Errata

Title & Document Type: **6941A Multiprogrammer Extender Operating and Service Manual**

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Agilent Technologies

OPERATING AND SERVICE MANUAL

MULTIPROGRAMMER EXTENDER

MODEL 6941A

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MULTIPROGRAMMER EXTENDER
MODEL 6941A

OPERATING AND SERVICE MANUAL
FOR SERIALS 1149A-00101 AND ABOVE*

*For Serials Above 1149A-00101 a change page may be included.

HP Part No. 06941-90001

Printed: December, 1971

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SECTION I
GENERAL INFORMATION

1-1 SCOPE

1-2 This instruction manual provides complete operating and service instructions for the 6941A Multiprogrammer Extender (see cover). Accessory input/output cards and the 6940A Multiprogrammer, which is the Master unit in a Multiprogrammer System, are covered in separate instruction manuals. Overall system concepts, including system installation, troubleshooting, and operating considerations are covered in the instruction manual for the 6940A Master unit and will not be repeated in this manual.

1-3 DESCRIPTION

1-4 6941A Multiprogrammer Extender

1-5 This unit is intended for use only as an addition to the 6940A Master and must be controlled through this unit. Up to fifteen Extenders can be operated with one 6940A to extend the maximum capacity of a Multiprogrammer System to 240 input/output channels.

1-6 The 6941A mainframe is similar in construction to the 6940A, having the same basic card cage, rear panel, and dc power supply. The main differences between the two units are in the circuit cards which plug into the mainframe. The plug-in card complement for the 6941A is as follows:

SLOT	6941A PLUG-IN CARDS
100	A1 Input Card (Extender)
200	A2 I/O Transfer Card
300	A3 Logic and Timing Card (same as A3 card in 6940A)
400-414	A4 Input and/or Output Accessory Cards
500	Vacant (occupied by Unit Select Card in 6940A)
600	A6 Regulator Card (when used).

1-7 The programmed data and address bits, 15 unit selection lines, and control and timing signals from the 6940A Multiprogrammer are cabled to input jack J1 of the first 6941A extender unit in the system. Further, when the input mode is selected, extender unit input data is placed on the programmed data lines and on to connector J1 for return along with control signals, to the 6940A Multiprogrammer.

1-8 When the input mode is not selected, the data and address bits are routed through input adapter card A7 to input card A1. After being properly terminated by card A1, the bits are coupled through I/O transfer card A2 in slot 200 to logic and timing card A3. When the input mode is selected, input data bits 0-11 from the A3 card are buffered on the A2 card and selected for return to the 6940A. Since the outputs of the A2 card selection logic are connected to the same lines as the output mode programmed data, the input data is routed to connector J1 in place of programmed data for return to the 6940A.

1-9 The A3 logic and timing card in the 6941A extender unit is identical to the A3 card in the 6940A multiprogrammer. The A3 card selects either programmed data for application to the extender unit output card slots or it selects input card data for application to the A2 card and transmission back to the computer. The selection is based on the input mode control signal supplied to the 6941A from the 6940A. Like the 6940A A3 card, in addition, the 6941A A3 card generates a flag signal which is returned to the 6940A, through the J1 connector and chaining cable, to indicate the busy-ready status of the 6941A extender unit Ø1.

1-10 The unit Ø1 select line of the 15 input unit select lines is wired to all input/output card slots of unit Ø1, while the remaining 14 unit select lines are jumpered directly from input jack J1 to output jack J2 and then through a chaining cable to the next extender unit in the system. This process is repeated until at the 15th extender unit all unit select lines have been terminated at their associated unit.

1-11 When unit Ø1 is selected, its 400 through 414 input/output card slots are partially enabled. The next data or address word will enable one input/output card of unit Ø1 to receive programmed data (output) or transmit (input) data. The input/output data, unit select, and control and timing signals at output jack J2 are chain-cabled to input jack J1 of the next 6941A extender unit in the system.

1-12 Input/Output Cards

1-13 The function of the output cards is to develop an output quantity proportional to programmed data, and to deliver this quantity to the user's system. The output cards are similar to one another in that each contains address gate, data storage, and output data conversion circuits. The nature of the output conversion circuits determines the card type.

1-14 Output cards are programmed using a 16-bit data word. Twelve of the bits represent programmed data while the

remaining four bits contain the output card slot address. The 12 bits are used in different ways on the various type output cards to develop an output to the user's systems. For digital-type output cards, the 12 output bits can be either identical to or the complement of the 12 programmed bits. For analog-type output cards (voltage, resistance, etc.) the data bits are used to adjust the value of binary-weighted precision resistance networks. The outputs of the networks are then either connected directly to external programmable power supplies (or other devices that can be programmed by a variable resistance) or used on the output card to adjust the gain of an operational amplifier. In the latter case, the operational amplifier will produce a voltage or current output proportional to the programmed data.

1-15 An output card programmed to a particular output value will hold that value until it is readdressed and the programmed data is changed.

1-16 The function of the input cards is to receive data from the user's system and make it available to the computer. The input cards each contain an address gate and input data interface circuits. Further, input cards can be supplied with storage capability so that the user's system need supply input data for a short period of time after which it is maintained on the input card until accepted by the computer. The nature of the user's input, i.e., digital input data versus relay contact closure data, determines the card type.

1-17 Input cards are programmed using a 16-bit address word. The same four bits used to specify an output card slot address are also used to address an input card slot. The remaining 12 bits are not relevant to the input cards. An input card's 12 data bit outputs are transmitted to the computer when an address word selects the associated input card slot and the multiprogrammer has been previously placed in the input mode.

1-18 When an input/output card is plugged into a particular slot of a particular unit, it assumes the address of that slot and unit, and will either receive and store data (output cards) or transmit data (input cards) only when that unit and slot are addressed. Unit selection is accomplished by decoding control words, as described previously, but slot address decoding is accomplished by directly wiring a unique combination of four slot address bits to each of the 15 input/output slots. If a card is moved to a new slot it assumes the address of that slot.

1-19 When one or more D/A voltage converter or current controller output cards are used in a 6940A (or a 6941A), an A6 voltage regulator card must be installed in slot 600 to supply operating power. This card contains four isolated +15 and -15 volt regulated supplies. One of the supplies has a 450mA capability while the remaining three can provide up to 150mA.

1-20 All input/output cards are fabricated on a 4½" x 11" printed circuit card. The inner end of the card contains a dual 24 pin (48 pin total) printed circuit plug that can mate with any connector in slot 400 through 414. For analog-type output cards, the output quantity is taken from a terminal block located on the outer end of the card; for digital-type input/output cards, the input/output bits are received/taken from a dual 15 pin printed circuit plug on the outer end of the card. All external device wiring is routed through a false bottom channel of the multiprogrammer unit to the user's system.

1-21 INTERFACING

1-22 Interfacing of the entire Multiprogrammer System with the digital programming device is accomplished by input card A1 in the 6940A Master. Input card A1 in the 6941A merely provides the proper termination for unit-to-unit cabling.

1-23 As supplied from the factory, the 6941A is configured for operation from a 115Vac ±10%, 48-440Hz power source. The 6941A can also be operated from a 230Vac ±10%, 48 to 440Hz power source by setting the 115V-230V selector switch (↓) within the ac power module on the rear panel to 230V and replacing the 4 AMP line fuse with a 2 AMP fuse. (See Paragraph 2-22.)

1-24 SPECIFICATIONS

1-25 Specifications for the 6941A Multiprogrammer Extender are given in Table 1-1.

Table 1-1. Specifications

INPUT POWER:	115Vac ± 10%, 48-440Hz, 2A (Standard) 230Vac ± 10%, 48-440Hz, 1A (Switch Selectable).
DATA WORD TRANSFER RATE:	100k word/sec. maximum, in the handshake mode. (Measured directly at the input terminals of the unit. Does not include external delays that might be caused by cables or computer interface circuitry.)
DATA RESOLUTION:	12 bits.
TEMPERATURE RANGE:	Operating: 0° to +55°C. Storage: -40° to +75°C.
OPERATING POSITION:	30 degrees off horizontal (maximum).
DIMENSIONS:	See Figure 2-1.
COOLING:	Natural convection.

1-26 ACCESSORIES

1-27 Tables 1-2 and 1-3, respectively, list the accessories furnished with and available for use with the 6941A. The descriptions of the available accessories in Table 1-3 are general and in no way represent complete specifications. Complete specifications are covered in the Instruction Manual for each accessory.

Table 1-2. Accessories Furnished

ACCESSORY	DESCRIPTION
Data Input Plug P1, Part No. 1251-0086	Mates with data input connector on 6941A; allows user to fabricate his own chaining cable.
Rack Mounting Kit, Part No. 5060-8741	Allows 6941A to be rack mounted.
Plug-In Extender Card, Part No. 5060-7901	Extends plug-in cards out of the unit chassis for troubleshooting.

Table 1-3. Accessories Available

ACCESSORY	DESCRIPTION
PROGRAMMABLE OUTPUT CARDS:	
Programmable Resistance Cards: Model 69300A	A versatile programmable output card that can be configured by the user to provide one 12-bit or two 6-bit output channels. Output resistors are not loaded on this model. The choice of output component values is left to the user.
Models 69301A through 69304A	Provides a single 12-bit resistance programming channel; the programming coefficients of these models are compatible with HP Programmable Power Supplies.
Models 69310A through 69313A	Provides two 6-bit resistance programming channels; these models are designed for programming the current limit of HP Programmable Power Supplies
Relay Output Card, Model 69330A	Provides 12 separate form A (SPST, normally open) mercury-wetted contact outputs that reflect the status of 12 programmed data bits.
Relay Output/Readback Card, Model 69433A	Provides same outputs as Model 69330A; also supplies 12 input data lines that can be read by the computer and which indicate the relay coil voltage status.
11-Bit D/A Voltage Converter Card (Low Speed), Model 69320A	Provides programmable voltage output from +10V to −10V at programming speeds of <10msec.
12-Bit D/A Voltage Converter Card (High Speed), Model 69321A	Provides programmable voltage output from +10V to −10V at programming speeds of <50μsec.
Current Controller Card, Model 69370A	Provides programmable current output from 0 to 20mA at programming speeds of < 100μsec.
Voltage Regulator Card, Model 69351A	Required for use with D/A Voltage Converter and Current Controller cards. Installed in multiprogrammer slot 600 to provide ±15Vdc operating voltage for D/A converter cards.
TTL Output Card, Model 69331A	Provides microcircuit logic level outputs on 12 separate output lines. Outputs reflect the status of 12 programmed data bits.

Table 1-3. Accessories Available (Continued)

ACCESSORY	DESCRIPTION
PROGRAMMABLE INPUT CARDS:	
Digital Input Card, Model 69431A	Accepts 12 bits of TTL, DTL, RTL, or contact closure logic from user's device. Outputs to computer reflect the status of 12 input bits.
Telephone Relay Monitor Card, Model 69432A	Accepts 12 bits of contact closure logic from user's device, can withstand 1500 volt transients without damage.
CHAINING CABLE ASSEMBLY, MODEL 14541A	Interconnects 6940A and 6941A's in expanded Multiprogrammer Systems.

1-28 INSTRUMENT IDENTIFICATION

1-29 Hewlett-Packard instruments are identified by a three-part serial number. The first part is the instrument model number. The second part is the serial number prefix, consisting of a number-letter combination denoting the date of a significant design change. The first two digits indicate the year (10 = 1970, 11 = 1971, etc.); the second two digits indicate the week; and the letter "A" designates the U.S.A. as the country of manufacture. The third part is the instrument serial number; a different 5-digit sequential number is assigned to each instrument, starting with 00101.

1-30 If the serial number on your instrument does not agree with those on the title page of this manual, Change Sheets supplied with the manual or Manual Backdating Changes define the differences between your instrument and the instrument described by this manual.

1-31 ORDERING ADDITIONAL MANUALS

1-32 One manual is shipped with each instrument. Additional manuals may be purchased from your local Hewlett-Packard field office (see list at rear of this manual for addresses). Specify the model number, serial number prefix, and MP Part number shown on the title page.

INSTALLATION

SECTION II
INSTALLATION

2-1 INITIAL INSPECTION

2-2 Before shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is received, proceed as instructed in the following paragraphs.

2-3 Mechanical Check

2-4 If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken controls or connectors, and dents or scratches on the panel surfaces. If the instrument is damaged, file a claim with the carrier's agent and notify your local Hewlett-Packard Sales and Service Office as soon as possible (see list at rear of this manual for addresses).

2-5 Electrical Check

2-6 Check the electrical performance of the instrument as soon as possible after receipt. Section V of this manual contains checkout procedures which will verify instrument operation. Refer to the inside front cover of the manual for the Certification and Warranty statements.

2-7 REPACKAGING FOR SHIPMENT

2-8 To insure safe shipment of the instrument, it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available, contact your local Hewlett-Packard field office to obtain the materials. This office will also furnish the address of the nearest service office to which the instrument can be shipped. Be sure to attach a tag to the instrument specifying the owner, model number, full serial number, and service required, or a brief description of the trouble.

2-9 INSTALLATION DATA

2-10 The 6941A is shipped with all standard mainframe cards (A1, A2, and A3) installed. To prepare the 6941A for operation, it is necessary to rack-mount it, install accessory input or output cards, and connect signal and power cables. The 6941A can be controlled only through a 6940A Master unit. Refer to the 6940A manual for system installation, cabling and other data.

2-11 Location

2-12 The 6941A is convection cooled. When mounted in a rack, a minimum of 0.25 inch (and preferably 1 inch) should be left between units so that a free flow of cooling air can reach internal components. The unit should be installed in an area where the ambient temperature remains between 0°C and +55°C.

2-13 Outline Diagram

2-14 Figure 2-1 illustrates the outline shape and dimensions of the 6941A.

2-15 Rack Mounting

2-16 An instruction card attached to the 6941A rack mounting kit (supplied with each unit) illustrates and describes the procedure for preparing the 6941A for rack mounting.

2-17 Accessory Card Installation

2-18 Before installing cards, be sure to first perform the 6941A checkout procedure given in Section V of this instruction manual. Accessory cards are installed in slots 400 through 414. To install the accessory cards, proceed as follows:

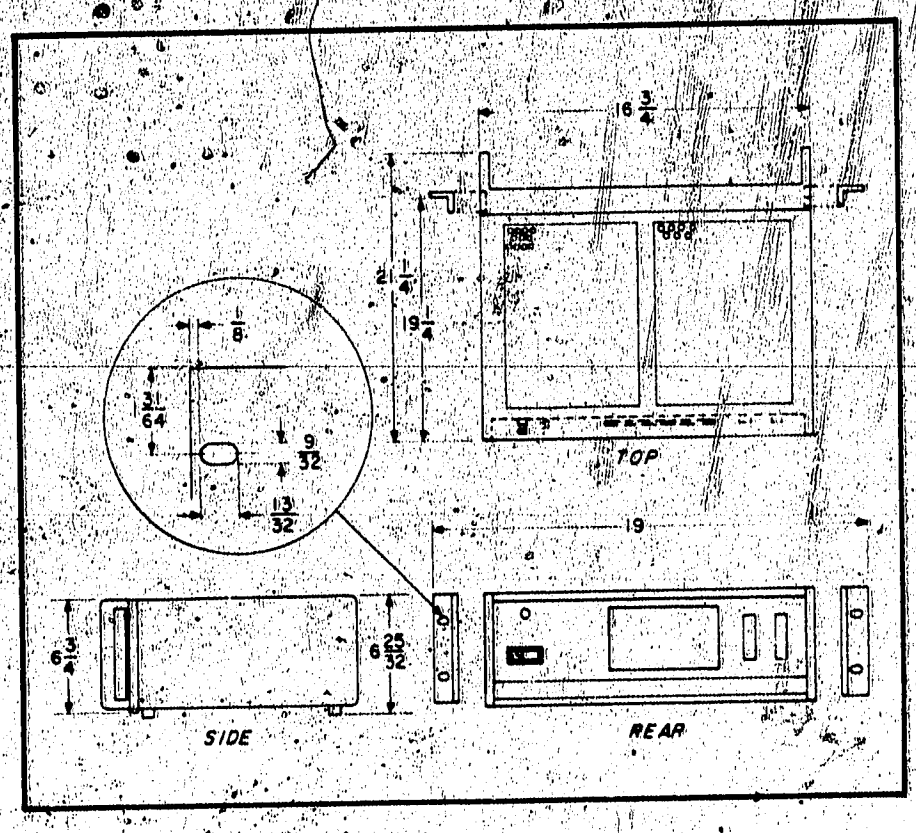


Figure 2-1. Outline Diagram

a. Open the hinged front panel of the unit by turning the recessed screw within the knurled handle counterclockwise.

b. With the accessory card components on the right, slide the card into the desired slot (400 through 414). Note that all accessory cards are slotted between pins 4 and 5 and all 400 series connectors on the mainframe are keyed between the same points. This makes it virtually impossible to plug an accessory card in upside down or into any other than a 400 series slot.

c. Route all wiring from the accessory cards through the false-bottom channel and out the back of the unit to the external system. Special wiring considerations are covered in the instruction manuals for the individual accessory cards.

d. As installation is completed for each accessory card, carefully note and record the following types of information on the installation record card located on the rear of the hinged front panel.

(1) Accessory card type

(2) Application in external system

(3) Nature of output (voltage, resistance, contact closure, etc.)

(4) Ranges, scaling factors, polarity, logic sense, etc.

2-19 System Cabling

2-20 Refer to Section II of the 6940A Operating and Service Manual for system cabling information.

2-21 INPUT POWER REQUIREMENTS

2-22 The 6940A and 6941A may be operated continuously from either a nominal 115 volt or 230 volt, 48-440Hz power source. A two-position selector switch (↓) located within the ac power module on the rear panel (Figure 2-2) selects the power source. Before connecting the instrument to the power source, check that the selector switch setting matches the nominal line voltage of the source. If required, move the switch to the other position. Note that the power cable must be removed, the plastic door on the power module must be moved aside, the fuse extractor must be pulled outward and the fuse must be removed in order to gain access to the selector switch.

2-23 When the instrument leaves the factory, the proper fuse is installed for 115 volt operation. An envelope containing a fuse for 230 volt operation is attached to the instrument. Make sure that the correct fuse is installed if the position of the slide switch is changed (4A for 115 volt operation and 2A for 230 volt operation).

