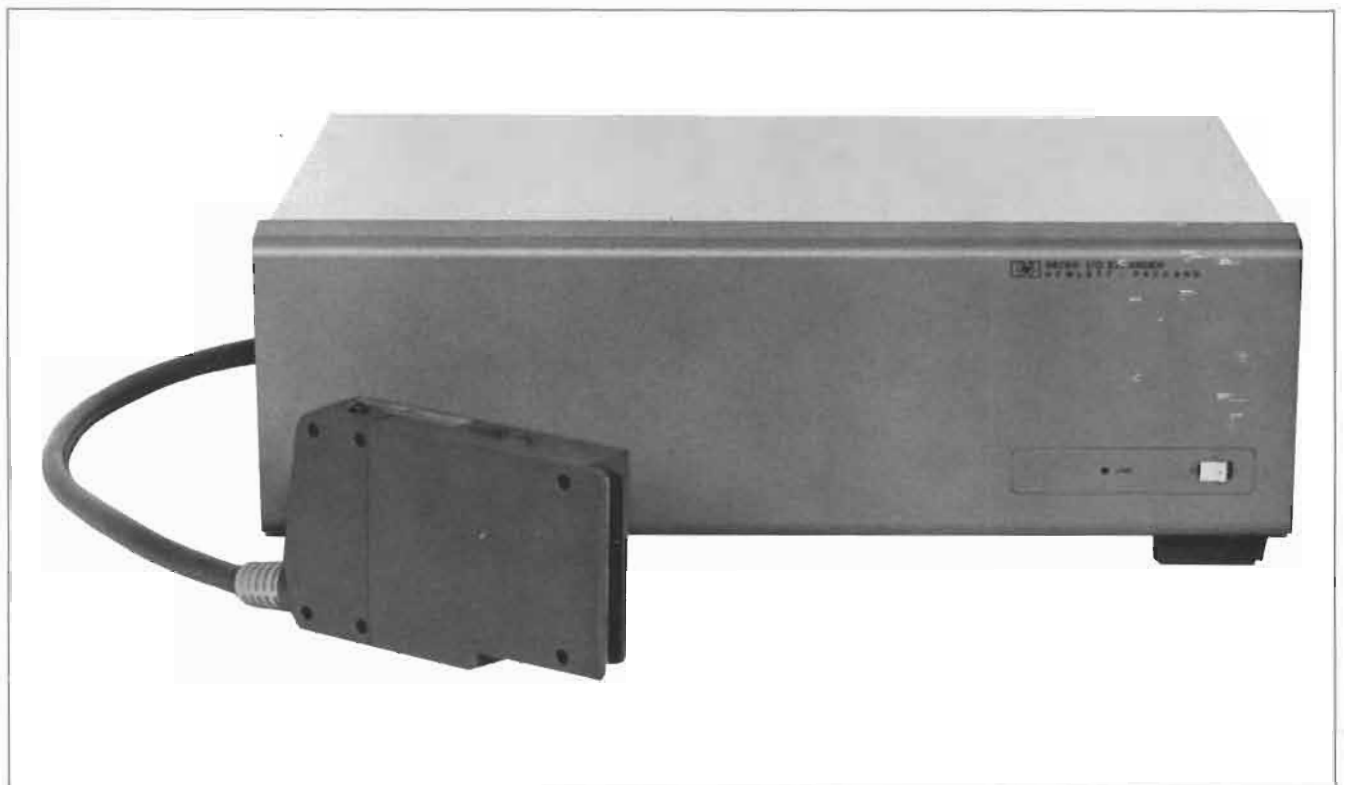


Hewlett-Packard 9878A I/O Expander Installation and Service Manual





9878A I/O Expander Installation and Service Manual



Hewlett-Packard Calculator Products Division
P.O. Box 301, Loveland, Colorado 80537, Tel. (303) 667-5000
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Chapter 1

General Information

Introduction

The HP 9878A I/O Expander enables up to seven peripheral devices to be connected to the HP 9825A Calculator, using one calculator I/O slot.

The I/O Expander is supplied with an interface cable which permits it to be located up to 2 meters (6 feet) from the calculator.

Equipment Supplied

The following equipment is furnished with the I/O Expander.

Table 1-1. Supplied Equipment

Description	Quantity	Part No.
Installation and Service Manual	1	09878-90000
Power Cord	1	8120-1378*
Spare Fuses		
.8A, 250V, SB	1	2110-0336
.4A, 250V, SB	1	2110-0340

*Part number for the standard power cord is shown. Refer to Figure 2-2 for power cord options .

Options

Option 001

The HP 9878A Option 001 I/O Expander provides the necessary hardware to install the I/O Expander in a standard 19-inch equipment rack.

