

**BASIC
TYPESETTING SYSTEM
INSTRUCTION MANUAL
(Preliminary)**

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TYPESETTING SYSTEM

CONTENTS

<u>Section</u>		<u>Page</u>
1	INTRODUCTION	1-1
2	SCOPE	2-1
3	OPERATION	3-1
3.1	General	3-1
3.2	Program Instructions	3-2
4	THEORY OF OPERATION	4-1
4.1	Introduction	4-1
4.2	IOT Decoder	4-1
4.3	Tape Reader Operation	4-2
4.3.1	PR-68A Paper-Tape Reader	4-2
4.3.2	Reader Selection	4-4
4.3.3	Control and Timing	4-5
4.3.4	Tape Feeding	4-5
4.3.5	Tape Reading	4-7
4.3.6	Data Transfer	4-7
4.4	Tape Punch Operation	4-7
4.4.1	PP67A Paper-Tape Punch	4-7
4.4.2	PR67A Paper-Tape Punch Control	4-8
4.4.3	Punch Selection	4-8
4.4.4	Control and Timing	4-8
4.4.5	Data Transfer	4-10
4.4.6	Motor Control	4-10
4.4.7	Tape Punching	4-10
5	INTERFACE	5-1
6	MAINTENANCE	6-1
6.1	Preventive Maintenance	6-1
6.1.1	Scheduling	6-1
6.1.2	Inspection	6-1
6.1.3	Operational Test	6-2
6.2	Corrective Maintenance	6-2
6.2.1	Preliminary Investigation	6-2
6.2.2	System Troubleshooting	6-2

TYPESETTING SYSTEM

CONTENTS (continued)

<u>Section</u>		<u>Page</u>
6.2.3	Circuit Troubleshooting	6-3
6.2.4	Repair	6-3
6.3	Adjustments	6-4
6.3.1	Tape Bed Adjustment Procedure	6-4
6.3.2	Lamp Replacement/Adjustment Procedure	6-7
6.3.3	Tape Sprocket Adjustment	6-9
7	PARTS LIST	7-1
8	GLOSSARY OF TERMS	8-1
9	SCHEMATICS	9-1
9.1	Semiconductor Substitution	9-1

TABLES

<u>Table</u>		
4-1	Program Instructions	4-3
7-1	Parts List	7-6
9-1	Semiconductor Substitution	9-1

ILLUSTRATIONS

<u>Figure</u>		
1-1	PR68A Paper-Tape Reader	1-1
1-2	PP67A Paper-Tape Punch	1-2
3-1	Configuration of PDP-8 Typeset System	3-2
4-1	Tape Reader Timing Sequence, PA60A Reader Control Unit	4-6
4-2	Tape Punch Timing Sequence, PA60A Punch Control Unit	4-9
5-1	Interface, PDP-8 to PA60A Reader/Punch Control	5-2
5-2	Interface, PR68A Paper-Tape Reader to PA61A Reader/Punch Interface Unit ...	5-3
5-3	Interface, PR67A Paper-Tape Reader to PA61A Reader/Punch Interface Unit ...	5-4
6-1	PR68A Paper-Tape Reader	6-5
6-2	Tape Reader Chassis, Front View	6-5
6-3	Tape Bed and Sprocket	6-6
6-4	Lamp and Lens Assembly	6-6
6-5	Orientation of Light Beam with Apertures	6-8
6-6	PR68A Tape Reader, Rear View	6-8

TYPESSETTING SYSTEM

ILLUSTRATIONS (continued)

<u>Figure</u>		<u>Page</u>
6-7	Data/Strobe Timing Diagram	6-10
7-1	PR68A Tape Reader, Front View	7-1
7-2	PR68A Tape Reader, Right Side View	7-2
7-3	Front Panel, Left Side View, Section	7-3
7-4	Lamp and Lens Assembly, Right Side View, Section	7-3
7-5	Tape Bed, Left Side View, Section	7-4
7-6	PR68A Tape Reader, Top View, Cutaway	7-5

ENGINEERING DRAWINGS

G900	Photo Amplifier	9-2
R001	Diode Network	9-2
R107	Inverter	9-3
R111	Diode Gate	9-3
R113	Diode Gate	9-4
R123	Diode Gate	9-4
R141	Diode Gate	9-5
R151	Binary to Octal Decoder	9-5
R202	Dual Flip-Flop	9-6
R203	Triple Flip-Flop	9-6
R302	Delay One Shot	9-7
R303	Integrating One Shot	9-7
R401	Clock	9-8
R602	Pulse Amplifier	9-8
W005	Clamp Loads	9-9
W028	Terminated Cable Connector	9-9
W040	Solenoid Driver	9-10
W051	100 MA Indicator and Relay Driver	9-10
W103	Device Selector	9-11
W501	Schmitt Trigger	9-11

TYPESETTING SYSTEM

ENGINEERING DRAWINGS (continued)

<u>Figure</u>		<u>Page</u>
D-BS-PA60-A-2	Reader Control	9-13
D-BS-PA60-A-3	IOT Decode	9-15
D-BS-PA60-A-4	Punch Control	9-17
D-MU-PA60-A-6	Module List	9-19
D-BS-PA61-A-2	Punch Interface	9-21
D-BS-PA61-A-3	Reader Interface	9-23
D-MU-PA61-A-4	Utilization Module List	9-25
D-IC-PA61-A-11	AC-DC Power Wiring Diagram	9-27
CS-D-PR68A-0-3	Reader Wiring	9-29

TYPESETTING SYSTEM

SECTION 1 INTRODUCTION

The PDP-8 Typesetting System is a combined software-hardware system providing a high-speed perforated-tape production capability to the composing room of a newspaper, book publisher, or typesetting company. The system consists of a Digital Equipment Corporation's PDP-8* General-Purpose Computer equipped with a Teletype keyboard, and up to eight paper-tape readers (see figure 1) and punches (see figure 2).

The system converts unjustified, unhyphenated 6-level perforated paper tape to formatted, justified paper tape. The 6-level tape produced operates hot-metal linecasting machines.

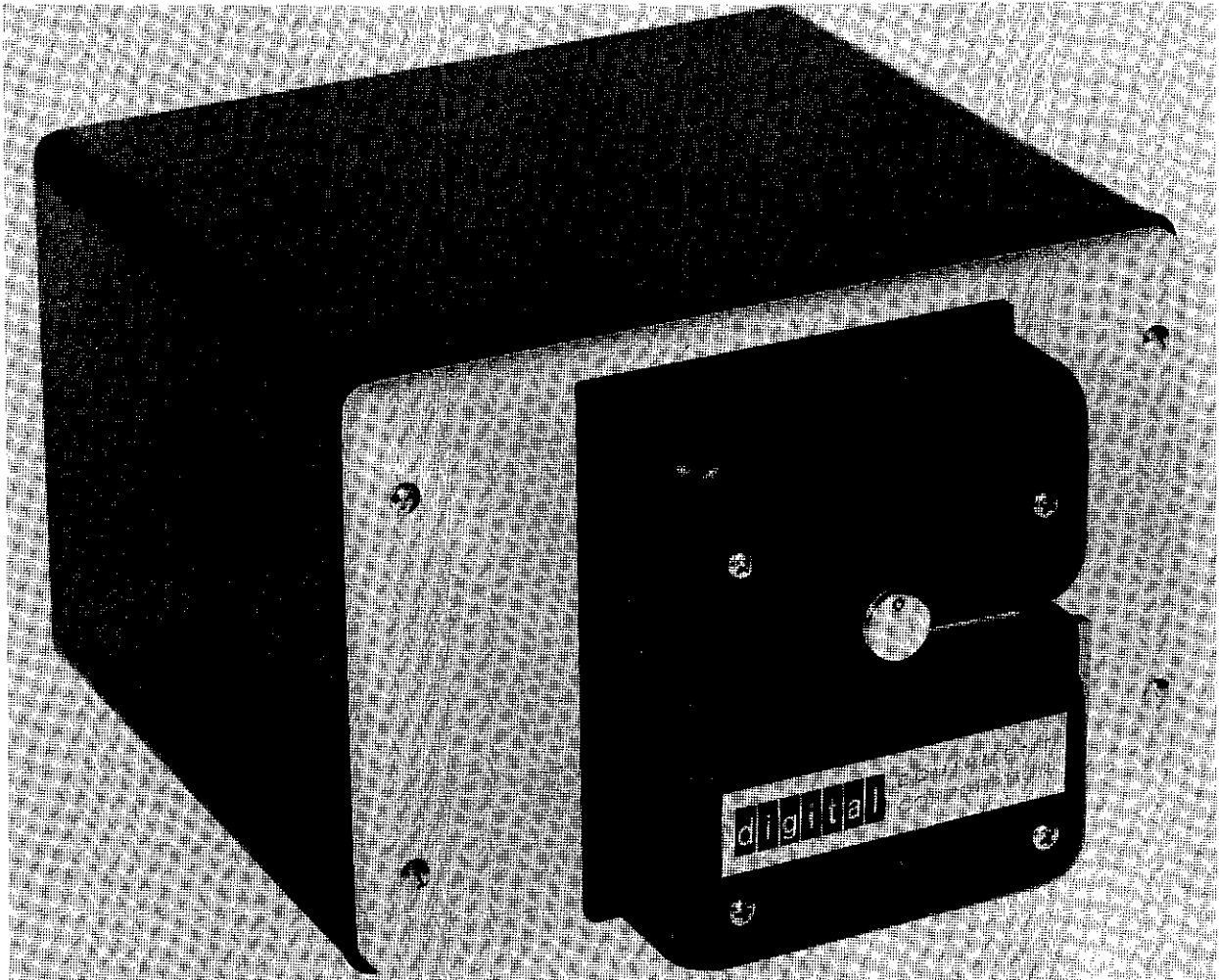


Figure 1-1 PR68A Paper-Tape Reader

*PDP is the registered trademark of the Programmed Data Processor manufactured by Digital Equipment Corporation, Maynard, Massachusetts.

TYPESSETTING SYSTEM

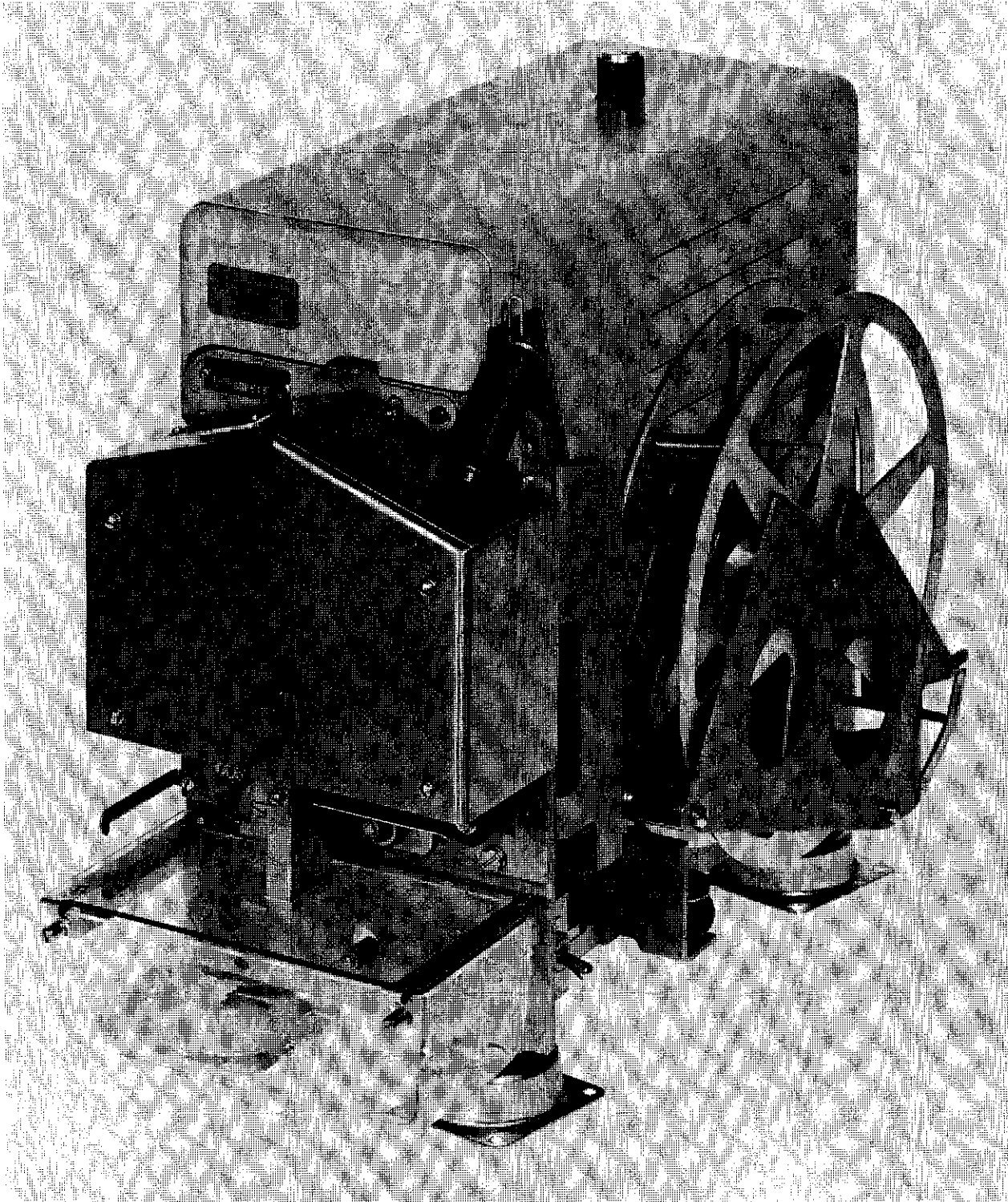


Figure 1-2 PP67A Paper-Tape Punch

TYPESETTING SYSTEM

SECTION 2

SCOPE

This manual provides maintenance information primarily for use by DEC personnel servicing the system at customer installations. The information provided is sufficient for a technician or engineer familiar with the operation, programming, and maintenance of this general type of equipment, and presupposes a thorough understanding of DEC logic.

This text furnishes a general discussion of overall system operation, as well as a detailed logic description of portions of the system unique to typesetting operation.

The PDP-8 Maintenance Manual (F-87) fully describes the operation and maintenance of the processor portion of the system. In addition, Teletype Manuals 273B and 215B, respectively, fully describe the ASR 33 Keyboard/Reader and the BRPE Paper-Tape Punch portions of the system.

The major portion of this document describes operation of the logic circuits interfacing the high-speed paper-tape readers and punches with the processor, and the operation of the DEC-produced PR68A High-Speed Paper-Tape Reader.

The following supplemental documents, together with this manual, cover complete documentation for this system.

PDP-8 Maintenance Manual (F-87)

DEC Logic Handbook (C105)

Small Computer Handbook (C-800)

Teletype Bulletin 215B; Technical Manual, High-Speed Tape Punch Set.

Teletype Bulletin 1154B; High-Speed Tape Punch Set, Parts

Teletype Bulletin 273B; Technical Manual, Automatic Send/Receive Set

Teletype Bulletin 1184B; Automatic Send/Receive Set, Parts

TYPESETTING SYSTEM

SECTION 3 OPERATION

3.1 GENERAL

The basic DEC PDP-8 Typesetting System consists of the following major components, interconnected as shown in figure 3.

- PDP-8 Computer
- PA60A Reader/Punch Control Unit
- PA61A Reader/Punch Interface Unit
- PP67A High-Speed Paper Tape Punches (1-4)
- PR68A High-Speed Paper Tape Readers (1-4)

The addition of a second PA61A Reader/Punch Interface Unit permits system operation with four additional sets of paper-tape readers and punches for a total of eight of each.

The basic PDP-8 contains a 4096 12-bit-word ferrite-core memory. The memory serves as an operating area where input data from the unjustified tape is stored and assembled into justified lines. Portions of the memory are also set aside as storage for program instructions, and as a hyphenating dictionary. Expanded memory options are available, to permit the storage of larger dictionaries, if desired.

A system tape (6-level binary perforated-paper tape) loads this data into memory prior to system use. The system tape also furnishes a glossary of the specific control codes used by the operator to specify the desired type style, type size, column indentions, line length, and special formatting instructions.

A RIM (Readin Mode) program is set into the processor through the PDP-8 control panel toggle switches. This program loads the system tape. The 6-level RIM Loader is described in full later in this chapter.

Loading the RIM Loader and, subsequently, the system tape prepares the typesetting system for processing input tapes. Operators using keyboard-controlled paper-tape perforators generate input tapes, also called unjustified, unhyphenated tapes, from final copy.

The input tape contains the material to be printed punched in 6, or in some cases 8-level codes, without regard for line endings or hyphenations. The operator punches the initial portion of the input tape with control codes which notify the PDP-8 of the type face, type size, and column indentation required for the material which follows. The operator then punches the material to be printed into the tape without regard for line endings.

Upon completion of punching, the input tape is loaded into the PR68A tape reader. When the tape spring is lowered, tape reading commences. The PDP-8 senses a READER FLAG output and starts the data transfer process.

TYPESETTING SYSTEM

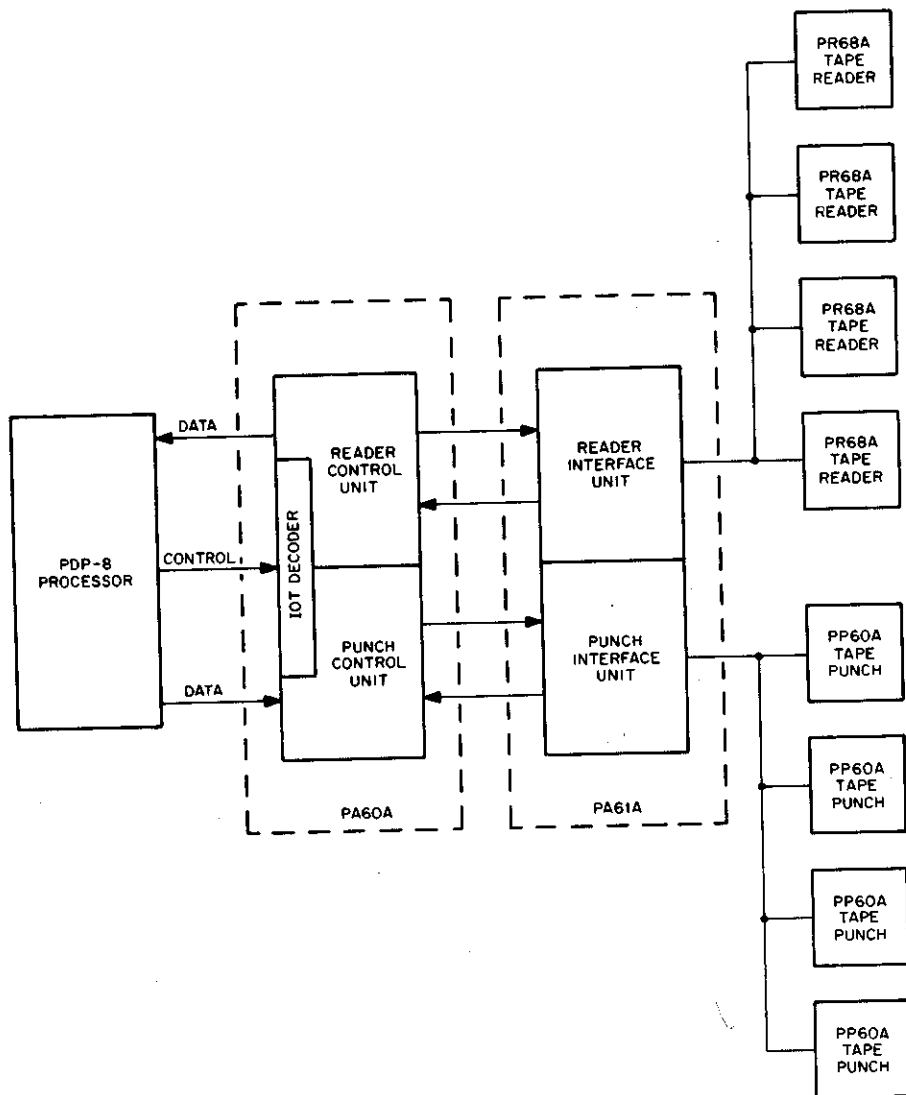


Figure 3-1 Configuration of PDP-8 Typeset System.

The processor assembles the material into lines, as specified by the line-length codes, determines the line-end point, hyphenates and/or inserts additional space codes between words and, if necessary, between letters, and retransmits the data to a PP67A Paper-Tape Punch. This process produces a 6-level output tape used by hot-metal linecasting or photocomposition machines.

The system simultaneously reads and punches tapes at a rate of 110 characters per second. This provides a throughput corresponding to 12,000 lines per hour.

3.2 PROGRAM INSTRUCTIONS

The RIM Loader program listing provided in this section is sufficiently detailed to permit its use with any system. The system tape differs in each installation, however, because of format and type style differences. For this reason, the customer's own system tape must be used.

TYPESSETTING SYSTEM

The system tape contains all information needed by the processor to translate unjustified, unhyphenated tapes into justified, hyphenated, formatted tapes. This information includes format codes, type style and size codes, special instruction codes, a hyphenating dictionary, and a set of hyphenating rules for use if the word ending the line is not in the dictionary.

Before the information contained in the perforated system tape can be used by the PDP-8, however, it must be loaded into the proper memory locations in the PDP-8. This task is performed by the RIM Loader. The RIM Loader is a short program toggled into the processor through the switches and controls located on the PDP-8 control panel. The following table shows the RIM Loader and its method of insertion into the PDP-8.

RIM LOADER

S.A. = 7770

<u>Memory Address</u>	<u>Instruction</u>
7757	6014
7760	6011
7761	5360
7762	7106
7763	7106
7764	6012
7765	7420
7766	5357
7767	5756
7770	4356
7771	3373
7772	4356

Entering the RIM Loader permits loading of the instructions punched in the system tape into memory through the tape reader. The starting point of the RIM Loader is then entered into the program counter, and the START key of the processor is actuated. This feeds the entire system tape into the processor memory and prepares the system for processing input tapes.

TYPESETTING SYSTEM

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

This section contains detailed information on the theory of operation of the Reader/Punch PA60A Control and PA61A Interface Units and the PR68A Paper-Tape Reader. Teletype Bulletin 1154B provides this data for the PP67B (BRPE-18) Paper-Tape Punch.

The information presented in this section attempts to assure the full understanding, by DEC-trained maintenance personnel, of all operational characteristics of the system. This permits on-site maintenance of typesetting systems by maintenance personnel, who, although qualified to service the PDP-8 itself, have not been formally trained in the operation, theory, and maintenance procedure of the PDP-8 in its typesetting configuration.

The engineering drawings provided in section 9 of this manual represent the system configuration as it existed at the time of writing. Electronic systems such as this one, are subject to continuing programs of change, however, both for the sake of improvement of operation and to satisfy particular customer requirements. The PDP-8 Typesetting System is no exception. For this reason, the engineering drawings and detailed operational discussions provided in this manual provide only a guide to understanding the operation of this type of system. For actual troubleshooting of an installed system, the DEC drawings provided with the system for that purpose must be used exclusively.

This section is divided into three major parts; IOT Decoder, Tape Reader Operation, and Tape Punch Operation. The IOT Decoder section describes the operation of this portion of the system in terms of its generation of operational pulses used elsewhere in the control circuitry. The sections pertaining to tape reader and punch operation are oriented functionally, in that the presentation of data conforms to the operational sequence of the system. This permits direct reference to areas of immediate interest. For instance, if a tape-feeding problem occurs in the tape reader, the individual concerned with maintenance need not know which portion of the circuitry controls this function. The paragraph on tape feeding in the Tape Reader section provides this information, along with a full description of the operation of the circuit, including drawing references.

4.2 IOT DECODER

The IOT decoder, shown in DEC drawing BS-D-PA60-A-3, performs the basic reader/punch addressing function. When properly addressed, these circuits admit IOP pulses, generated in the PDP-8, for translation into IOT pulses used within the reader and punch control circuits.

The IOT decoder connects to the bit-3 through bit-8 memory buffer (MB) outputs of the PDP-8 through W028 Connectors at B3 and B4, shown on the lower left of drawing BS-D-PA60-A-3.

TYPESETTING SYSTEM

These inputs parallel-connect to three W103 Device Selectors at AB7, AB8, and AB9. The 6-bit binary code configuration representing the number 01 (000001_2) activates the inverter gate of AB7 W103 Device Selector through the input diode gate of the selector. The receipt of the 6-bit binary code configuration representing the numbers 31 (011111_2) and 02 (000010_2) respectively, activate the two remaining device selectors (AB8 and AB9).