2-24 Power Cable

2-25 To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three conductor power cable. The

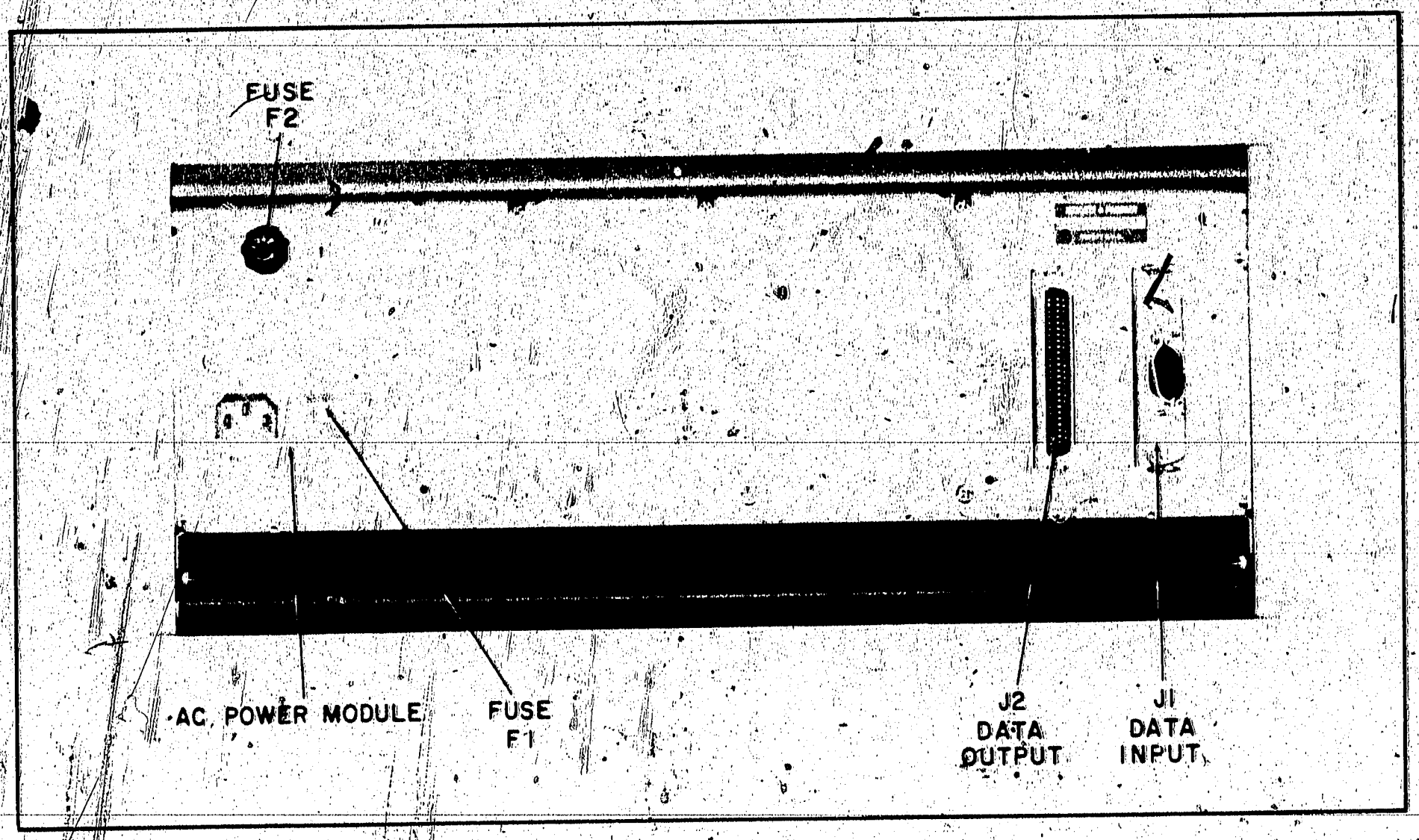
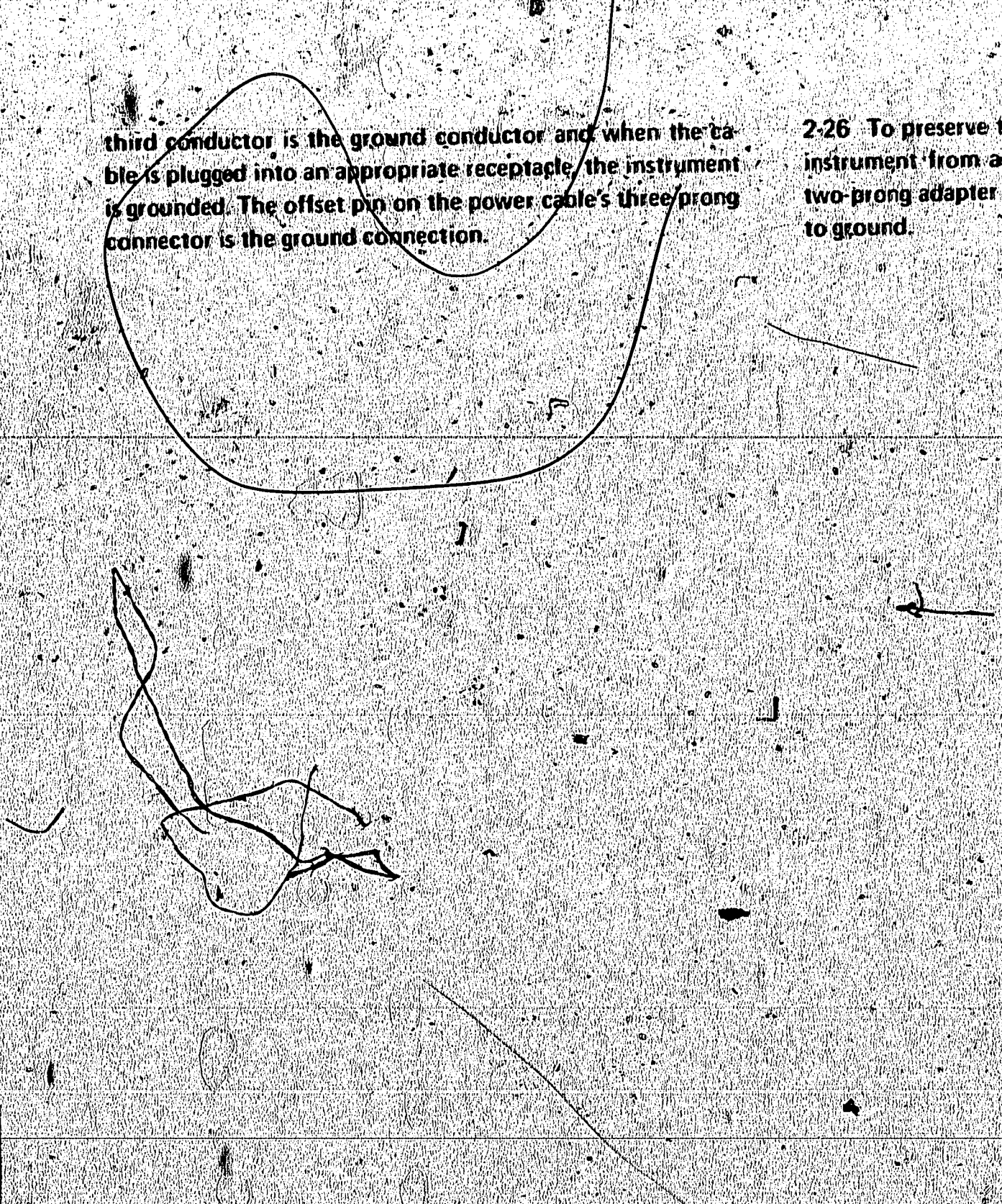


Figure 2-2. 6941A Multiprogrammer Extender, Rear View

third conductor is the ground conductor and when the cable is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable's three-prong connector is the ground connection.

2-26 To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.



OPERATION

SECTION III
OPERATING INSTRUCTIONS

3-1 PRE-OPERATIONAL CONSIDERATIONS

3-2 Before applying power to the unit, ensure that the ac selector switch (↓) within the ac power module on the rear panel is in the proper position (115V or 230V). All system cable connections (between the computer and the 6940A Multiprogrammer and between the 6940A and all 6941A Multiprogrammer Extenders) should be made as outlined in Section II of the 6940A manual.

3-3 Input/Output Cards

3-4 Input/Output cards should be inserted into the desired slots (400 through 414) of the 6941A card cage. A location diagram showing all of the card positions is included on the inside portion of the hinged front panel. For convenience, the four-bit binary address of each of the 15 input/output slots is included beneath each slot and a blank space for each slot is provided for the user to denote the model number and type of input/output card that is used in that slot. Further, all input/output cards are marked as to type on the card extractor handles. Notice that whenever an input/output card is inserted into a slot (400 through 414) it assumes the address of that particular slot position. Detailed information about each input/output card is contained in the instruction manual associated with each card.

3-5 Pre-Operation Checkout

3-6 Before connecting system loads to any of the input/output cards, perform the basic checkout procedures given in Section V of this instruction manual.

3-7 If the checkout procedure results are satisfactory, external device connections can be made to the cards (as described in the card manuals) and the unit operated normally.

3-8 Operating Controls

3-9 The 6941A contains only an ON-OFF LINE switch and associated pilot lamp on the front panel. To ready the unit for operation, simply set the LINE switch to ON. Also ensure that the rear panel ac input power switch is in the correct position (refer to Paragraph 2-21).

3-10 Programming

3-11 The 6941A is a "slave-type" device which is remotely programmed by a computer (or other digital device) through the 6940A Master unit. Each 6941A can also be programmed manually using the front panel proximity switches on the 6940A. Complete system programming instructions are given in the Operating and Service Manual for the 6940A Multiprogrammer.

3-12 INPUT/OUTPUT DATA

3-13 Figures 3-1 and 3-2 show the 6941A input and output connectors and the data and control signal designations. Notice that all digital signals that are exchanged between the computer and a Multiprogrammer System are interfaced within the 6940A Master unit. The following paragraphs contain a brief description of each input/output line shown on Figures 3-1 and 3-2.

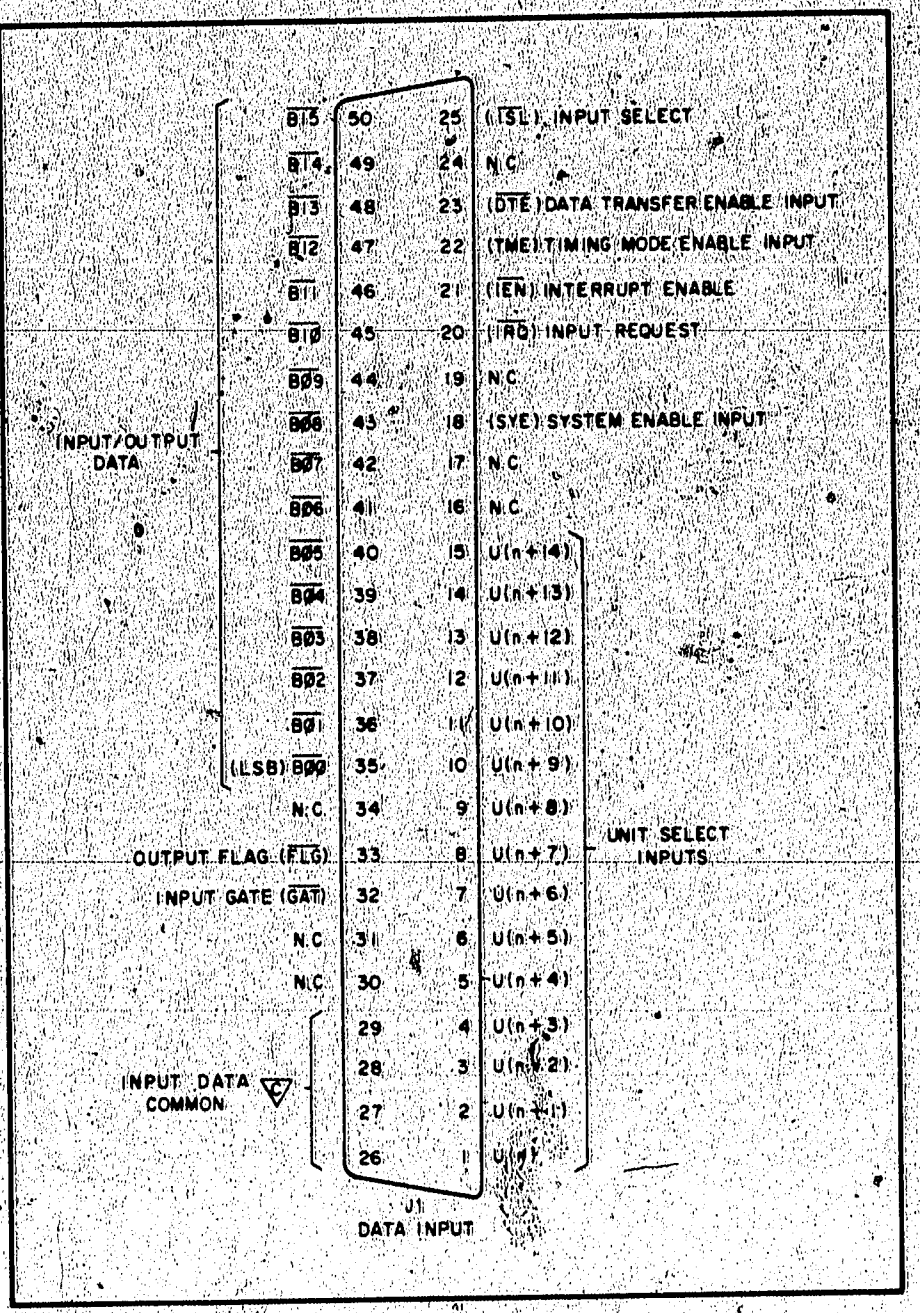


Figure 3-1. Data Input Connector

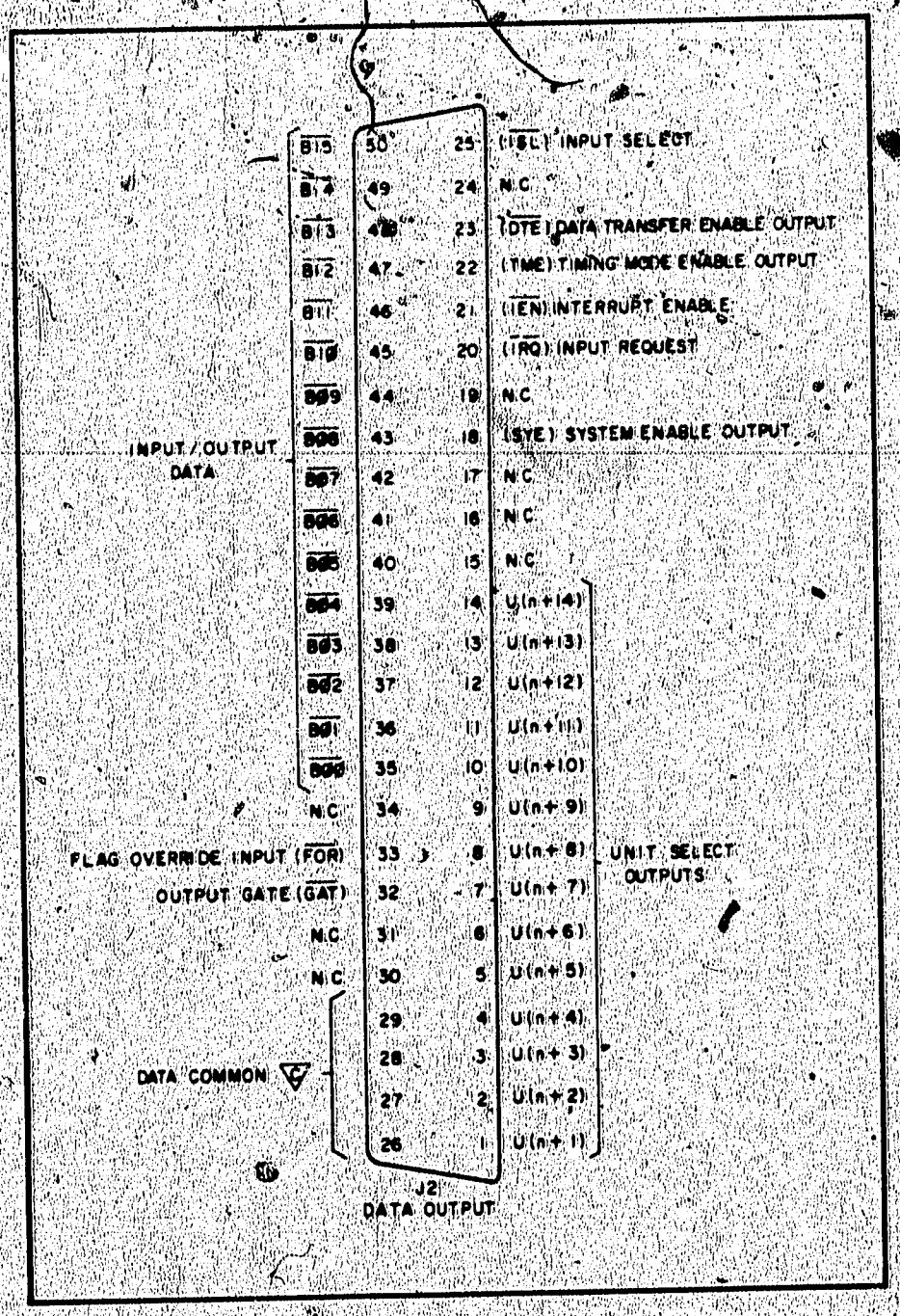


Figure 3-2. Data Output Connector

3-14 Input/Output Data Bits

3-15 Data bits $\overline{B15}$ through $\overline{B00}$ are exchanged between the 6940A and 6941A's in negative-true form (e.g., logic 1 = $\overline{B15}$, LO; logic 0 = B15, HI). The four most significant bits ($\overline{B15}$ through $\overline{B12}$) represent input/output card slot addresses and are always transmitted from the 6940A to the 6941A's. Bits $\overline{B11}$ through $\overline{B00}$, however, represent either data word output data (in which case they are transmitted from the 6940A to the 6941A's) or input data from an addressed input card (in which case they are received by the 6940A from the 6941A's). Notice that only output-mode data words or input-mode address words are meaningful in the extender units. The control word code (slot address 1111) serves no function in the extender units.

3-16 Gate Signal $\overline{GAT}$

3-17 Gate signal $\overline{GAT}$ is utilized by all extender units to initiate actions on the input/output cards. For output cards, $\overline{GAT}$ initiates (when the card is also addressed) the storage of programmed data bits $\overline{B11}$ through $\overline{B00}$. For input cards, $\overline{GAT}$ enables (when the card is addressed) the gate/flag circuits on the input card or initiates the resetting of control circuits on the card, depending upon the state of mode signal ISL. A HI to LO transition of $\overline{GAT}$ initiates these actions. Refer to Paragraphs 3-110 and 3-115 of the 6940A manual for additional details.

3-18 Flag Output and Flag Override Input

3-19 The meaning of the flag ($\overline{FLG}$) output of a 6941A depends on the programmed mode of operation (input/output; handshake/timing). An extender unit flag has the same meaning to the computer as a master unit flag. Section III of the 6940A manual covers the flag functions in detail.

3-20 The $\overline{FLG}$ output signal of each 6941A is applied to the flag override ($\overline{FOR}$) input of the next upstream unit in the system, forming the system flag ORing configuration described in Paragraph 4-26 of this manual.

3-21 $\overline{ISL}$, $\overline{IEN}$, $\overline{DTE}$, TME, SYE, and $\overline{IRQ}$

3-22 $\overline{ISL}$ (input select), $\overline{IEN}$ (interrupt enable), $\overline{DTE}$ (data transfer enable), TME (timing mode enable), and SYE (system enable) are mode selection bits which are chain-cabled to each extender unit in the system from the 6940A master unit. The signals are derived from programmed control words and are stored on the unit select card of the 6940A. The signals are received through data input connector J1 of each 6941A, utilized on the unit, buffered, and coupled through data output connector J2 to the next downstream unit.

3-23 Input request signal $\overline{IRQ}$ is a common signal line from all input-type cards in the system. The signal is looped from unit-to-unit in the upstream direction. $\overline{IRQ}$ is buffered on each unit before being passed on to the next upstream unit.

3-24 The function of each control bit is described in detail in Section III of the 6940A manual.

3-25 Unit Select Bits

3-26 The unit select bits are received by the extender units in positive logic form [logic 1 = U(n) HI; logic 0 = U(n) LO]. When a unit select line goes HI, all of the output cards associated with that unit are enabled. The U(n) line, at pin 1 of the INPUT connector, is the unit select line for any particular 6941A in the system chain. The U(n) line is connected to each accessory card in the applicable unit. The remaining unit select lines (Un + 1 through Un + 14) are connected directly to the rear OUTPUT connector, pins 1 through 14, respectively. These outputs are distributed to the downstream units as described in Note 1 of Figure 7-1, Sheet 1.

3-27 SAFETY FEATURES

3-28 In addition to the system safety features (SYE override and monitor data check) provided by the 6940A Master, each 6941A power supply contains a built-in crowbar and current latch circuit to protect its accessory cards. The crowbar and current latch circuits are identical to those used in the Master unit (refer to Paragraphs 3-155 and 3-157 in the 6940A manual).

THEORY

SECTION IV
PRINCIPLES OF OPERATION

4-1 INTRODUCTION

4-2 This section contains principles of operation for the 6941A Multiprogrammer Extender. The Section is divided into two main paragraphs: first, a basic block diagram discussion and second, a detailed circuit description using the schematic diagrams at the rear of the manual.

4-3 Circuits which are identical to those used in the 6940A are not discussed in detail in this Section, since the reader must be familiar with the operation of the 6940A Master unit in order to understand Multiprogrammer System concepts.

4-4 The 6941A mainframe is similar in construction to the 6940A, having the same basic card cage, rear panel, and dc power supply. The main differences between the two units are in the circuit cards which plug into the mainframe. The plug-in card complement for the 6941A is as follows:

SLOT	6941A PLUG-IN CARDS
100	A1 Input Card (Extender)
200	A2 I/O Transfer Card
300	A3 Logic and Timing Card (same as A3 card in 6940A)
400-414	A4 Input and/or Output Accessory Cards
500	Vacant (occupied by Unit Select Card in 6940A)
600	A6 Regulator Card (when used).

4-5 BASIC BLOCK DIAGRAM DISCUSSION

4-6 Figure 4-1 is an overall block diagram of the 6941A showing all of its major circuits and principal input/output signals. Each major circuit has an associated sheet number so that this diagram can be correlated with the schematic sheets (Figure 7-1) at the rear of the manual. It should be noted that the logic symbols and signal designations shown on Figure 4-1 represent simplified logical operations and do not reflect the actual logic circuits. Actual circuit implementation of these functions is covered in the detailed circuit analysis.

4-7 The 6941A is a slave type device which is controlled by data originating from a computer. The computer data is first processed by the 6940A Master unit and then looped to each 6941A in the system by means of chaining cables.

4-8 Addressing

4-9 The two-step addressing procedure described for the 6940A Master unit also applies to the 6941A Extender units. In the first step, a control word containing the desired unit address is programmed. The 6940A detects the control word and stores and decodes the unit address. The unit select line (1 of 15) corresponding to the addressed unit is energized and partially enables all accessory card slots of that unit. The last unit selection will remain in effect until a new unit is selected by a later control word. In the second step, the four address bits (15-12) of a data word (for data output modes) or an address word (for data input modes) enable the selected accessory card in the energized unit.

4-10 Control Modes

4-11 All control mode data is received from the computer via control words. The 6940A Master unit stores the mode selections and cables them to the 6941A Extender units. The control mode signals are buffered by each extender unit before being passed on to the next unit downstream.

4-12 Input/Output Mode Selection

4-13 The programmed state of mode signal ISL (input select) determines the input/output status of the Multiprogrammer System. When ISL is programmed off, 12 output-logic gates in each 6941A in the system are enabled and pass the 12 programmed data bits (11 through 0) to every downstream unit. When ISL is programmed on, the output gates are inhibited and a set of 12 input-gates are enabled. This effectively reverses the 12-bit data bus in the direction of the computer.

