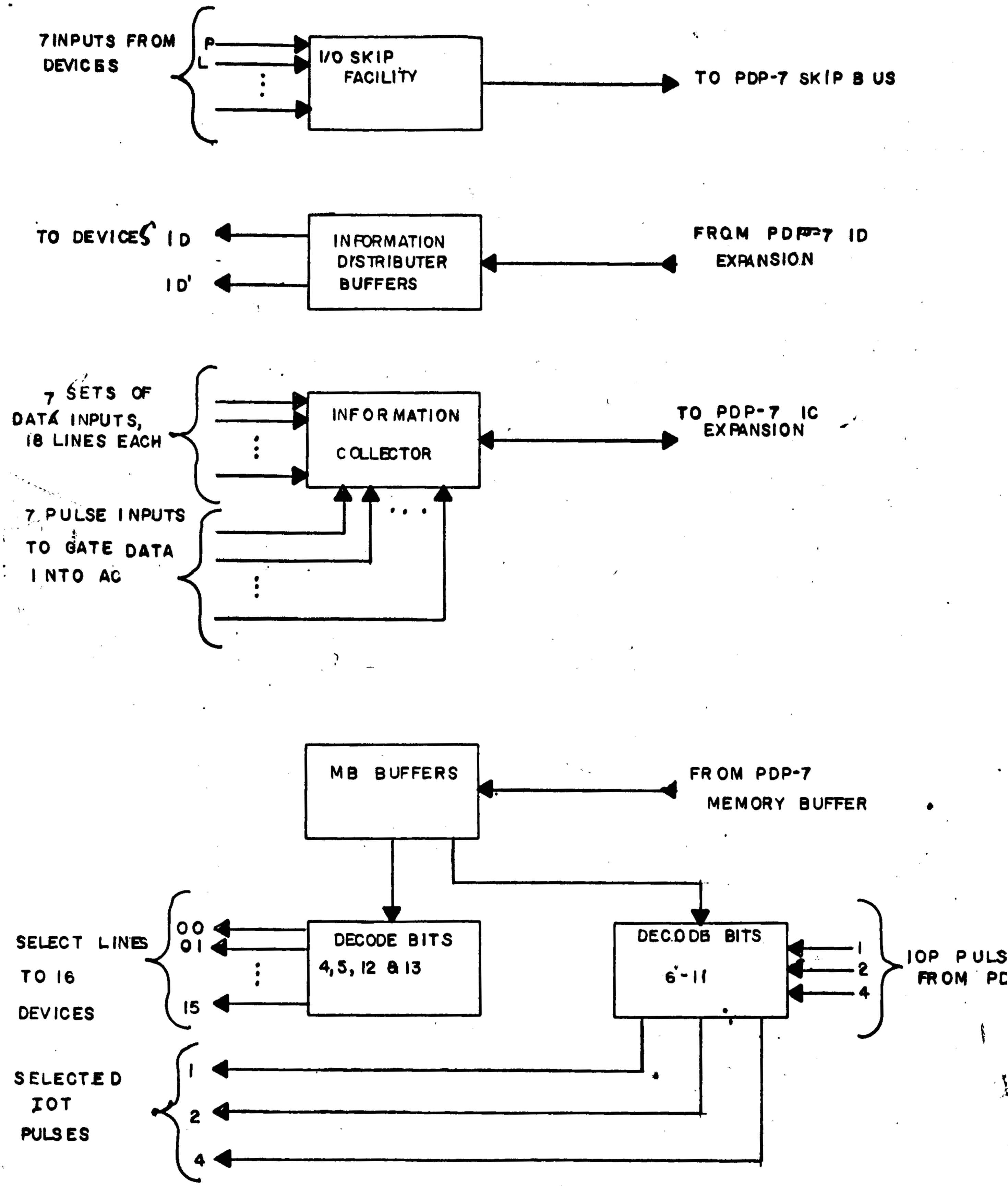

FIGURE IA - ELEMENTS OF THE PDP-7 REAL-TIME CONNECTION