Each device selector contains three pulse amplifiers (PA's) with inverter-controlled inputs. Activation of a device selector by its particular code configuration enables the inputs of these inverters, permitting the passage of IOP pulses through pins K, M, and P of the W028 Connector at B2 from the PDP-8.

Each of the three device selectors generates a particular group of IOT pulses used by the control circuits. The PDP-8, under program control, determines which of the device selectors is to be activated. When activated, the W103 Device Selector at AB7 generates IOT011, 012, and 014 pulses to control operation of the PR-68A Paper-Tape Readers. The device selector at AB8, when activated, generates IOT311, 312, and 314 pulses to control the selection of the particular reader or punch desired. The device selector at AB9 generates IOT021, 022, and 024 pulses to control operation of the PP67A Paper-Tape Punches.

The following table (4-1) shows the applicable program instructions, their mnemonic codes, and the IOT pulses generated and their functions for each of the three device selectors.

All IOT pulses generated in the IOT decoder are transmitted to the reader and punch control circuits for further use.

4.3 TAPE READER OPERATION

4.3.1 PR-68A Paper-Tape Reader

The PR-68A Paper-Tape Reader performs the basic functions of feeding and reading perforated 6-channel paper tape. The tape-reading function is performed by a photoelectric read head, containing nine light-sensitive semiconductors, and by associated amplifier circuits. A tape-drive sprocket, rotated by a 4-pole, dc-operated synchronous motor, performs the tape-feeding function. Pins on this wheel engage feed holes in the tape to transport the tape past the read station. High-current drive pulses, generated by solenoid drivers in the reader interface unit, produce the required torque in the motor.

Two switch-tail-connected flip-flops (A and B) in the PA-60A Reader Control Unit provide the pair-sequential triggering outputs controlling the solenoid drivers. Four feed cycles are required to move the tape a distance equal to one character position. Switching the activation of the solenoid pairs at 2.3 msec intervals produces a tape-feeding rate of 110 characters per second.

TYPESETTING SYSTEM

TABLE 4-1 PROGRAM INSTRUCTIONS

Mnemonic	Instruction	IOT Pulse	Function
RSF	6011	IOT011	Skip if Reader Flag is 1
RRB	6012	IOT012	Read Reader Buffer and Clear Reader Flag
RFC	6014	IOT014	Clear Flag and Buffer, Fetch and Load Character
SKNPA	6311	IOT311	Skip on Punch Not Available
RSC	6312	IOT312	Clear and Load Reader Selector
PSC	6314	IOT314	Clear and Load Punch Selector
PSF	6021	IOT021	Skip if Punch Flag is 1
PCF	6022	IOT022	Clear Punch Buffer and Clear Punch Flag
PPC	6024	IOT024	Load Punch Buffer and Punch Character
PLS	6026	IOT022/024	Clear and Load Punch Buffer, Clear Punch Flag and Punch Character

The photoelectric tape reader consists of a light source, a photovoltaic read head, and amplifier circuits for the photocell outputs. The read head, located below the tape, contains nine photovoltaic cells physically arranged to sense or read perforations in the eight data tracks or channels of the tape and in the tape feed-hole track. The light source is directly above the photocells.

Light passing through a hole in the tape activates an appropriate photocell. A photoamplifier produces a $-3v$ output for transmission to the PA61A Reader Control Circuits. The reader control and reader interface circuits control the transmission of the data read from the tape. The tape position is determined by monitoring the states of the A and B flip-flops.

The outputs of the tape-reading photocells change between the light and no-light conditions. Eight photoamplifier circuits, located in the tape reader, continuously monitor the outputs of the photocells. The amplifiers generate a $0v$ output level when a hole is sensed, and a $-3v$ output level when no hole is sensed.

DEC drawing CS-B-G900-0-1 shows the circuit configuration of the photoamplifier. The channel 3 circuit, consisting of transistors Q1 and Q3, is used for the purpose of this discussion.

With the photocell in the "no hole" condition, the voltage drop across R6 permits Q1 to conduct. The conducting current through the Q1 collector develops sufficient voltage across R7 (10k ohm) to hold Q3 cut off. With Q3 cut off, D3 clamps terminal N to $-3v$.

TYPESETTING SYSTEM

When the photocell senses light, the current flow across R6 increases, applying a more positive voltage to the base of Q1. This cuts off Q1, permitting the voltage at its collector to revert to the level preset by the R1 Trimpot. This level, which determines the sensitivity of the amplifier, drives Q3 into conduction. With Q3 conducting, D3 is cut off, and a 0v level is applied to terminal N.

In summary: a hole in a tape channel generates a 0v level at its particular output terminal of the G900 Photoamplifier Module. The lack of a hole in a tape channel generates a -3v level at its particular output terminal at G900.

4.3.2 Reader Selection

The reader control unit, shown in DEC drawing BS-D-PA60-A-2, controls all phases of tape reader operation, including the implementation of reader selection, tape feeding, and data transfer both from the reader and to the accumulator of the PDP-8. The PDP-8 controls reader selection.

In the select mode, under program control, accumulator bits 9 through 11 contain the 3-bit binary equivalent of any one of eight tape readers from which data is desired. These three bits of the accumulator connect to the reader control through pins D, E, and H of the W028 Connector at A2.

The select register receives both positive and negative IOT312 pulses generated in the IOT decoder. The positive-going IOT312 pulse clears the select register. The positive transition of the negative-going IOT312 pulse transfers the desired accumulator bits into the select register.

The outputs of the register produce a single ground level select signal from the decoder. The particular output activated determines which of eight readers is selected for operation. The ground level output of the decoder activates one of eight inverter-drivers. The activated driver generates a -3v SELECT READER level for transmission to a PA61 Reader Interface Unit. If a reader in the group consisting of readers one through four is selected, the -3v level is transmitted through the W991 Connector at AB31. If the selected reader is in the group consisting of readers 5 through 8, however, the -3v level is transmitted through the W991 Connector at AB32.

NOTE: If the system in use contains from one to four tape readers, only one PA61 Reader Interface unit is provided. It interfaces with the control unit through the W991 Connector at AB31. The output circuits of the control unit are configured, however, for a system containing eight tape readers. This facilitates expansion of the system at a later date. All tape readers assigned to a particular system must be connected, however, to assure proper system operation.

System POWER CLEAR pulses, generated by the PDP-8, both at turn-on and when the START key is operated, are inverted from their -3v level to 0v, and activate R602 PA at A22. The ground level output pulses of the PA clear the select register.

TYPESETTING SYSTEM

4.3.3 Control and Timing

POWER CLEAR pulses, generated both at power turn-on in the PDP-8 and when the START key is actuated, perform three functions in the reader control unit. (Refer to figure 4-1.) They clear the reader select buffer, activate the change reader unit 10-msec delay, and clear the RUN flip-flop.

The 0v change reader unit (1) output disables the 2.3 msec clock, clears the FLAG flip-flop, sets the B flip-flop to the 1 state, and activates the pulse amplifier at A22. The output of this pulse amplifier assures that the RUN flip-flop is cleared and sets the A flip-flop to the 1 state. The 0v RUN (0) output then holds the A flip-flop in the 1 state.

The change reader unit delay times out in 10 msec, applying the -3v activating level to the reader clock. If, at this time, a 6014 program instruction is implemented in the processor, the RUN flip-flop is in the set (1) state, permitting the A and B flip-flops to react to the clock output. This starts the tape-feeding sequence.

Upon the completion of one full cycle of the A/B flip-flops, signified by the next 0 to 1 transition of the B flip-flop, the 0v B (1) output is applied to the DCD (diode-capacitor-diode) gate input of the A22 pulse amplifier. The 0v RUN (1) level enables this DCD gate. The output of this pulse amplifier strobes data into the reader buffer, output clears the RUN flip-flop, direct clears the FEED HOLE SEEN (no tape) flip-flop, and attempts to set the FLAG flip-flop. If the FEED HOLE SEEN flip-flop is not set by the appearance of a feed-hole output, the FLAG flip-flop is set, activating the INTERRUPT output and half-enabling the SKIP output.

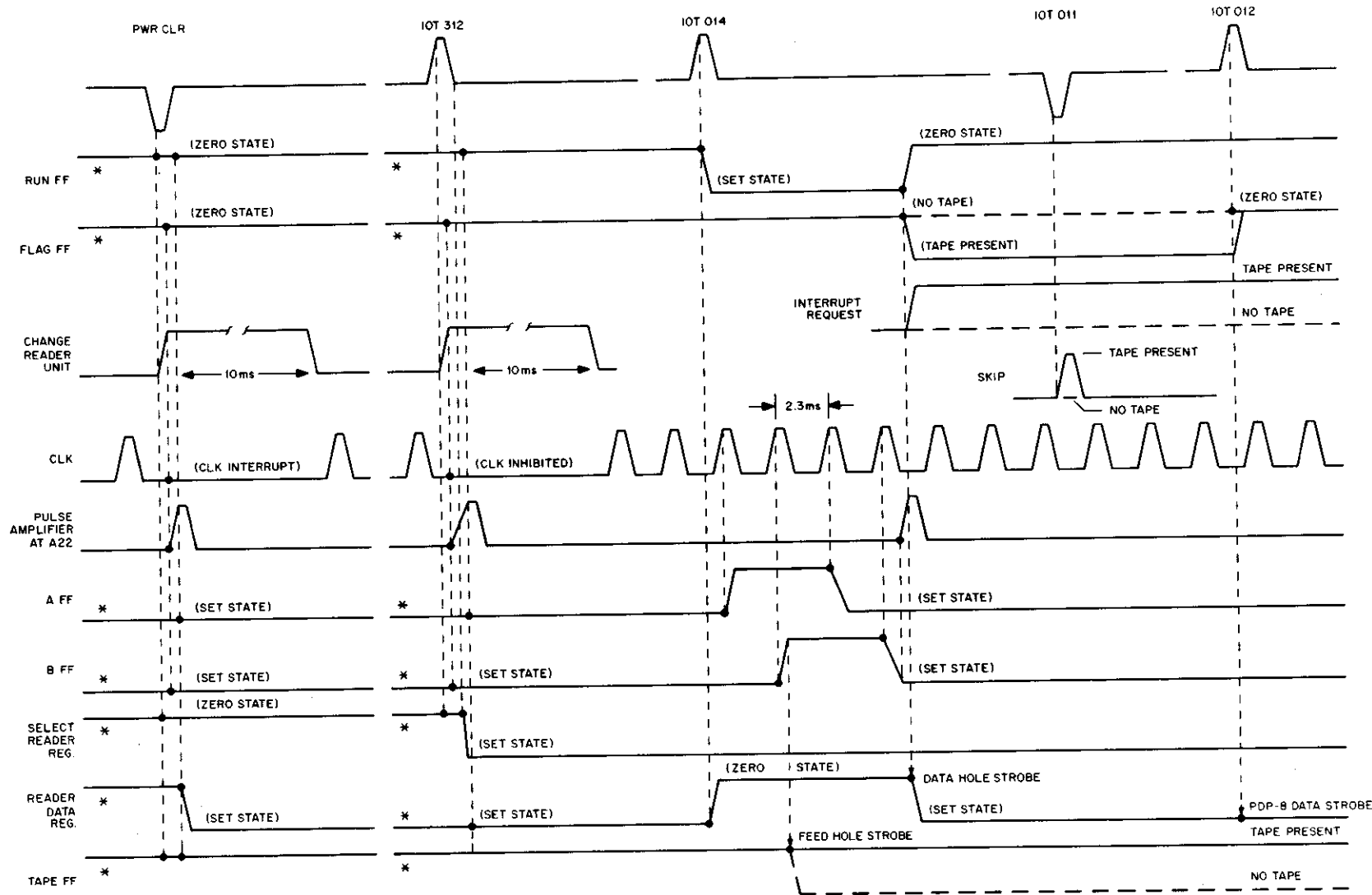
The feed-hole output of the G900 Photodiode Amplifier is gated into the set input of the FEED HOLE SEEN (no tape) flip-flop at a time (A = 0, B = 0) when no feed hole output is available. Its appearance, therefore, indicates that tape is not present in the selected reader. The lack of tape, accordingly, sets the FEED HOLE SEEN (no tape) flip-flop, preventing the setting of the flag. The lack of a -3v FLAG (1) output prevents the setting of both the INTERRUPT REQUEST and SKIP outputs.

This permits the processor to select another reader and, through the generation of an IOT312 pulse, activate the change reader unit delay to restart the reader operation sequence.

4.3.4 Tape Feeding

The SELECT READER output from the W991 Connector at AB31 enables the desired pair of solenoid driver in the reader interface unit. For example, if the reader buffer receives the code to select Reader 1, a -3v level half-enables the B3 and B4 W040 Solenoid Drivers in the reader interface unit. The outputs of the AB flip-flops provide the second required half-enable inputs to the solenoid drivers.

The drivers are sequentially actuated in pairs to provide drive current to the stepping motor tape drive. Their outputs exit the reader interface unit and activate the coils of the synchronous dc stepping motor.



- NOTES
1. NO HORIZONTAL SCALE - DASHED LINES CONNECT END OF TRANSITION CAUSING CHANGE TO DOTTED WAVE FORM BEING CHANGED. NO CHANGE IS SHOWN IF WAVEFORM IS CORRECT.
 2. * - EITHER STATE OF FF POSSIBLE BEFORE SET OR CLEAR PULSE.
 3. † - STROBES
 4. VERTICAL SCALE - 0V AND -3V LEVELS REPRESENTED, WITH 0V UP.

Figure 4-1 Tape Reader Timing Sequence, PA60A Reader Control Unit.

TYPESSETTING SYSTEM

4.3.5 Tape Reading

The SELECT READER level half-enables the associated R141 gate inputs. The second half-enable inputs are supplied by the amplified outputs of each of the seven photodiodes (6 data, 1 feed hole) when no hole is sensed. This applies to the normal typesetting installation, which uses 6-channel, advanced-feed-hole tape.

For example, the SELECT READER 1 -3v output level half-enables the two-input EF NAND gate of NOR R141 at A3. When no hole is sensed at channel 0, a -3v level from the G900 Photocell Amplifier fulfills the NAND gate through Pin D of the W990 Connector at A1. This produces a 0v output from R141. The sensing of a hole in channel 0 produces a 0v output from the photocell amplifier, which disables the EF NAND gate input of R141. This produces a -3v output from R141 during the time the hole is sensed. This -3v output is transmitted to the reader control unit for storage and subsequent transfer to the PDP-8.

4.3.6 Data Transfer

The W991 Connector at AB31 couples the outputs of the R141 gate, previously described, to the level inputs of the reader buffer. A positive-going transition from R602 PA at A22 strobes the data into the reader buffer.

The sensing of a hole in the tape generates a -3v level at the level input of its respective DCD gate. This -3v level prevents the enabling of the gate, assuring that each READER BUFFER flip-flop which is to contain a true bit (hole in tape) remains in the clear state previously produced by the receipt of the IOT014 pulse.

Each flip-flop in the reader buffer containing a true bit applies a -3v half-enable level to its respective inverter gate. The second half-enable input to all of the inverter gates is supplied by the IOT012 pulse.

Upon the receipt of the IOT012 pulse, each gate, which has been half-enabled by the reader buffer outputs, transmits a ground level output to the accumulator of the PDP-8.

4.4 TAPE PUNCH OPERATION

4.4.1 PP67A Paper-Tape Punch

Teletype Bulletin 215B (Technical Manual; High-Speed Tape Punch Set) contains all required maintenance information on the tape punch. This section, therefore, furnishes information only on the logic operation of the punch control and interface circuits.

TYPESSETTING SYSTEM

4.4.2 PR67A Paper-Tape Punch Control

The PR67A Paper-Tape Punch Control circuits are mounted on the chassis of the PP60A Paper-Tape Punch. These circuits provide the interfacing point between the punch mechanism and the control logic circuits. DEC drawing CS-D-7005095-0-1 shows these circuits. As shown in the drawing, only punch status and motor control signals are processed in these circuits. Drive current to the punch solenoids is coupled to the punch independently.

4.4.3 Punch Selection

The PA60A Punch Control circuits, shown in DEC drawing BS-D-PA60-A-4, control all phases of tape punch operation, including the implementation of punch selection, tape feeding, and data transfer to the punch from the PDP-8. The PDP-8 controls punch selection.

In the select mode, under program control, accumulator bits 9 through 11 contain the 3-bit binary equivalent of any one of eight tape punches into which data is to be transmitted for punching. These three bits of the accumulator connect to the punch control select register.

The select register receives both positive and negative IOT314 pulses generated in the IOT decoder. The positive-going IOT314 pulse clears the select register. The positive transition of the negative-going IOT314 pulse transfers the desired accumulator bits into the select register.

The outputs of the register produce a single ground level select signal from the decoder. The particular output activated determines which of eight (8) punches is to be selected for operation. The ground level output of the decoder activates one of eight inverter-drivers. The activated driver generates a -3v SELECT PUNCH level for transmission to a PA61 Punch Interface Unit. If a punch in the group, consisting of punches one through four, is selected, the -3v level is transmitted through the W991 Connector at AB31. If the selected punch is in the group consisting of punches 5 through 8, however, the -3v level is transmitted through the W991 Connector at AB32.

NOTE: If the system in use contains one to four tape punches, only one PA61 Punch Interface Unit will be provided. The output circuits of the control unit are configured, however, for eight punches. This facilitates expansion of the system at a later date.

4.4.4 Control and Timing

Whenever power is turned on in the PDP-8, and each time the START key is operated, POWER CLEAR pulses are transmitted to the reader control unit. These pulses are inverted and shaped in the reader control unit, and coupled to the punch control unit as positive-going pulses.

These pulses clear the PUNCH SELECT buffer flip-flops at their outputs (see figure 4-2), and clear the PUNCH ACTIVE and PUNCH FLAG flip-flops. This sequence clears the punch control unit for operation, and prepares it to receive function commands from the IOT decoder.

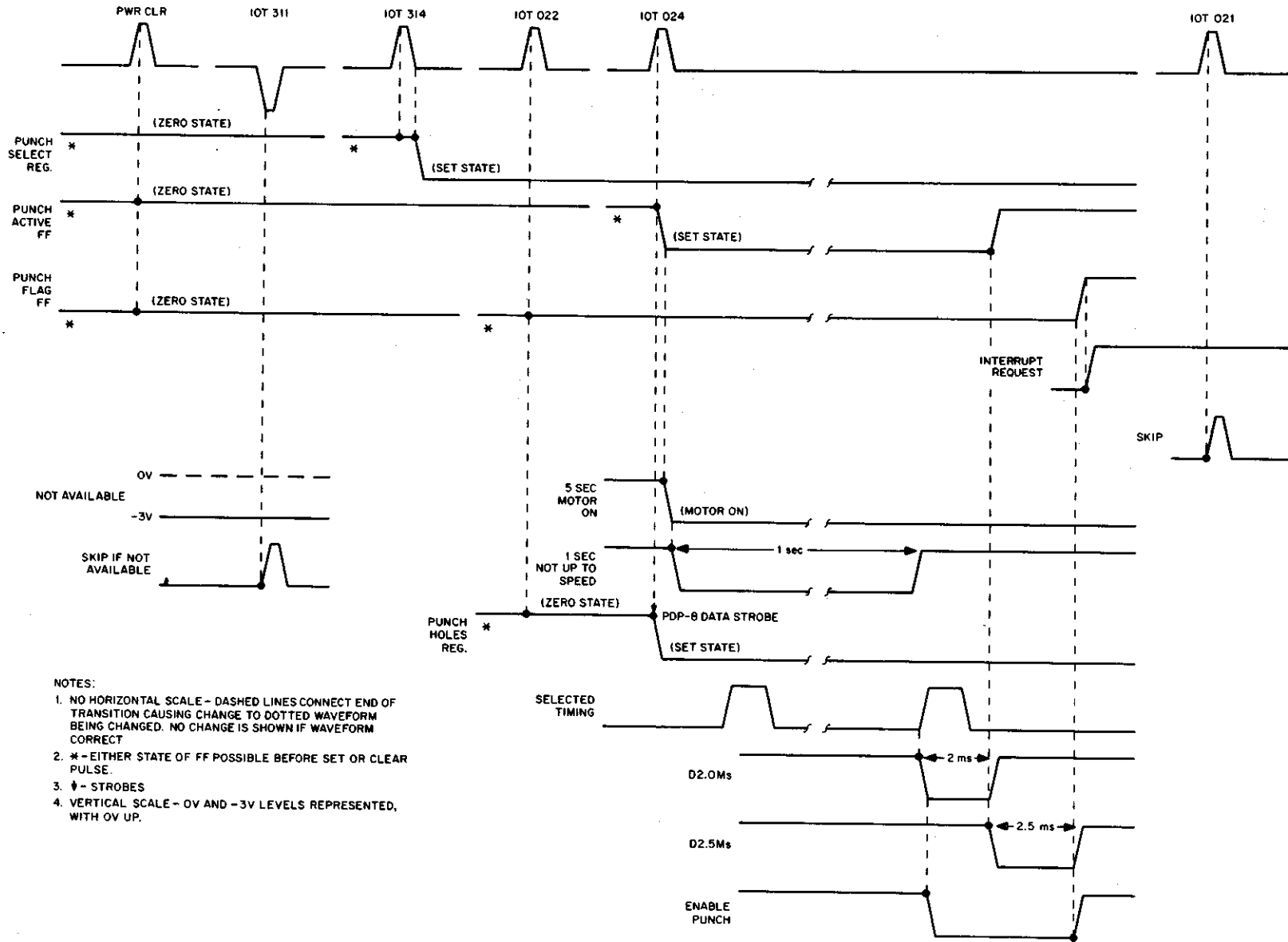


Figure 4-2 Tape Punch Timing Sequence, PA 60A Punch Control Unit.

TYPESSETTING SYSTEM

The output of a Tape-Out switch in the selected punch ANDs with the SELECT PUNCH level produced in the IOT decoder. If the punch is found to be available, the SELECTED AVAILABLE level disables the SKIP-IF-NOT-AVAILABLE output. To find a punch available, the Available switch on the punch must be in the AVAILABLE position, and tape must be present in the punch. If a no-tape condition exists, a SKIP-IF-NOT-AVAILABLE pulse is generated. The PDP-8 may then select a new tape punch and repeat the process to check its availability.

An IOT024 pulse, generated by the IOT decoder, sets the PUNCH ACTIVE flip-flop and starts the punching sequence described in detail in the section of this manual entitled Tape Punching.

4.4.5 Data Transfer

The IOT decoder generates the IOT pulses that control the transfer of data from the accumulator to the punch buffer in the punch control unit.

An IOT022 pulse, generated as a result of a 6022 program instruction, direct clears the punch buffer and the punch flag.

An IOT024 pulse, generated as a result of a 6024 program instruction, strobes the desired data into the punch buffer.

The PUNCH HOLE (1) ground level output of each flip-flop activates an inverter driver, producing a $-3v$ level output for transmission to the punch interface unit. This output half-enables solenoid drivers in the punch interface unit which provide the drive current to the tape punch solenoids.

4.4.6 Motor Control

In combination with the START MOTOR output of the 5-second motor-on delay, the SELECT PUNCH level activates one of four inverter gates. The output of the selected inverter gate enables the motor start circuit in the desired punch. This circuit remains activated and the punch motor runs, until either the punch is no longer selected or no punch commands are received for a period longer than 5 seconds. The lack of punch commands permits the 5-second motor-on delay to time out. This disables the motor start circuit in the selected punch.

4.4.7 Tape Punching

The selected punch generates the basic timing standard to which the punching operation is synchronized. A reluctance pickup, located in proximity to a punch-motor-driven cam, is activated during each punch cycle. The output of this reluctance pickup, developed across a 1 Kohm, 1/4-watt resistor in the punch interface circuits, provides a $-3v$ half-enable input to an R141 Gate. This R141 Gate receives its second half-enable input from the SELECT PUNCH levels. The PUNCH SYNC output

TYPESSETTING SYSTEM

of a particular punch NAND's with its own SELECT PUNCH level to activate the R141 Gate. The ground level selected timing output produced by this gate activates a Schmitt trigger in the punch control.

The positive-going transition created by the initial setting of the 5-second motor-on-delay sets the not-up-to-speed delay to the 1 state. This sequence ensures that the selected punch motor is in fact rotating at its proper operational speed before punching of tape is attempted. The $-3v$ outputs of the Schmitt trigger, the 5-second motor-on-delay (1), and the not-up-to-speed delay (0) AND to provide a pulse input to the 2.0-msec delay at A16.

The ground level output of the PUNCH ACTIVE flip-flop (1) provides the level input to this delay. Since the PUNCH ACTIVE flip-flop is set to the 1 state by an IOT024 pulse, this assures that the system is indeed in a punching mode of operation.