4-14 Output Modes

4-15 In the absence of an input mode selection (ISL, off) the 6941A will function as an output device, supplying programmed data to selected output cards. Two of the five programmable modes, SYE and DTE, relate exclusively to output functions; TME is used for both output and input modes. Each of these three functions is covered briefly in the following paragraphs.

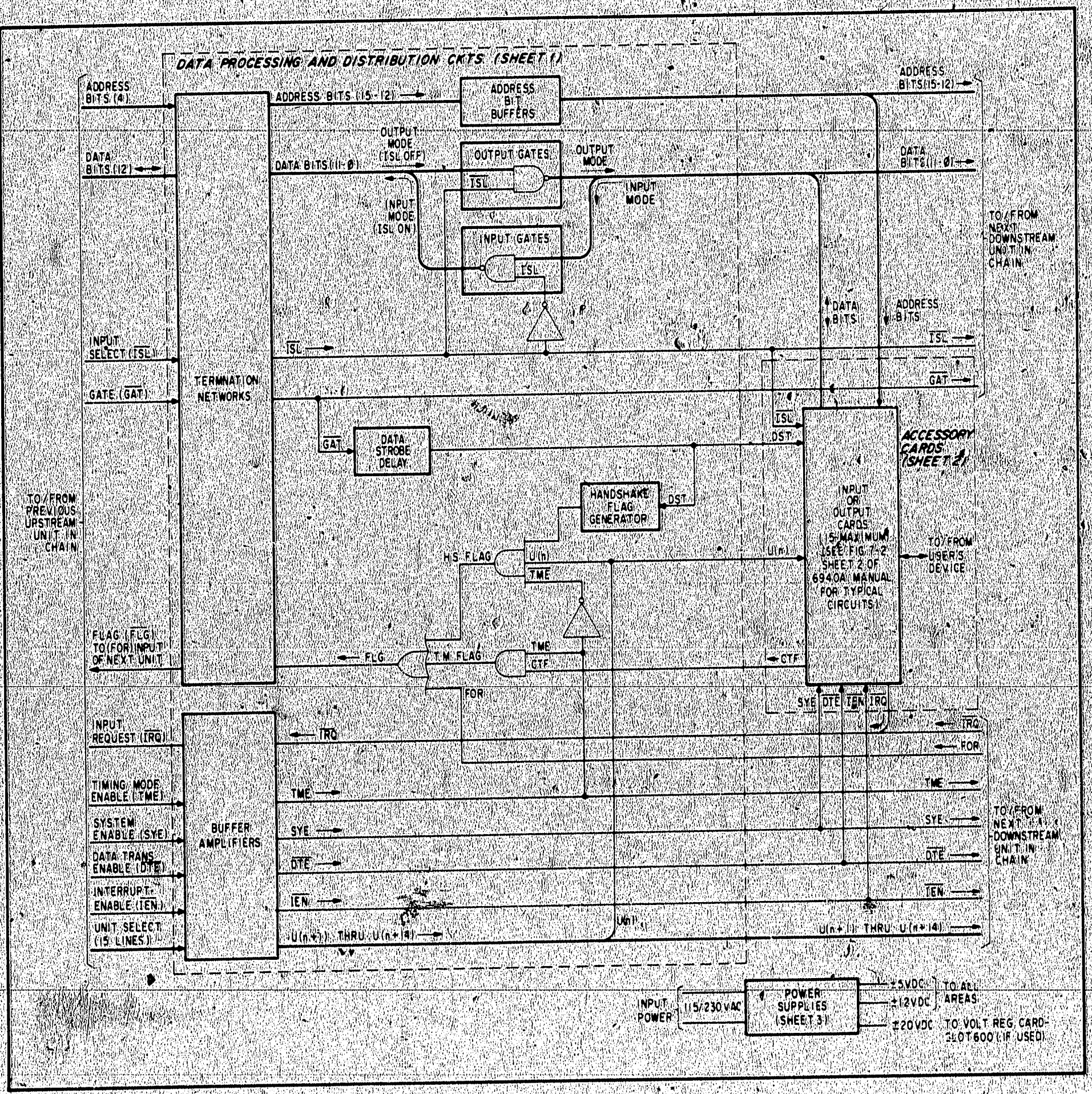


Figure 4-1. Basic Block Diagram

4-16 **System Enable Mode.** The system enable mode (SYE) is selected when bit 5 of a control word is programmed to the 1-state. SYE is routed from the programmed mode storage circuits of the 6940A to all accessory card slots in the system. Prior to SYE being programmed, the output circuits of all output cards are disabled, resistance outputs are short circuited, voltage outputs are held at 0 volts, current outputs are opened, relay contact outputs are held open, and TTL outputs are at logical Ø's. When SYE is programmed, the output cards are allowed to respond to programmed data. SYE is reset by programming bit 5 = 0. As an added safety feature, a jumper on input data plug P1 of the 6940A completes the SYE path to all card slots making it necessary to have input computer data connected to the system in order to enable the output cards.

4-17 **Timing Mode.** The timing mode (TME) is utilized for both output and input operations. It is selected by programming bit 4 of a control word to the 1-state. For output functions, TME causes the flag signal returned to the computer to be held in the busy state until the programmed output cards have completed processing their last data input. The busy state of the flag signals the computer not to input new data. TME is distributed to all timing mode flag circuits of all units in the system. The mode remains in effect until programmed off by bit 4 = 0.

4-18 **Data Transfer Enable Mode.** The data transfer enable mode (DTE) is selected by programming bit 6 = 1. DTE is wired to all accessory card slots of the system but is utilized only by output cards having dual-rank storage, by relay output cards and by TTL output cards. Output cards with dual-rank storage have two sets of storage registers. The first set of registers store the programmed data as it is strobed in by DST. The second set of registers receive the data from the first set of registers and apply it to the output conversion circuits only when DTE is programmed.

4-19 For output cards with dual-rank storage, the DTE mode is normally used in either of two ways:

(1) *DTE is selected first and latched.* The output cards are then addressed and programmed one at a time. Since DTE is present, the programmed data is transferred immediately from the first set of registers to the second set of registers to the conversion circuits. Each card thus produces an output proportional to the programmed data, as it receives the data.

(2) *DTE is not initially selected.* The output cards are addressed and store the programmed data in the first set of registers, but do not transfer the data to the second set of registers, since DTE has not been programmed. This method permits the first registers of all cards of this type to be loaded with data first; then by programming DTE, the outputs of all the cards are simultaneously transferred to the user's system. The output cards will continue to hold the most recently programmed value after DTE is removed in preparation for the next data loading cycle.

4-20 The relay output cards have only a single level of storage and the output relays respond to data as the card is programmed. However, a gate line (a contact closure available on each relay output card) is enabled only when DTE is programmed. These contacts can be used in the external system to initiate two operations:

(1) To simultaneously strobe the outputs of all relay output cards into the external system.

(2) To start a timing flag circuit in the external system that will hold the flag line returned to the multiprogrammer in the busy state until the circuit times out. The delay provided by this circuit should coincide with the maximum time required for the user's system to process the data relay outputs.

4-21 For TTL output cards, DTE is used in the same manner described for relay output cards.

4-22 **Data Input.** For output modes, the output cards are programmed by 16-bit data words derived from the computer and channeled through the 6940A to the extender units. A data word contains two types of information; slot addresses (bits 15, 14, 13, and 12 programmed to any number from 0000 to 1110) and data (bits 11 through 0). A unique combination of the four address bits is wired to each of the 15 card slots. Slot 400 receives address 0000; slot 401 receives 0001; ... slot 414 receives 1110. The same slot address wiring is carried through in all units so that when a given slot address is programmed, all slots in the system having that address are partially enabled. However, only one unit of the system can be selected at a time, so only the slot of the unit selected by a previous control word is fully enabled to accept the data contained in bits 11 through 0. (Input-type cards require ISL in addition to the appropriate slot and unit addresses to be enabled.) The 6940A Multiprogrammer is assigned unit number ØØ (UØØ), while the extender units are numbered consecutively from U01 up to U15.

4-23 **Handshake Mode.** Computer data is entered into the Multiprogrammer System in either of two modes; the handshake mode or the timing mode. The return path to the computer for the handshake flag is enabled when TME is programmed off, and blocked when it is programmed on.

4-24 In the handshake mode, a 6941A will accept data at rates up to 100k words/sec. A timing diagram of the data, gate, flag and data strobe signals for the handshake mode are given in Figure 4-2. The significant multiprogrammer and computer operations at each time interval are described as follows:

T_0 — The gate signal from the computer goes LO indicating that a valid word is available on the 16 data input lines. The gate signal is applied to identical data strobe delay

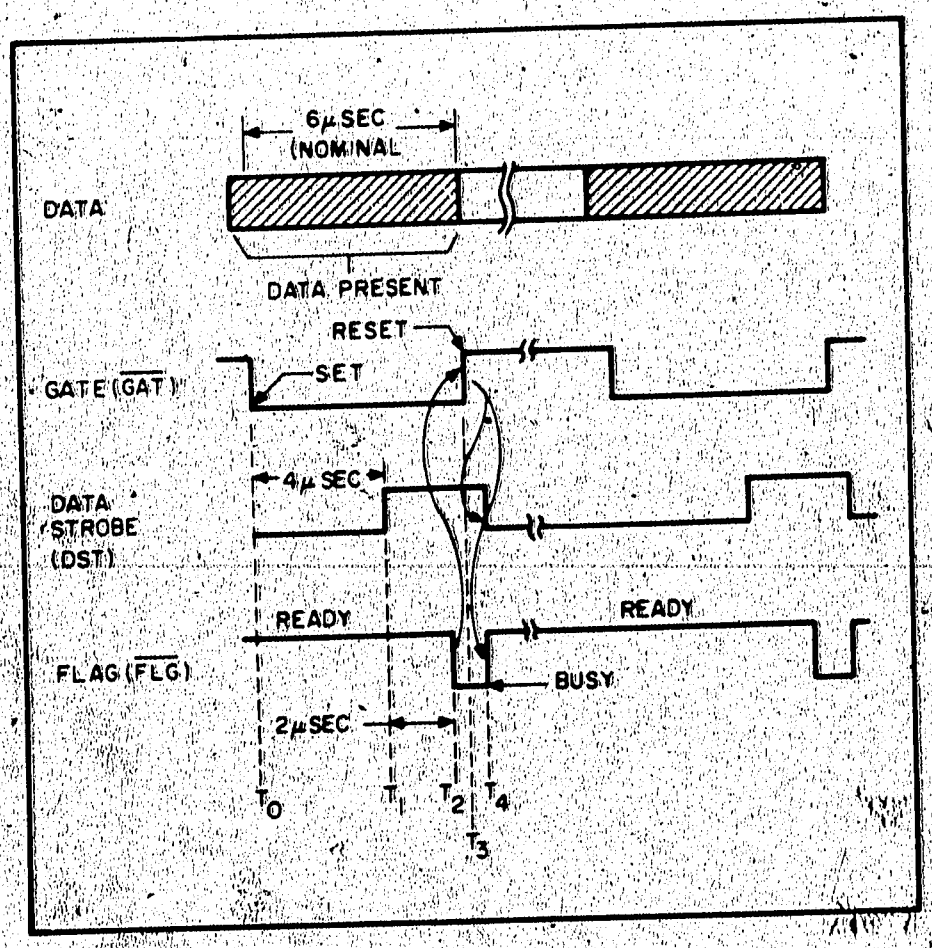


Figure 4-2. Handshake Mode, Timing Diagram

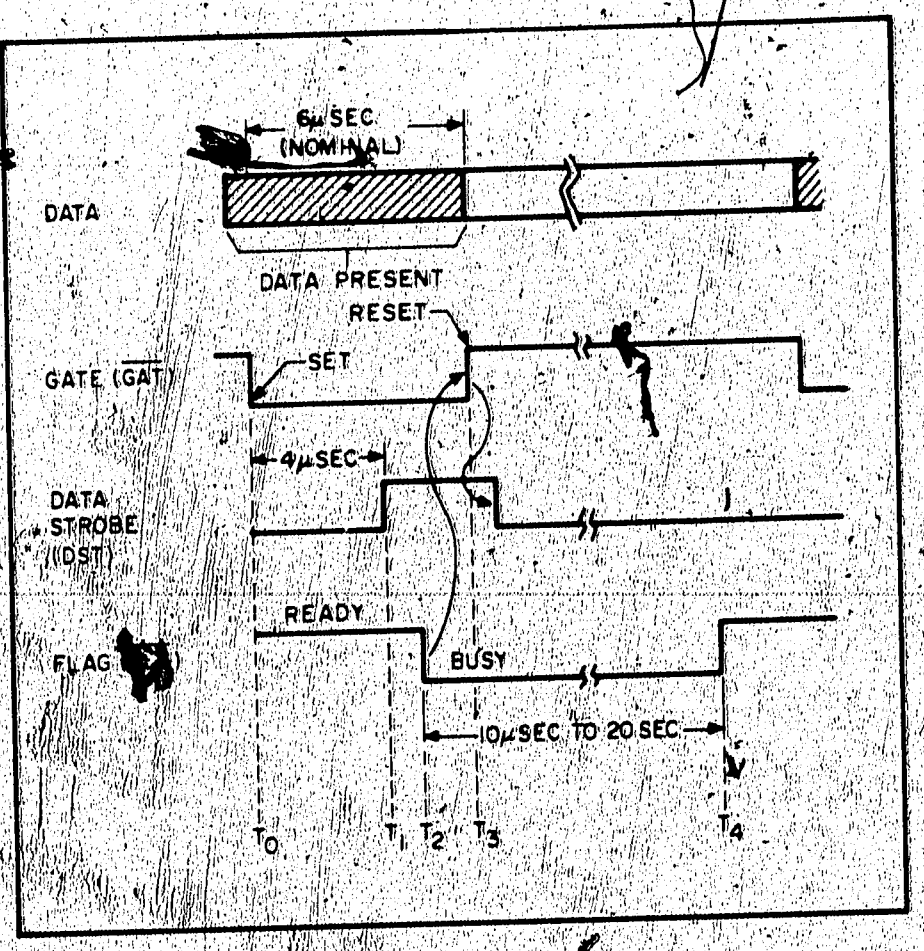


Figure 4-3. Timing Mode, Timing Diagram

circuits in all extender units in the system.

T_1 – Following a 4μsec delay to allow the input lines to settle, the data strobe delay circuit switches DST to a HI level. This level loads the programmed data into the address output card.

T_2 – After a delay of approximately 6μsec from the start of the gate, the handshake flag generator sets the flag line LO. This action ultimately informs the computer that the applicable unit has completed the data input operation.

T_3 – The gate line is reset by the computer in preparation for the next data output operation.

T_4 – When the gate line is reset, the data strobe delay circuit resets DST and the handshake flag generator resets the flag line. The computer may initiate a new data output cycle any time after T_4.

4-25 **Timing Mode**. Whenever an output card is addressed and data is strobed in, a CTF pulse is produced by a timing circuit on the addressed card. This flag pulse (Figure 4-3) is initiated by DST but its duration depends on the timing circuit on the individual output cards. The timing flag duration for a particular output card is selected on the basis of the maximum time required for the card, or the external device connected to it, to complete processing data before it can accept new data. The timing flag output of the individual cards are ORed together to become the common timing flag (CTF). When the timing mode is not programmed, CTF is still generated by the output cards but has no effect on the flag line back to the computer. When TME is programmed, the CTF pulse becomes the flag to the computer. In the timing mode, the flag is held busy until the timing flag pulses from the individual output cards have timed out.

4-26 **Extender Unit Flags**. Every extender unit in the system has an identical flag circuit. Figure 4-4 is a block diagram showing the interconnection between flag circuits. As can be seen from Figure 4-4, a handshake or timing flag generated by

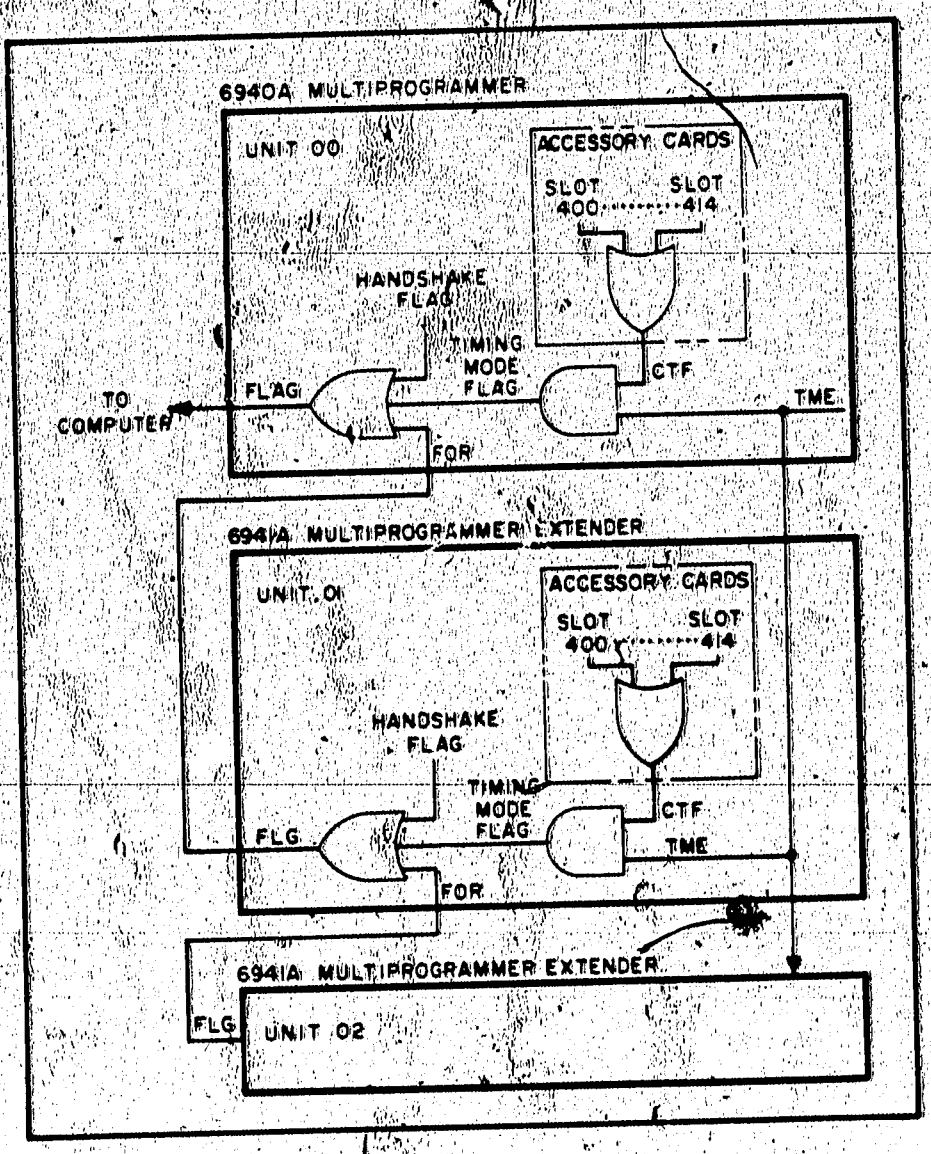


Figure 4-4. Flag ORing Circuits, Block Diagram

an extender unit is ORed through each unit in the system to the 6940A master unit. The 6940A receives the flag line as FOR and returns it to the computer as the system flag. The operation of the extender unit flag circuits is identical to the master unit flag circuits.

4-27 Input Modes

4-28 There are two primary input modes and a number of secondary variations of these modes involving both hardware and software options. The two primary modes are designated:

(1) The Dedicated Input Mode
(2) The Interrupt-Search Mode.

4-29 The basic theory of operation for input functions will be described in terms of the two primary input modes as related to a typical digital input card.

4-30 **Dedicated Input Mode.** In this mode, the computer reads data from input cards on an individual card basis. Until it completes its operation on the currently addressed card, the computer should not go on to another input card. The dedicated input mode is normally used in either of two ways; ungated, or in the timing mode.

4-31 *Ungated.* This is the most basic method of reading data from an input card. The procedure is accomplished in two programming steps: (1), programming a control word with ISL = 1, IEN = 0, and TME = 0; and (2), programming the desired card address and *not* issuing a computer gate signal.

4-32 In Step (1), ISL = 1 simply turns the 12-data bit lines of each unit in the Multiprogrammer System in the direction of the computer. Although ISL is also applied to the input cards it has no effect on their operation in the ungated mode.

4-33 In Step (2), the 12-data bits currently stored on the addressed input card are placed on the return data lines and will remain there for as long as the card address is present. Since a computer gate is not issued in this mode, the multiprogrammer does not produce a data strobe (DST) and the addressed card is not armed. (CTF and IRQ are neither generated nor required in the ungated mode.)

4-34 *Timing Mode.* This mode is also programmed in two steps: (1), a control word is programmed with ISL = 1, IEN = 0, and TME = 1; and (2), the desired card address is issued along with a computer gate signal.

4-35 Step (1) sets up three initial conditions for this mode. First, ISL reverses the direction of the 12 data-bit lines; second, ISL is applied to all input cards as a condition necessary to enable (arm) an input card when it is addressed and data strobed; and third, TME enables the common timing flag (CTF) return path from the input cards to the computer.