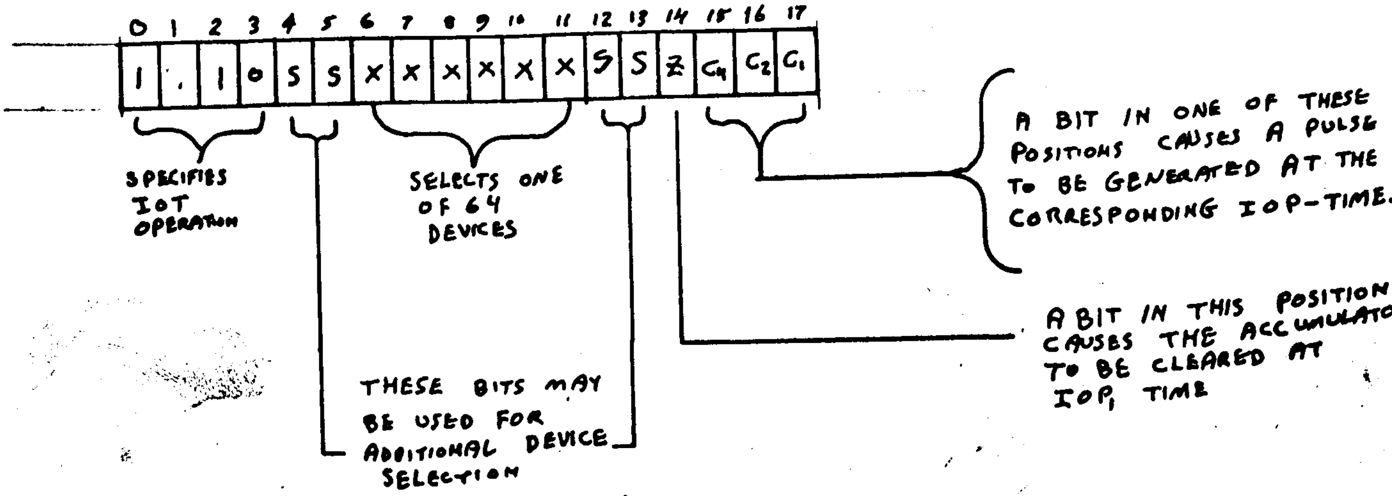

FIGURE 1B – BIT ASSIGNMENT OF PDP-7 IOT OPERATION

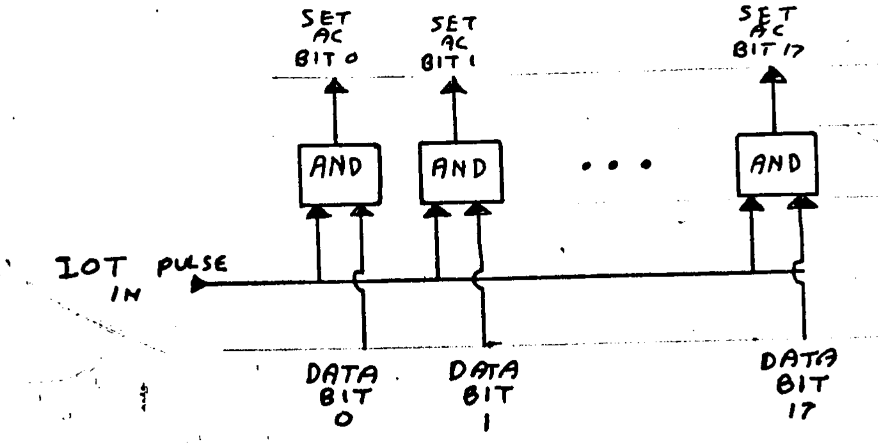