When activated, the 2.0-msec delay output will switch from its normal ground level to a $-3v$ level for a period of 2.0 msec. This provides the enabling level needed for the clear input of the PUNCH ACTIVE flip-flop. The positive-going transition, generated by the delay timing out after 2.0 msec, provides the pulse input required to clear the PUNCH ACTIVE flip-flop. This assures that only one punch cycle can be performed for each data-transfer operation initiated by the PDP-8.

The 0v level of the 2.5-msec delay at R16 enables its own input when the delay is inactive. The positive-going transition produced by the runout of the 2.0-msec delay provides the required pulse input to activate the 2.5-msec delay.

The double-inverted output of the 2.5-msec delay half-enables all eight (8) R123 Inverter Gates in the enable punch circuits.

The $-3v$ output of the select punch decoder (previously discussed) provides the second half-enable input to one of these inverters. The 0v output of the activated inverter gate triggers a W051 Inverter-Driver corresponding to the selected punch. A W991 Connector at AB31 (punches 1-4) or AB32 (punches 5-8) couples the output of the inverter-driver to the punch interface unit.

The punch interface unit contains seven (7) W040 Solenoid Drivers for each of four punches, for a total of 28 drivers per interface unit. Six drivers in each group actuate solenoids producing data holes in the tape. The seventh driver in each group (A15 in Punch 1 group) provides current to actuate the feed-hole and tape-feed solenoid.

This configuration applies to a system using a 6-level high-speed BRPE punch. As indicated by the drawings, a high-speed 8-level BRPE punch may also be used.

The $-3v$ ENABLE PUNCH output, coupled from the punch control unit through the W991 Connector at AB31, half-enables all seven solenoid drivers in the group serving its particular punch. The

TYPESSETTING SYSTEM

8-bit punch buffer in the punch control unit provides, through the same connector, the second half-enable input needed to activate the data-hole drivers. The second half-enable input to the feed-hole and tape-feed solenoid driver is provided as a constant bias voltage to the driver inputs.

TYPESETTING SYSTEM

SECTION 5 INTERFACE

This section shows the interface connections and signals between the PDP-8 and the tape readers and punches, including the reader and punch control and interface units.

TYPESETTING SYSTEM

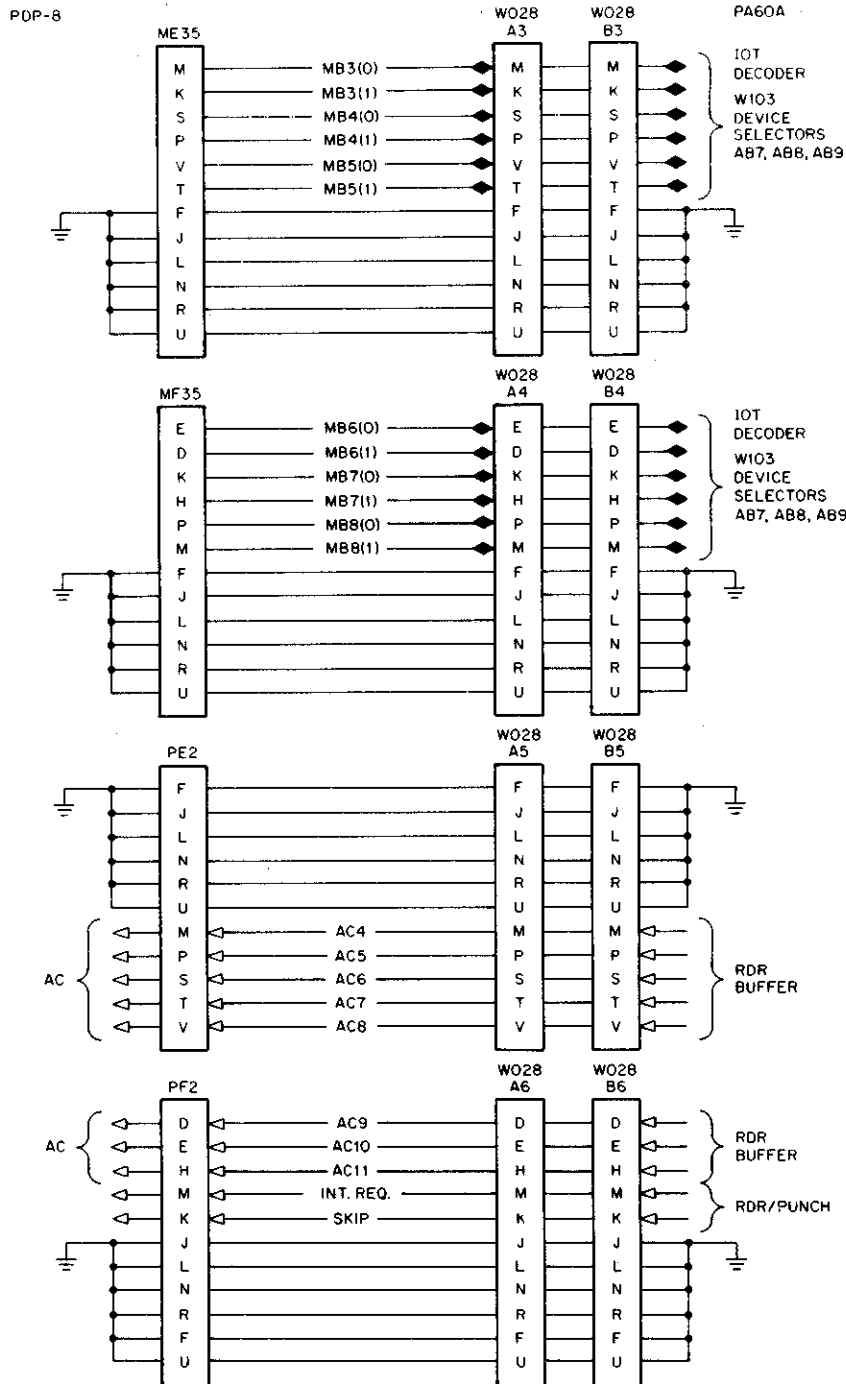


Figure 5-1 Interface, PDP-8 to PA60A Reader/Punch Control.

TYPESETTING SYSTEM

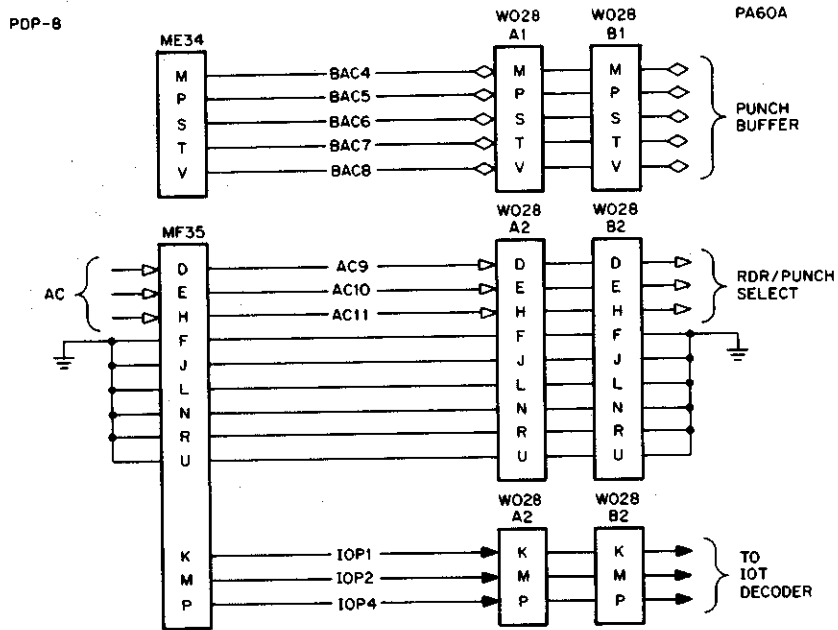


Figure 5-1 Interface, PDP-8 to PA60A Reader/Punch Control (continued)

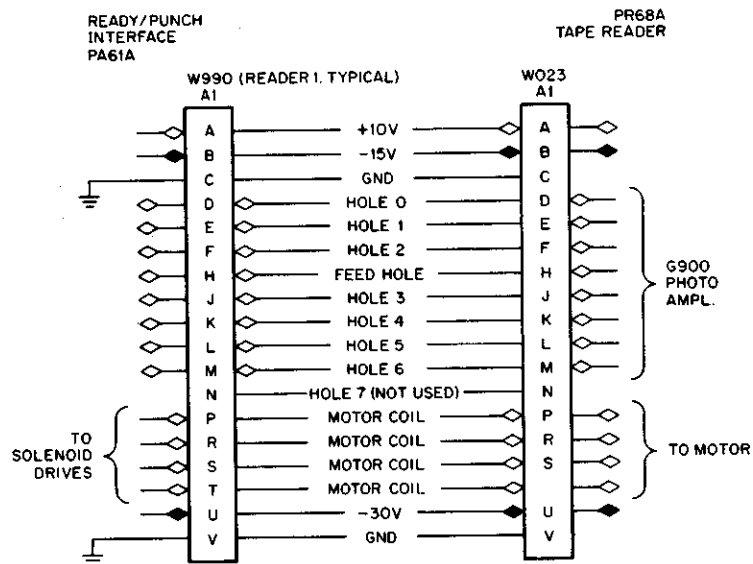


Figure 5-2 Interface, PR68A Paper-Tape Reader to PA61A Reader/Punch Interface Unit.

TYPESETTING SYSTEM

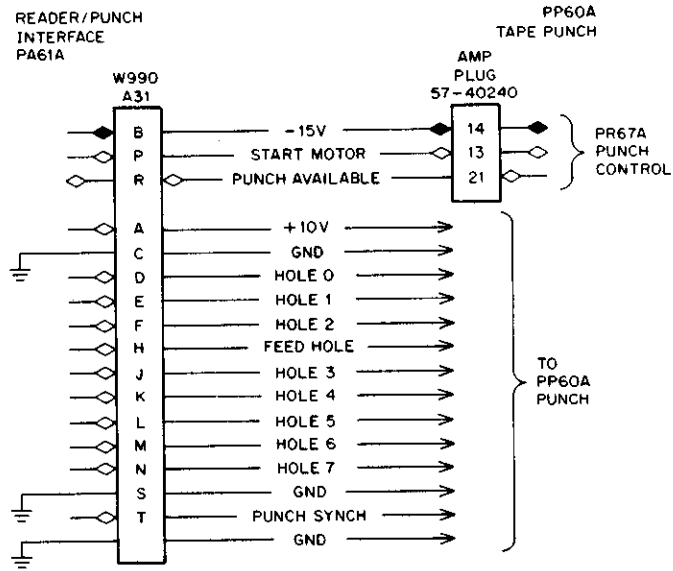


Figure 5-3 Interface, PR67A Paper-Tape Reader to PA61A Reader/Punch Interface Unit.

TYPESSETTING SYSTEM

SECTION 6 MAINTENANCE

The information and procedures presented on the following pages refer directly to the DEC PR68A Paper-Tape Reader used in the PDP-8 Typeset System. Maintenance data on the PDP-8 Processor is contained in PDP-8 Maintenance Manual F-87. Maintenance data on the PP67A (BRPE 18) Paper-Tape Punch is contained in Teletype Bulletin 215B (Technical Manual, High-Speed Tape Punch Set). Maintenance data on the Automatic Send/Receive Set (ASR 33) is contained in Teletype Bulletin 273B (Technical Manual, Automatic Send/Receive Set).

6.1 PREVENTIVE MAINTENANCE

Preventive maintenance comprises tasks performed at periodic intervals to assure proper equipment operation and minimum unscheduled down time. These tasks consist of visual inspection, operational checks, cleaning, lubrication, adjustment, and replacement of borderline or partially defective parts.

6.1.1 Scheduling

Preventive maintenance scheduling depends upon the existing environmental and operating conditions at the installation site. Under normal environmental and work-load conditions, a schedule of preventive maintenance consisting of inspection, cleaning, and lubrication every 600 hours of operation, or every four months, whichever occurs first, is recommended. Relatively extreme conditions, however, of temperature, humidity, or dust, and/or abnormally heavy work loads demand more frequent maintenance.

6.1.2 Inspection

Inspect the PR68A Tape Reader as follows:

- a. Visually inspect the tape reader for completeness and general condition.
- b. Clean the interior and exterior of the tape reader, using a vacuum cleaner or clean cloth moistened in nonflammable solvent.
- c. Inspect all wiring and cables for cuts, breaks, fraying, wear, deterioration, kinks, strain, and mechanical security. Tape, solder, or replace any defective wiring or cable covering.
- d. Inspect the following for mechanical security: tape spring knob, lamp assembly, diode assembly, all connectors and circuit modules, tape-feed motor, and front cover boxes.

TYPESSETTING SYSTEM

6.1.3 Operational Test

Use the diagnostic program provided as part of the system software to exercise and operationally test the reader.

6.2 CORRECTIVE MAINTENANCE

Before commencing troubleshooting procedures in the PR68A Tape Reader, assure that the processor portion of the system, including the reader control logic and power supplies, is operating properly. Refer to the PDP-8 Processor Maintenance Manual (F-87) for operational checks to determine the system status.

When the processor is eliminated as a source of trouble, perform the troubleshooting procedures outlined below.

6.2.1 Preliminary Investigation

Examine the system maintenance log to determine if this fault has occurred before, noting what steps were taken to correct it. Especially note if there appears to be any cyclic occurrence to the fault.

6.2.1.1 Visual Inspection - Visually inspect the tape reader to determine the physical and electrical security of all cables, connectors, modules, and wiring. Check the lamp for operation and the plastic plate over the photodiodes for cleanliness. Pay special attention to ground connections between lines. Pay special attention to ground connections between the tape reader and the processor. Poor ground connections may produce a variety of faults.

6.2.2 System Troubleshooting

DEC provides special test programs (Maindec) with all processors to exercise and check the operation of input/output equipment. The program determines whether the peripheral is at fault, and helps localize the problem area.

After localizing the fault within a functional logical element, program the computer to repeat some operation that uses all functions of that element. Trace signal flow through the suspected element with an oscilloscope. Synchronize the oscilloscope sweep with control signals or clock pulses generated within the processor or in the reader control logic. Carefully examine all tape reader input and output signals for proper level, duration, rise and fall characteristics, and timing.

Use a combination of signal tracing and aggravation techniques to localize intermittent failures. If the system is equipped for them, marginal power checks may localize intermittent failures by causing borderline components to fail consistently. Refer to the processor maintenance manual for marginal test techniques.

TYPESSETTING SYSTEM

Intermittent failures may also be caused by poor wiring connections. Run a repetitive test program, and introduce physical vibration into the unit by gently tapping or moving the module connector block, circuit modules, and signal and power connectors. After isolating the malfunction in this manner, check the seating of the modules and the connectors; check the module connector block for wear or misalignment of terminals; and check the module wiring for cold solder joints and loose or broken wires or copper.

Since only two module types (four W040 Solenoid Drivers and one G900 Photodiode Amplifier) are used in the tape reader, system troubleshooting is relatively simple. Output checks of both card types can quickly determine the location of the fault.

6.2.3 Circuit Troubleshooting

When the faulty module is isolated, circuit troubleshooting may be performed either with the module in the reader or on the bench. Replacing the faulty module with one from spares holds system downtime to a minimum. It also permits the module to be subjected to bench static or dynamic checks, to isolate the faulty component, or permits its return to DEC for repair or replacement. If on-site repair of the faulty module is desired, however, circuit troubleshooting with the module in the reader is the most economical of personnel time. This approach permits program exercising of the module for rapid fault isolation.

Formal engineering diagrams of each module are supplied with the tape reader. Copies of these schematics are provided in section 9 of this manual. Basic function descriptions and specifications for these modules are presented in the Digital FLIP CHIP™ Modules Catalog, C-105.

6.2.4 Repair

Limit FLIP CHIP module repairs to the replacement of semiconductors. In all soldering and unsoldering operations, avoid placing solder or flux on adjacent parts or service lines. When soldering semiconductors (transistors, crystal diodes, metallic rectifiers, or integrated circuits) take the following precautions to avoid heat damage:

- a. Use a heat sink, such as a pair of pliers, to grip the lead between the device and the joint being soldered.
- b. Use a 6v soldering iron with an isolation transformer. Use the smallest soldering iron adequate for the work.
- c. Perform the soldering operation in the shortest possible time, to prevent damage to the component and delamination of the module etched wiring.

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TYPESETTING SYSTEM

When removing any part of the equipment for repair and/or replacement, make sure that all leads or wires which are unsoldered or otherwise disconnected are legibly tagged or marked for identification with their respective terminals. Replace defective components only with parts of equal or better quality and equal or narrower tolerance.

6.3 ADJUSTMENTS

The following adjustment procedures may be performed, by qualified maintenance personnel, whenever misadjustment of the tape reader is suspected. Do not, however, perform these adjustments until the trouble is definitely isolated to the tape reader.

6.3.1 Tape Bed Adjustment Procedure

If realignment of the tape bed becomes necessary, perform the following adjustment procedures.

- a. Turn PDP-8 power OFF.
- b. Loosen the two allen set screws securing the tape spring control knob (see figure 6-1) to its shaft (see figure 6-2) and remove the knob.
- c. Remove the two screws securing each of the front cover boxes (see figure 6-1), and remove the boxes.
- d. Disengage the tape spring by turning the spring control shaft clockwise.
- e. Insert a piece of paper tape 8 to 10 inches long, and engage the tape spring.
- f. Check for air gap between the tape and the left-most edge of the tape block (see figure 6-3). The existence of an air gap indicates a misalignment between the tape block and the face of the tape feed sprocket wheel (see figure 6-2).
- g. If an air gap exists, loosen the two tape block mounting screws (see figure 6-3) and adjust the tape block to be level with the face of the sprocket wheel.
- h. Remove the tape.
- i. Check that the tape guide (see figure 6-3) is in the upmost position (6-level tape) and level with the surface of the tape block.
- j. If necessary, loosen the tape guide mounting screw (see figure 6-3) and perform the required adjustment.
- k. Check the tape spring (see figure 6-2) for light, even pressure between the spring fingers and the sprocket wheel face. If necessary loosen the screws securing the tape spring to its shaft (see figure 6-4) and reposition the spring. If additional movement is needed, slightly form the vertical portion of the spring. Avoid bending the fingers if possible.

TYPESSETTING SYSTEM

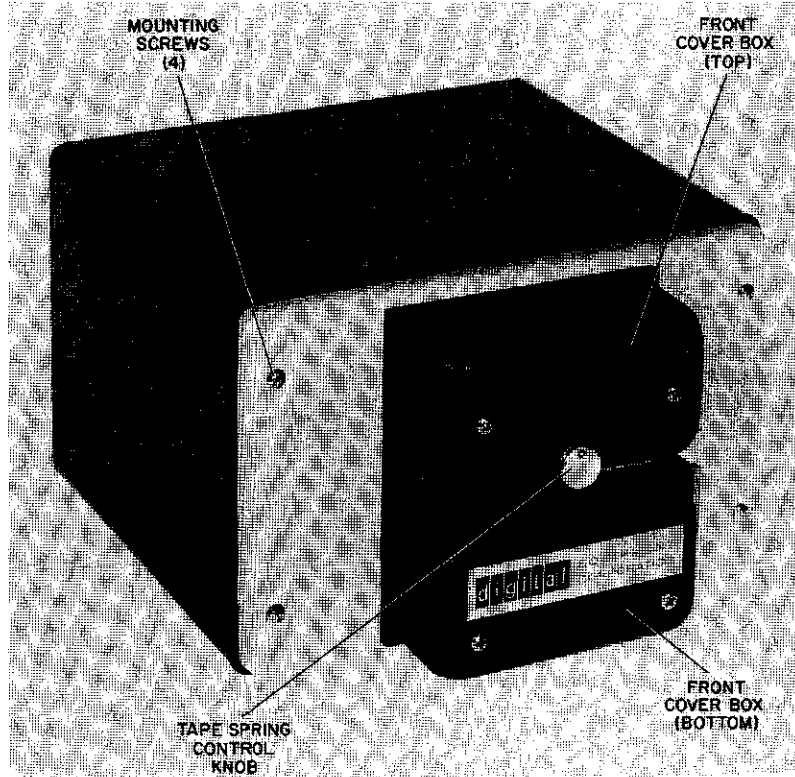


Figure 6-1 PR68A Paper-Tape Reader.

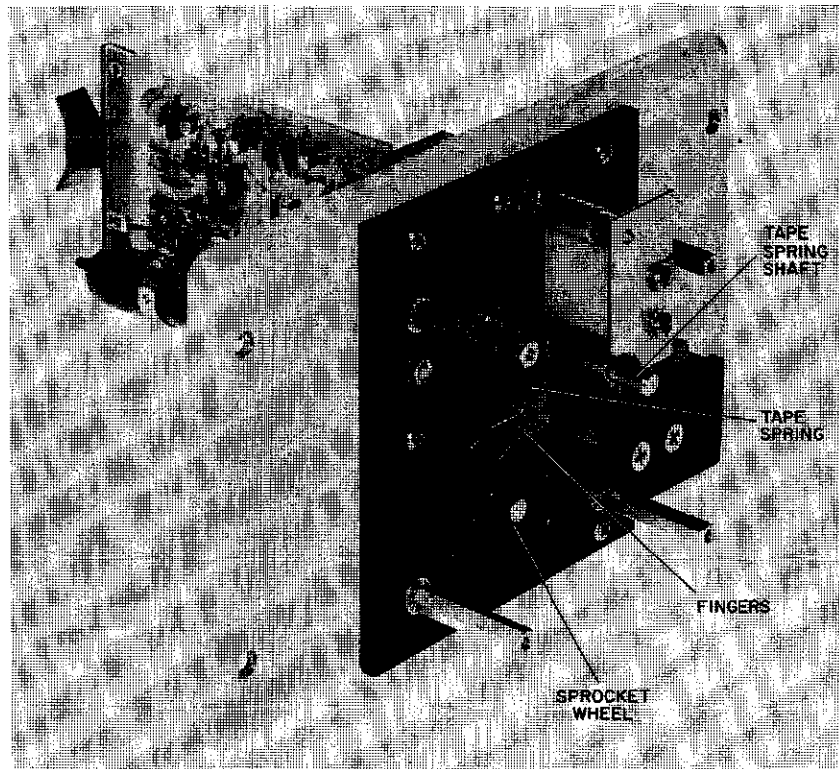


Figure 6-2 Tape Reader Chassis, Front View.

TYPESSETTING SYSTEM

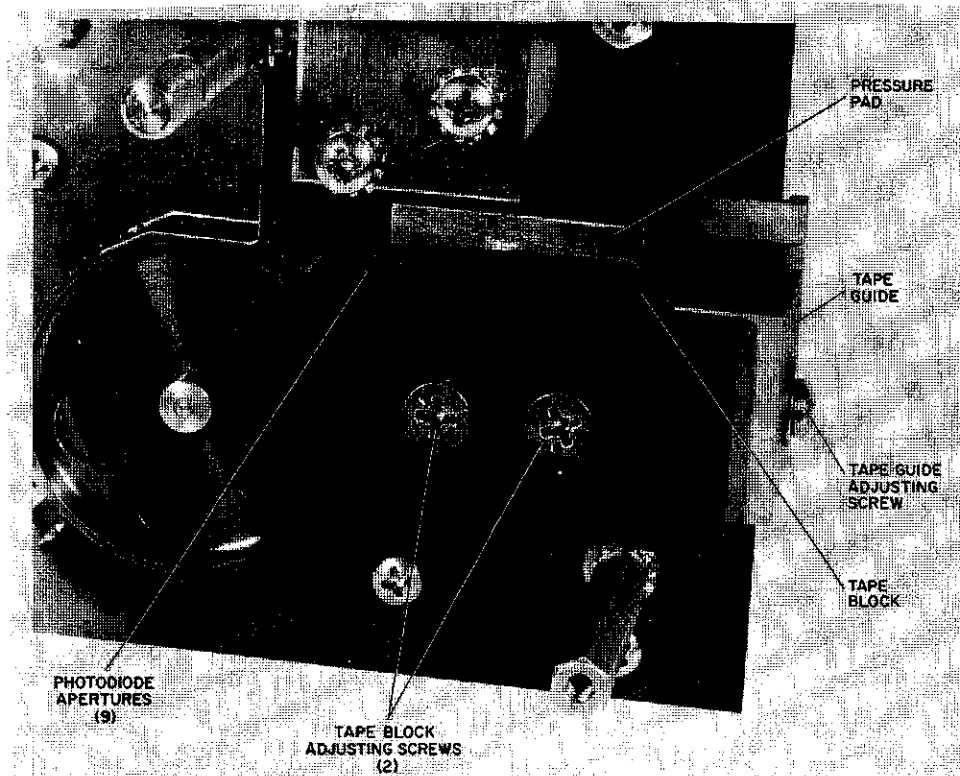


Figure 6-3 Tape Bed and Sprocket.