4-36 In Step (2), the address of the desired input card is programmed along with a computer gate. Upon receipt of its address bits, the selected input card will immediately place 12-bits of data on the return data bus to the computer. However, the computer should not accept this data until the multiprogrammer signals, via the trailing edge of CTF, that the input data from the addressed card has been updated and is now ready to be read.

4-37 Within the selected input card, the combination of ISL, DST, and the card address will send a gate signal to the external device and simultaneously reset the flag flip-flop on the input card. Resetting the flag flip-flop causes the CTF line back to the multiprogrammer to switch to the busy state. When the external device is ready with new data it will signal the input card via the trailing edge of its device flag. This edge will set the input card flag flip-flop which will return the CTF line to the ready state. At the same time, new data will be strobed into the storage registers on the input card. The computer should interpret the trailing edge of CTF as permission to read the return data.

4-38 Before going on to an interrupt-search mode, previously armed cards whose flag flip-flops have been set should either be rearmed (by programming ADDR-DST-ISL) or disarmed (by programming ADDR-DST-$\overline{\text{ISL}}$), with either operation done in the handshake mode.

4-39 **Interrupt-Search Mode.** The interrupt-search mode offers an efficient means of retrieving data from groups of input cards. As covered in Section III of the 6940A manual, there is a hardware option available which adds versatility to this mode by allowing all digital input cards with jumper W6 installed to be armed as a group. However, in order to keep this explanation simple, the multiprogrammer operation in the interrupt-search mode will be described in terms of four basic programming steps, with W6 *not* installed. (Figure 3-12A of the 6940A instruction manual is a timing diagram of the interrupt-search mode.)

Step 1. Establish initial mode conditions by programming a control word with ISL = 1, IEN = 0, and TME = 0.

Step 2. Arm desired input cards by programming card addresses: (A computer gate must accompany each address as it is programmed.)

Step 3. Select the interrupt enable mode by programming a control word with IEN = 1, TME = 1, and ISL = X. (X = doesn't care).

Step 4. Wait for the multiprogrammer CTF flag to indicate that one or more addressed input cards has valid data ready. Then, poll the input cards (by issuing their addresses) in a software determined order. Do not issue a computer gate while polling. Examine bit 15 of each return data word in the computer and accept the data only when bit 15 = 1. (The state of bit 15 is determined by IRQ from the addressed input card; when the addressed input card has valid data available,

IRQ makes bit 15 = 1.)

4-40 Step (1) establishes two initial conditions for this mode: First, ISL reverses the direction of the 12 data bit lines; and second, ISL is applied to all input cards as a condition necessary to enable (arm) an input card when it is addressed and data strobed. Since the timing mode has been programmed off in this step, subsequent data transfers between the computer and the multiprogrammer will be done in the handshake mode.

4-41 In Step (2), the address of the desired input card is programmed along with a computer gate. Upon receipt of its address bits, the selected input card will momentarily place 12-bits of data on the return data bus to the computer. The computer should ignore this data.

4-42 As in the dedicated input timing mode, the combination of ISL and DST and the card address arm the addressed card; a gate is sent to the external device and the flag flip-flop on the card is reset. When the device is ready with data it will signal the input card via the trailing edge of its device flag. This edge will set the flag flip-flop and strobe new data into the storage registers on the input card. When the interrupt mode is programmed in the next step, the "set" flag flip-flop on this, or any other input card with new data ready, will generate an interrupt. Also, when the input cards are polled in the search mode, any card whose flag flip-flop is set will cause IRQ, and thus bit 15 returned to the computer, to be true.

4-43 Step (3) establishes conditions for enabling interrupts from previously armed input cards which now have data available. Along with the control word containing IEN = 1 and TME = 1, the computer must also issue a gate signal. When the control word containing IEN = 1 is programmed the unit select card in the 6940A, which normally generates a handshake flag when a control word is programmed, is prevented from doing so. The computer will now wait for a transition of the CTF line from an input card to signal an interrupt. Within the input cards, IEN and DST (derived from the computer gate) are logically ANDed with the output of the flag flip-flop, which is true when the external device has data ready. When all three conditions are true on any input card, the CTF line will be set to the busy state. This transition of the CTF line to the busy state signals the computer to reset its gate, which in turn resets DST. With DST reset, the CTF AND-gate within the input cards is inhibited, causing CTF to return to the ready state. The computer interprets this transition an an interrupt request.

4-44 In Step (4), the address of each input card of the selected group is programmed in a software assigned order, without a computer gate. As each card is addressed, it places, its 12-data bits on the return data bus. The card address is also ANDed with the output of the flag flip-flop on the input card, and when both are true (signifying that the addressed input card has new data) the IRQ signal is made true. IRQ directly controls the state of bit 15 returned to the computer; when bit 15 is true, the computer should accept the associated 12 data bits.

4-45 DETAILED CIRCUIT ANALYSIS (See Figure 7-1)

4-46 Logic Definitions

4-47 As in the 6940A, the internal logic circuits of the 6941A are designed within and conform to the definition of positive logic. This simply means that a logical 1 is represented by a voltage level more positive than a logical 0 and that the logic circuits are utilized within this framework. The actual logic levels utilized within the 6941A are:

LOGIC 1 = +2.4V to +5.5V (HI)
LOGIC 0 = 0V to +0.4V (LO).

4-48 A system of mnemonics is also used to identify functions implemented at specific points through out the system. Mnemonics are three character abbreviations of the signal function name. A signal function may be designated in either its true form (e.g., TME) or its complemented form ($\overline{TME}$). When a particular function is set to its assertive state, its true form = logical 1 (HI) and its complement = logical 0 (LO). The opposite states exist when the function is not asserted. A few examples will be given relative to this system to expand on the previous definitions:

(1) When a flag signal is generated by the logic and timing card, the $\overline{FLG}$ line makes a transition from a logical 1 (HI) to a logical 0 (LO) and returns to a logical 1 (HI) when the flag has been completed.

(2) When a specific bit is programmed to a logical 1 at the computer, the corresponding $\overline{B--}$ input line to each 6941A goes to the logical 0 (LO) state.

4-49 Input Card A1

4-50 The four address bits ($\overline{B15}$ through $\overline{B12}$), the twelve data bits ($\overline{B11}$ through $\overline{B00}$), and the gate ($\overline{GAT}$) signal from the previous upstream unit are applied to identical termination networks on input card A1. The networks minimize noise and ringing on the transmission lines by providing the ideal line termination impedance. The 1kΩ pull-up resistor in the $\overline{FLG}$ return circuit improves the 1-state driving capability of the output NAND gate (G14) on the logic and timing card.

4-51 Input select signal $\overline{ISL}$ is buffered by circuit A1Z1 before being transferred to the required circuits in this unit and on to the next down stream unit. Also located on the A1 Input Card is a +5 volt shunt regulator which provides

isolated +5 volt power for the termination resistors. This circuit is described in detail in Paragraph 4-117 of the 6940A manual.

4-52 I/O Transfer Card A2

4-53 I/O Transfer Card A2 is comprised of 12-input NAND gates (G11 through G00) and associated inverter amplifiers; and buffer amplifiers for mode signals $\overline{ISL}$, $\overline{IEN}$, $\overline{DTE}$, and $\overline{IRQ}$. For all input modes (ISL, off), the 12-input NAND gates are inhibited and data bits $\overline{B11}$ through $\overline{B00}$ are passed in the downstream direction, through flat cable W1, to logic and timing card A3. When an input mode is programmed (ISL, on), gates G11 through G00 are allowed to pass the 12 data bits from an addressed input card in the direction of the the computer (upstream).

4-54 Logic and Timing Card A3

4-55 Logic and Timing Card A3 performs data and address bit buffering, I/O data bit selection, and data strobe and flag signal generation. This card is identical to the one used in the 6940A Master unit and, therefore, will not be described here. Refer to Paragraphs 4-51 and 4-121 in the 6940A Operating and Service Manual for complete circuit description of the A3 card.

4-56 Main Power Supply Board A10

4-57 The main power supply board contains a +5 volt regulator (with current latch and overvoltage circuits) and four ±20 volt rectifier-filters. The power supply board is identical to that used in the 6940A Master unit (refer to Paragraph 4-132 in the 6940A manual).

MAINTENANCE

SECTION V
MAINTENANCE

5-1 INTRODUCTION

5-2 This Section contains a basic checkout procedure for the 6941A, together with detailed troubleshooting procedures for all of its circuits. These procedures make use of the local programming capabilities of the associated 6940A and the test instruments listed in Table 5-1.

5-3 A faster and more comprehensive method of testing and troubleshooting Multiprogrammer Systems is available through use of the optional HP Service Kit, Model 69356A. This kit, and other useful service aids, are listed in Table 1-2 of the 6940A manual.

5-4 Detailed checkout and troubleshooting procedures for the 6940A and the accessory input/output cards are provided in their associated instruction manuals.

5-5 MAINTENANCE FEATURES

5-6 Several maintenance features have been incorporated into the design of multiprogrammer instruments for the purpose of minimizing down-time, and for convenience in troubleshooting and repairing malfunctions. These features are listed as follows:

a. *Local Programming.* This feature permits manual programming of the extender units through use of proximity switches on the 6940A front panel. Refer to Paragraph 3-134 of the 6940A manual for details.

b. *Logic Probe Connector.* Logic probe connectors are provided on both the 6940A and 6941A. The connectors are located on the card cage behind the hinged front panel, and provide operating voltage (+5 volts) for a logic probe.

c. *Power Supply Indicators.* The 6941A has lamps that indicate the status of the ac input power (LINE indicator) and the +5 volt power supply (lamp on card A3). Although there is no direct indication of ±12 volts on the 6941A, its presence is implied by the +5 volt indicator.

d. *Slot 414.* Slot connector 414 on both the 6940A and the 6941A (in addition to being a normal slot for an accessory card) has special test capabilities. The wiring to slot 414 includes all eight card address lines, whereas the other slot connectors contain only the four address lines peculiar to the particular slot.

e. *Test Points on Card A3.* Logic and timing card A3 contains stand-off test points which provide access to key signals on the A3 card.

f. *Plug-In Circuit Cards and IC's.* Most components of the 6940A and 6941A are located on plug-in printed circuit cards. All IC's are mounted on sockets.

5-7 All of the above capabilities are utilized in the testing and troubleshooting procedures of this section.

5-8 Handling Plug-In Components

5-9 While the plug-in cards and IC's are a great convenience, care must be exercised in their handling, especially while they are being installed or removed. For example, the printed circuit plug of each plug-in card is slotted between a particular parr of fingers, and the mating connector on the mainframe is keyed at the same point. This makes it virtually impossible to plug a card into the wrong slot. However, if the card is forced into the wrong slot, the key, the mainframe connector and the printed circuit card could be damaged. The IC's should also be handled carefully. When removing an IC, lift it straight out of the socket to avoid bending its pins. When installing an IC, be sure that the identification dot or notch is located at the same end as the bevel on the IC socket.

5-10 Recommended Test Equipment

5-11 Table 5-1 lists the test equipment recommended for use in testing and troubleshooting Multiprogrammer Extender units.

5-12 BASIC CHECKOUT PROCEDURE

5-13 The basic checkout procedure given in Table 5-2 represents complete static check of the 6941A using the 6940A local switch register as the programming source. The procedure is useful for incoming inspection and for verifying operation of each 6941A prior to its installation into a system. All signals into and out of a 6941A, including those supplied to accessory input/output cards, are checked by these procedures. Of course, operation of the 6940A Master should be verified first, before checking out a 6941A. Each 6941A that is used in the system should then be checked in sequence. As the operation of each 6941A is verified, that unit should be chained to the next unit to be checked-out so that actual system operation can be duplicated.

5-14 If an abnormal indication is noted during performance of the checkout procedure, Table 5-2 will recommend either of two solutions: (1) where the fault may be corrected by

replacing one or two plug-in IC's, the suspect IC's will be listed in the table; and (2), where more extensive troubleshooting is indicated, a separate table will be referenced for the appropriate procedure.

NOTE

Although the unit was completely checked prior to shipment, faults may be introduced as a result of rough handling in transit or during installation. If the troubleshooting procedures fail to uncover the fault, check for open or shorted connections in plugs, jacks, back-plane, extender card, etc.

5-15 Before proceeding to Table 5-2, perform the following preliminary proceddres:

a. Open the hinged front panel of the 6941A and install the extender card in slot 414.

b. Connect the logic probe to the mating connector on the front of the 6941A card cage.

c. Connect one end of the chaining cable (14541A) into DATA INPUT connector J1 of the 6941A to be checked and the other end of the cable into the DATA OUTPUT connector J2 of the next upstream unit.

Table 5-1. Recommended Test Equipment

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Extender Card	Supplied with 6941A.	Extends plug-in cards out of the extender chassis for testing and troubleshooting.	HP 5060-7901
Logic Probe	Impedance: 10kΩ. Trigger Threshold: +1.4V nominal. Min. Pulse Width: 30nsec.	Logic circuit troubleshooting.	HP 10525A
Oscilloscope	Bandwidth: dc to 50MHz. Sensitivity: 20mV/div.	Monitor GATE, FLAG, and DST pulses.	HP Model 180A with 1804A and 1821A plug-ins.
Multimeter	10Ω to 1MΩ, ±5% 0.1V to 100V, ±2%.	General troubleshooting.	HP 427

Table 5-2. Basic Checkout Procedure

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1 POWER TURN-ON	Connect ac power cord to primary power. Set LINE switches on all applicable units to ON.	On unit under test, LINE indicator lamp and lamp on card A3 should go on.	Refer to power supply troubleshooting Table 5-4.
2 DATA/ ADDRESS BITS	Set DATA SOURCE switch on 6940A to LOCAL. Touch CLEAR REGISTER. Starting with bit 15, alternately set bit switches on 6940A off (dark) and on (light). With logic probe, monitor logic levels at extender card pins (slot 4,14) for each proximity button setting. (Be sure that ISL mode is off.)	As switch register lamps go on and off, bit levels at the extender card pins switch HI and LO. (Where two extender card pins are specified for a switch setting, the bit levels will be complementary.)	**MECHANICAL CHECKS** (1) Check that DATA SOURCE switch on 6940A is in LOCAL position. (2) Check that flat cable W1 is plugged into card A2. (3) Check that cards A1, A2, and A3 are properly installed. **ADDRESS BIT (12-15) FAILURE** Check address bit amplifiers on card A3. Refer to Table 5-6. **DATA BIT (0-11) FAILURE** (1) Make sure ISL is off. (2) Note the failure pattern and try to relate it to the applicable IC's on card A3 listed below:

	SW. REG. BUTTON	EX. CD. PIN
ADDR BITS	15	24, BB
	14	23, AA
	13	22, Z
	12	21, Y
DATA BITS	11	20
	10	19
	9	18
	8	17
	7	16
	6	15
	5	14
	4	13
	3	12
	2	11
	1	10
	0	9

Failed Bit	Replace IC	
11	Z4	Z2
10	Z5	Z2
9	Z4	Z2
8	Z5	Z2
7	Z4	Z2
6	Z4	Z2

Table 5-2. Basic Checkout Procedure (Continued)

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
2 (Continued)			Failed Bit — Replace IC 5 — Z6 Z1 4 — Z6 Z1 3 — Z6 Z1 2 — Z5 Z1 1 — Z5 Z1 0 — Z6 Z1 (3) Check flat cable W1. **ALL BITS FAIL** Check 5V shunt regulator on card A1. Refer to Table 5-5.
3 DST	Monitor pin D (DST) on extender card. Touch CLEAR REGISTER. Touch LOAD OUTPUT.	When LOAD OUTPUT is touched, DST bit level goes HI.	Replace A3Z3; retest. If test fails again, refer to DST troubleshooting, Table 5-6.
4 CONTROL MODE AMPLIFIERS	At 6940A switch register, touch CLEAR REGISTER. Select control word (bits 15, 14, 13, and 12 on). Select control modes TME (bit 4 on), SYE (bit 5 on), DTE (bit 6 on) and IEN (bit 8 on). Check that ISL (bit 7) is off. Touch LOAD OUTPUT. Monitor bit levels at the following pins on the extender card and at DATA OUTPUT connector J2 of the extender unit under test. FUNCTION — EX. CD. PIN NO. — CONNECTOR J2 PIN NO. TME — N/A — 22 — HI-level SYE — 1 — 18 — HI-level $\overline{DTE}$ — 5 — 23 — LO-level $\overline{ISL}$ — 6 — 25 — HI-level $\overline{IEN}$ — J — 21 — LO-level		**TME FAILURE** Check wiring. Refer to Figure 7-1. **SYE FAILURE** (1) If SYE fails at both test points, check wiring. (2) If failure occurs on extender card only, replace amplifier A3Z7 and check A3Q3. **DTE FAILURE** Replace A2Z6, retest. If $\overline{DTE}$ fails again, check wiring. **IEN FAILURE** Replace A2Z6, retest. If $\overline{IEN}$ fails again, check wiring. **ISL FAILURE** Replace A1Z1; retest. If $\overline{ISL}$ (off) fails again, check A2Z6 and wiring.

Table 5-2. Basic Checkout Procedure (Continued)

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
5 ISL PROGRAMMING	With control word still selected, program ISL mode on (bit 7, on). Monitor bit level at pin 6 of extender card or pin 25 of DATA OUTPUT connector J2. Touch LOAD OUTPUT → Clear control word address →	$\overline{ISL}$ level remains HI. $\overline{ISL}$ level goes LO.	Replace A1Z1; retest. If test fails again, check A2Z6 and wiring.
6 INPUT MODE DATA	At switch register, touch switches 11-0 to make sure that ISL mode (programmed in previous step) is on. The switch indicators will not respond to being touched if ISL is on. While observing switch register lamps 11-0, ground the extender card pins listed below: OBSERVE SW. REG. LAMP / GROUND PIN ON EX. CARD 11 — 20 10 — 19 9 — 18 8 — 17 7 — 16 6 — 15 5 — 14 4 — 13 3 — 12 2 — 11 1 — 10 0 — 9	Lamp on switch register goes on when corresponding bit is grounded at extender card.	ALL BITS FAIL Replace A2Z6; retest. If test fails again, check A2Q1. (ISL level can be checked at TP13 on card A2.) SOME BITS FAIL Note the failure pattern and try to relate it to the applicable IC's listed below: FAILED BIT / CHECK IC A2 / A3 11 — [Z2 Z5] Z9 10 — [Z2 Z5] Z9 9 — [Z2 Z5] Z9 8 — [Z1 Z4] Z9 7 — [Z1 Z3] Z9 6 — [Z1 Z3] Z9 5 — [Z1 Z4] Z8 4 — [Z1 Z4] Z8 3 — [Z1 Z5] Z8 2 — [Z2 Z4] Z8 1 — [Z2 Z3] Z8 0 — [Z2 Z3] Z8
7 HANDSHAKE FLAG	Program control word. Program the address of the unit under test; as part of the same control word, program ISL off. Touch LOAD OUTPUT. With logic probe, monitor the $\overline{FLG}$ test point on the outer edge of logic and timing card A3. Touch LOAD OUTPUT.	$\overline{FLG}$ goes LO while LOAD OUTPUT is touched.	Replace A3Z10; retest. If test fails again, check A3Q2 delay circuit.

Table 5-2. Basic Checkout Procedures (Continued)

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
8 TIMING MODE FLAG	Retain control word. Select TME (bit 4, on). Touch LOAD OUTPUT. Monitor $\overline{FLG}$ test point on A3 card. On extender card, connect a jumper from pin 7 ($\overline{CTF}$) to C.	$\overline{FLG}$ goes LO while $\overline{CTF}$ is grounded.	Replace A3Z7; retest. If test fails again, replace A3Z3.
9 $\overline{FOR}$ FLAG	Monitor $\overline{FLG}$ test point on logic and timing card in 6940A Master unit. Connect jumper from pin 33 ($\overline{FOR}$) of DATA OUTPUT connector J2 of unit under test to C.	$\overline{FLG}$ goes LO.	Check $\overline{FOR}$ wiring. Refer to Figure 7-1.
10 $\overline{IRQ}$ AMPLIFIER	Monitor $\overline{IRQ}$ test point on I/O transfer card A2. Connect pin F ($\overline{IRQ}$) of extender card to C.	$\overline{IRQ}$ goes LO.	Replace amplifier A2Z6.
11 UNIT SELECT WIRING	The unit select wiring through each extender unit can be checked by first programming the address of the unit currently under test (Un), at the switch register and monitoring the corresponding logic level at pin 4 of the extender card. Next, program the address of each unit further downstream and monitor the corresponding logic levels at DATA OUTPUT connector J2, as listed below. [For example, if unit Ø3 is currently under test, then the logic level for unit address Ø4 (or U3 + 1) is available at J2-1; unit address Ø5 (or U3 + 2) is available at J2-2, etc.] PROGRAM UNIT ADDR. / CHECK LOGIC LEVEL U (n) — Extender Card, Pin 4 U (n + 1) — J2-1 U (n + 2) — J2-2 U (n + 3) — J2-3 U (n + 4) — J2-4 U (n + 5) — J2-5 U (n + 6) — J2-6 U (n + 7) — J2-7 U (n + 8) — J2-8	Logic level goes HI for each address when LOAD OUTPUT is touched.	Check wiring. Refer to Figure 7-1.