Rack Mount Kit

A Rack Mount Kit, part number 98023F, is available to convert the standard I/O Expander to an option 001. Refer to Rack Mount Kit Installation in Chapter 2.

NOTE

The rack mount brackets are not able to support the entire weight of the I/O Expander. A shelf or other support should be placed in the equipment rack or cabinet to support the weight of the instrument.

Initial Inspection

The I/O Expander and its accessories were carefully inspected before they were shipped to you. Please verify that the correct accessories are present; then inspect the I/O Expander for physical damage. If any damage is found, contact the nearest HP Sales and Service Office; office locations are listed at the back of this manual. Refer to Chapter 2 for the electrical inspection information after you have installed your I/O Expander.

Maintenance Agreements

When you buy Hewlett-Packard equipment, service is an important factor. If you are to get maximum use from your equipment, it must be in good working order. An HP Maintenance Agreement is the best way to keep your equipment in optimum running condition.

Consider these important advantages:

- **Fixed Cost** – The cost is the same regardless of the number of calls, so it is a figure that you can budget.
- **Priority Service** – Your Maintenance Agreement assures that you receive priority treatment, within an agreed upon response time.
- **On-Site Service** – There is no need to package your equipment and return it to HP. Fast and efficient modular replacement at your location saves you both time and money.

- A Complete Package – A single charge covers labor, parts, and transportation.
- Regular Maintenance – Periodic visits are included, per factory recommendations, to keep your equipment in optimum operating condition.
- Individualized Agreements – Each Maintenance Agreement is tailored to support your equipment configuration and your requirements.

After considering these advantages, we are sure you will agree that a Maintenance Agreement is an important and cost-effective investment.

For more information , please contact your local HP Calculator Sales and Service Office.



4 General Information

Chapter 2

Installation

Power Requirements

The I/O Expander operates from nominal power line voltages of 100, 120, 220, or 240 volts AC. The range of operation is within +5% and – 10% of each nominal voltage. Two switches on the I/O Expander back panel allow selection of any one of the four nominal voltages (see Figure 2-1). The line frequency must be within 48 to 66 Hz and the I/O Expander requires a maximum of 70 voltamps.

CAUTION

THE I/O EXPANDER MAY BE DAMAGED IF THE SWITCH SETTINGS ARE INCORRECT. CHECK THE SWITCH SETTINGS BEFORE APPLYING POWER.

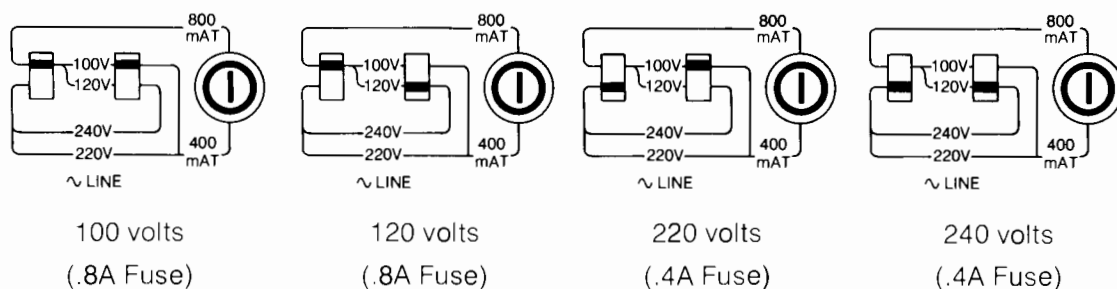


Figure 2-1. Line Voltage Switches

Grounding Requirements

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the I/O Expander cabinet be grounded. The I/O Expander is equipped with a three-conductor power cable which, when connected to an appropriate receptacle, grounds the cabinet of the I/O Expander.

Fuses

The I/O Expander must be fitted with a .8 amp fuse for 100/120V operation and a .4 amp fuse for 220/240V operation. Fuse part numbers are listed in Table 1-1.

WARNING

BEFORE CHANGING THE FUSE, BE SURE THAT THE I/O EXPANDER IS DISCONNECTED FROM ANY POWER SOURCE.

Always be sure that the correct fuse is used, since failure to follow this precaution may result in needless damage to the I/O Expander if a malfunction or an unusual line voltage occurs.

To remove a fuse, press in on the cap of the fuseholder and at the same time twist the cap in the direction indicated by the arrow on the cap. Pull the cap free and remove the fuse. To install a fuse, place either end of the fuse into the pocket in the cap, and reinstall the cap by pressing in on the cap and twisting it in the opposite direction from the arrow.