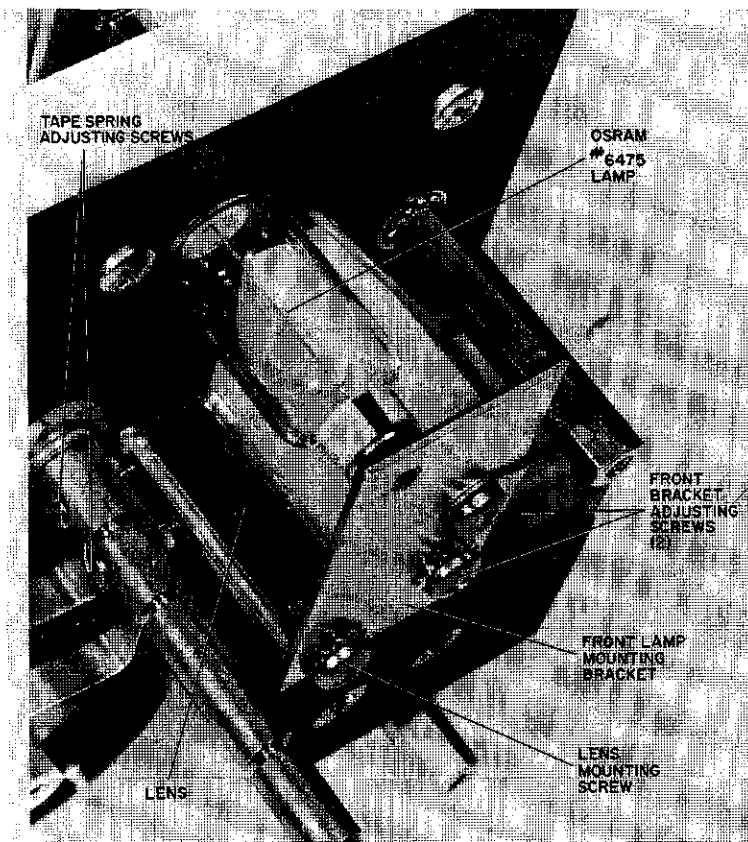


Figure 6-4 Lamp and Lens Assembly.

TYPESETTING SYSTEM

6.3.2 Lamp Replacement/Adjustment Procedure

Aging of the lamp may produce sagging of the filament with a resultant change in light intensity across the photocell apertures. This may result in errors in tape reading. If this condition is suspected, or if the lamp fails, replace the lamp using the following procedure.

- a. Remove the top and bottom cover boxes and the tape spring knob as shown in the tape bed adjustment procedure.
- b. Remove the rear cover plate and the cable clamp.
- c. Remove the four mounting screws in the corners of the front panel and carefully slide out the chassis.
- d. Loosen the two screws on the right side of the front lamp bracket (see figure 6-4), and remove the bulb.
- e. Select a new OSRAM #6475 lamp which has a straight filament.
- f. Insert the bulb in the bracket with the engraved end toward the rear.

Tighten the two mounting screws to a point which still permits movement of the bracket.

- g. Slightly loosen the single screw securing the lens (see figure 6-4), and adjust the lens so that the flat portion is on top and parallel with the tape bed. Tighten the mounting screw securely.
- h. Rotate the lamp in the socket until the filament appears its straightest, as viewed from above.
- i. Turn on PDP-8 power. The lamp will light.
- j. Observe the beam of light projected onto the tape bed. The beam of light must be parallel to the photocell apertures, with the right edge of the beam aligned with the right edge of the apertures (see figure 6-5). If the conditions described above and shown in figure 6-5 are not met, move the front and/or rear lamp mounting brackets (see figure 6-6) until the light beam is correctly positioned. Loosen the front bracket mounting screws if necessary to perform this adjustment. The rear bracket mounting screw should not need to be loosened.

NOTE: Movement of the front bracket provides adjustment of both the lamp and lens, and laterally repositions the light band. This adjustment may, however, introduce a skew into the light band orientation. Adjustment of the rear lamp bracket permits relative movement between the lamp and the lens to compensate for this skew. Since these adjustments interact, a "rocking-in" type of operation may be required to meet the stated criteria. The lens should not be adjusted away from the horizontal unless absolutely necessary, since this may affect the width of the light beam.

TYPESETTING SYSTEM

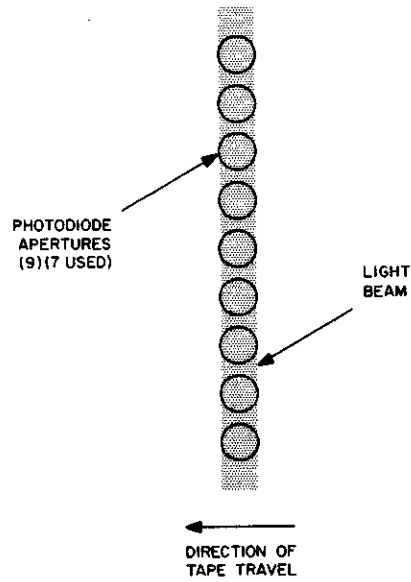


Figure 6-5 Orientation of Light Beam with Apertures.

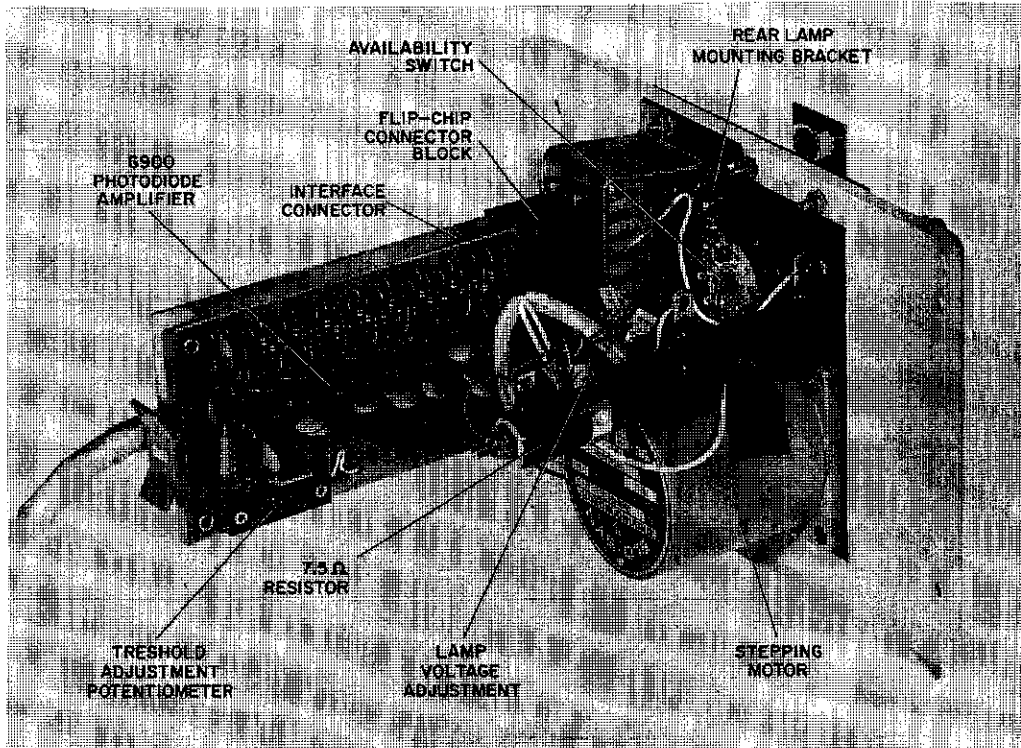


Figure 6-6 PR68A Tape Reader, Rear View.

TYPESSETTING SYSTEM

k. Observe the width of the light beam projected on the apertures. If the apertures are not completely covered, as shown in figure 6-5, loosen the lens mounting screw on the lower left of the front mounting bracket and rotate the lens slightly for optimum beam width.

NOTE: If the lens adjustment adversely affects the light beam position and/or skew, return to step 10 and repeat the bracket and lamp adjustment procedures.

l. Connect the negative (-) lead of a voltmeter to the front lamp bracket and the positive (+) lead to the rear lamp spring bracket. Turn PDP-8 power ON. Adjust the center clamp on the 7.5 ohm, 25-watt wire-wound resistor located on the rear of the front panel (see figure 6-6) to provide -10 vdc (-9.5 to -10.25 vdc) across the lamp.

6.3.3 Tape Sprocket Adjustment

If, for any reason, the tape feed sprocket wheel, shown in figure 6-2, is removed, replaced, or moved on the motor shaft, the following adjustment procedure must be performed.

- a. Turn on PDP-8 power.
- b. Through use of a diagnostic or other program, cause the PR68A to cycle through several character feed cycles. This assures that the AB flip-flops in the control circuits are in the idle state so that later generation of the data strobe pulse is synchronized with tape position.
- c. Disengage the tape spring.
- d. Loosen the two allen set screws securing the sprocket to the motor shaft.
- e. Insert a strip of paper tape, alternately punched with all 1s and all 0s engaging sprocket pins in tape feed holes.
- f. Roughly center the sprocket pins between the tape spring fingers and engage the tape spring.
- g. Rotate the sprocket wheel until a row of tape holes is centered, in the direction of tape travel, over the photodiode apertures.
- h. Maintaining this rotational orientation, move the sprocket wheel, and the tape, along the axis of the motor shaft until the apertures are centered over the last (innermost) seven photocell apertures. Take care to ensure that the tape lies straight on the tape bed with no buckling or stress due to improper sprocket wheel positioning.
- i. Maintaining this adjustment, carefully rotate the sprocket wheel until the leading edge of a set of tape holes is on the right (as viewed from the front) edge of the light band.
- j. Tighten the allen set screws to secure the sprocket wheel on the motor shaft. Re-check the adjustments after tightening the screws.

TYPESETTING SYSTEM

- k. Obtain a dual-trace oscilloscope (Tektronix Model or equivalent). Connect the input to the upper trace to pin V of A29, PA60A. Connect the input to the lower trace to pin V of A24, PA60A.
- l. Insert a 1/0-punched tape loop in the PR68A reader.
- m. Using a DEC Maintenance program (Maindec-08-D25A-D), start tape feeding through the reader.
- n. Adjust the G900 Amplifier threshold potentiometer (see figure 6-6) for a minimum-width negative-going signal on the upper trace of the oscilloscope.
- o. The positive-going transition of the signal displayed on the lower trace must be centered on the negative-going signal on the upper trace (see figure 6-7).
- p. If this criterion is not met, stop the program, loosen the allen set screws securing the sprocket wheel to the motor shaft and move the sprocket slightly. Recheck the signals for their required timing relationships.
- r. When this criterion has been met, determine the lock-to-lock adjustment range available on the amplifier threshold potentiometer and center the potentiometer.
- s. With the 1/0 tape running, the signal-to-no-signal ratio must be 1:1.8 (see figure 6-7). Adjust the threshold potentiometer to obtain this ratio.

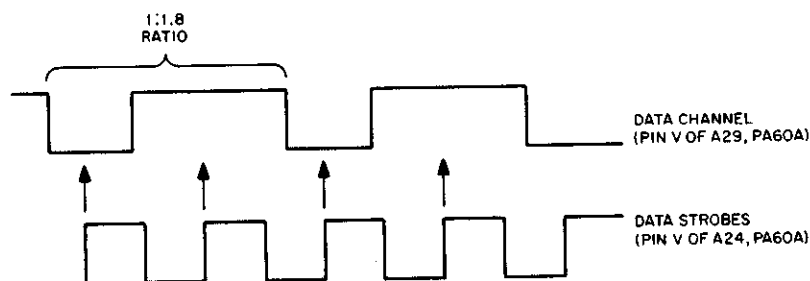


Figure 6-7 Data/Strobe Timing Diagram.

TYPESSETTING SYSTEM

SECTION 7

PARTS LIST

The drawings on the following pages present a breakdown of the replaceable parts of the PR68A Paper-Tape Reader. Equivalent data for the PP67A (BRPE) Paper-Tape Punch can be found in Teletype Bulletin 1154B, High-Speed Tape-Punch Set, Parts; and for the ASR 33 in Teletype Bulletin 1184B, Automatic Send/Receive Set, Parts.

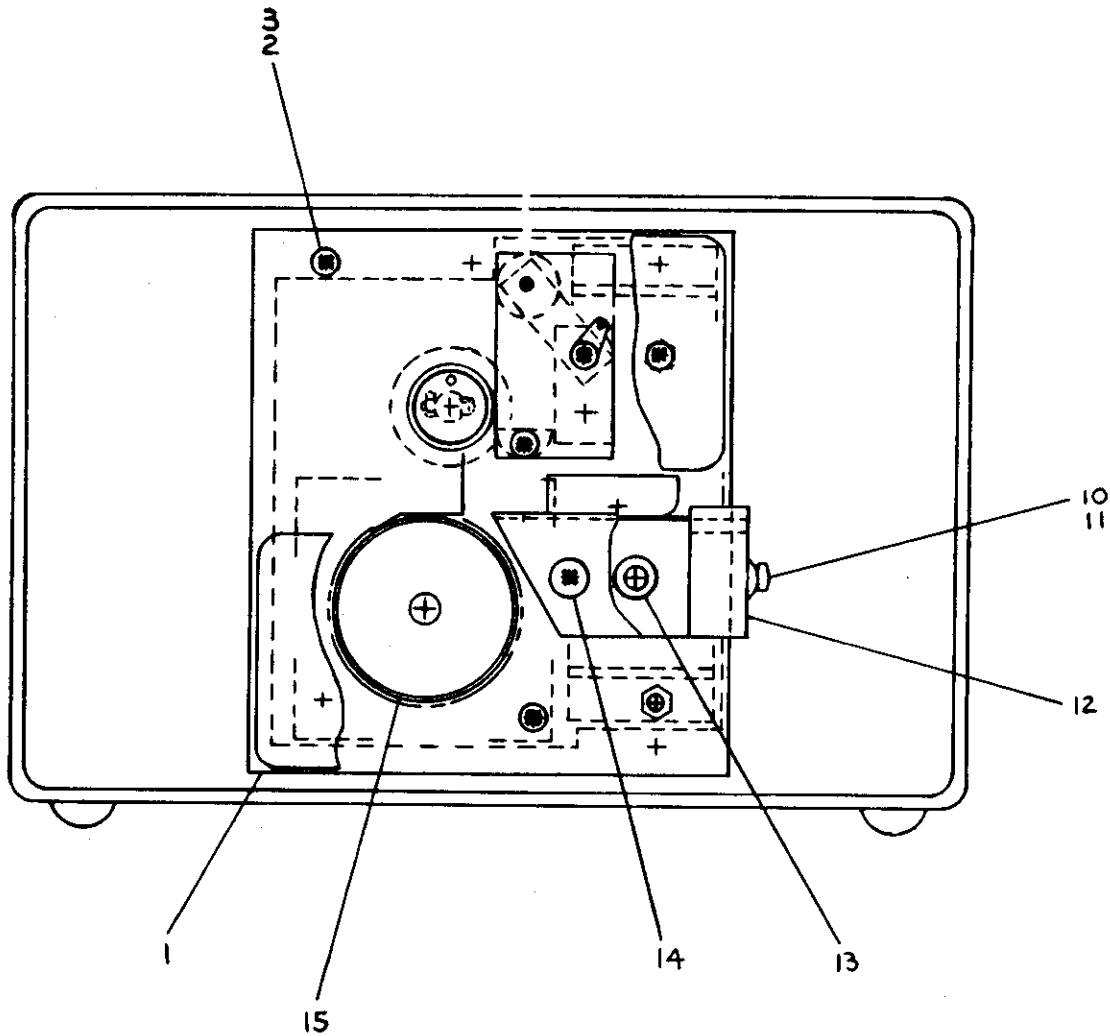


Figure 7-1 PR68A Tape Reader, Front View.

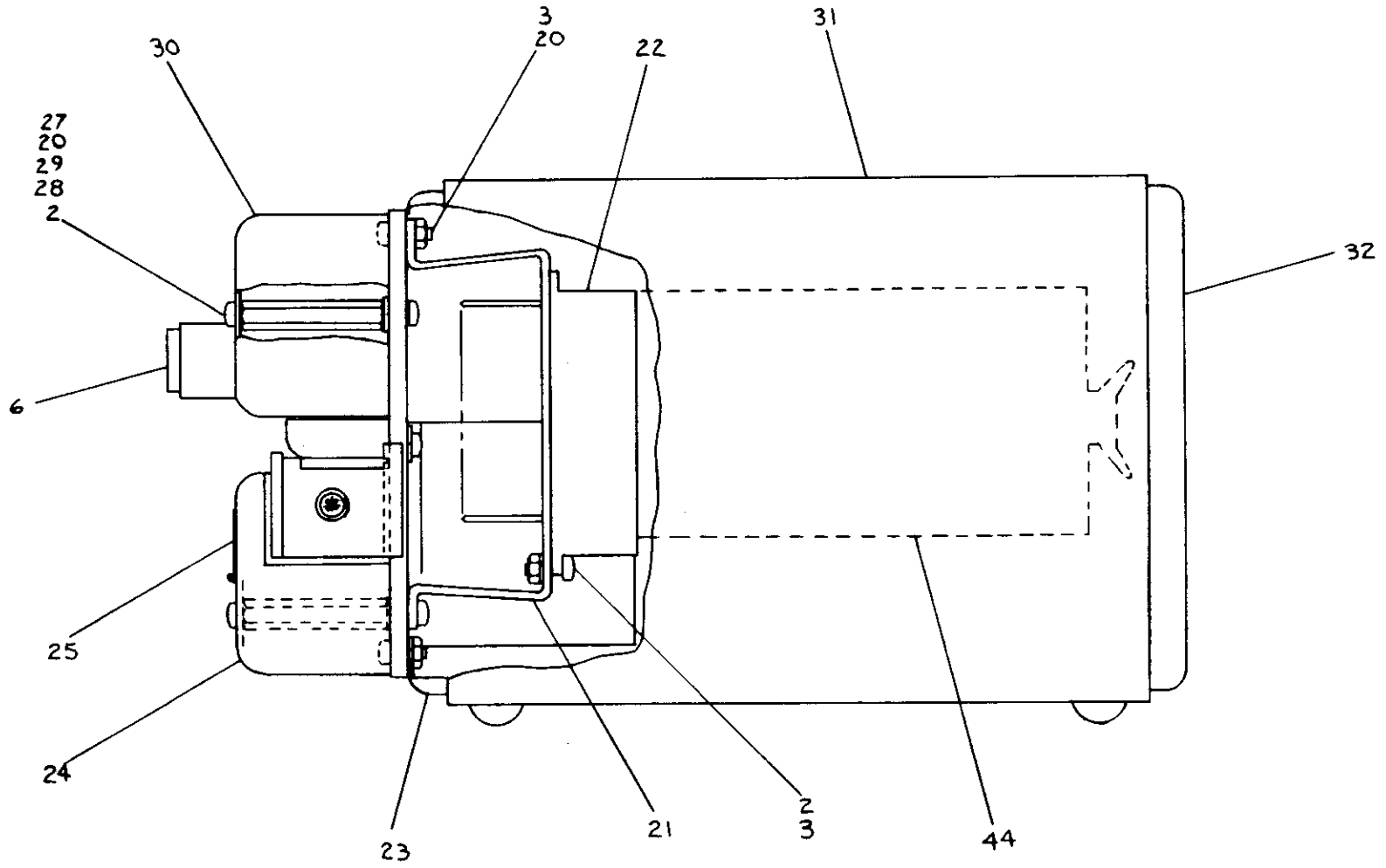


Figure 7-2 PR68A Tape Reader, Right Side View.

TYPESSETTING SYSTEM

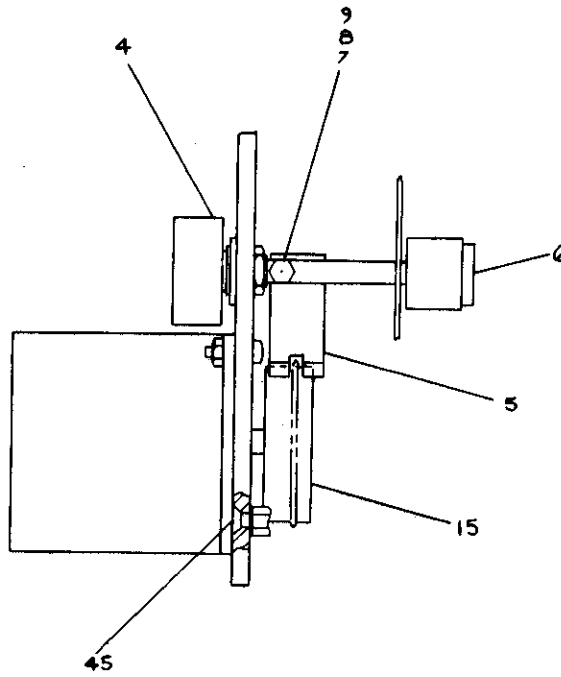


Figure 7-3 Front Panel, Left Side View, Section.

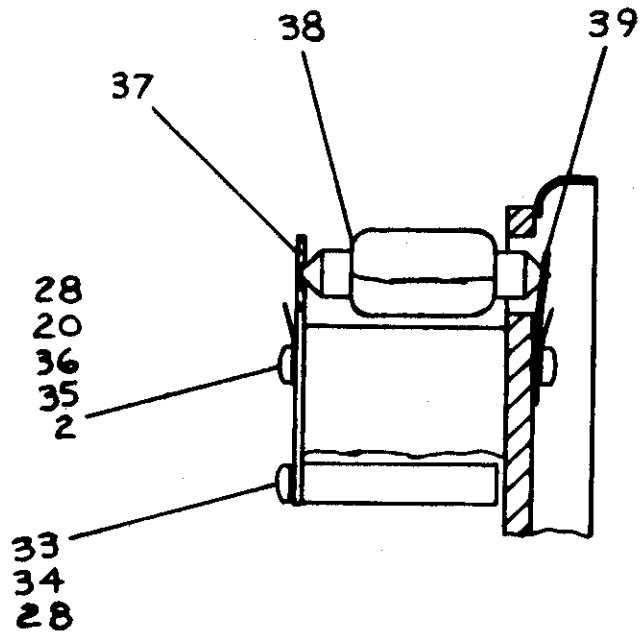


Figure 7-4 Lamp and Lens Assembly, Right Side View, Section.

TYPESetting SYSTEM

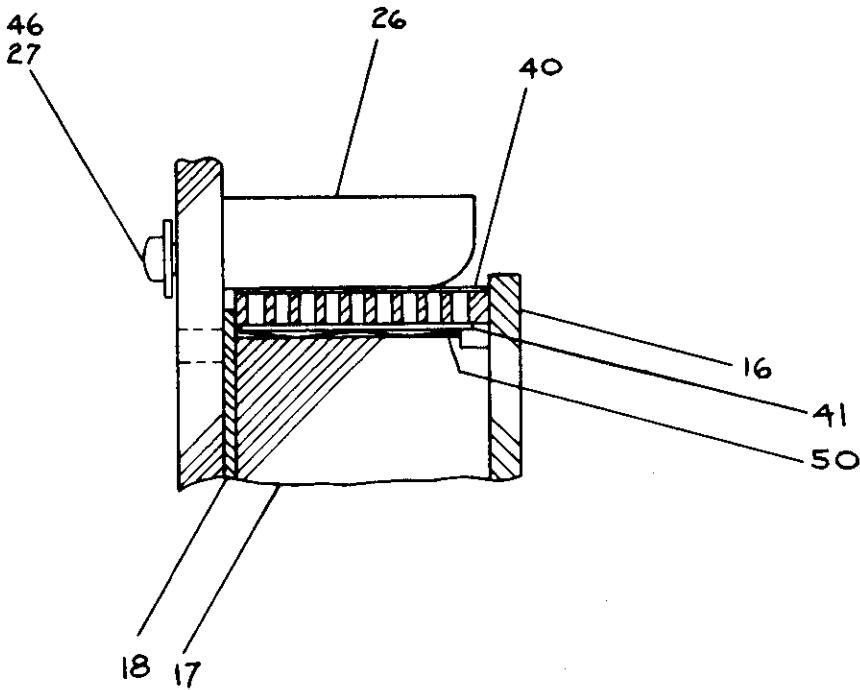


Figure 7-5 Tape Bed, Left Side View, Section.