Table 5-2. Basic Checkout Procedure (Continued)

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
11 (Continued)	PROGRAM UNIT ADDR. / CHECK LOGIC LEVEL U (n + 9) — J2-9 U (n + 10) — J2-10 U (n + 11) — J2-11 U (n + 12) — J2-12 U (n + 13) — J2-13 U (n + 14) — J2-14		
12 BITS TO DOWNSTREAM UNITS	Monitor output bits to downstream units at data output connector J2 while toggling each bit on and off at switch register. BIT / J2 PIN NO. B15 — 50 B14 — 49 B13 — 48 B12 — 47 B11 — 46 B10 — 45 B09 — 44 B08 — 43 B07 — 42 B06 — 41 B05 — 40 B04 — 39 B03 — 38 B02 — 37 B01 — 36 B00 — 35	Bit level switches LO (when bit switch lights) and HI (when switch is off).	Check wiring. Refer to Figure 7-1.

5-16 TROUBLESHOOTING

5-17 If trouble is encountered in a previously normal system, follow the system troubleshooting procedures in Paragraph 5-18 of the 6940A manual. Briefly, these procedures recommend a "quick check" of the 6940A first to ensure that it is operational. When proper operation of the Master unit and the programming source is verified, proceed to the first 6941A that exhibits the malfunction and perform the quick check (Table 5-3) again.

5-18 When troubleshooting a 6941A, the following types of failures can be anticipated. Each failure-type is analyzed in succeeding paragraphs and troubleshooting procedures recommended.

a. Failures involving data and address bits.
b. Failures involving gate-flag functions.
c. Power supply failures.

5-19 Data or Address Bit Failure

5-20 This will probably be the most commonly encountered hardware trouble, since the 16 programmed bits are part of most system functions. The failure of one or more bits can produce many different types of failure symptoms including erroneous addressing, erroneous programming of output magnitude or direction, and erroneous mode selection. Depending on where the bit is lost, the trouble may show-up in one unit, in several units, or in all units. The quick-check procedure given in Table 5-3 exercises all bits. The bits are programmed at the local control panel of the 6940A, and the bit levels are monitored on an extender card plugged into accessory card slot 414 of the 6941A. Unless the location of the faulty bit is obvious, or if the failure is restricted to one accessory card, perform the quick-check on the 6940A first. If the 6940A checks out, go to the first 6941A exhibiting the malfunction and perform the quick-check again. If the failure is restricted to one accessory card, the card itself is probably at fault. However, check that the mainframe is providing the proper inputs (by performing the quick-check in slot 414 of the applicable unit) before troubleshooting the card.

5-21 Gate-Flag Failures

5-22 Tests 3, 7, 8, and 9 of the Basic Checkout Procedure, Table 5-2, are static tests of the gate-flag functions of the 6941A. However, it is possible to have a condition where a faulty circuit on the A3 card would not be detected by the Basic Checkout Procedure. Symptoms of this condition could be the inability to program at a 100k word/sec. rate, random loss of flag, or random failure to gate data into storage. The quickest method of dynamically checking a suspect logic and timing card of an extender unit is to install it in slot 300 of a working 6940A Master unit and perform the dynamic test described in Paragraph 5-26 of the 6940A manual.

5-23 Power Supply Failures

5-24 Power supply failures can easily be verified by observing the states of the LINE and +5V indicator lamps on the 6941A. If either indicator is off when the LINE switch is ON, refer to the power supply troubleshooting procedures in Table 5-4.

⚠

CAUTION

If fuse F2 requires replacement, use HP Part No. 2110-0051, only.

5-25 POWER SUPPLY TROUBLESHOOTING

5-26 Procedures for troubleshooting the power supply circuits of the 6941A are given in Table 5-4. If a faulty heat-sink mounted component is found during troubleshooting, refer to Paragraph 5-35 for replacement procedures.

5-27 Power Supply Adjustment

5-28 Following replacement of any component of the +5 volt power supply, check the +5 volt output and adjust +5V ADJ potentiometer A10R3, before returning the unit to service. The voltage measured from the +5 volt line to Ⓒ, following a 5 minute warm-up period, should be set to precisely 5.10 volts.

5-29 EXTENDER INPUT CARD A1, TROUBLESHOOTING

5-30 Extender Input Card A1 consists of input termination resistors and a 5 volt shunt regulator. Failure of an individual termination network will result in loss of an individual bit. Failure of the shunt regulator could cause loss of all bits. Table 5-5 covers troubleshooting procedures for both types of circuits.

5-31 I/O TRANSFER CARD A2, TROUBLESHOOTING

5-32 I/O Transfer Card A2 consists of a set of 12 input selection gates and associated amplifiers, and buffer amplifiers for control signals $\overline{\text{ISL}}$, $\overline{\text{IEN}}$, $\overline{\text{DTE}}$, and $\overline{\text{IRQ}}$. Checkout and troubleshooting instructions for these functions are provided in Steps 4, 6, and 10 of Table 5-2.

5-33 LOGIC AND TIMING CARD A3, TROUBLESHOOTING

5-34 Logic and Timing Card A3 consists of data bit I/O selection gates, data-bit buffers, address-bit buffers, and DST-flag circuits. Checkout and troubleshooting instructions for the I/O selection and data bit buffer circuits are provided in Table 5-2, Step 2. The DST and flag circuits, as well as the address-bit buffers, are covered in Table 5-6.

5-35 REMOVAL AND REPLACEMENT

5-36 Heat Sink Mounted Components

5-37 Series regulator transistor Q1 and rectifier diodes CR1 and CR2 are installed on a heat-sink located in the left-rear section of the mainframe. The three components are electrically insulated from the heat sink by mica washers and nylon bushings. If a component replacement becomes necessary, coat both sides of the mica washers with silicon grease (Dow Corning DC-5, or equivalent) to insure maximum thermal transfer between the component and the heat sink.

Table 5-3. Quick Check Procedure.

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set LINE switches to ON and DATA SOURCE switch on 6940A to LOCAL.	LINE indicator lamp and lamp on card A3 of 6941A under test go on.	Refer to power supply troubleshooting, Table 5-4.
2	Touch CLEAR REGISTER. Select control word (15, 14, 13, 12, on). Select SYE and TME (5 and 4, on). Using buttons 0 through 3, address the 6941A under test. Touch LOAD OUTPUT. (Selects proper unit, SYE, and TME). Touch 12, 5, 4, and return 0, 1, 2, and 3 to the unlit state. Check the logic level or voltage at the following extender card pins (slot 414) and observe the normal indications shown for Test No. 2.		

PIN NO	NORMAL IND FOR TEST NO 2	NORMAL IND FOR TEST NO 3	CHECK CIRCUIT	REFER TO TABLE
1 (SYE)	HI	LO	SYE (A3Q3, A3Z7)	——
2	+12V	+12V	Power Supply	5-4
3	+5V	+5V	Power Supply	5-4
4 (Un)	HI	LO	Unit Select (6940A)	——
5 ($\overline{DTE}$)	HI	LO	DTE (A2Z6)	——
7 ($\overline{CTF}$)	HI	HI	Pull out I/O cards one at a time and note which card is holding $\overline{CTF}$ LO.	
9 ($\overline{B00}$)	HI	LO	Bit Control	5-2, Test 2
10 ($\overline{B01}$)	HI	LO		
11 ($\overline{B02}$)	HI	LO		
12 ($\overline{B03}$)	HI	LO		
13 ($\overline{B04}$)	HI	LO		
14 ($\overline{B05}$)	HI	LO		
15 ($\overline{B06}$)	HI	LO		
16 ($\overline{B07}$)	HI	LO		
17 ($\overline{B08}$)	HI	LO		
18 ($\overline{B09}$)	HI	LO		
19 ($\overline{B10}$)	HI	LO		
20 ($\overline{B11}$)	HI	LO		
21 ($\overline{B12}$)	HI	LO		
22 (B13)	HI	LO		
23 (B14)	HI	LO		
24 (B15)	HI	LO	Bit Control	5-2, Test 2

Table 5-3. Quick-Check Procedure (Continued)

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
(2)	Check only when A6 Voltage Regulator Card is used.	PIN NO. / NORMAL IND. FOR TEST NO. 2 / NORMAL IND. FOR TEST NO. 3: B: +12V / +12V C: +5V / +5V D (DST): LO* / LO* E: -12V / -12V F ($\overline{IRQ}$): HI / HI J ($\overline{IEN}$): HI / LO K: +15V / +15V L: -15V / -15V M: (4) / (4) N: +15V / +15V P: -15V / -15V R: (3) / (3) S: +15V / +15V T: -15V / -15V U: (2) / (2) V: +15V / +15V W: -15V / -15V X: (1) / (1) Y (B12): LO / HI Z ($\overline{B13}$): LO / HI AA ($\overline{B14}$): LO / HI BB ($\overline{B15}$): LO / HI *DST goes HI when LOAD OUTPUT on 6940A is touched.	CHECK CIRCUIT / REFER TO TABLE: Power Supply / 5-4 Power Supply / 5-4 DST / 5-2, Test 3 Power Supply / 5-4 Pull out accessory input cards one at a time and note which card is holding $\overline{IRQ}$ LO. $\overline{IEN}$ (A2Z6) / — A6 Voltage Regulator Card / Refer to Instruction Manual for A6 Voltage Regulator Card. Buffer Amplifier / 5-5 Buffer Amplifier / 5-5 Buffer Amplifier / 5-5 Buffer Amplifier / 5-5
3	Touch CLEAR REGISTER. Select control word (15, 14, 13, 12, on). Select DTE and IEN (6 and 8, on). Select unit 15 (3, 2, 1, 0, on). Touch LOAD OUTPUT. Touch CLEAR REGISTER. Touch switches 12 through 0. Check the logic level or voltage at the extender card pins specified in Test No. 2 and observe the normal indications shown for Test No. 3.	See Test No. 2.	See Test No. 2.

Table 5-3. Quick-Check Procedure (Continued)

TEST	INSTRUCTIONS	NORMAL INDICATION	IF INDICATION IS ABNORMAL
4	Touch CLEAR REGISTER. Select control word. Select ISL (bit 7, on). Touch LOAD OUTPUT. Monitor pin 6 on extender card. Clear control word (touch switch 15).	$\overline{ISL}$ remains HI until after control word is cleared, and then goes LO.	Check A2Z6, A1Z1, and A2Q1.

Table 5-4. Power Supply Troubleshooting

STEP NO.	TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	LINE indicator and lamp on card A3 both fail to light when LINE switch is on.	a. Primary ac power not connected.	a. Check that power cord is connected to primary ac source and that fuse F1 is installed.	--	--
		b. Fuse F1 open.	b. Set LINE switch to OFF, replace fuse F1 and set LINE switch ON again.	b. Lamps go on.	b. Check if F1 has blown. If it has, set LINE switch to OFF and check for a short circuit in the primary circuit of transformer T1.
2	LINE indicator ON, but +5V lamp on card A3 is OFF.	a. Fuse F2 open due to short circuit between +12V line and C.	a. Set LINE switch to OFF. Measure resistance from +12V line to C. If a short circuit exists, start removing plug-in cards one at a time while observing the ohmmeter.	a. Above 4 ohms (the exact resistance reading will be subject to the ohmmeter range and lead connections).	a. Troubleshoot the plug-in card causing the short circuit.
		b. Fuse F2 open due to short circuit between +12V line and +5V line.	b. Measure resistance from +12V line to +5V line. If a short circuit exists, first check if series regulator A10Q1 is shorted. If A10Q1 is not shorted, follow the procedure in Step (a) above.	b. Above 4 ohms for both readings (the exact resistance reading will be subject to the ohmmeter range and lead connections).	b. Replace the shorted A10Q1 or troubleshoot the plug-in card causing the short circuit, as applicable.
		c. +5 volt regulator in current-latch due to	c. Attempt to clear the latch condition by setting LINE switch OFF and ON. If	c. Lamp on card A3 lights when LINE	c. Troubleshoot the plug-in card causing the fault.

Table 5-4. Power Supply Troubleshooting (Continued)

STEP NO.	TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
(2)		overvoltage or overcurrent condition.	this procedure is unsuccessful, remove all plug-in cards and try clearing the condition again. If the condition is now cleared, reinstall the cards one at a time until the fault reoccurs.	switch is set to ON.	
		d. Open series regulator transistor A10Q1.	d. Set LINE switch to ON. Examine resistor A10R7. If it is charred or very hot, A10Q1 is probably open. The nominal voltage drop across A10R7 is approximately 1.5V; if A10Q1 opens, the voltage drop will rise to approximately 4 volts.	d. 1.5 volts across A10R7.	d. Replace A10Q1 and A10R7 (if damaged).
		e. Shorted crowbar SCR.	e. Set LINE switch to OFF. Measure the resistance across SCR A10CR22.	e. Above 4 ohms (the exact resistance reading will be subject to the ohmmeter range and lead connections).	e. Open connection at cathode of A10CR22, and measure the resistance from +5V line to C. If the short circuit is cleared, replace A10CR22. If the short circuit still exists, check diode CR21 and wiring.
		f. Faulty component in crowbar circuit.	f. Open connection at cathode of A10CR22. Set LINE switch to ON. Measure voltage from +5V line to C.	f. +5 volts.	f. If voltage reading is now normal, check A10VR2, Q7, and CR22, and associated components.
		g. Faulty current latch circuit.	g. Set LINE switch to ON. While monitoring the +5V line, connect a jumper from the base to emitter of A10Q5.	g. +5 volts.	g. If the jumper connection returns the +5V line to the normal level, check A10Q6, Q4, and Q5, and associated components.
		h. Faulty bias reference circuit.	h. Measure voltage at base and emitter of A10Q3.	h. +6.2 volts at base. +5.6 volts at emitter.	h. If the base voltage is abnormal, check A10VR1, CR23, R3, and R4. If the emitter voltage is abnormal, check A10Q3 and Q2.

Table 5-5. Extender Card A1, Troubleshooting

STEP NO.	TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Some programmed bits missing at slot 414 connector.	Faulty termination network on A1 input card.	Set LINE switch to OFF. Remove A2 card and install extender card in its place. Reapply power. At the 6940A switch register, toggle the faulty bits while observing the bit levels (on the extender card) associated with the faulty bits. (Check that ISL is off at the switch register).	Bit levels switch HI and LO.	Check associated termination network on card A1.
2	All programmed bits missing at slot 414 connector.	Faulty shunt regulator on card A1.	Set LINE switch to OFF. Install A1 card on extender. Set LINE switch to ON. Monitor the voltage at the emitter of A1Q1 (+ side of A1C1).	+5 volts.	Check A1Q1 and associated components.

Table 5-6. Logic and Timing Card A3, DST, FLAG, and Address Bit Amplifier Troubleshooting

STEP NO.	TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	DST not generated.	a. Faulty 4μsec delay circuit. b. Faulty DST amplifier.	a. With 6940A switch register in LOCAL mode, monitor test point A3 (1) while tapping LOAD OUTPUT button. b. Monitor DST signal at A3 TP3 while tapping LOAD OUTPUT button.	a. LO signal starting 4μsec after start of $\overline{GAT}$. b. HI level when LOAD OUTPUT is touched.	a. Check A3Q1 and associated components. b. Check A3Q9 and associated components.
2	DST generated but $\overline{FLG}$ not generated.	Faulty 2μsec delay circuit.	Monitor signal at test point A3 (14) (collector of A3Q2) while tapping LOAD OUTPUT button.	Positive signal starting 6μsec after start of $\overline{GAT}$.	Check A3Q2 and associated components.
3	Address-bit erroneous at extender card.	Faulty address-bit amplifier.	Monitor address bit levels at test points A3 (2) through (13) while selecting bits 15, 14, 13, and 12 at switch register.	Bit levels $\overline{B15}$, $\overline{B14}$, $\overline{B13}$, and $\overline{B12}$ all LO. Bit levels B15, B14, B13, and B12 all HI.	Replace any amplifier having a normal input but an abnormal output.

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2. This section contains information for ordering replacement parts. Table 6-4 lists parts in alphanumeric order by reference designators and provides the following information:

a. Reference Designators. Refer to Table 6-1.

b. Description. Refer to Table 6-2 for abbreviations.

c. Total Quantity (TQ). Given only the first time the part number is listed except in instruments containing many sub-modular assemblies, in which case the TQ appears the first time the part number is listed in each assembly.

d. Manufacturer's Part Number or Type.

e. Manufacturer's Federal Supply Code Number. Refer to Table 6-3 for manufacturer's name and address.

f. Hewlett-Packard Part Number.

g. Recommended Spare Parts Quantity (RS) for complete maintenance of one instrument during one year of isolated service.

h. Parts not identified by a reference designator are listed at the end of Table 6-4 under Mechanical and/or Miscellaneous. The former consists of parts belonging to and grouped by individual assemblies; the latter consists of all parts not immediately associated with an assembly.

6-3 ORDERING INFORMATION

6-4. To order a replacement part, address order or inquiry to your local Hewlett-Packard sales office (see lists at rear of this manual for addresses). Specify the following information for each part: Model, complete serial number, and any Option or special modification (J) numbers of the instrument; Hewlett-Packard part number, circuit reference designator, and description. To order a part not listed in Table 6-4, give a complete description of the part, its function, and its location.

Table 6-1. Reference Designators

A = assembly	E = miscellaneous electronic part
B = blower (fan)	F = fuse
C = capacitor	J = jack, jumper
CB = circuit breaker	K = relay
CR = diode	L = inductor
DS = device, signaling (lamp)	M = meter
P = plug	Q = transistor
R = resistor	S = switch
T = transformer	TB = terminal block
TS = thermal switch	V = vacuum tube, neon bulb, etc.
VR = zener diode	X = socket
Z = integrated circuit or network	

Table 6-1. Reference Designators (Continued)

Table 6-2. Description Abbreviations

A = ampere	mfr = manufacturer
ac = alternating current	mod. = modular or modified
assy = assembly	mtg = mounting
bd = board	n = nano = 10^{-9}
bkt = bracket	NC = normally closed
°C = degree Centigrade	NO = normally open
cd = card	NP = nickel-plated
coef = coefficient	Ω = ohm
comp = composition	obd = order by description
CRT = cathode-ray tube	OD = outside diameter
CT = center-tapped	p = pico = 10^{-12}
dc = direct current	P.C. = printed circuit
DPDT = double pole, double throw	pot. = potentiometer
DPST = double pole, single throw	p-p = peak-to-peak
elect = electrolytic	ppm = parts per million
encap = encapsulated	pvr = peak reverse voltage
F = farad	rect = rectifier
°F = degree Farenheit	rms = root mean square
fxd = fixed	Si = silicon
Ge = germanium	SPDT = single pole, double throw
H = Henry	SPST = single pole, single throw
Hz = Hertz	SS = small signal
IC = integrated circuit	T = slow-blow
ID = inside diameter	tan = tantulum
incnd = incandescent	Ti = titanium
k = kilo = 10^{3}	V = volt
m = milli = 10^{-3}	var = variable
M = mega = 10^{6}	ww = wirewound
μ = micro = 10^{-6}	W = Watt
met. = metal	

No.	Name and Address
[illegible]	[illegible] Inc., Elmira, N.Y.
[illegible]	[illegible] Corp., North Tonawanda, N.Y.
[illegible]	[illegible] Co., Fremont, Ohio
[illegible]	[illegible] Co., Newburyport, Mass.
[illegible]	[illegible] Inc., Lawndale, Calif.
[illegible]	[illegible] Inc., Dallas, Texas
[illegible]	[illegible] Inc., Manchester, N.H.
[illegible]	[illegible] Corp., Melrose, Ill.
[illegible]	[illegible] Co., Dover, Ohio
[illegible]	[illegible] Corp., Somerville, N.J.
[illegible]	[illegible] Corp., Morton Grove, Ill.
[illegible]	[illegible] Corp., Iron View, Ill.
[illegible]	[illegible] Corp., Solid State
[illegible]	[illegible] Corp., Somerville, N.J.
[illegible]	[illegible] Semiconductor Products Dept., Syracuse, N.Y.
[illegible]	[illegible] Corp., Compton, Calif.
[illegible]	[illegible] Electronic Corp., Wakefield, Mass.
[illegible]	[illegible] Resistor Co. Inc., Cedar Knolls, N.J.
[illegible]	[illegible] Hart and Hegeman Electric Co., Hartford, Conn.
[illegible]	[illegible] Electronics, Inc., Harbor City, Calif.
[illegible]	[illegible] Burns Mfg. Co. Inc., Mineola, N.Y.
[illegible]	*Hewlett-Packard Co., Palo Alto Div., Palo Alto, Calif.
[illegible]	Motorola Semiconductor Prod., Inc., Phoenix, Arizona
[illegible]	Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa.
[illegible]	Ultronix, Inc., Grand Junction, Colo.
[illegible]	[illegible] Inc., Wakefield, Mass.
[illegible]	General Elect. Co. Electronic Capacitor & Battery Dept., Irmo, S.C.
[illegible]	Passik Div., Stewart-Warner Corp., Bridgeport, Conn.
[illegible]	IRC Div. of TRW Inc., Semiconductor Plant, Lynn, Mass.
[illegible]	Vactron Electronic Hardware Co. Inc., New Rochelle, N.Y.
[illegible]	Beede Electrical Instrument Co., Penacook, N.H.
[illegible]	General Devices Co. Inc., Indianapolis, Ind.
[illegible]	Semcor Div. Components, Inc., Phoenix, Arizona
[illegible]	Robinson Nugent, Inc., New Albany, Ind.
[illegible]	Torrington Mfg. Co., West Div., Van Nuys, Calif.
[illegible]	Transistor Electronics Corp., Minneapolis, Minn.