FIGURE 1C – TYPICAL INFORMATION COLLECTOR CHANNEL

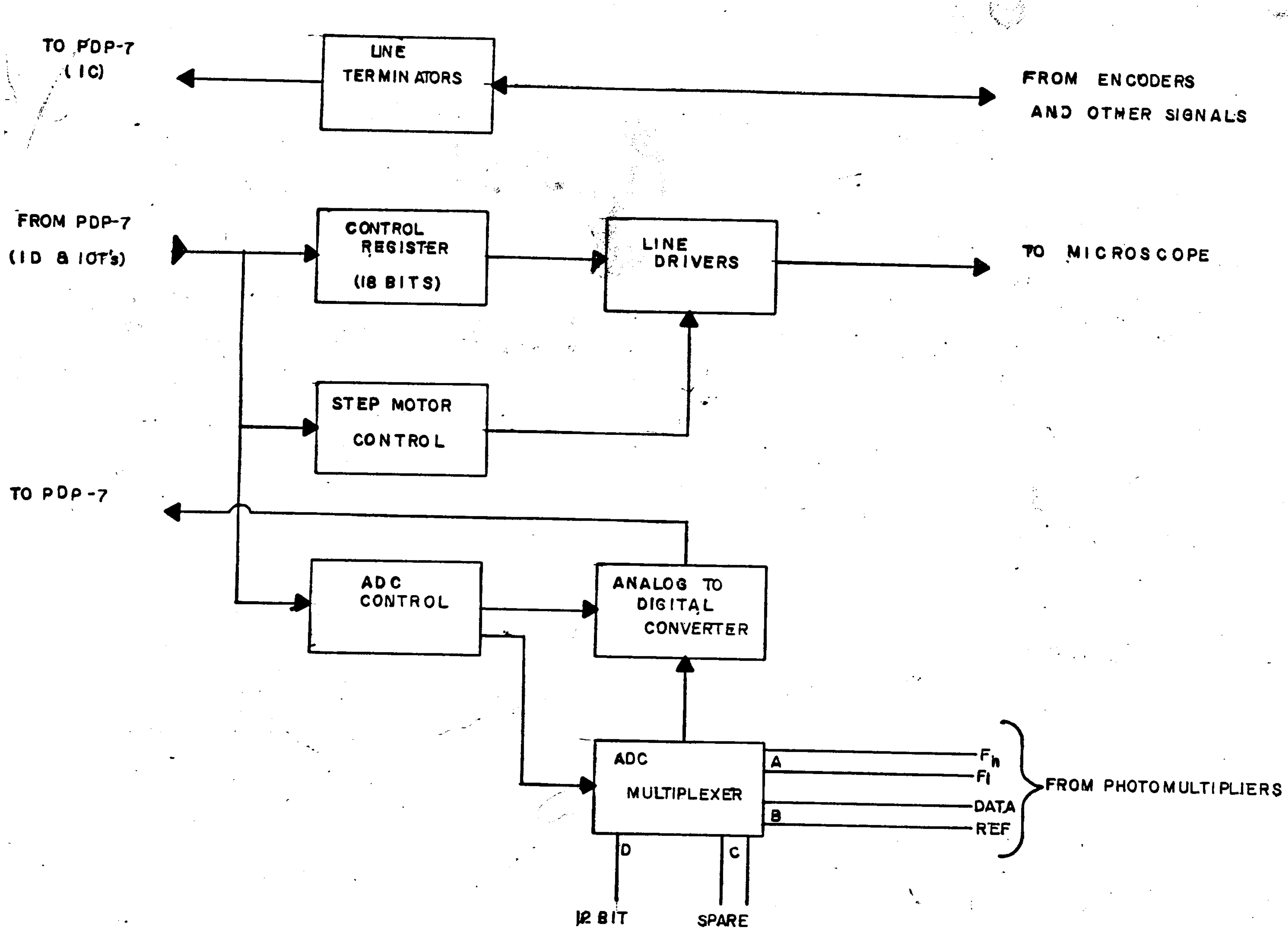