TYPESETTING SYSTEM

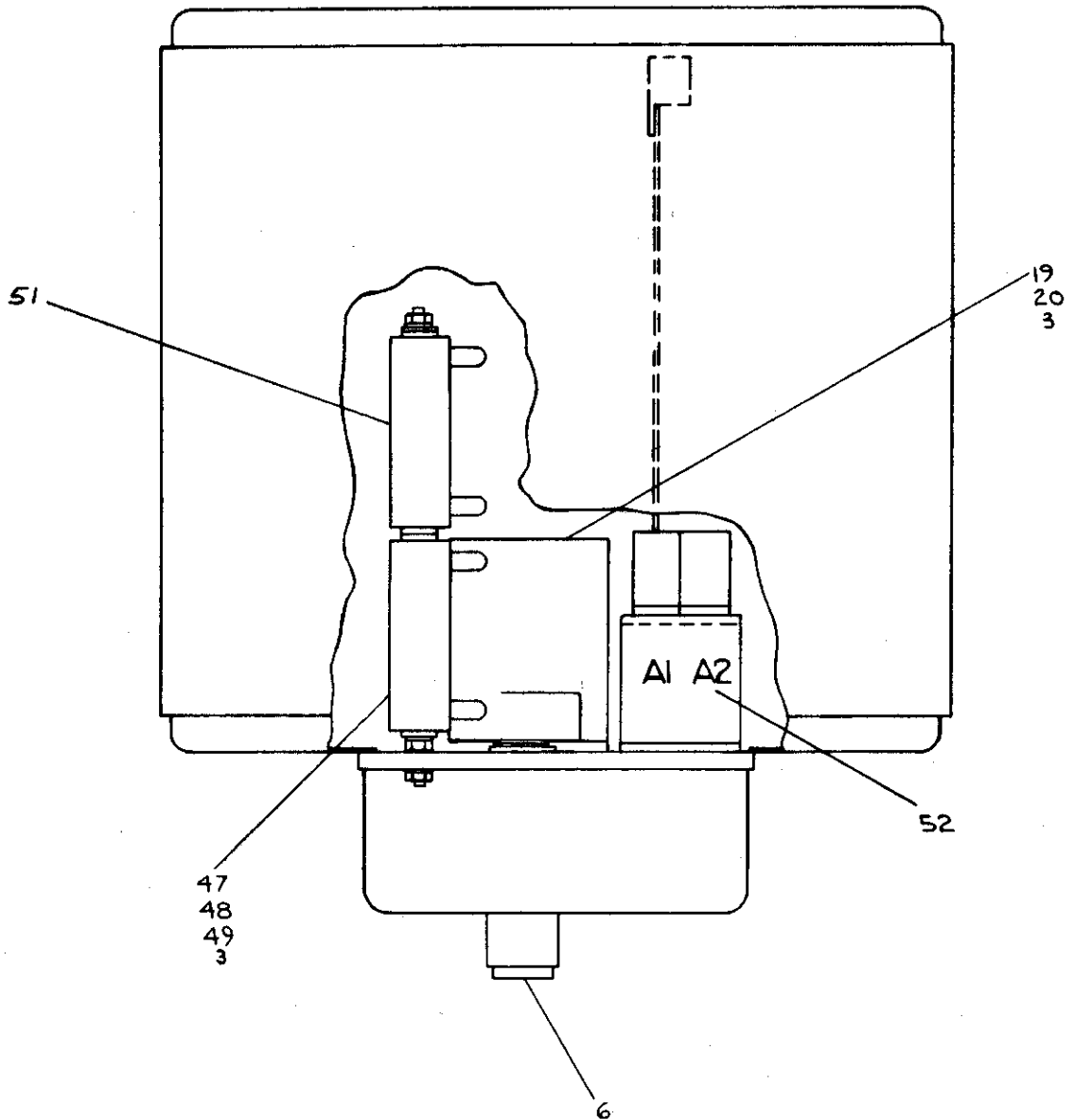


Figure 7-6 PR68A Tape Reader, Top View, Cutaway.

TYPESETTING SYSTEM

TABLE 7-1 PARTS LIST

Item Number	Part	Part Number	Quantity
1	Reader Plate (Bottom)	MD-C-PR68A-0-1-0-8	1
2	Phillips Pan Head Mach. Screw- #6-32 x 3/8 Lg. Sst.		13
3	Keps Hex Nuts #6-32 Sst.		13
4	Switch	MD-B-PR68A-0-1-0-19	1
5	Tape Spring	MD-B-PR68A-0-1-0-9	1
6	Instrument Knob	#PS-70D-2 Buckeye	1
7	Phillips Pan Head Mach. Screw- #2-56-3/8 Lg. Sst.		2
8	Hex Nuts #2-56 Sst.		2
9	External Tooth Lock Washer #2 Hole		2
10	Phillips Pan Head Mach. Screw- #6-32 x 7/8 Lg. Sst.		1
11	Belvell Washer Type Dip Sprint #6 Hole Sst.	All Metal Screw Products	1
12	Tape Adjuster	MD-C-PR68A-0-1-0-1	1
13	Bushing	MD-B-PR68A-0-1-0-18	2
14	Phillips Flat Head Mach. Screw- #8-32 x 1-1/2 Lg. Sst.		2
15	Sprocket, Low Inertia, Tape	C-100309	1
16	Front Guide	MD-B-PR68A-0-1-0-7	1
17	Reader Head	MD-C-PR68A-0-1-0-15	1
18	Shim Reader Head	MD-B-PR68A-0-1-0-3	1
19	Driving Motor	#SS25-1001 11.8v Slo-Syn	1
20	Phillips Pan Head Mach. Screw- #6-32 x 1/2 Lg. Sst.		8
21	Mtg. Brkt. Connector	MD-C-PR68A-0-1-0-10	1
22	Connector	#1712-18-PCC Sylvania	2
23	Cover Panel	MD-C-PR68A-0-1-0-12	1
24	Cover Box (Bottom)	MD-C-PR68A-0-1-0-6	1
25	Control Box Logo	MD-B-616-0-25-0-3	1
26	Pressure Pad	MD-B-PR68A-0-1-0-17	1
27	Plain Washer (Medium) 5/16 O.D. x 5/32 I.D. x 1/16 Thk. Sst.		5

TYPESETTING SYSTEM

TABLE 7-1 PARTS LIST (continued)

Item Number	Part	Part Number	Quantity
28	External Tooth Lock Washer, #6 Hole Sst.		10
29	Threaded Standoffs #6-32 x 1 3/8 Lg.		4
30	Cover Box (Top)	MD-B-PR68A-0-1-0-2	1
31	Utility Cabinet	MD-C-PR68A-0-1-0-13	1
32	Louvered Rear Panel	MD-C-PR68A-0-1-0-11	1
33	Phillips Pan Head Mach. Screw- #6-32 x 1/4 Lg. Sst.		1
34	Lens	MD-B-PR68A-0-1-0-16	1
35	Terminal	#2106-06-00 Shakeproof	2
36	Standoff	MD-B-PR68A-0-1-0-14	1
37	Brkt., Front Light	MD-B-PR68A-0-1-0-4	1
38	Light Bulb 12v-10W	#6475 Osram	1
39	Brkt. Rear Light	MD-B-PR68A-0-1-0-5	1
40	Cover Glass #1 Thk x 24 x 40 MM		1
41	Photosensing Cell #HPC-9-01 Hoffman		1
42	Strain Relief Bushing #SR-8P-1 Heyco		1
43	Rubber Extr. Channel	#X-172 x 2" Lg. Atlantic India Rubber Work	1
44	FLIP CHIP #G900		1
45	Phillips Flat Head Mach. Screw- #6-32 x 3/8 Lg., Sst.		1
46	Phillips Pan Head Mach. Screw- #6-32 x 3/4 Lg.		1
47	Fixed Resistor #0200R 25 Watt, 1.290 Amp; 15 ohms Ohmite		1
48	Fiber Shoulder Washer	#2150 HH Smith	4
49	Threaded Rod 6-32 x 4-7/8		1
50	Shim Corrugated	MD-A-PR68A-0-1-0-20	1
51	7.5 ohm 25W Resistor	TRU-OHM AR-25	1

TYPESETTING SYSTEM

SECTION 8

GLOSSARY OF TERMS

The following pages contain a glossary of terms commonly used in the printing, graphic arts, and newspaper fields. This glossary is designed to provide DEC maintenance personnel with a basic understanding of the terminology used in these areas. Hopefully, this may lead to improved communication and a better understanding of the problems encountered in those areas using the PDP-8 Typeset System.

Agate line	A standard of measurement for depth of columns of advertising space. Fourteen agate lines make one column inch.
Alterations	In composition, changes made in the copy after it has been set in type.
Ascender	That part of the letter which rises above the main body, as in "b".
Backing up	Printing the reverse side of a sheet already printed on one side. In electrotyping, backing a copper shell with metal to make the plate the required thickness.
Bad break	In composition, the setting of a hyphenated line as the first line of a page. Also, incorrect word division.
Base	In composition, all the metal below the shoulder of a piece of type. In letterpress, the metal or wood block on which printing plates are mounted to make them type high.
Basis weight	The weight in pounds of a ream (500 sheets) of paper cut to a given standard size for that grade: 25 x 38 for book papers, 20 x 26 for cover papers, 22 1/2 x 28 1/2 or 22 1/2 x 35 for bristols, 25 1/2 x 30 1/2 for index. E.g., 500 sheets 25 x 38 of 80-lb. coated will weigh eighty pounds.
Bearer	In photoengraving, the dead metal left on a plate to protect the printing surface while molding. In composition, type-high slugs locked up inside a chase to protect the printing surface. In presses, the surface-to-surface ends of cylinders that come in contact with each other.
Benday	A method of laying a screen (dots, lines and other textures) on artwork or plates to obtain various tones and shadings.

TYPESETTING SYSTEM

Bite	In photoengraving, the various stages of standard etching accomplished through the action of acid, the depth increasing after each bite.
Blanket	In offset-lithography, a rubber-surfaced sheet clamped around the cylinder, which transfers the image from plate to paper.
Blueprint	In offset-lithography and photoengraving, a photoprint made from negatives or positives, used as a proof.
Body	A term referring to the viscosity, consistency, or covering power of an ink or vehicle.
Bold-face type	A name given to type that is heavier than the text type with which it is used.
Break for color	In artwork and composition, to separate the parts to be printed in different colors.
Bulk	The degree of thickness of paper.
Burnishing	In photoengraving, the corrective treatment of a printing plate to darken local areas by spreading the printing surface of lines and dots.
Burr	Rough edges of metal caused by routing or cutting.
Caliper	The thickness of paper, usually expressed in thousandths of an inch.
Caps and small caps	Two sizes of capital letters made in one size of type, commonly used in most roman type faces.
Carbro	A photograph in full color, frequently used for process color reproduction.
Chase	A rectangular metal frame in which type and plates are locked up for printing.
Collate	In binding, the assembling of sheets or signatures.
Combination plate	In photoengraving, halftone and line work combined on one plate; etched for both halftone and line depth.
Column indent	A format in which all lines in a column are indented from the flush position.

TYPESSETTING SYSTEM

Comet	Trade name linecaster (See Electron)
Composing stick	In composition, a hand tool in which type is assembled and justified.
Condensed type	A narrow or slender type face.
Continuous tone	A photographic image which has not been screened and contains gradient tones from block to white.
Copy	Any furnished material (typewritten manuscript, pictures, artwork) used in the production of printing.
Curved plate	In letterpress, an electrotpe or stereotype which is backed up and pre-curved to fit the cylinder of a rotary press.
Cut	In letterpress, a photoengraving of any kind.
Cutscore	In die-cutting, a sharp-edged knife, usually several thousandths of an inch lower than the cutting rules in a die, made to cut part way into the paper or board for folding purposes.
Densitometer	A sensitive photoelectric instrument which measures the density of photographic images, or of colors in color printing. Used in quality control to determine accurately whether color is consistent throughout the run.
Descender	That part of the letter which extends below the main body, as in "p".
Display type	In composition, type set larger than the text, used to attract attention.
Distribution	In composition, the act of returning type, rules, leads, slugs, furniture, and other printing materials to their proper places after use.
Doctor blade	In gravure, a knife-edge blade pressed against the engraved printing cylinder which wipes away the excess ink from the non-printing area.
Dot	The individual element of a halftone.
Double dot halftone	Two halftone negatives combined into one printing plate, having greater tonal range than a conventional halftone. One negative reproduces the highlights and shadows; the other reproduces middletones. Used primarily in offset-lithography.

TYPESetting SYSTEM

- Drier** In inkmaking, any substance added to hasten drying.
- Dropout** A halftone with no screen dots in the highlights.
- Dummy** A "preview" of a proposed piece of printing.
- Duotone** In photomechanics, a term for a two-color halftone reproduction from a one-color photograph.
- Dropped rule** A straight type-high ruling slug often used to separate classified advertisements. See example below.

BABYSITTER needed. Once a week on Thursday 11 a.m. to 11 p.m. for one 6 yr. old girl. Agency fee rate paid : transportation. Call PL 54321 bef. 9 a.m. any morning.

HOUSEKEEPER, steady & dependable, short hours, 5 days per week. Weekly salary. Must have car. 791-8762.

BABYSITTER needed nites, 5 days a week, 3:15 - 12:30. Call 365-6605.

LIGHT housekeeping & some cooking for elderly people. Live in. Los Altos. \$150 month. 948-4598 or 812-7649.

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- Electron** Trade name for a linecaster similar to the Linotype; operates in the 6 to 9 pt range.
- Electron mixer** Same as Electron but capable of mixing up to four fonts in the 6 to 24-point range.
- Em** In composition, the square of a type body. So named because the letter "M" in early fonts was usually cast on a square body.
- En** One-half the width of an em.
- Engraving** A general term applied to any printing plate produced by an etching or cutting process.
- Etch** In photoengraving, to produce an image on a plate by chemical or electrolytic action. In offset-lithography, an acidified gum solution used to desensitize the non-printing areas of the plate; also, an acid solution added to the fountain water to help keep non-printing areas of the plate free from ink.
- Expanded type** Type whose width is greater than normal; also called extended type.

TYPESETTING SYSTEM

Face	The printing surface of a piece of type .
Feeder	The section of a press which separates the sheets and feeds them in position for printing .
Filling in (or filling up)	A condition in letterpress or offset-lithography where ink fills the area between the halftones dots or plugs up the type .
Flat	In off-set lithography, the assembled composite of negatives or positives, ready for platemaking . Also, a picture that is lacking in contrast .
Flow	The ability of an ink to spread over a surface or into a thin film .
Flush and Hang	A printing format in which the first line of text is set flush with the left margin with all following lines indented . See example below .

WSRS-FM
WORCESTER-96.1 mcs

A.M.

6:00--STEREO AT DAYBREAK: Cius Ogorman; Andre Kostelanetz; Howard Roberts Quartet; Anthony Newley; Enoch Light; Norman Luboff Choir.

9:00--STEREO MAGIC: Tony Bennett; Edmundo Ros; Peter Nero; Doris Day; Andre Kostelanetz; Ray Conniff.

P.M.

12:00--STEREO SHOWCASE: Peter Nero; Matti Monro; Warner Mueller; Rodgers and Hart; Rennie Aldrich; Teresa Brewer; Henry Mancini; 101 Strings; Enoch Light; Mel Davis.

5:00--STEREO SPECTRUM: Andre Previn; Jackie Gleason; Gita Bryant; George Shearing; Mantovani; Edmundo Ros.

8:00--BEST OF BROADWAY: Ray Conniff; Andre Previn; 101 Strings; Living Strings.

10:00--TONIGHT ON PCPS: Richard Tucker; A Pops Concert with various artists; Eugene Ormandy; Athena.

12:00--STEREO TILL SIX: Living Trio; Hollywood Bowl Symphony; Glen Gray; Nat King Cole; Frankie Carter; Enoch Light; Bob Eberly and Helen O'Connell; Exodus (soundtrack); Webley Edwards; Aretha Franklin; Cozy Cole; McGuire Sisters.

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Flush blocking	Mounting a plate so that the printing surface is flush with the edge of the block .
Flush left (or right)	In composition, type set to line up at the left (or right) . This glossary of terms is set flush left .
Flush paragraph	A paragraph with no indentation .
Flying paster	In web printing, an automatic pasting device that splices a new web of paper onto an expiring roll, without stopping the press .

TYPESSETTING SYSTEM

Font	A complete assortment of type of one size and face.
Form	Type and other matter locked in a chase ready for printing.
Form rollers	The rollers, either ink or dampening, which contact the plate.
Format	The size, style, type page, margins, printing requirements, etc., of any magazine, catalog, book or printed piece.
Furniture	In lockup, wood or metal blocks used to fill the blank spaces in a form.
Fuzz	Fibers projecting from the surface of a sheet of paper.
Galley	A shallow metal tray used to hold type.
Galley proof	A proof taken of type standing in a galley, before being made up into pages.
Gathering	The assembling of folded signatures in proper sequence.
Grippers	Metal fingers which hold the paper in place to the delivery end of a press.
Gripper edge	The leading edge of paper as it passes through a printing press.
Gripper margin	Unprintable blank edge of paper on which grippers bear, usually 1/2 inch or less.
Gutter	The blank space or inner margin, from printing area to binding.
Half-column cut	A photoengraved illustration, one-half column in width, inserted into a column of text. Also called a run-around. See example below.

Dr. Andras Fabry, a member of the Royal College of Veterinary Surgeons, has been appointed to the department of pharmacology and toxicology of Mason Research Institute, 21 Harvard St., it has been announced.



Dr. Fabry studied veterinary medicine in Liverpool, England, from 1956 to 1962 and did postgraduate work anaesthetics at the University of Glasgow.

Dr. Fabry

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TYPESETTING SYSTEM

Halftone	A reproduction of continuous tone artwork, such as a photograph, with the image formed by dots of various sizes.
Head margin	The white space above the first line on the page.
Hickeys	In offset-lithography, an imperfection in presswork due to many things such as dirt on the press, hardened by specks of ink, etc.
Highlight	The lightest or whitest parts in a printed picture, represented in a half-tone by the smallest dots or the absence of all dots.
Hot-metal equipment	A class of machines producing lines of type (slugs) used in the making of type cylinders for newspaper printing.
Imposition	The laying out of type pages in a press form so that they will be in the correct order after the printed sheet is folded.
Impression	In printing, the pressure of type or plate as it comes in contact with the paper.
Ink fountain	The container which supplies ink to the inking rollers.
Insert	A specially printed piece usually prepared for insertion in a publication.
Intaglio printing	Printing from plates in which the image is in intaglio or sunken below the surface, such as in steel-plate engraving or gravure.
Justify	In composition, to space out lines uniformly to the correct length.
Key	To code copy to a dummy by means of symbols, usually letters. Insertions are sometimes "keyed" in a like manner. In lockup, a device for operating quoins.
Key plate	In color printing, the plate used as a guide for the register of other colors. It normally contains the most detail.
Layout	The drawing or sketch of a proposed printed piece.
Leaders	In composition, rows of dashes or dots used to guide the eye across the page. Used in tabular work, programs, tables of contents, etc.
Leads	Thin strips of metal placed between lines of type to separate them vertically.
Letterspacing	The spacing between each letter of a word.

TYPESSETTING SYSTEM

Linecasting machines	Any of a group of keyboard and/or perforated-tape controlled devices which cast lines of lead type (slugs) using brass mats (matrices) as molds.
Linofilm	Trade name for a group of photocomposition machines. <u>Linofilm</u> - Used in display advertising work; operates in the 6 to 48 pt range. <u>Linofilm Quick</u> - Used in straight text work; operates in the 6 to 18 pt type range.
Linotype	Trade name for a hot-metal linecasting machine controlled from a keyboard or paper tape; operates in the 6 to 14 pt range.
Lockup	In letterpress, to position a form in a chase for printing.
Logotype (or logo)	Name of a company or product in a special design used as a trademark in advertising.
Long ink	An ink that has good flow in the fountain.
Loose lines	Lines in which the total width of the mats used is less than the preset line length. When this occurs, the linecaster will not mold a slug.
Lower case	The small letters in type, as distinguished from the capital (upper case) letters.
Ludlow	Trade name for a manually operated linecaster which produces type slugs from hand-set type mats.
Magazine	In hot-metal typesetting equipment, a container, usually mounted at the top of the equipment, from which type-molding mats are automatically drawn to produce type slugs.
Makeready	In letterpress, the building up of the press form so that heavy and light areas print with the correct impression.
Makeup	In composition, the arrangement of lines of type and illustrations into pages of proper length.
Mask	In color separation photography, an intermediate photographic negative or positive used in color correction. In offset-lithography, opaque material used to protect open or selected areas of printing plates during exposure.

TYPESSETTING SYSTEM

Masking paper	In offset-lithography, goldenrod paper to which negatives are fastened in stripping to produce a flat.
Mat	Newspaper term for a matrix.
Matrix	A mold in which type is cast in linecasting machines. In stereotyping, the paper mold made from a type form.
Measure	In composition, the width of type, usually expressed in picas.
Middletones	The tonal range between highlights and shadows of a photograph or reproduction.
Mixing	The process by which mats are drawn from different magazines on a single linecaster to produce distinctive printing formats; as in advertisements. See example of four-magazine mixing below.



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Moire	Undesirable screen pattern in color process printing caused by incorrect screen angles of halftones.
Mottle	The spotty or uneven appearance of printing. Most pronounced in solid areas.
Newsprint	A generic term used to describe the kind of paper generally used in the publication of newspapers.
Nickeltype	In electrotyping, a plate on which the first deposit is of nickel and the remainder of the shell is copper. Nickeltypes give sharper definition in printing and are more durable than copper.

TYPESSETTING SYSTEM

Offset	See Set-off.
Opaque	In photoengraving and offset-lithography, to paint out areas on a negative not wanted on the plate. In paper, the property which makes it less transparent.
Overlay	In letterpress makeready, a piece of paper placed in the packing to make that part of the form print more heavily. In artwork, a transparent or translucent covering over copy where color break, instructions, or corrections are marked.
Overprinting	Double printing; printing over an area that already has been printed.
Overset	In composition, type set in excess of space needs in publications.
Paragraph indent	A format in which the initial line of a paragraph is indented with the balance of lines flush left.
Pasteup	The preparation of copy for photographic reproduction by putting all elements in the proper position.
Patent base	In letterpress, a slotted metal base on which unmounted electrotypes are secured.
Perfecting press	A press which prints both sides of paper at one time.
Photocomposition	A process by which reproducible page masters are photographically produced.
Photon	Trade name for a group of photocomposition machines. <u>Photon 513</u> - Used in display advertising; operates in the 6 to 72 pt range. <u>Photon 560</u> - similar to the 513. <u>Photon 713</u> - Used in straight text operation; type font in the 6 to 18 pt range.
Pi	Type mixed and in an unusable condition.
Pica	Printer's unit of measurement used principally in measuring lines. One pica equals 1/6 of an inch.
Picking	The lifting of the paper surface during printing. It occurs when pulling force (tack) of ink is greater than surface strength of paper.

TYPESSETTING SYSTEM

Piling	The building up or caking of ink on rollers, plate or blanket; will not transfer readily.
Point	Printer's unit of measurement, used principally for designating type sizes. There are 12 points to a pica; 72 points to an inch.
Primary colors	In printing inks, yellow, magenta (process red) and cyan (process blue). In light, the primary colors are red, green and blue.
Process printing	The printing from a series of two or more halftone plates to produce intermediate colors and shades. Usually in four-color process: yellow, red, blue, and black.
Progressive proofs	Proofs of each individual plate in a set of color process plates, pulled in the proper colored inks, and also showing the results of adding each color.
Quad	In composition, blank spacing material less than type high used to fill out lines.
Quoin	In letterpress, steel wedge-shaped or expanding devices used in lockup.
Register	Fitting of two or more printing images upon the same sheet of paper in exact alignment with each other.
Register marks	Crosses or other devices applied to original copy prior to photography. Used for positioning negatives in perfect register, or for color register of two or more colors in printing.
Reproduction proof	In composition, the proof of a type form for photographic reproduction.
Reverse plate	A printing plate in which the parts that are usually black or shaded are reversed, so as to appear white or grey.
Routing	Cutting away the non-printing areas of a letterpress plate.
Sans-serif	A typeface having no serifs. The typeface used in this book is sans-serif.
Scale	The proportion between dimensions of an original and its reproduction. Degree of enlargement or reduction.
Scanner	An electronic device used in the making of color separations.