No.	Name and Address
[illegible]	[illegible] Instrument Corp., Elmira, N.Y.
[illegible]	[illegible] Instrument Corp. of Del., Mountain View, Calif.
[illegible]	Barker & Corp., The, Los Angeles, Calif.
[illegible]	Systron-Donner Prod., Inc., Concord, Calif.
[illegible]	Electronic Systems, Western Div., Mountain View, Calif.
[illegible]	IRC Div. of TRW Inc. Burlington Plant, Burlington, Iowa
[illegible]	Continental Device Corp., Hawthorne, Calif.
[illegible]	Raytheon Co. Components Div., Semiconductor Operation, Mountain View, Calif.
[illegible]	Sprague Corporation, Inc., Union, N.J.
[illegible]	Reliance Mica Corp., Brooklyn, N.Y.
[illegible]	Sloan Company, The, Sun Valley, Calif.
[illegible]	Varadine Products Co. Inc. Wyckoff, N.J.
[illegible]	General Elect. Co. Miniature Lamp Dept., Cleveland, Ohio
[illegible]	Nytronics Corp., Norristown, Pa.
[illegible]	RCH Supply Co., Vernon, Calif.
[illegible]	Airco Speer Electronic Components, Bradford, Pa.
[illegible]	*Hewlett-Packard Co. New Jersey Div., Berkeley Heights, N.J.
[illegible]	General Elect. Co. Semiconductor Prod. Dept., Buffalo, N.Y.
[illegible]	General Elect. Co. Semiconductor Prod. Dept., Auburn, N.Y.
[illegible]	C. K. Components Inc., Newton, Mass.
[illegible]	Burndy Corp., Norwalk, Conn.
[illegible]	Wagner Electric Corp., Tung-Sol Div., Bloomfield, N.J.
[illegible]	CTS of Berne, Inc., Berne, Ind.
[illegible]	Chicago Telephone of Cal., Inc., So. Pasadena, Calif.
[illegible]	IRC Div. of TRW Inc. Boone Plant, Boone, N.C.
[illegible]	General Instrument Corp., Rectifier Div., Newark, N.J.
[illegible]	Philadelphia Handle Co. Inc., Camden, N.J.
[illegible]	U.S. Terminals, Inc., Cincinnati, Ohio
[illegible]	Hamlin Inc., Lake Mills, Wisconsin
[illegible]	Clarostat Mfg. Co. Inc., Dover, N.H.
[illegible]	Thermalloy Co., Dallas, Texas
[illegible]	*Hewlett-Packard Co. Loveland Div., Loveland, Colo.
[illegible]	Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., Newark, N.J.
[illegible]	General Instrument Corp. Semiconductor Prod. Group, Hicksville, N.Y.
[illegible]	Fenwal Elect., Framingham, Mass.
[illegible]	Corning Glass Works, Electronic Components Div., Raleigh, N.C.

*Use Code 28480 assigned to Hewlett-Packard Co., Palo Alto, California

Table 6-3. Col. List of Manufacturers (Continued)

CODE NO.	MANUFACTURER	ADDRESS
10956	Delco Radio Div. of General Motors Corp.	Kokomo, Ind.
17545	Atlantic Semiconductors, Inc.	Asbury Park, N. J.
17dd3	Fairchild Camera and Instrument Corp. Semiconductor Div. Transducer Plant	Mountain View, Calif.
17870	Raven Div. Thomas A. Edison Industries McGraw-Edison Co.	Orange, N. J.
18324	Signetics Corp.	Sunnyvale, Calif.
19315	Bendix Corp. The Navigation and Control Div.	Teterboro, N. J.
19701	Electra/Midland Corp.	Mineral Wells, Texas
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
22229	Union Carbide Corp. Electronics Div.	Mountain View, Calif.
22753	UID Electronics Corp.	Hollywood, Fla.
23936	Pamotor, Inc.	Pampa, Texas
24446	General Electric Co.	Schenectady, N. Y.
24455	General Electric Co. Lamp Div. of Consumer Prod. Group	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	LTV Electrosystems Inc Memcor/Components Operations	Huntington, Ind.
26982	Dynacool Mfg. Co. Inc.	Saugerties, N. Y.
27014	National Semiconductor Corp.	Santa Clara, Calif.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N. J.
28875	IMC Magnetics Corp. New Hampshire Div.	Rochester, N. H.
31514	SAE Advance Packaging, Inc.	Santa Ana, Calif.
31827	Budwig Mfg. Co.	Ramona, Calif.
33173	G. E. Co. Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill.
37942	P. R. Mallory & Co. Inc.	Indianapolis, Ind.
42190	Muter Co.	Chicago, Ill.
43334	New Departure-Hyatt Bearings Div. General Motors Corp.	Sandusky, Ohio
44655	Ohmite Manufacturing Co.	Skokie, Ill.
46384	Penn Engr. and Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
49956	Raytheon Co.	Lexington, Mass.
55026	Simpson Electric Co. Div. of American Gage and Machine Co.	Chicago, Ill.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Electric Co.	Bristol, Conn.
58849	Syntron Div. of FMC Corp.	Homer City, Pa.
59730	Thomas and Betts Co.	Philadelphia, Pa.
61637	Union Carbide Corp.	New York, N. Y.
63743	Ward Leonard Electric Co.	Mt. Vernon, N. Y.

CODE NO.	MANUFACTURER	ADDRESS
70563	Amperite Co. Inc.	Union City, N. J.
70901	Beemer Engrg. Co.	Fort Washington, Pa.
70903	Belden Corp.	Chicago, Ill.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionic Corp.	Cambridge, Mass.
71400	Bussmann Mfg. Div. of McGraw Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	I.T.T. Cannon Electric Inc.	Los Angeles, Calif.
71590	Globe-Union Inc. Centralab Div.	Milwaukee, Wis.
71700	General Cable Corp. Cornish Wire Co. Div.	Williamstown, Mass.
71707	Coto Coil Co. Inc.	Providence, R. I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co. and Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co. Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N. Y.
72699	General Instrument Corp.	Newark, N. J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72962	Elastic Stop Nut Div. of Amerace Esna Corp.	Union, N. J.
72982	Erie Technological Products Inc.	Erie, Pa.
73096	Hart Mfg. Co.	Hartford, Conn.
73138	Beckman Instruments Inc. Helipot Div.	Fullerton, Calif.
73168	Fenwal, Inc.	Ashland, Mass.
73293	Hughes Aircraft Co. Electron Dynamics Div.	Torrance, Calif.
73445	Amperex Electronic Corp.	Hicksville, N. Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73734	Federal Screw Products, Inc.	Chicago, Ill.
74193	Heinemann Electric Co.	Trenton, N. J.
74545	Hubbell Harvey Inc.	Bridgeport, Conn.
74868	Amphenol Corp. Amphenol RF Div.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	IRC Div. of TRW, Inc.	Philadelphia, Pa.
75183	*Howard B. Jones Div. of Cinch Mfg. Corp.	New York, N. Y.
75376	Kurz and Kasch, Inc.	Dayton, Ohio
75382	Kilka Electric Corp.	Mt. Vernon, N. Y.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76381	Minnesota Mining and Mfg. Co.	St. Paul, Minn.
76385	Minor Rubber Co. Inc.	Bloomfield, N. J.
76487	James Millen Mfg. Co. Inc.	Malden, Mass.
76493	J. W. Miller Co.	Compton, Calif.

*Use Code 71785 assigned to Cinch Mfg. Co., Chicago, Ill.

Table 6-4. Replaceable Parts

REF DESIG	DESCRIPTION †	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
A1	Extender Input Card, Plug-In	1		28480	06941-60024	
C1,2	fxd, elect, 1μF 35Vdc	2	150D105X9035A2	56289	0180-0291	1
CR1,2	Rect, Si, 80V 200mA	2		28480	1901-0050	2
Q1	Power PNP Si	1	2N3740	04713	1853-0037	1
R1	fxd, comp 300 5% ½W	1	EB 3015	01121	0686-3015	1
R2	fxd, ww 35 5% 10W	1	247E3505	56289	0811-1900	1
Z1	Quad 2-Input NAND gate, IC	1		28480	1820-0054	1
Z2-Z4	Resistor Network, 1kΩ, 9 Pin	3		28480	1810-0121	3
A2	I/O Transfer Card, Plug-In	1		28480	06941-60020	
C1-C7	fxd, elect, 1μF 35Vdc,	7	150D105X9035A2	56289	0180-0291	2
CR1-CR4	Diode, Si, 180V 200mA	4		28480	1901-0033	4
Q1	SS NPN Si	1		28480	1854-0071	1
R1-R9	fxd, comp 1k 5% ½W	9	EB-1025	01121	0686-1025	2
R10	fxd, comp 2k 5% ½W	1	EB-2025	01121	0686-2025	1
Z1,2	Inverting Amplifier, IC	2		28480	1820-0174	2
Z3-Z5	Quad 2-Input NAND gate, IC	3		28480	1820-0054	3
Z6	Buffer Amplifier, IC	1		28480	1820-0618	1
A3	Logic and Timing Card, Plug-In	1		28480	5060-7960	
C1-C4	fxd, elect, 1μF 35Vdc	4	150D105X9035A2	56289	0180-0291	1
C5	fxd, mylar 0.0047μF 200V	1	192P47292	56289	0160-0157	1
C6-C8	fxd, mylar 0.001μF 200V	3	192P10292	56289	0160-0153	1
CR1,2	Diode, Si, 180V 200mA	2		28480	1901-0033	2
DS1	Lamp, Incandescent 6.0V	1		28480	2140-0324	1
Q1-3,7,9	SS NPN Si	5		28480	1854-0071	5
R13	fxd, comp 5.1k 5% ½W	4	EB-5125	01121	0686-5125	1
R18-R20	fxd, comp 1k 5% ½W	5	EB-1025	01121	0686-1025	1
R21	fxd, comp 51 5% ½W	1	EB-5105	01121	0686-5105	1
R22	fxd, comp 270 5% ½W	1	EB-2715	01121	0686-2715	1
R23	fxd, comp 510 5% ½W	1	EB-5115	01121	0686-5115	1
R24	fxd, comp 2k 5% ½W	2	EB-2025	01121	0686-2025	1
R25	fxd, comp 1k 5% ½W		EB-1025	01121	0686-1025	
R26,27	fxd, comp 5.1k 5% ½W		EB-5125	01121	0686-5125	
R28-R31	fxd, comp 10k 5% ½W	4	EB-1035	01121	0686-1035	1
R35	fxd, comp 2k 5% ½W		EB-2025	01121	0686-2025	
R36	fxd, comp 100k 5% ½W	1	EB-1045	01121	0686-1045	1
R41	fxd, comp 1k 5% ½W		EB-1025	01121	0686-1025	
R42	fxd, comp 5.1k 5% ½W		EB-5125	01121	0686-5125	
Z1-Z3	Inverting Amplifier, IC	3		28480	1820-0174	3
Z4-Z6	Open Coll, Quad 2-Input NAND gate	3		28480	1820-0621	3
Z7	Quadruple 2-Input NAND gate, IC	1		28480	1820-0054	1
Z8,9	Buffer Amplifier, IC	2		28480	1820-0618	2
Z10	Triple 3-Input NAND gate, IC	1		28480	1820-0068	1
Z11,12,16	Resistor Network, 1kΩ, 9 Pin	3		28480	1810-0121	3
Z13,14	Resistor Network, 500Ω, 9 Pin	2		28480	1810-0132	2
Z15	Hex Inverter, IC	1		28480	1820-0577	1
A7	Adapter Card, Includes Data Input Connector (J1)	1		28480	5060-6200	

† NOTE: All resistors are in ohms unless otherwise indicated.

REF DESIG	DESCRIPTION†	TQ	MFR PART NO	MFR CODE	HP PART NO	RS
A8	Adapter Card, includes Data Output Connector (J2)	1	-	28480	5060-6200	
A9	Interconnect Board (Backplane Assy)	1		28480	06941-60022	
J1-J22	P C Card Edge Connectors	22		28480	1251-2025	5
A10	Main Power Supply Board	1	-	28480	5060-6197	
C1	fxd, elect 2000μF 28Vdc	9		28480	0180-1916	2
C4	fxd, elect 200μF 15Vdc	1	30D207G015DF2	56289	0180-0104	1
C5-C12	fxd, elect 2000μF 28Vdc			28480	0180-1916	
C13	fxd, elect 1μF 35Vdc	1	150D105X9035A2	56289	0180-0291	1
CR3,4	Diode, Si, 3A 200prv	3		28480	1901-0416	3
CR5-CR20	Rect, Si, 200V 1A	16		28480	1901-0327	8
CR21	Diode, Si, 3A 200prv			28480	1901-0416	
CR22	SCR 25A 50V	1		28480	1884-0046	1
CR23	Diode, Si, 80V 200mA	1		28480	1901-0050	1
Q2	SS NPN Si	1		28480	1854-0244	1
Q3-Q5	SS NPN Si	3		28480	1854-0071	3
Q6,7	SS PNP Si	2		28480	1853-0099	2
R1	fxd, comp 510 5% ¼W	2	EB 5115	01121	0686-5115	1
R2	fxd, comp 100 5% ¼W	2	EB 1015	01121	0686-1015	1
R3	var, ww 1k	1	Type 110 F4	11236	2100-0391	1
R4	fxd, comp 6.2k 5% ¼W	1	EB 6225	01121	0686-6225	1
R5,6	fxd, comp 200 5% ¼W	2	EB 2015	01121	0686-2015	1
R7	fxd, comp 10 5% ¼W	1	EB 1005	01121	0686-1005	1
R8	fxd, ww 25 5W	1	243E2505	56289	0811-1853	1
R9	fxd, wirewnd 0.1 5% 8W T C +100ppm/°C	1		28480	0811-2545	1
R10	fxd, comp 10k 5% ¼W	1	EB 1035	01121	0686-1035	1
R11,12	fxd, comp 3k 5% ¼W	2	EB 3025	01121	0686-3025	1
R13,14	fxd, comp 20k 5% ¼W	2	EB 2035	01121	0686-2035	1
R15	fxd, comp 1k 5% ¼W	1	EB 1025	01121	0686-1025	1
R16	fxd, comp 68 5% ¼W	1	EB 6805	01121	0686-6805	1
R17	fxd, comp 150 5% ¼W	1	EB 1515	01121	0686-1515	1
R18	fxd, comp 100 5% ¼W		EB 1015	01121	0686-1015	
R19	fxd, comp 510 5% ¼W		EB 5115	01121	0686-5115	
R20-R27	fxd, comp 2k 5% ¼W	8	EB 2025	01121	0686-2025	2
VR1	Diode, zener 6.2V	1	1N825	03877	1902-1221	1
VR2	Diode, zener 4.22V 400mW	1		28480	1902-3070	1
A11	NOT USED	-	-	-	-	-
A12	Power Module (includes fuse, slide switch and filter)	1		28480	5060-1188	
F1	Fuse, 4A @ 250V Slo-Blo	1		28480	2110-0365	5
	FRONT PANEL - Electrical					
DS1	Line Indicator Lamp	1		28480	2140-0015	1
R1	fxd, comp 33k 5% ¼W	1	EB 3335	01121	0686-3335	1
S1	LINE switch	1		28480	3101-1296	1

†NOTE: All resistors are in ohms unless otherwise indicated.

REF DESIG	DESCRIPTION	TQ	MFR PART NO	MFR CODE	HP PART NO	RS
	REAR DECK ASSEMBLY					
	Electrical					
C2,3	fxd, elect 8600uF 25V	2		28480	0180 1882	1
CR1,2	Diode, Si (Heat Sink) 12A 100prv	2	1N1200A	02735	1901 0002	2
F2	Fuse, ceramic 10A @ 250V	1	314 010	75915	2110 0051	5
J1,2	Data Input/Output Connectors - Part of A7, A8					
Q1	Power PNP Si	1		28480	1853 0063	1
T1	Transformer, Power	1		28480	06936 80091	1
	MECHANICAL					
	Front Door Assembly, Complete	1		28480	06941 60001	
	Base, Indicator DS1	1		28480	5040 0305	
	Base, Clear, DS1	1		28480	5040 0234	
	Shield, Outer, Aluminum	1		28480	5000 9309	
	Latch, Door	1		28480	0510 1136	
	Door, Blank, Lettering Only	1		28480	06941 60002	
	Card Cage Assembly, Complete	1		28480	5060 7926	
	Guide, Plug-In Cards	40		28480	4040 0765	
	Snap Tabs (for card guides)	120		28480	4040 0771	
	Stand-off, Metal, Side Plate	12		28480	0380 0950	
	Support Bar, Aluminum, Guides	6		28480	5020 8027	
	Support Bar, Alum. (with slot no.s)	1		28480	5060 7925	
	Side Plate, Right	1		28480	5000 9307	
	Side Plate, Left	1		28480	5000 9308	
	Block, Barrier	1		28480	0360 1690	
	Shield, Barrier Block	1		28480	5020 8040	
	Rear Deck Assembly	1		28480	5060 7961	
	Heat Sink, Blank	1		28480	5000 9305	
	Insulator, Mica, Q1	1	734	08530	0340 0174	1
	Bushing, Transistor Pins, Q1	2		28480	0340 [redacted]	2
	Shoulder Washer, Q1, Mtg. Screws	2		28480	2190 04[illegible]	2
	Bushing, Nylon, CR1,2	2		28480	0340 0170	2
	Washer, Mica, CR1,2	4		28480	2190 0708	4
	Grommet, Nylon, Heat Sink Wiring	1	SB 562 6	28520	0400 0108	
	Clamp, C2,3	2	4586 2B	56289	0180 0078	1
	Fuseholder	1	342 014	75915	1400 0084	1
	Washer, Neoprene, Fuseholder	1	901 129	75915	1400 0090	1
	Lockwasher, Fuseholder	1	1224-08	78189	2190-0037	1
	Hex Nut, Fuseholder	1	903 12	75915	2950 0038	1
	Rear Panel	1		28480	5000 9468	
	Top Trim Assembly, Front	1		28480	5060 7962	
	Trim, Aluminum, Bar	1		28480	5020 8056	
	Insert, Black Plastic	1		28480	5020 8030	
	Hinge Plate, Door	1		28480	5000 9310	
	Bottom Trim Assembly, Front	1		28480	5060 796[illegible]	
	Trim, Bottom	1		28480	5020 805[illegible]	
	Insert, Black Plastic	1		28480	5020-8034	
	Hinge Plate, Door	1		28480	5000-9311	

REF DESIG	DESCRIPTION	TQ	MFR PART NO	MFR CODE	HP PART NO	RS
	Bottom Trim Assy, Front (Complete)	1		28480	1250-0118	
	Connector, 5V	1		28480	5000-9318	
	Bracket, Connector Lock (Pair)	2		28480	2190-0494	
	Shoulder Washer	1		28480	5000-9312	
	Side Panel, Front Door	1		28480	5000-9317	
	Side Panel, Rear Door	1		28480	5000-9455	
	Cover, Top	1		28480	5000-9401	
	Cover, Bottom	2		28480	5000-9456	
	Cover, Side	2		28480	08660-20076	
	Side, Front	2		28480	5060-0222	
	Handle Assembly, Side	2		28480	5060-8735	
	Rear Panel, Handle Assembly	2		28480	5000-0052	
	Side Trim, Front, Adhesive Backed	2		28480	5000-9492	
	Cover, Plate, Rear Panel	1		28480	5060-0767	
	Front Assembly	5		28480	0403-0180	
	Extender Handle, A1 Card	1		28480	1205-0206	1
	Card Guide	1		[illegible]	0403-0180	
	Extender Handle, A2 Card	1		91506	1200-0768	6
	Socket, IC, A2Z1-Z6	6	314 AG5D 3R	91506	1200-0767	1
	Socket, IC, A2X2 (Quad) W1 (Dual)	1	316 AG5D 3R	28480	0403-0180	
	Extender Handle, A3 Card	1		91506	1200-0768	7
	Socket, IC, A3Z1-Z10	10	314 AG5D 3R	91506	1200-0767	1
	Socket, IC, A3X2-Z1 (Quad) W2 (Dual)	1	316 AG5D 3R	28480	5020-8026	
	Support Bar, A9 Board	2		28480	5060-7964	
	Cable Assembly, W1 Interconnects A2 and A3	1				
	MISCELLANEOUS					
	Stand, Tilt	1		28480	1490-0030	
	Input Connector, P1	1	57-30500-375	71785	1251-0086	
	Extender Board, Plug In	1		28480	5060-7901	
	Connector, Extender Board	1	251-24-30-380	71785	1251-0497	
	Fuse, 2A Slo-Blo, 230V, Input	1		28480	2110-0303	5
	Bracket, Trim	2		28480	5020-8031	
	Bracket, Trim	2		28480	5020-8032	
	Rack Mounting Kit	1		28480	5060-8741	
	Power Cord	1		28480	8120-1348	
	Screw, Nylon (A9 Support Bars)	24	N 440 5 8	95987	2200-0768	
	Key, Connectors	20		28480	1251-1115	
	Packing Carton	1		28480	9211-1187	
	Floater Pad, Packing Carton	2		28480	9220-1400	