FIGURE 2 - INTERFACE TO AUTOMATIC MICROSCOPE

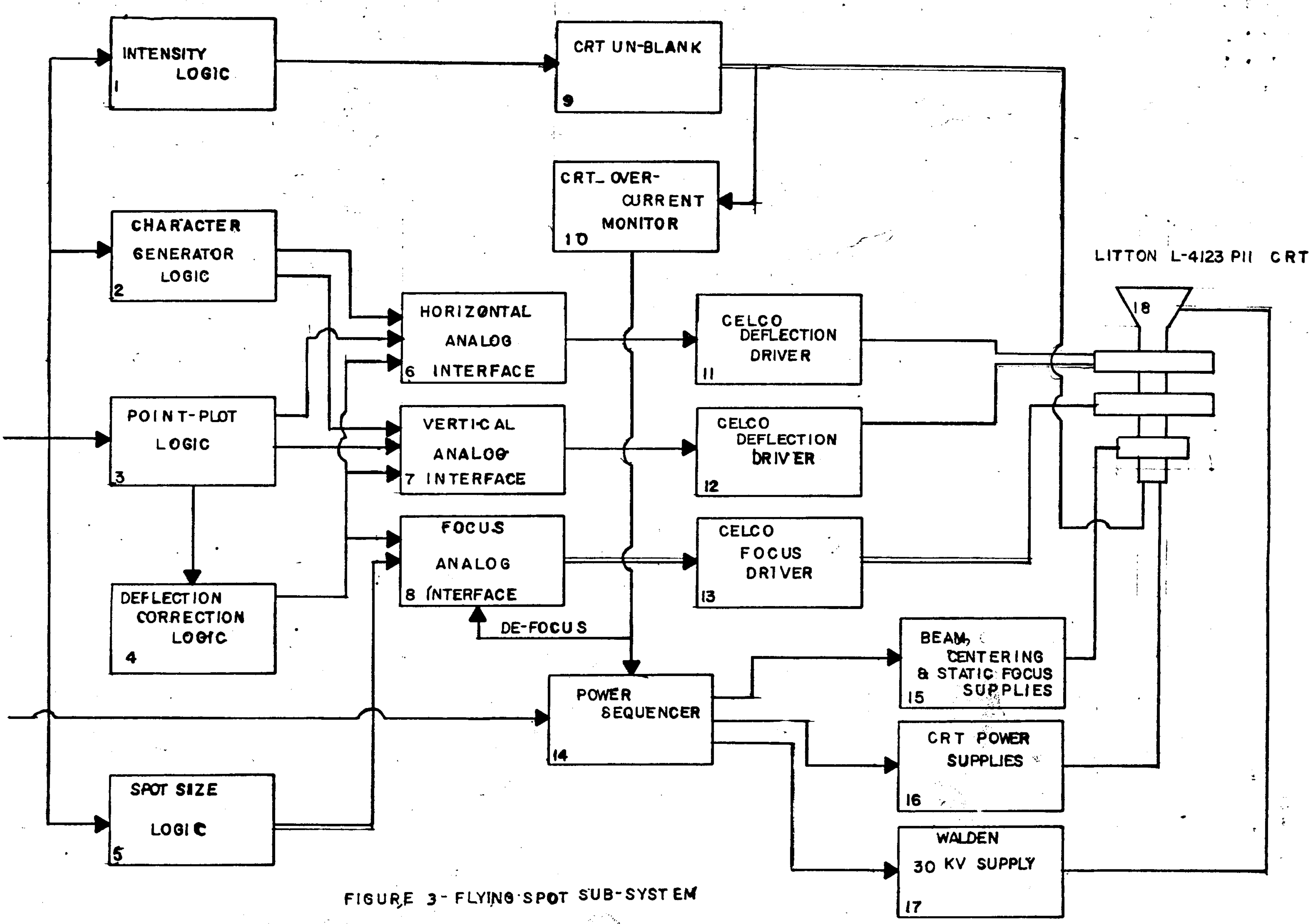

FIGURE 3 - FLYING SPOT SUB-SYSTEM