Power Cords

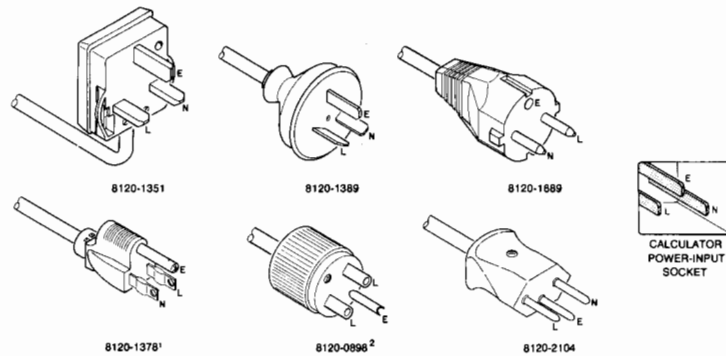
Power cords supplied by HP will have polarities matched to the power-input socket on the equipment, as shown below:

- L = Line or Active Conductor (also called "live" or "hot")
- N = Neutral or Identified Conductor
- E = Earth or Safety Ground

WARNING

IF IT IS NECESSARY TO REPLACE THE POWER CORD, THE REPLACEMENT CORD MUST HAVE THE SAME POLARITY AS THE ORIGINAL. OTHERWISE A SAFETY HAZARD FROM ELECTRICAL SHOCK TO PERSONNEL, WHICH COULD RESULT IN INJURY OR DEATH, MIGHT EXIST. IN ADDITION, THE EQUIPMENT COULD BE SEVERELY DAMAGED IF EVEN A RELATIVELY MINOR INTERNAL FAILURE OCCURRED.

Power cords with different plugs are available for the equipment; the part number of each cord is shown in Figure 2-2. Each plug has a ground connector. The cord packaged with the equipment depends upon where the equipment is to be delivered. If your equipment has the wrong power cord for your area, please contact your local HP Sales and Service Office.



¹UL and CSA approved for use in the United States of America and Canada with calculators set for either 100 or 120 Vac operation.

²UL and CSA approved for use in the United States of America and Canada with calculators set for either 220 or 240 Vac operation.

Figure 2-2. Power Cords

Installing the I/O Expander

The I/O Expander should be connected between the calculator and the peripheral devices. Be sure to switch the calculator and the I/O Expander OFF before connecting an interface cable to either instrument. The end of the interface cable (see Figure 2-3) must be plugged into one of the calculator's I/O slots. After installing the I/O Expander, connect the interface cable from each peripheral device to one of the I/O connectors on the back panel of the I/O Expander.

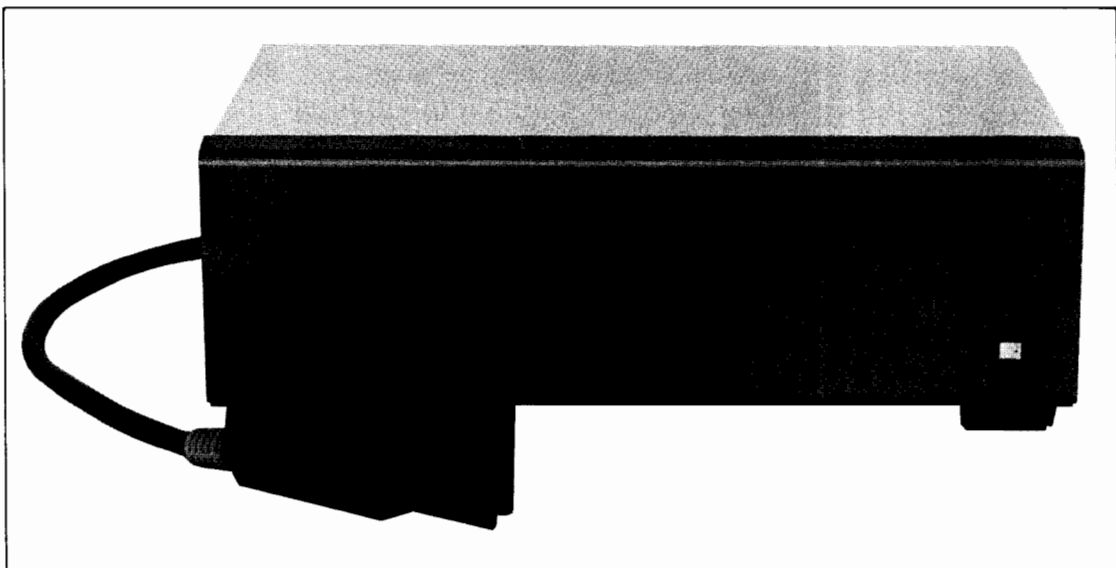


Figure 2-3. I/O Expander

System Operation

The switch on the front panel controls power to the I/O Expander; the LINE light indicates when power is applied.