SCHEMATIC DIAGRAMS

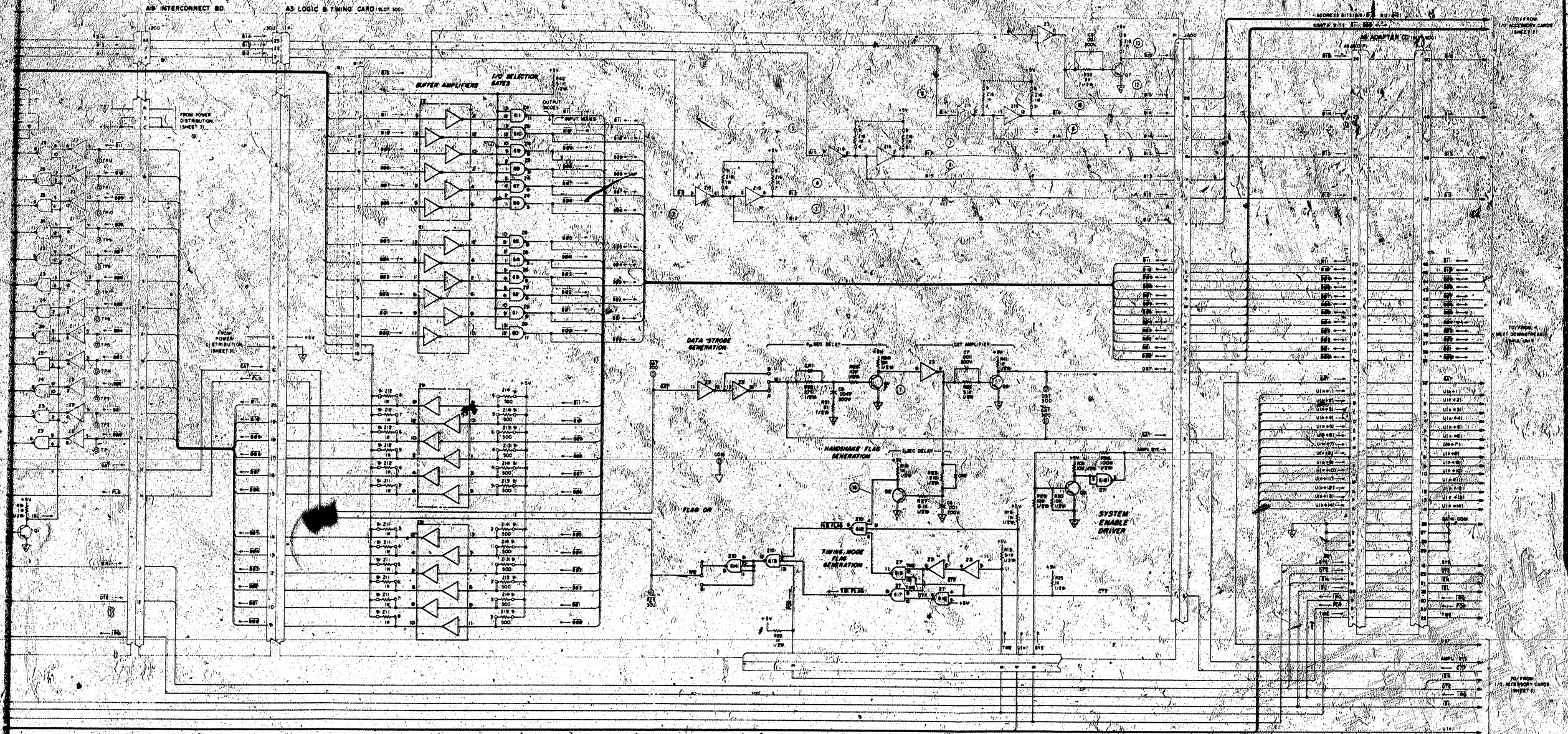
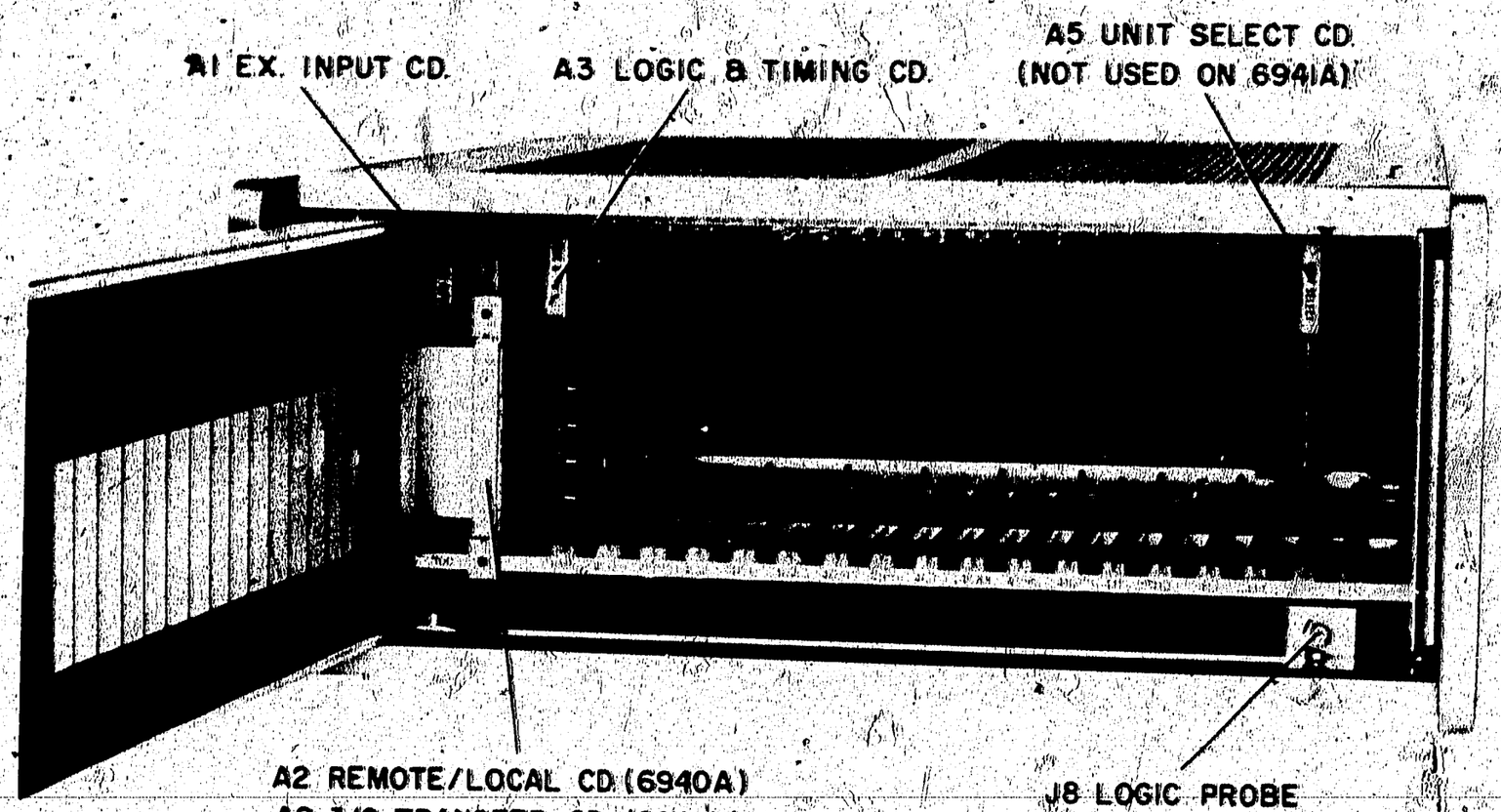


Figure 7-1 (Sheet 1). Data Processing and Distribution Circuits



6941A Multiprogrammer Extender Slot Locations

TO/FROM SHEET 1

ADDRESS BITS (B15/B15 - B12/B12)
DATA BITS (B11 - B00)
DATA STROBE (DST)
AMPL SYE
COMMON TIMING FLAG (CTF)
INTERRUPT ENABLE (IEN)
DATA TRANSFER ENABLE (DTE)
INPUT REQUEST (IRQ)
INPUT SELECT (ISL)
UNIT SELECT (U(n))

24 LINES

A4 (SLOT 400) — J400

A4 (SLOT 401) — J401

A4 (SLOT 402) — J402

A4 (SLOT 403) — J403

A4 (SLOT 404) — J404

A4 (SLOT 405) — J405

A4 (SLOT 406) — J406

A4 (SLOT 407) — J407

A4 (SLOT 408) — J408

B15 B14 B13 B12 B11 B10 B09 B08 B07 B06 B05 B04 B03 B02 B01 B00 DST U(n) SYE CTF DTE ISL IEN IRQ

NOTE:
WITH THE EXCEPTION OF ADDRESS BITS B12/B12 THROUGH B15/B15 (PINS 21 THROUGH 24) THE WIRING TO ALL ACCESSORY CARD CONNECTORS (J400 THROUGH J414) IS IDENTICAL. THIS PERMITS ANY TYPE OF ACCESSORY CARD TO BE USED IN ANY OF THE 15 SLOTS. NOTE, HOWEVER, THAT WHEN AN ACCESSORY CARD IS ASSIGNED A SLOT, IT HAS THE ADDRESS OF THAT SLOT. IF IT IS MOVED TO A DIFFERENT SLOT, IT ASSUMES THE ADDRESS OF THE NEW SLOT. DETAILS FOR EACH DIFFERENT TYPE ACCESSORY CARD ARE GIVEN IN SEPARATE INSTRUCTION MANUALS.

BLOCK DIAGRAMS OF TYPICAL OUTPUT AND INPUT CARDS ARE SHOWN ON FIGURE 7-2, SHEET 2 OF THE 6940A INSTRUCTION MANUAL.

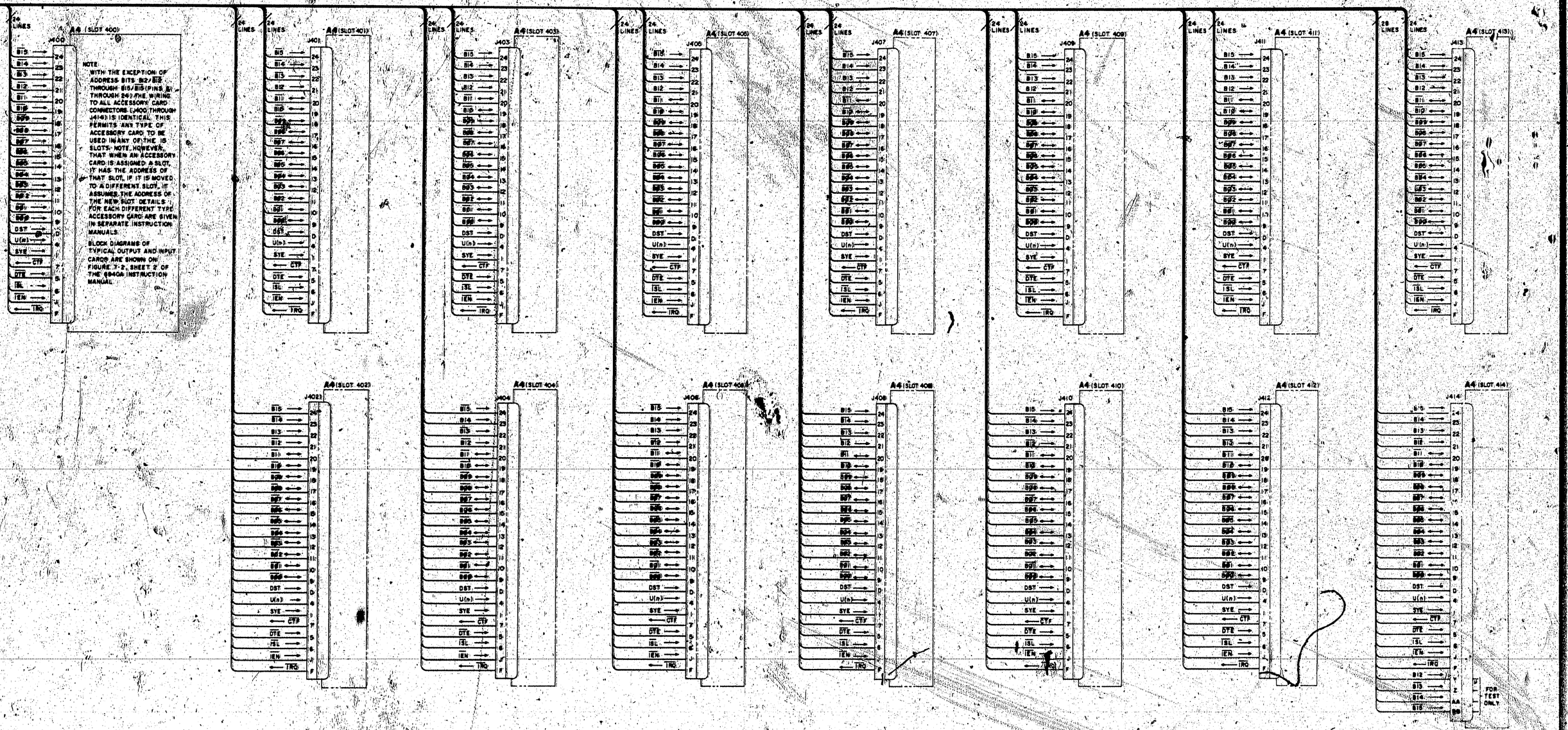


Figure 7-1 (Sheet 2). Accessory Cards

SECTION VII
CIRCUIT DIAGRAMS

7-1 INTRODUCTION

7-2 This section contains circuit diagrams necessary for the operation and maintenance of the Model 6941A Multiprogrammer Extender.

7-3 COMPONENT LOCATION DIAGRAMS

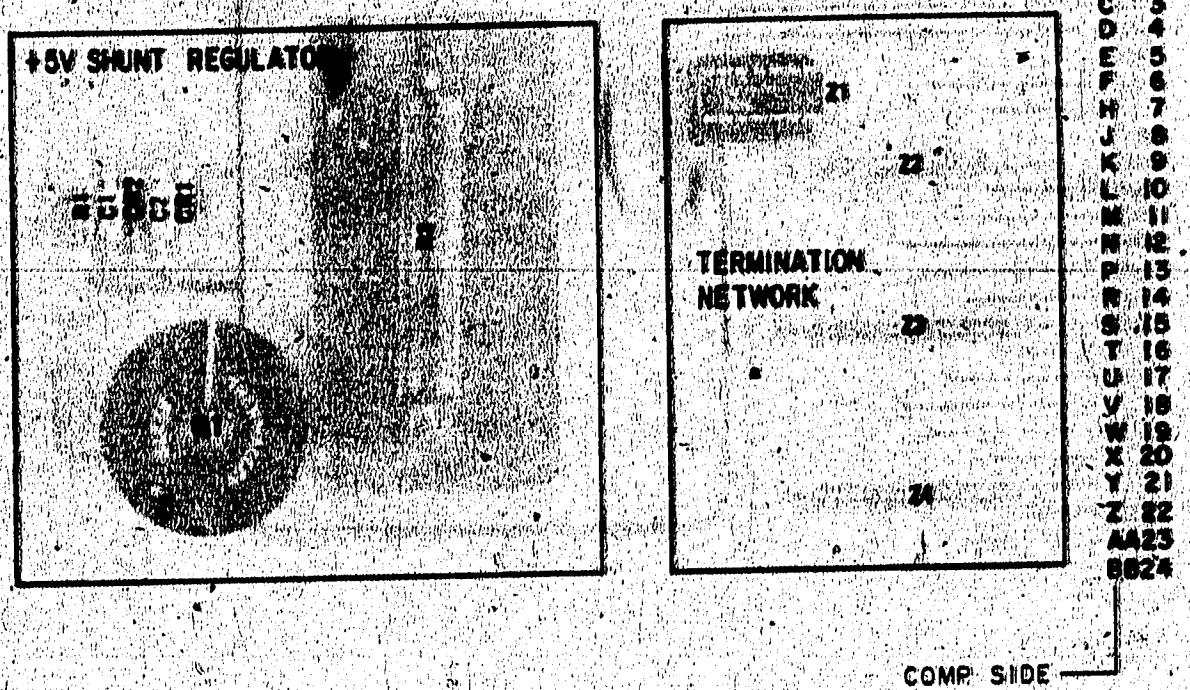
7-4 The component location diagrams show the physical location of parts mounted on each assembly. They are included on the schematic diagrams where they apply or on the rear of the previous schematic. Thus, the schematic diagram is unfolded to the right and the component location diagram is unfolded to the left.

7-5 SCHEMATIC DIAGRAMS

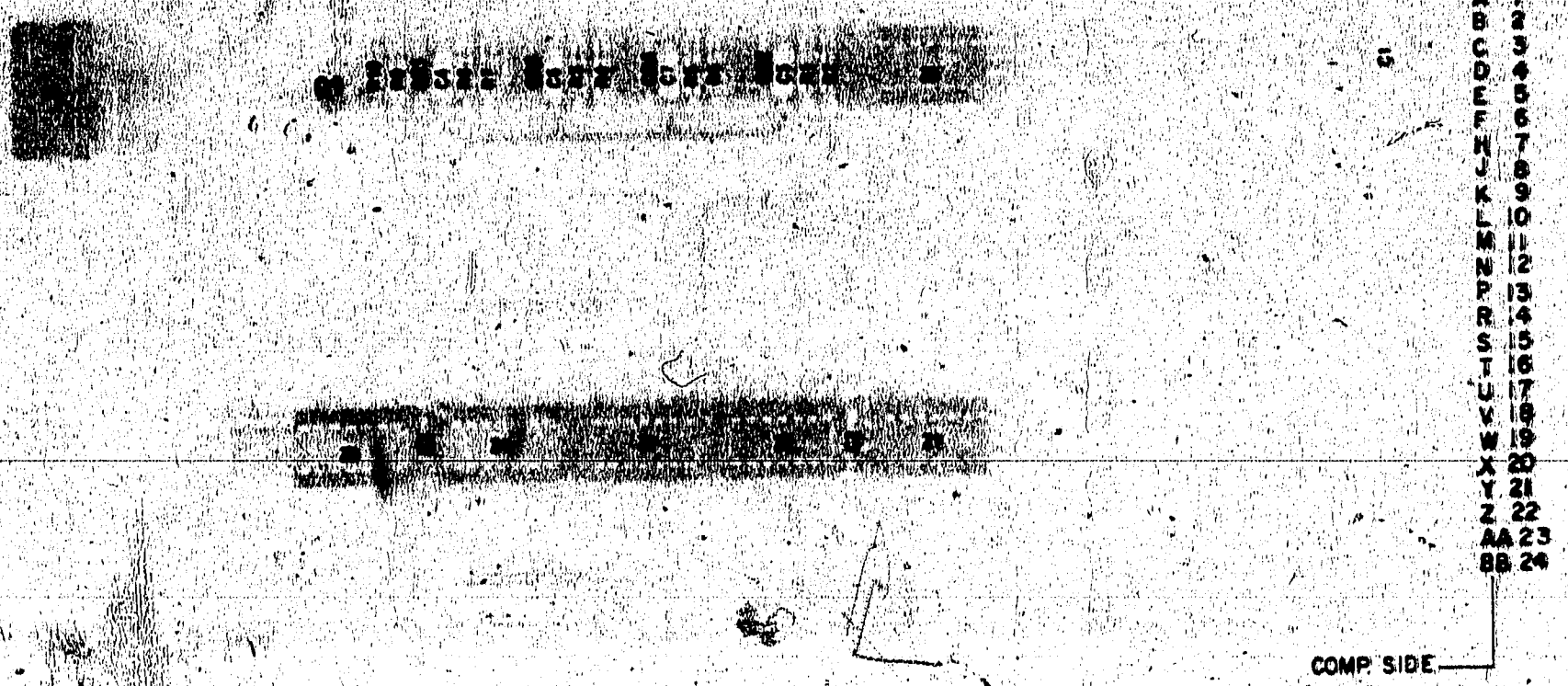
7-6 The circuits are functionally separated and included on three sheets of Figure 7-1. The three sheets cover the following functional areas:

Sheet 1: Data Processing and Distribution Circuits
Sheet 2: Accessory Cards
Sheet 3: Power Distribution.