TYPESSETTING SYSTEM

Score	To impress or indent a mark with a string or rule in the paper to make folding easier.
Screen	In photoengraving and offset-lithography, glass or film with cross-ruled opaque lines or vignetted dots used to reproduce continuous tone artwork such as photographs. Also, the number of lines or dots to the linear inch on printed illustrations.
Serif	The short cross-lines at the ends of the main strokes in roman type faces.
Set-off	In presswork, when the ink of a printed sheet rubs off or marks the next sheet as it is being delivered. Formerly called offset.
Shadow	The darkest parts in a photograph, represented in a halftone by the largest dots.
Short ink	An ink that does not flow freely.
Signature	In book, magazine and catalog work, the name given to a large printed sheet after it has been folded to the required size.
Slitting	Cutting printed sheets or webs into two or more sections by means of cutting wheels on the press or folding machine.
Slug	In composition, a one-piece line of type. Also a strip of metal, usually 6 points, used for spacing.
Small caps	An alphabet of small capital letters available in most roman type faces approximately the size of the lower case letters. Used in combination with larger capital letters.
Stet	A proofreader's mark, written in the margin, signifying that copy previously marked for corrections should stand as printed and not be corrected.

TYPESETTING SYSTEM

Straight matter Columns of printing containing continuous text matter using the same type style and size. See example below.

The Worcester Chapter of the Administrative Management Society will hold "Education Night" tomorrow at 6:45 p.m. in the Coach and Six Restaurant.

Highlighting the evening's activities will be the awarding of a scholarship to a Worcester area high school student, a panel discussion on "How Are We Preparing Our Young People For Business?", and installation of new officers for the coming year.

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Strike-through The penetration of ink through paper.

Stripping In offset-lithography, the arranging of negatives (or positives) in their proper position on a flat prior to platemaking.

Substance The weight in pounds of a ream (500 sheets) of paper cut to the standard size (17 x 22) for business papers (bond, ledger, mimeograph, duplicator and manifold). E.g., 500 sheets of 20-lb. bond cut to the standard size will weigh 20 pounds.

Tabular matter Tabulated lists of data, often statistical. See examples of single-, and half-column tabular matter below.

	American					National			
	W.	L.	Pct.	GB		W.	L.	Pct.	GB
Chicago	18	7	.720	...	Cincinnati	21	10	.677	...
Detroit	17	9	.654	1½	Pittsburgh	16	9	.640	2
Kansas City	13	14	.481	6	St Louis	15	11	.577	3½
Boston	13	14	.481	6	Chicago	15	11	.577	3½
Cleveland	12	13	.480	6	Atlanta	14	14	.500	5½
New York	12	13	.480	6	San Francisco	14	14	.500	5
Washington	12	15	.444	7	Philadelphia	13	14	.481	6
California	13	17	.433	7½	New York	10	15	.400	8
Minnesota	11	15	.423	7½	Los Angeles	10	17	.370	9
Baltimore	11	15	.423	7½	Houston	8	21	.276	12

Single-column tabular matter

TYPESETTING SYSTEM

FIFTH — \$2,800, Claiming, 3 and 4
Year-olds, 6 furlongs.

Blenham	111	Merry Flight	113
Broken Note	113	County C.	113
Ma Tarzan	111	Henry W.	107
Mr. Peppercorn	109	Abdicatè	116
Madre To M'ket	104	Alex The Fox	114
Winged Action	123	Interstate	118

Half-column tabular matter

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Thirty	Used in newspapers, the symbol "-30-" means the end of the story.
Tight lines	Lines in which the total width of the mats used is too great to fit within the jaws of the linecaster. Often produces a jam.
Transpose	To exchange the position of a letter, word, or line with another letter, word, or line.
Type gauge	A printer's tool calibrated in picas used to measure the various sizes of types.
Type high	0.918 inch; the standard in letterpress printing.
Vacuum frame	In photoengraving and offset-lithography, a printing frame used in plate-making. The negative (or positive) is held in close contact with the plate by vacuum.
Vehicle	The fluid component of printing ink which acts as a carrier for the pigment.
Vignette	An illustration in which the background fades gradually until it blends into the unprinted paper.
Washup	The process of cleaning the rollers, form or plate, and sometimes the fountain of a press.
Web	A roll of paper used in web or rotary presses, printed, and most often folded, pasted and counted in one continuous operation.
Web press	A general term applied to high-speed presses which print from continuous rolls of paper.
Web tension	The amount of pull or tension applied in the direction of travel of a web of paper by the action of a web-fed press.

TYPESSETTING SYSTEM

Widow	In composition, a single word in a line by itself, ending a paragraph; frowned upon in good typography.
Work-up	In letterpress, a space, lead or other spacing material which works itself to the surface during printing, normally caused by poor lockup.
Wrap-around plate	In rotary letterpress, a thin one-piece relief plate which is wrapped around the press cylinder; similar in appearance to an offset plate.
Wrong font	In proofreading, the mark "WF" indicates a wrong letter or character in a line.

TYPESETTING SYSTEM

SECTION 9 SCHEMATICS

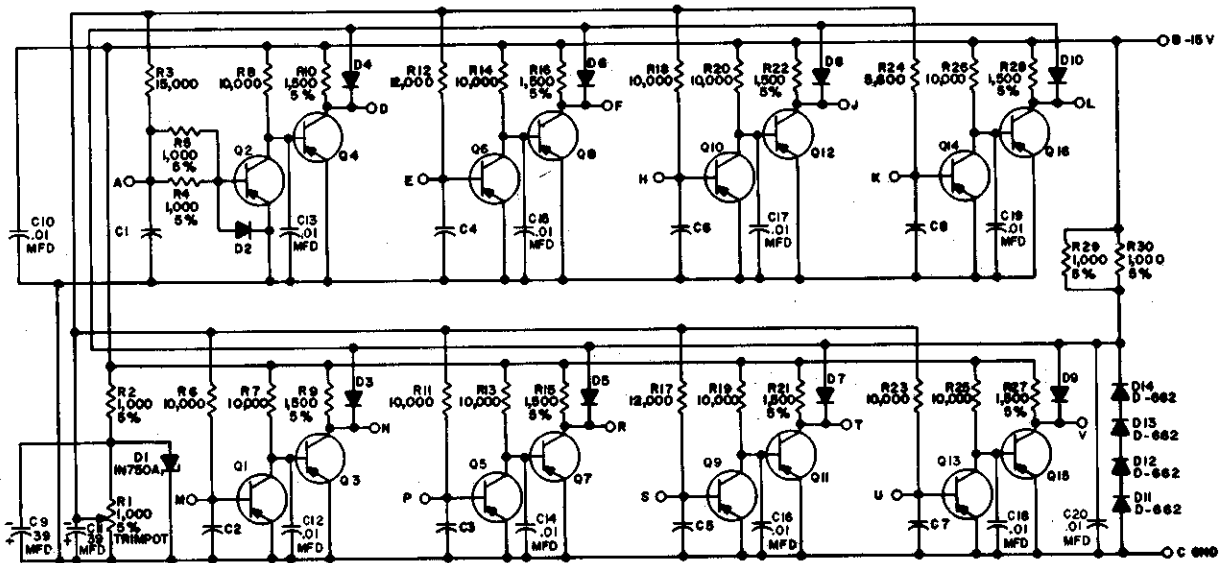
The following pages contain schematics of all circuit modules used in the PA60A Reader/Punch Control Unit, PA61A Reader/Punch Interface Unit, and the PR68A Paper Tape Reader. Also included are block schematics of these units.

9.1 SEMICONDUCTOR SUBSTITUTION

Standard EIA components specified in table 9-1 can replace the majority of DEC semiconductors used in modules of the interface, control and tape reader units and shown on the RS drawings. Exact replacement is recommended for semiconductors not listed.

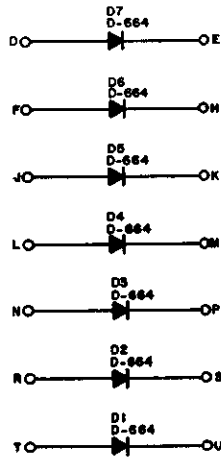
TABLE 9-1 SEMICONDUCTOR SUBSTITUTION

DEC	EIA
D-662	1N645
D-664	1N3606
D-664	1N645
DEC2219	2N2219
DEC3009	2N3009
DEC3009B	2N3009
DEC3494	2N3494
DEC3639	2N3639
DEC3639-0	2N3639
DEC3790	2N3790
DEC6534B	MPS6534
MR2066	1N4003

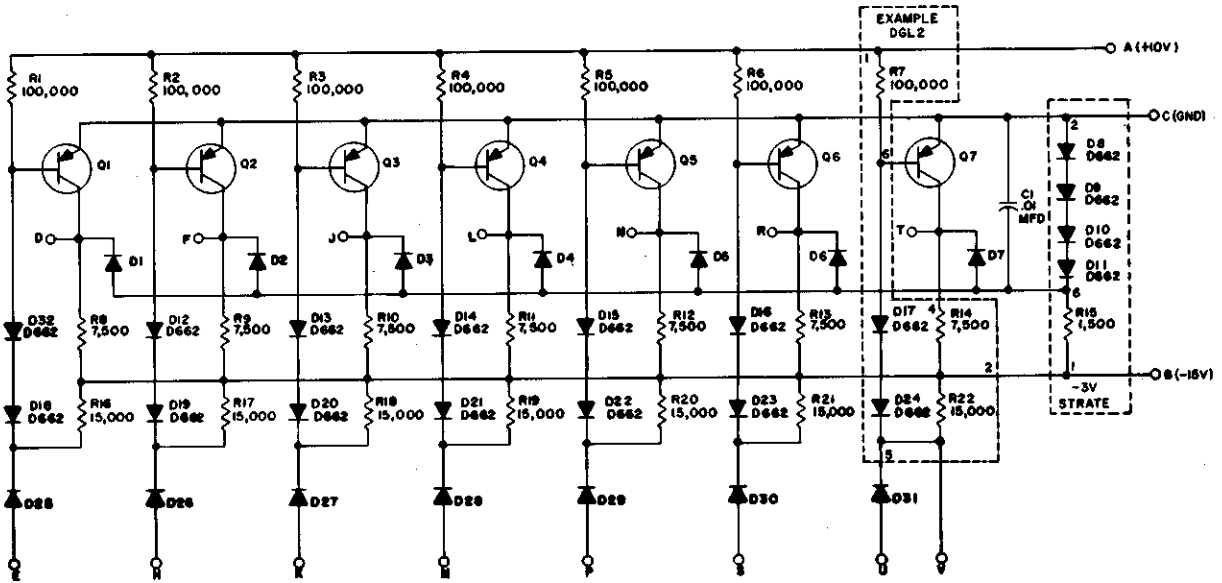


UNLESS OTHERWISE INDICATED:
 TRANSISTORS ARE DEC 2894-1B
 RESISTORS ARE 1/4 W, 0%
 DIODES ARE D-664
 CAPACITORS ARE 180 MMFD

Photo Amplifier G900

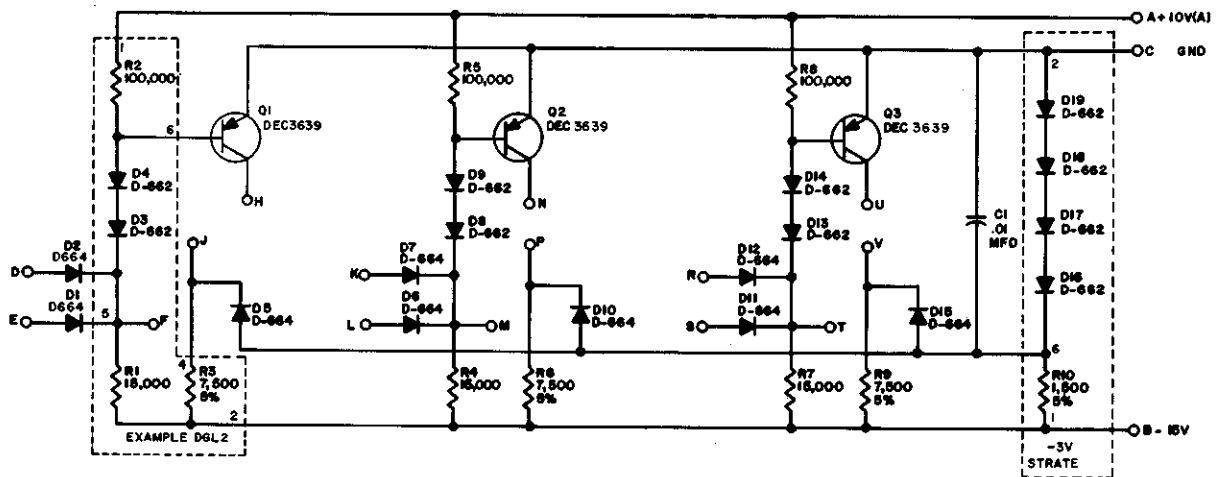


Diode Network R001



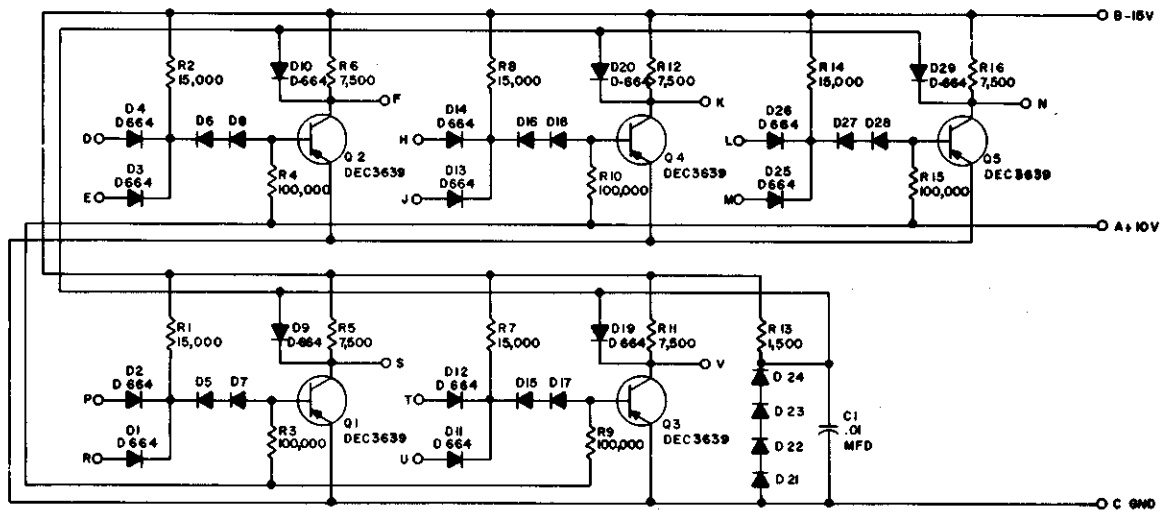
UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 5%
 DIODES ARE D-664
 TRANSISTORS ARE DEC 3639
 PRINTED CIRCUIT REV. FOR
 DGL BOARD IS S1A

Inverter R107



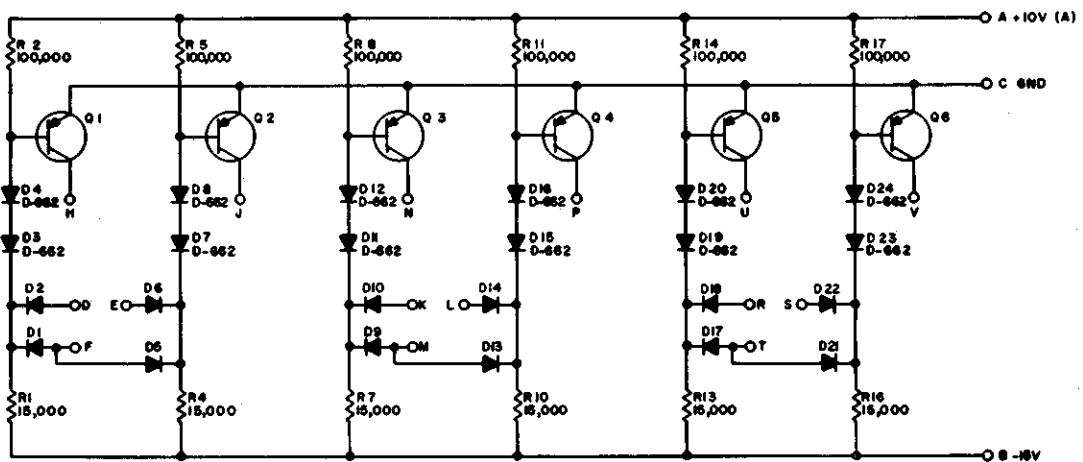
UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 5%
 PRINTED CIRCUIT REV. FOR
 DGL BOARD IS S1A

Diode Gate R111



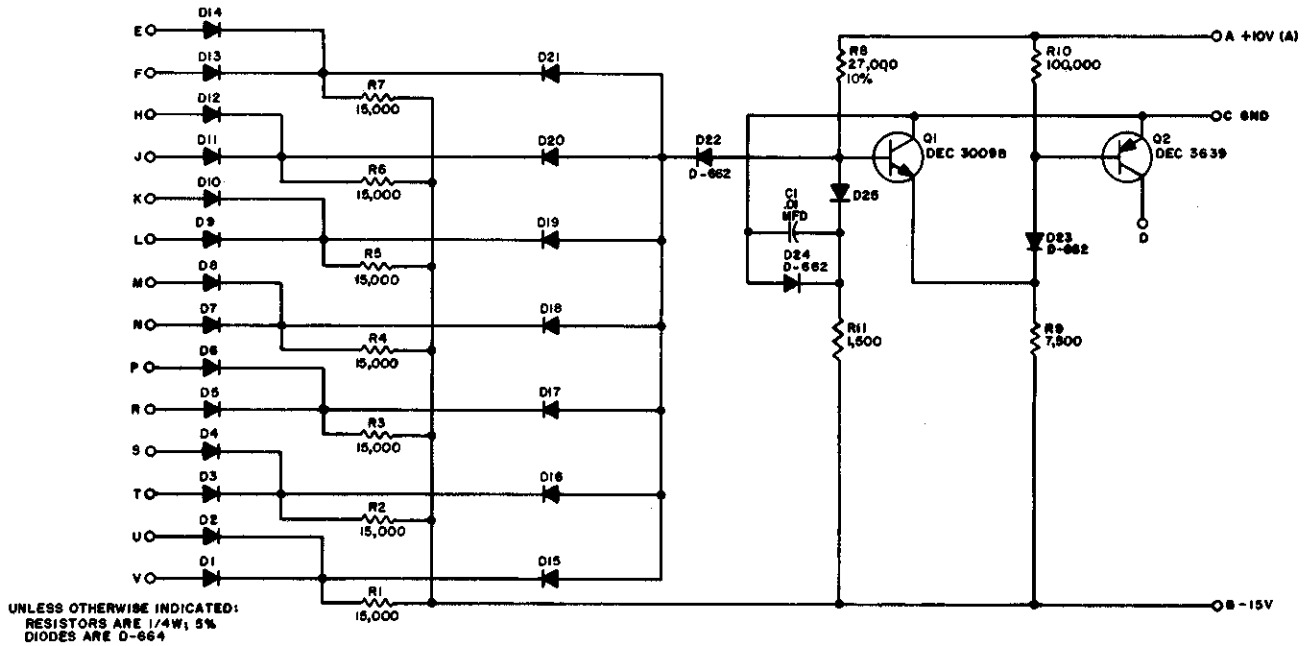
UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4 W, 5%
 DIODES ARE D 664