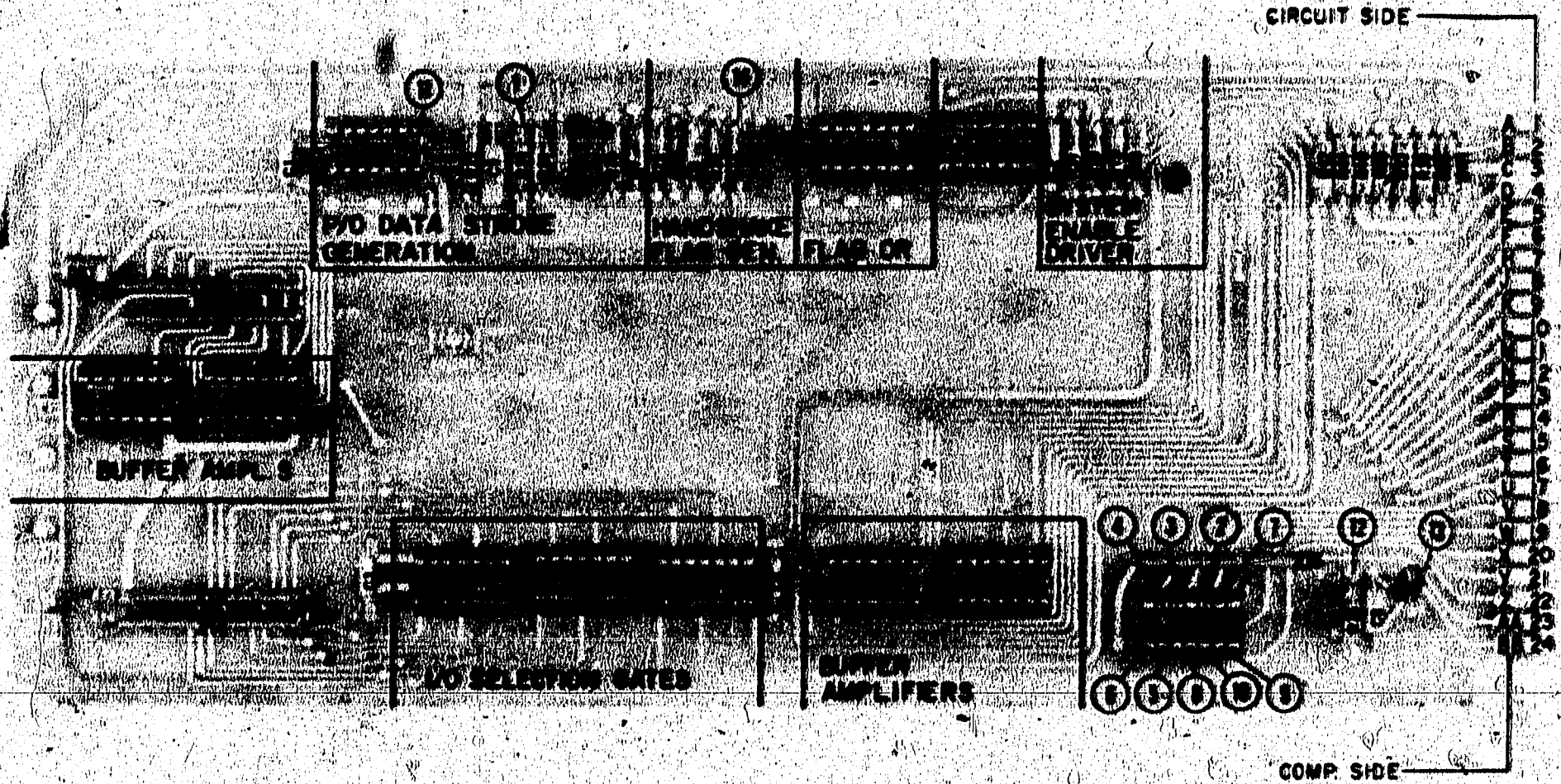
7-7 Test points (encircled numbers) appear on the schematics. These points coincide with the test points on the component location diagrams and are referred to throughout the maintenance instructions.



A1 Extender Input Card, Component Locations



A2 I/O Transfer Card, Component Locations



A3 Logic and Timing Card, Component Locations

A7 ADAPTER CARD (SLOT 700)

A5 INTERCONNECT BD.

A1 EXTENDER INPUT CD (SLOT 100)

A9 INTER-CONNECT BD.

A2 I/O TRANSFER CARD

A9 INTERCONNECT BD.

A3 LOGIC & TIMING CARD (SLOT 500)

ADDRESS BITS

DATA BITS

FROM NEXT UPSTREAM UNIT (59140A OR 59141)

UNIT SELECT LINES (SEE NOTE 1)

DATA COMMON

(GATE)

(INPUT SELECT)

(FLAG)

(INTERRUPT ENABLE)

(DATA TRANSFER ENABLE)

(INPUT REQUEST)

(TIMING MODE ENABLE)

(SYSTEM ENABLE)

+5V (ISOLATED)

TERMINATION NETWORKS

SHUNT REGULATOR (SEE POWER DISTRIBUTION, FIGURE 7-5, SHEET 3)

FROM POWER DISTRIBUTION (SHEET 3)

OUTPUT MODES

INPUT MODES

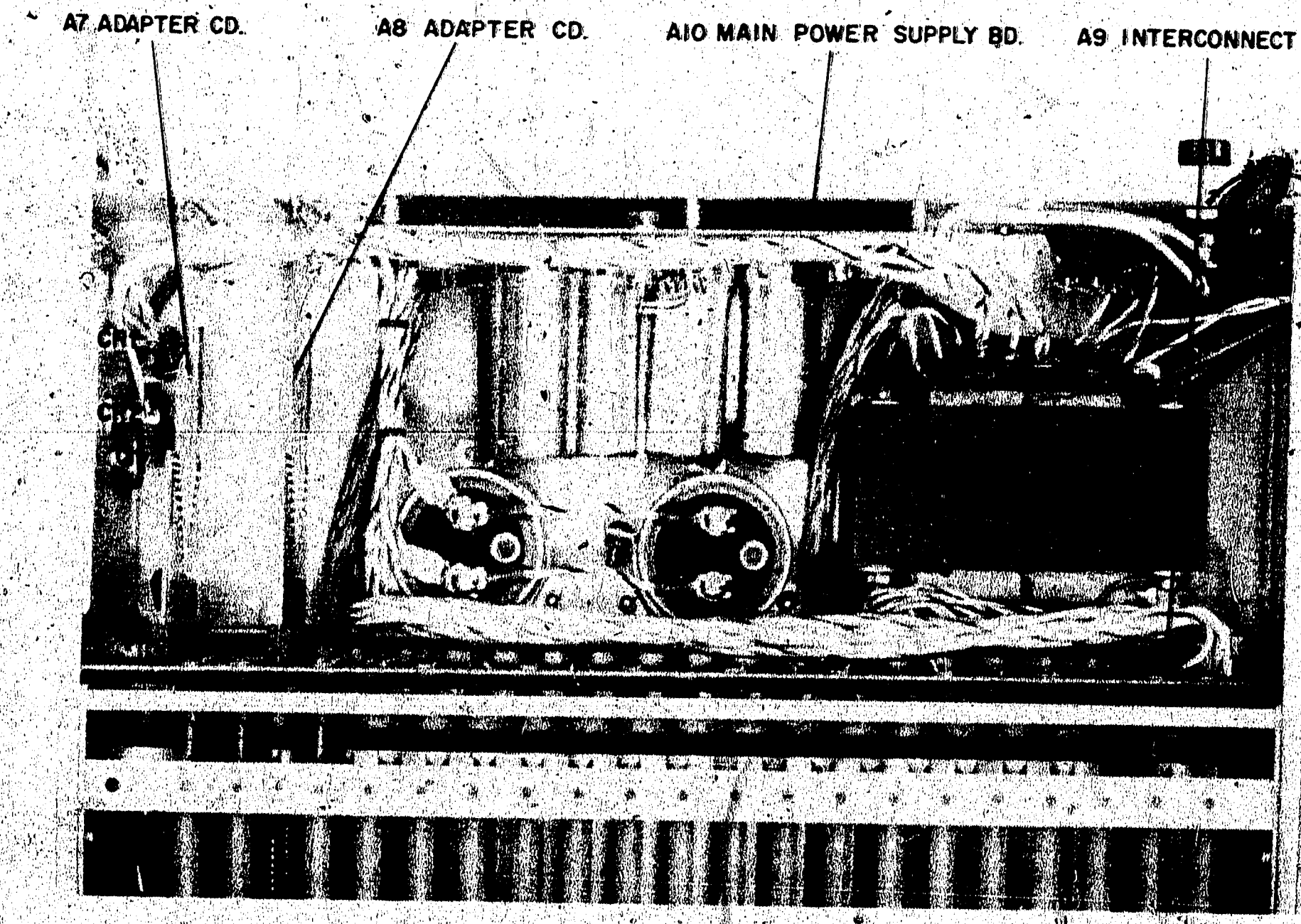
FROM POWER DISTRIBUTION (SHEET 3)

BUFFER AMPLIFIERS

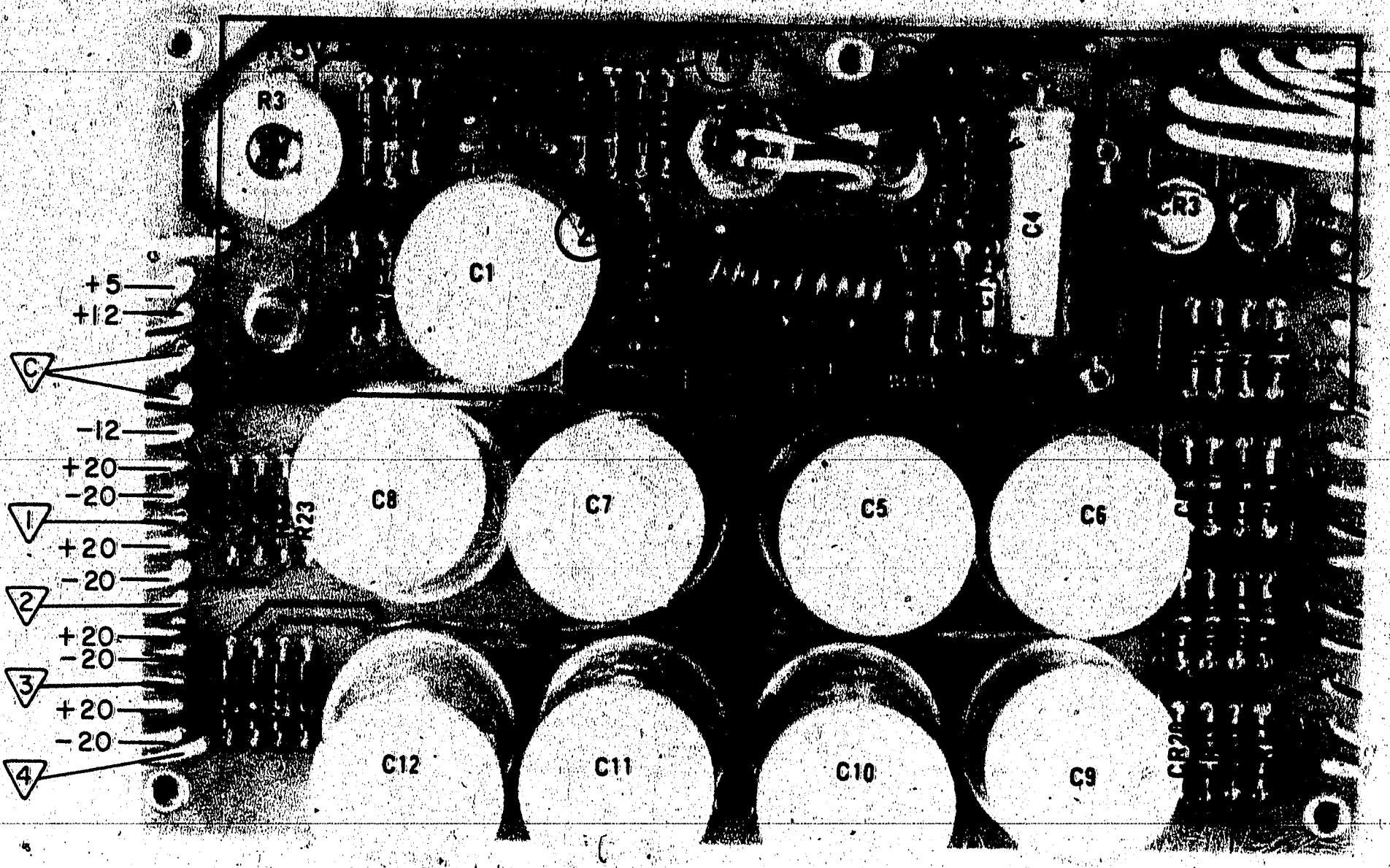
I/O SELECTION GATES

OUTPUT MODES

INPUT MODES



Rear Chassis, Component Locations



A10 Main Power Supply Board, Component Locations

A12 POWER MODULE

(COMPONENTS LOCATED ON CHASSIS)

A10 MAIN POWER SUPPLY BD.

+5V REGULATOR

A1 EXTENDER INPUT CD.

A6 VOLTAGE REGULATOR CD. (MODEL 6936A)

NOTE: USED IN CONVERSION DETAILS 6936A

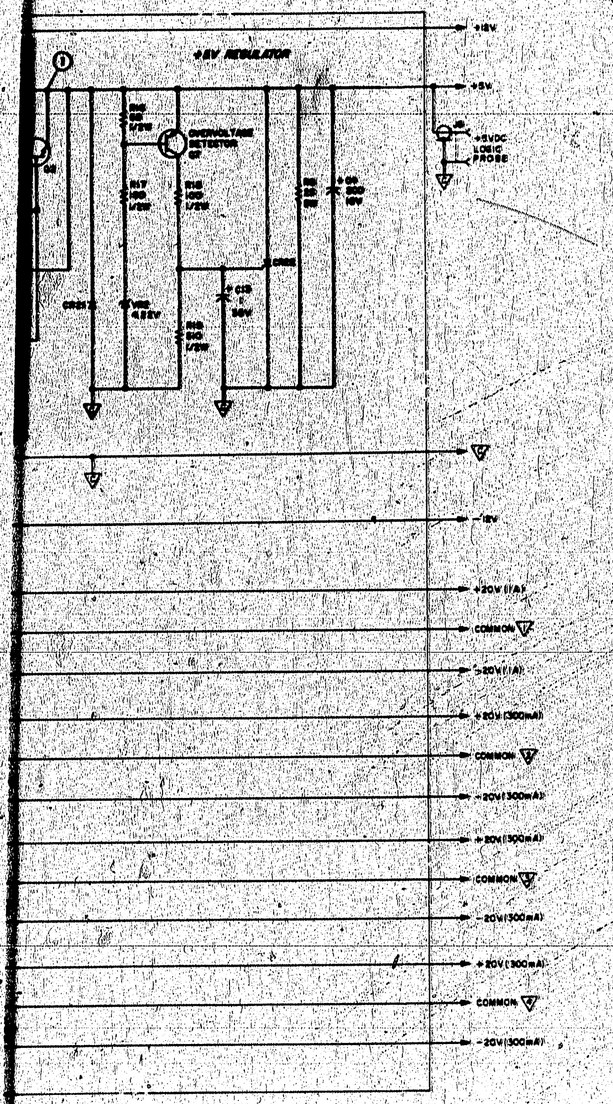
NOT USED, FOR TEST ONLY

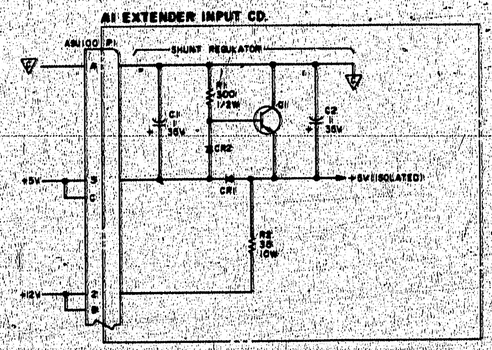
REGULATOR A1

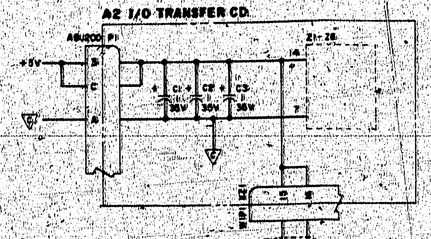
REGULATOR A2

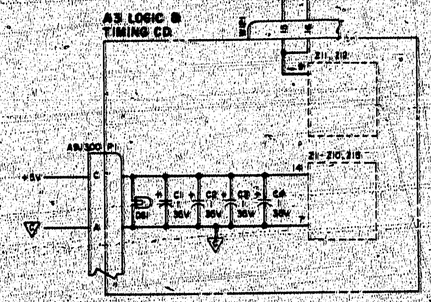
REGULATOR A3

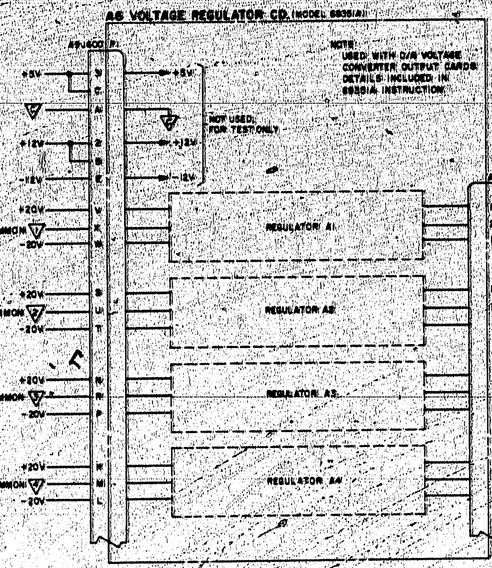
REGULATOR A4

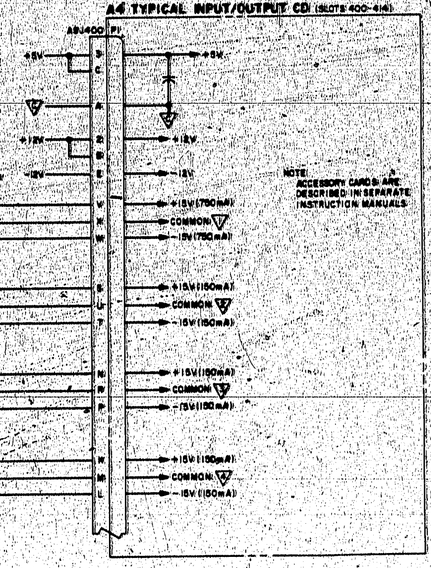






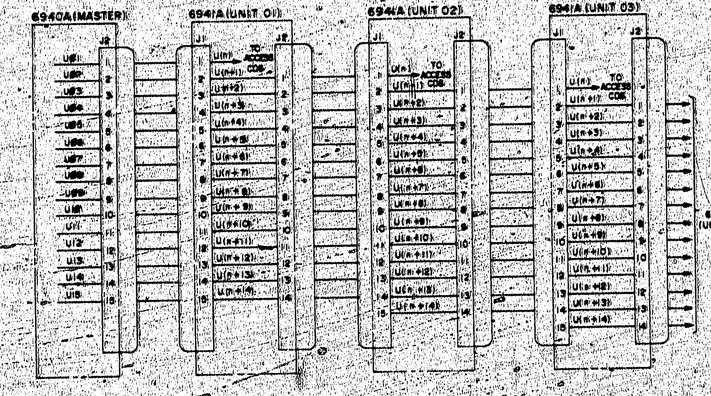






NOTES:

1. UNIT SELECT WIRING FOR A MULTIPROGRAMMER SYSTEM IS SHOWN IN THE DIAGRAM BELOW. ALTHOUGH ONLY THREE 6941A EXTENDERS ARE SHOWN, UP TO FIFTEEN COULD BE EMPLOYED WITHIN EACH 6941A THE WIRING IS IDENTICAL ALLOWING A GIVEN UNIT TO OCCUPY ANY POSITION IN A SYSTEM CHAIN. TO ALLOW THIS SCHEMATIC TO APPLY TO ANY ONE OF FIFTEEN POSSIBLE UNITS, (01 THRU 15) IN A CHAIN, THE UNIT SELECT LINES ARE LABELED U(n), U(n+1), U(n+2), ETC. U(n) IS THE ACTIVE LINE FOR THE PARTICULAR UNIT OF INTEREST WHILE U(n+1) IS THE ACTIVE LINE FOR THE NEXT DOWNSTREAM UNIT (IF USED) AND U(n+2) IS THE ACTIVE LINE FOR THE SECOND DOWNSTREAM UNIT.



2. THE HANDSHAKE OR TIMING FLAG (FEO) OUTPUT FROM EACH 6941A IS CONNECTED TO THE FLAG OVERRIDE (FOR) INPUT OF THE NEXT UNIT UPSTREAM (REFER TO FIG. 4-6 IN MANUAL).

3. PIN LOCATIONS FOR INTEGRATED CIRCUITS ARE SHOWN BELOW.

4. ALL 1/2W AND 1/4W RESISTORS ARE ±5% UNLESS OTHERWISE INDICATED.

5. ALL 1/8W RESISTORS ARE ±1% UNLESS OTHERWISE INDICATED.

6. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE INDICATED.

7. ▭ DENOTES FRONT PANEL MARKING.

8. ▭ DENOTES REAR PANEL MARKING.

9. PIN LOCATIONS FOR TRANSISTORS ARE SHOWN BE BELOW.

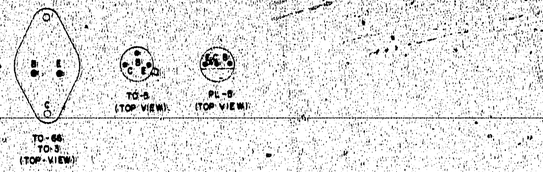


Figure 7-1 (Sheet 3). Power Distribution

MANUAL CHANGES

MANUAL CHANGES

Model 6941A Multiprogrammer
Manual HP Part No. 06941-90001

Make all corrections in the manual according to errata below, then check the following table for your multiprogrammer serial number and enter any listed change(s) in the manual.

SERIAL		MAKE CHANGES
Prefix	Number	
ALL	-	Errata
1149A	0101	1
	0102	
	0104	
	0106 - up	

▶CHANGE 1:

In the Replaceable Parts Table, under A2 I/O Transfer Card, change Z3, Z5 to HP Part No. 1820-0621.

7-3-72