Diode Gate R113

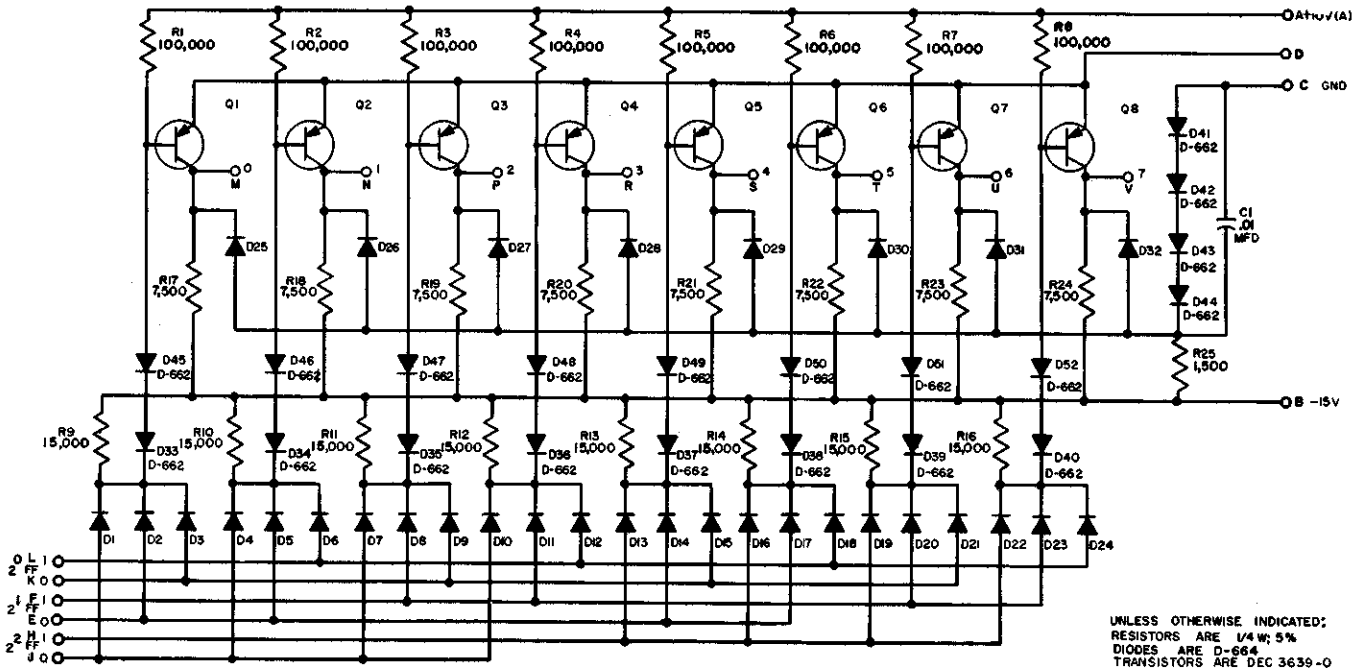


UNLESS OTHERWISE INDICATED:
 TRANSISTORS ARE DEC 3639
 RESISTORS ARE 1/4 W, 5%
 DIODES ARE D-664

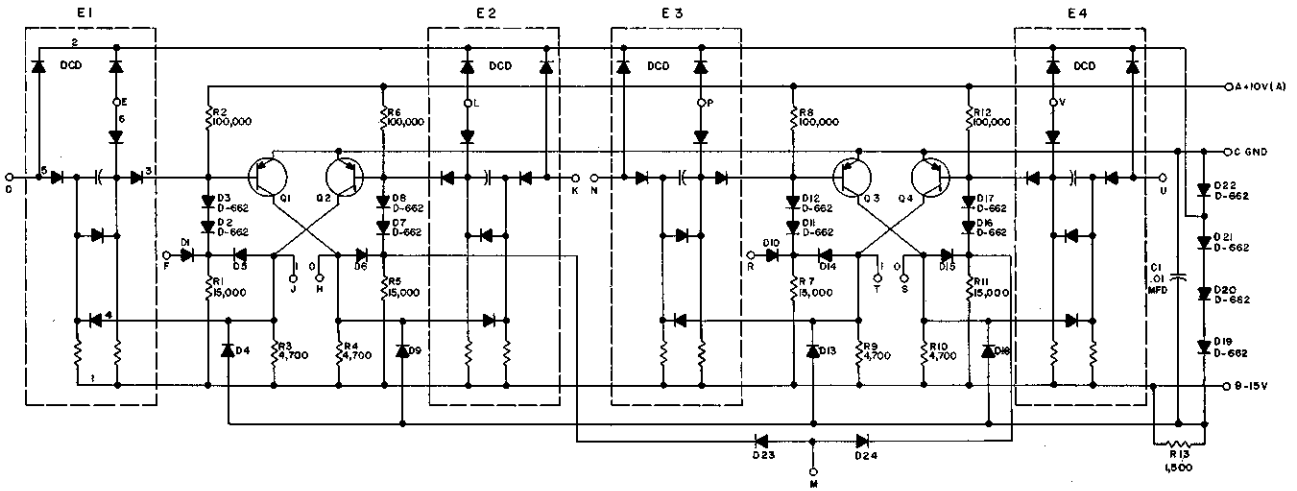
Diode Gate R123



Diode Gate R141

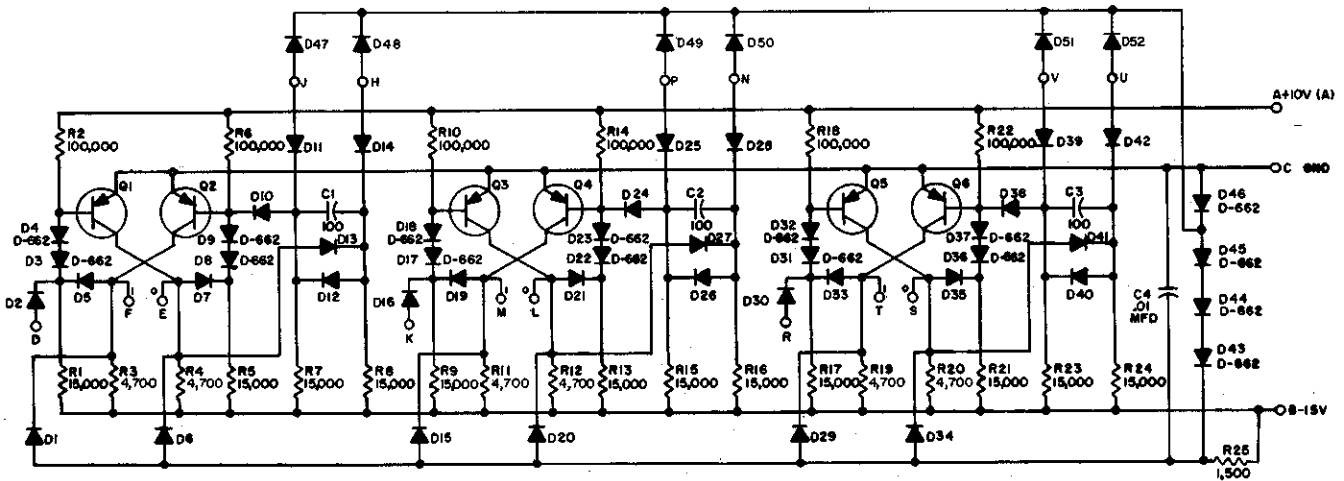


Binary to Octal Decoder R151



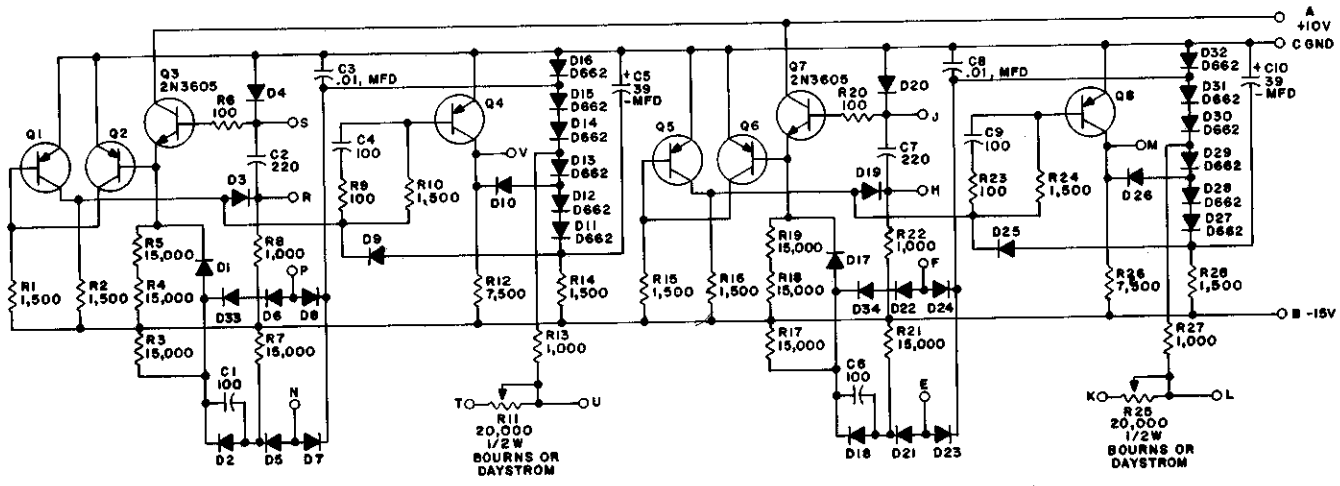
UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4 W, 5%
 TRANSISTORS ARE DEC 3639
 DIODES ARE D-664

Dual Flip-Flop R202



UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 5%
 CAPACITORS ARE MMFD
 DIODES ARE D-664
 TRANSISTORS ARE DEC 3639C

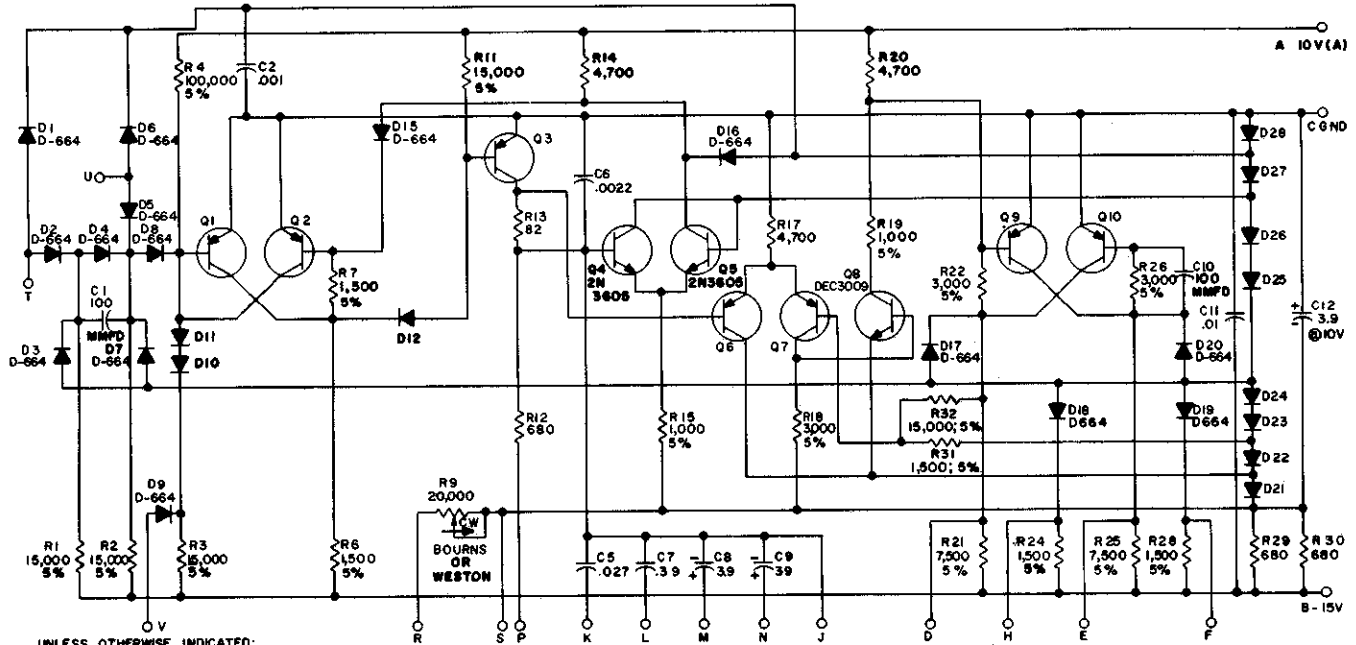
Triple Flip-Flop R203



UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W; 5%
 CAPACITORS ARE MMFD
 DIODES ARE D664
 TRANSISTORS ARE DEC3639

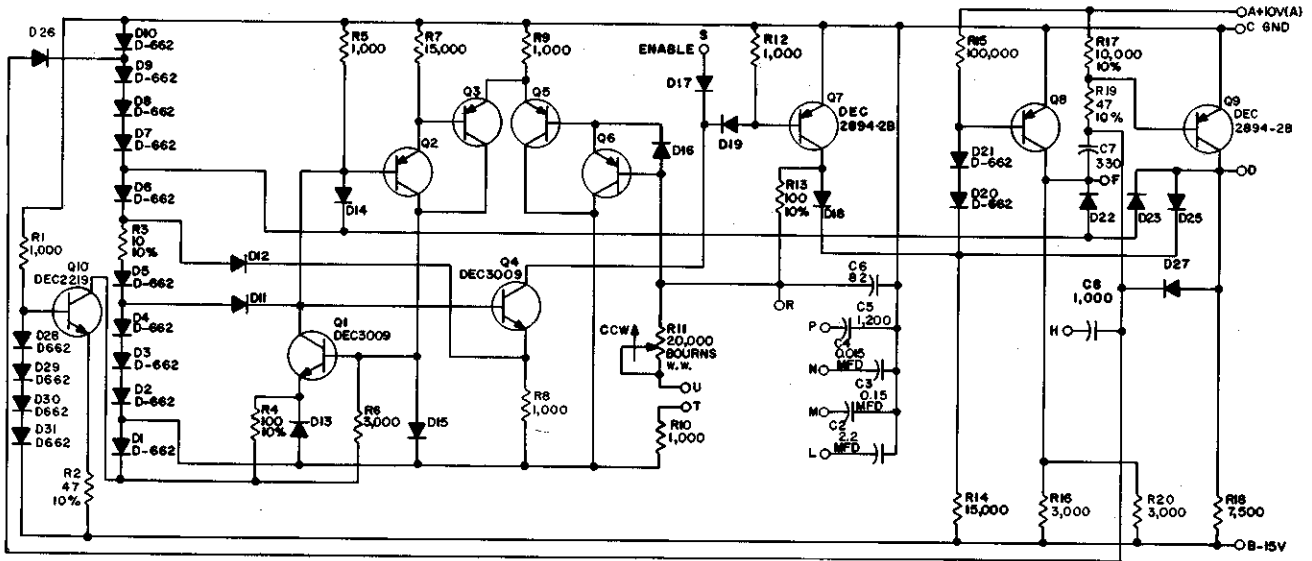


Delay One Shot R302



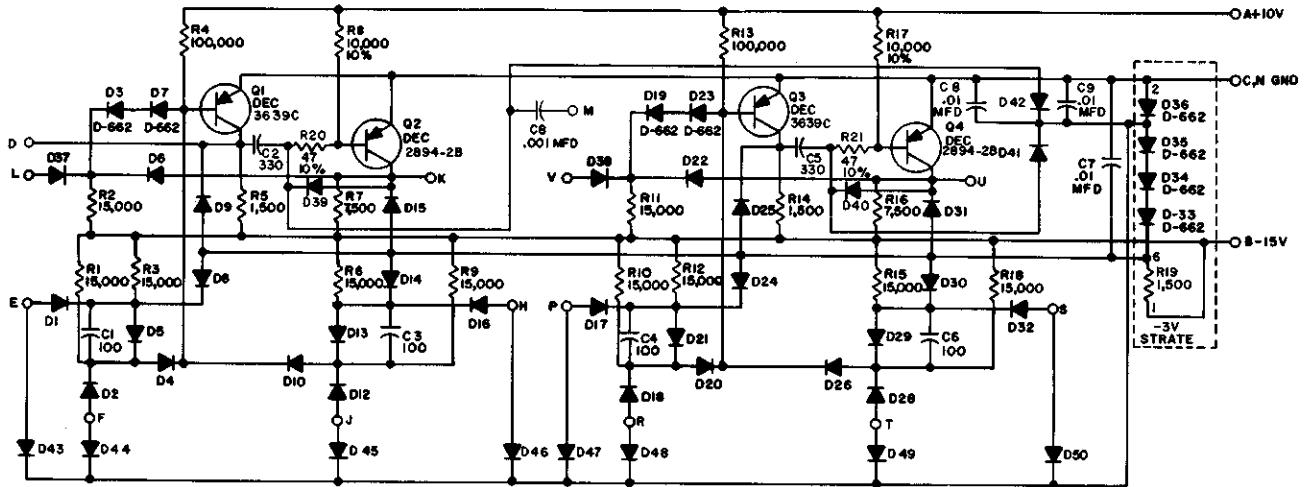
UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 10%
 DIODES ARE D-662, R9 IS A 27SP
 TRANSISTORS ARE DEC 3639, CAPACITORS ARE MFD

Integrating One Shot R303



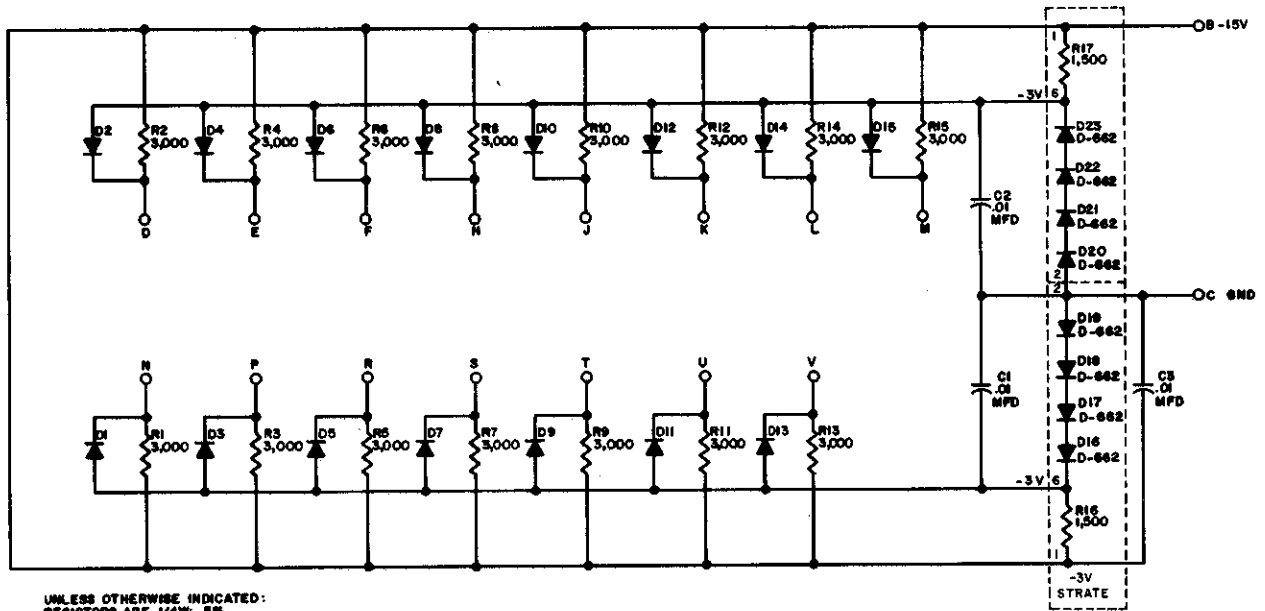
UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 5%
 CAPACITORS ARE MMFD
 DIODES ARE D-664
 TRANSISTORS ARE DEC 3639-0
 R11 IS A #275P

Clock R401



UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 5%
 CAPACITORS ARE MMFD
 DIODES ARE D-664

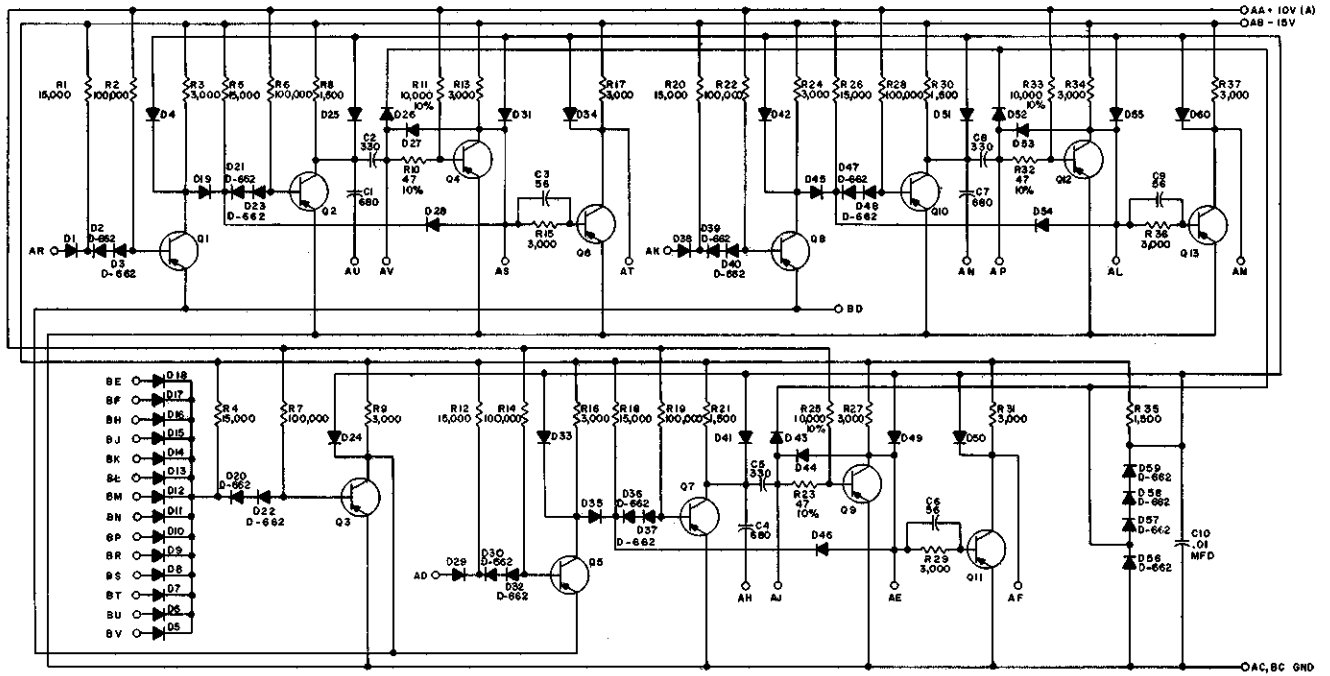
Pulse Amplifier R602



UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 5%
 DIODES ARE D-664

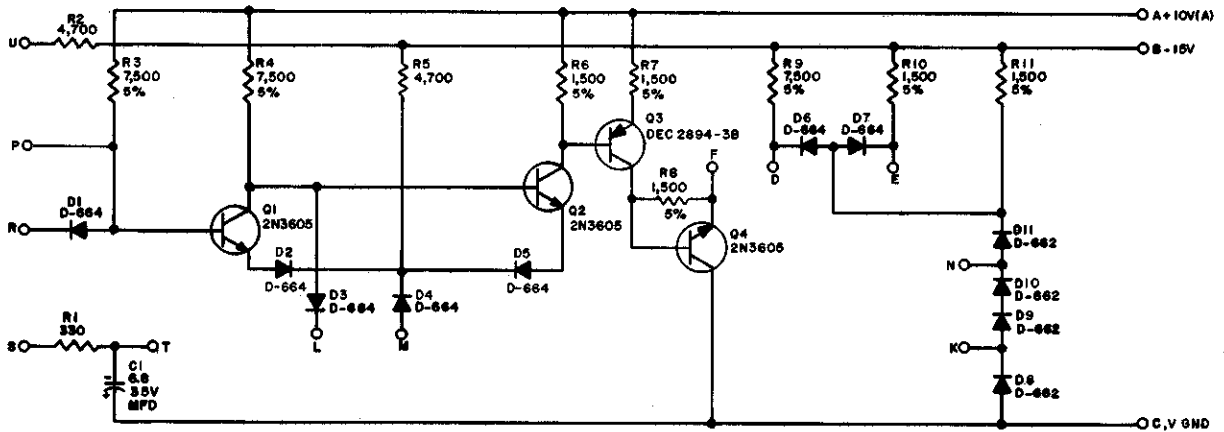
Clamp Loads W005

Terminated Cable Connector W028



UNLESS OTHERWISE INDICATED:
 TRANSISTORS ARE DEC 3639
 RESISTORS ARE 1/4 W, 5%
 CAPACITORS ARE MMFD
 DIODES ARE D-664

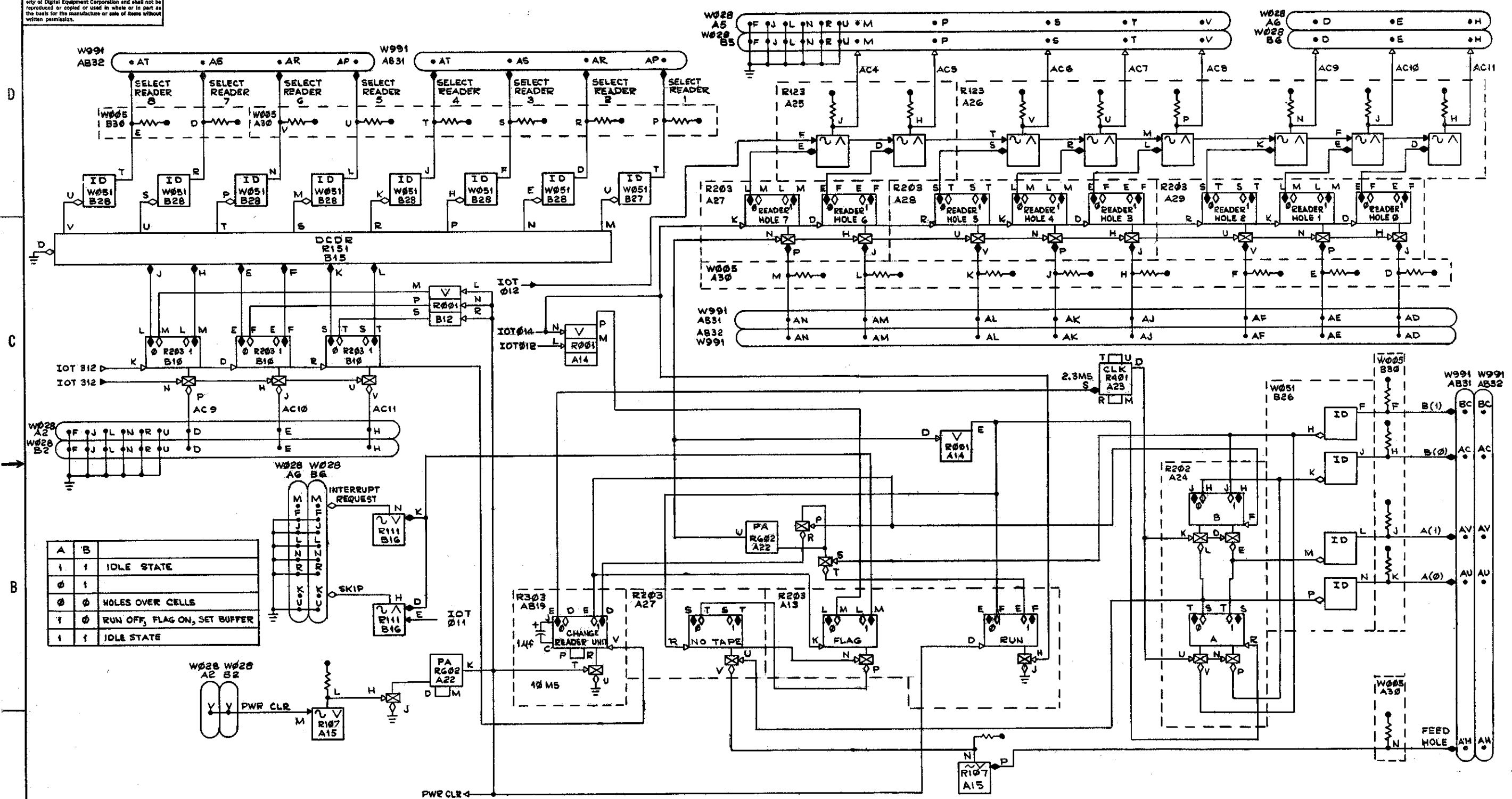
Device Selector W103



UNLESS OTHERWISE INDICATED:
 RESISTORS ARE 1/4W, 10%

Schmitt Trigger W501

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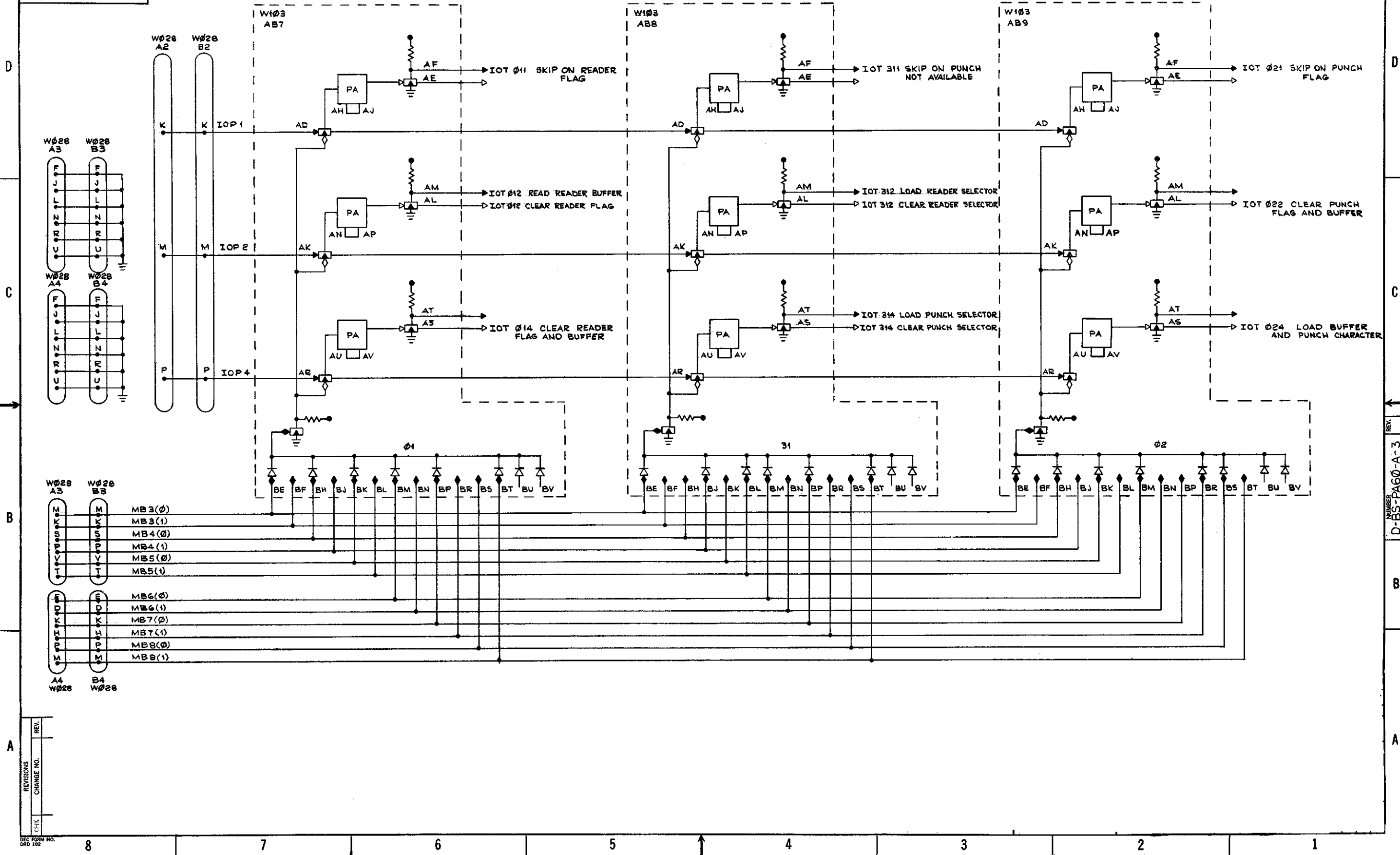


A	B	
1	1	IDLE STATE
0	1	HOLES OVER CELLS
1	0	RUN OFF, FLAG ON, SET BUFFER
1	1	IDLE STATE

REVISIONS	CHG. NO.	REV.
	ECO # 95	A
	ECO # 114	B
	ECO # 131	C

DEC FORM NO. DRD 102

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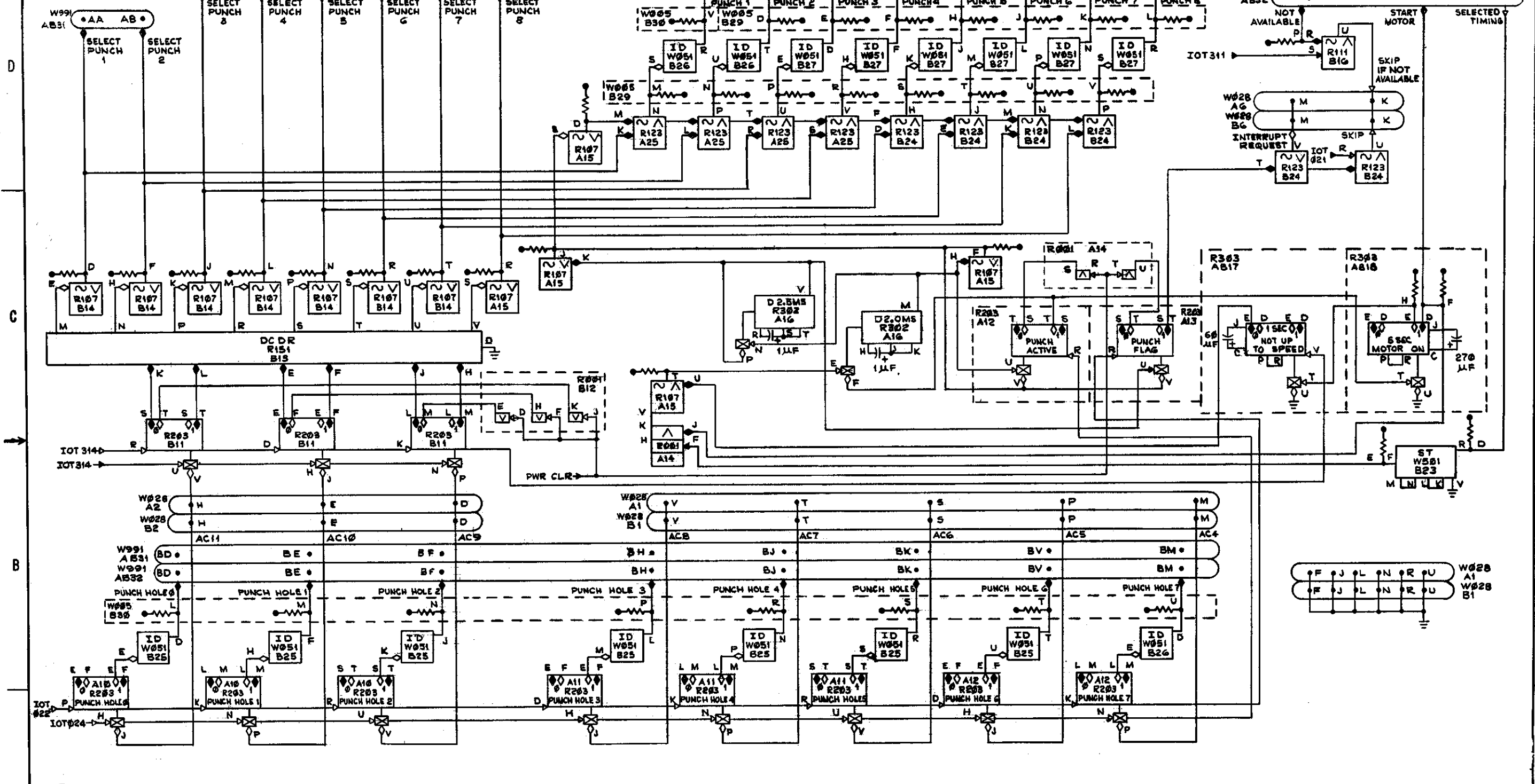


REV.	CHANGE NO.	REVISIONS

DEC FORM NO. 500 102

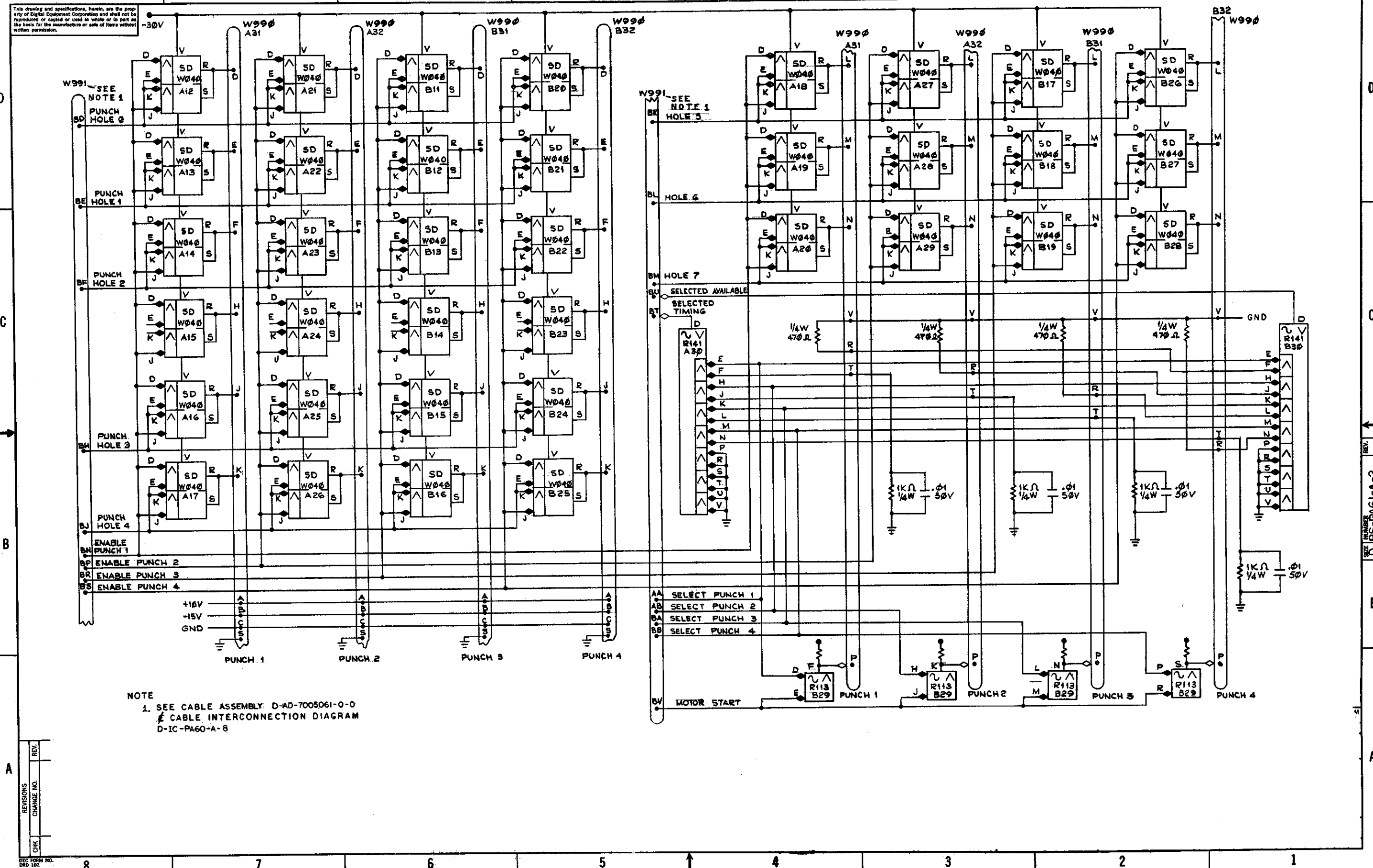
NUMBER D-BS-PA60-A-3

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REV.	
CHANGE NO.	
CHK.	
DEC FORM NO.	DRP 102

D-BS-PA60-A-4

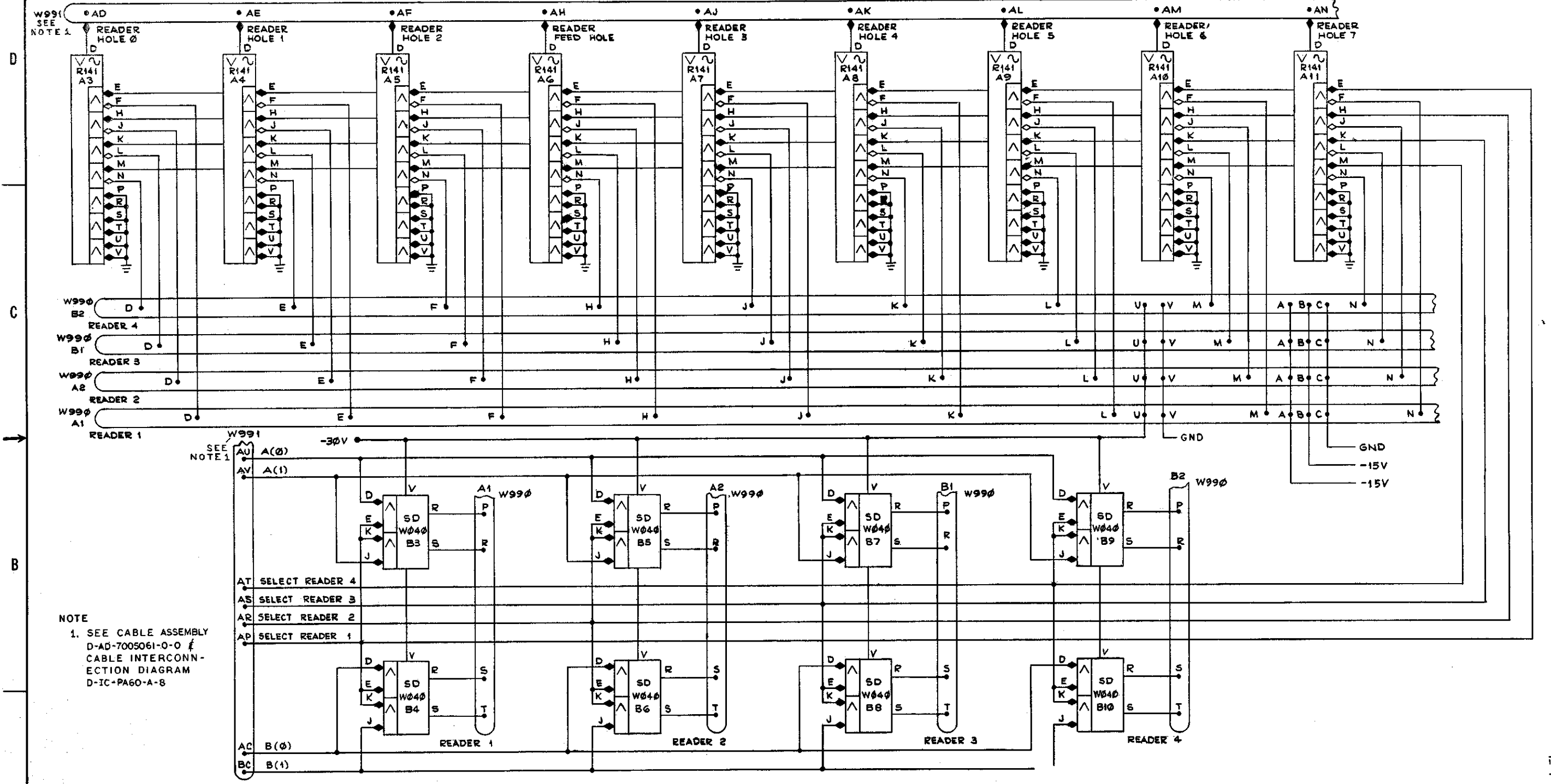


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NOTE
 1. SEE CABLE ASSEMBLY D-AD-7005061-0-0
 & CABLE INTERCONNECTION DIAGRAM
 D-IC-PA60-A-8

REV.
 D-BS-PA61-A-2

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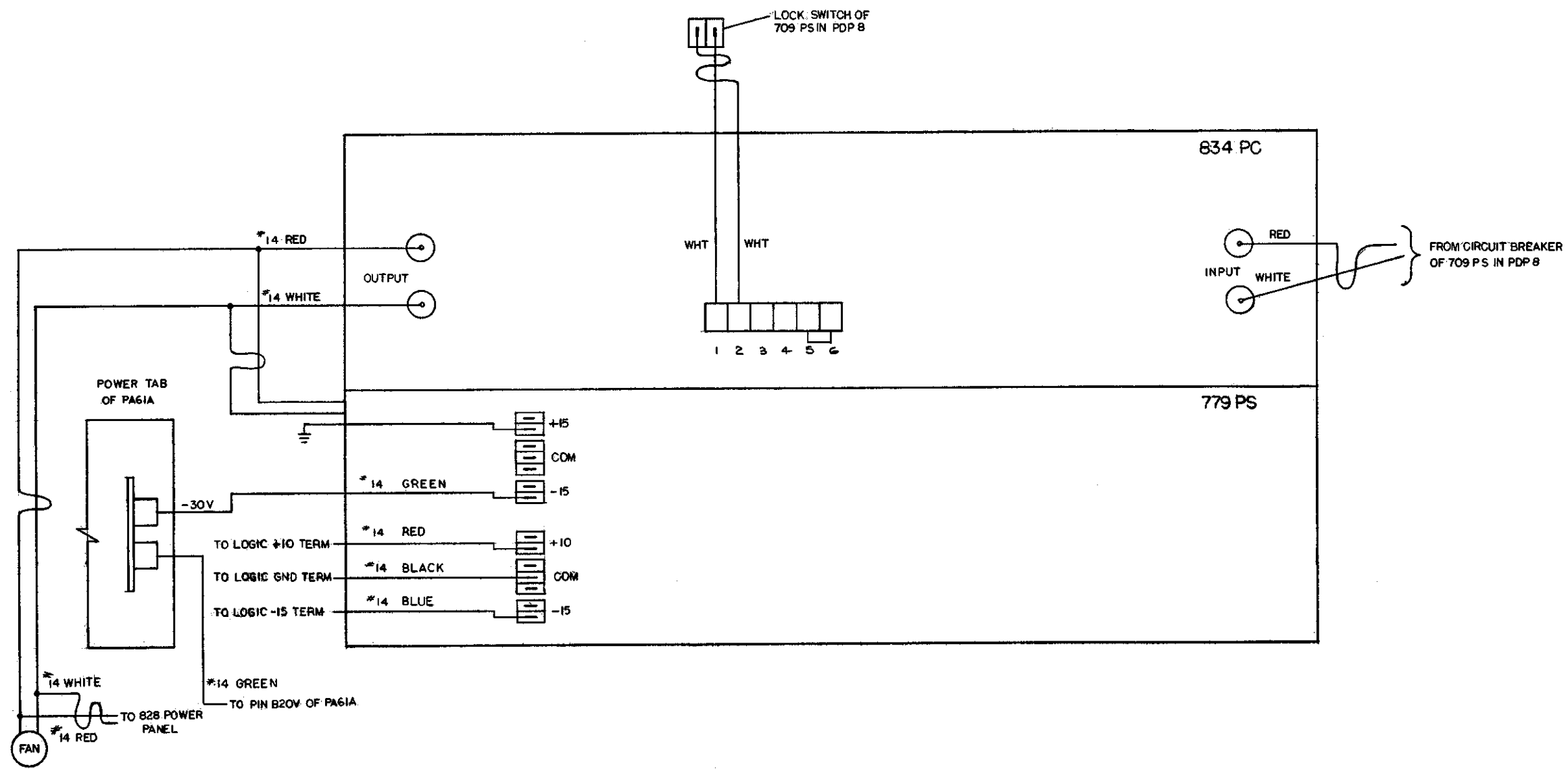


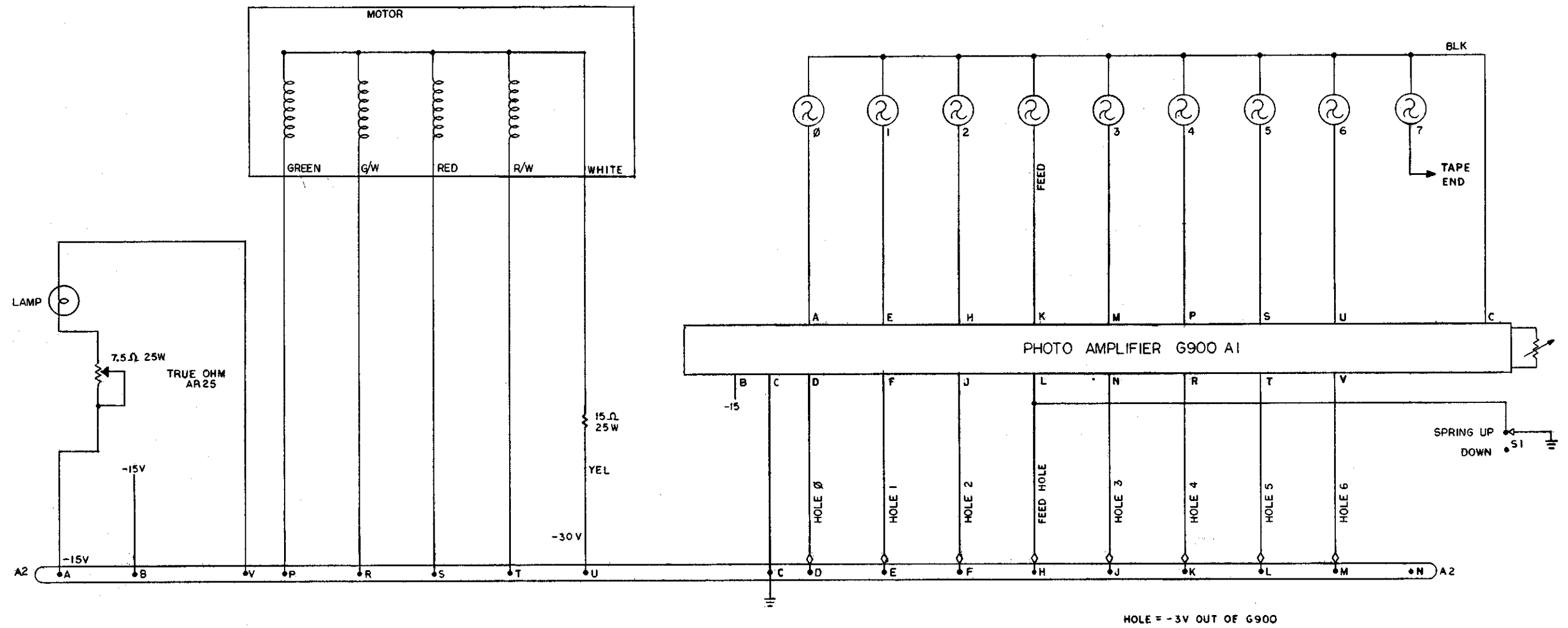
NOTE
 1. SEE CABLE ASSEMBLY
 D-AD-7005061-0-0 &
 CABLE INTERCONNECTION
 DIAGRAM
 D-IC-PA60-A-8

REVISIONS	CHANGE NO.	REV.
CHK	ECO #112	A
BY		
12-27-66		
J. Chubbuck		
J. P. ...		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
A	W990	W990	RT41	RT41	RT41	RT41	RT41	RT41	RT41	RT41	RT41	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040		
	READER 1	READER 2	READER HOLE 0	READER HOLE 1	READER HOLE 2	READER FEED HOLE	READER HOLE 3	READER HOLE 4	READER HOLE 5	READER HOLE 6	READER HOLE 7	PUNCH 1 HOLE 0	PUNCH 1 HOLE 1	PUNCH 1 HOLE 2	PUNCH 1 FEED	PUNCH 1 HOLE 3	PUNCH 1 HOLE 4	PUNCH 1 HOLE 5	PUNCH 1 HOLE 6	PUNCH 1 HOLE 7	PUNCH 2 HOLE 0	PUNCH 2 HOLE 1	PUNCH 2 HOLE 2	PUNCH 2 HOLE 2	PUNCH 2 FBED	PUNCH 2 HOLE 3	PUNCH 2 HOLE 4	PUNCH 2 HOLE 5	PUNCH 2 HOLE 6	PUNCH 2 HOLE 7	SELECTED TIMING	PUNCH 0	PUNCH 2		
	*	**							()	()		*	*	*	*	*	*	()	()	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
B	W990	W990	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040	W040		
	READER 3	READER 4	READER 1 A(0)	READER 1 B(0)	READER 2 A(0)	READER 2 B(0)	READER 3 A(0)	READER 3 B(0)	READER 4 A(0)	READER 4 B(0)	PUNCH 3 HOLE 0	PUNCH 3 HOLE 1	PUNCH 3 HOLE 2	PUNCH 3 FEED	PUNCH 3 HOLE 3	PUNCH 3 HOLE 4	PUNCH 3 HOLE 5	PUNCH 3 HOLE 6	PUNCH 3 HOLE 7	PUNCH 4 HOLE 0	PUNCH 4 HOLE 1	PUNCH 4 HOLE 2	PUNCH 4 FEED	PUNCH 4 HOLE 3	PUNCH 4 HOLE 4	PUNCH 4 HOLE 5	PUNCH 4 HOLE 6	PUNCH 4 HOLE 7	PUNCH 1 MOTOR START	PUNCH 2 MOTOR START	PUNCH 3 MOTOR START	PUNCH 4 MOTOR START	SELECTED AVAILABLE	PUNCH 3	PUNCH 4
			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	()	()	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

NOTE:
 1. IF NO (*) IS PRESENT USE IRREGARDLESS OF PUNCHES & READERS
 2.* USE WHEN 1 PUNCH OR 1 READER IS USED
 ** USE WHEN 2 PUNCH OR 2 READER ARE USED
 *** USE WHEN 3 PUNCH OR 3 READER ARE USED
 **** USE WHEN 4 PUNCH OR 4 READER ARE USED
 3. () USE WHEN 8 LEVEL OPERATION IS REQUIRED.





HOLE = -3V OUT OF G900