The System Integrity light, located on top of the I/O Expander's interface, indicates when the I/O Expander and the Calculator are properly connected together and power is applied to each.

When the I/O Expander is installed in the system and switched ON, it acts just like a junction box and has no effect on the operation of the calculator or peripherals.

If the I/O Expander is switched OFF all interfaces that are plugged into it are effectively disconnected from the calculator.

Multiple I/O Expanders

To further increase the number of I/O connections, two I/O Expanders can be connected to the same calculator, but an I/O Expander should NOT be connected to another I/O Expander.

NOTE

Unpredictable operation will result if the I/O Expanders are connected to each other.

Electrical Inspection

There is no exerciser program or special inspection procedure available to check the performance of the I/O Expander. However, if you suspect the performance of a peripheral device (or the calculator) when the I/O Expander is connected in your system, disconnect the I/O Expander and any other peripherals from the calculator; then run the calculator's electrical inspection program(s). After verifying the performance of the calculator, connect the peripheral in question directly to the calculator and perform the peripheral's electrical inspection procedure.

If the peripheral and calculator operate correctly when the I/O Expander is not connected in the system, but the instrument operates marginally, or does not operate when the I/O Expander is connected, the I/O Expander is probably defective. In this case, refer to Chapter 3 of this manual or contact the nearest HP Sales and Service Office for assistance; office locations are listed at the back of this manual.

Rack Mount Kit Installation

The Rack Mount Kit, part number 98023F, provides the necessary hardware to install the I/O Expander in a standard 19-inch equipment rack.

The rack mount brackets are not able to support the entire weight of the I/O Expander. A shelf or other support should be provided by the equipment rack or cabinet to support the weight of the instrument.

Installation Procedure

1. Replace the standard side panels with those supplied in the rack mount kit (refer to the figure below).
2. Install the rack mount brackets with the screws provided in the kit.

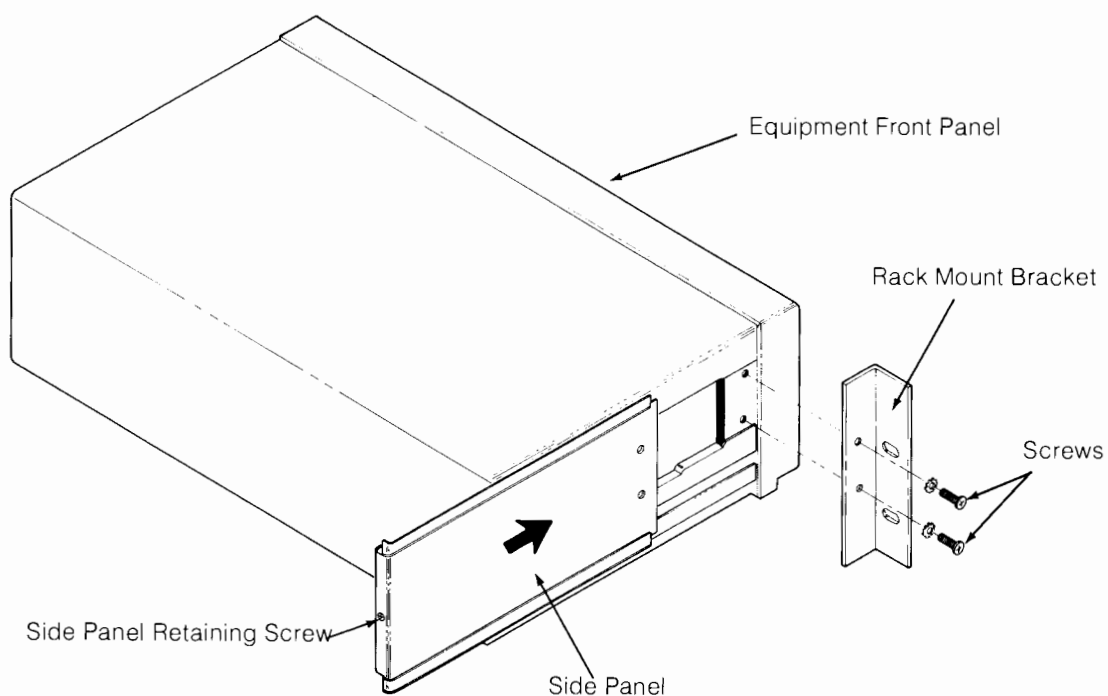


Figure 2-4. Rack Mount Kit Installation

Chapter **3**

Service

Introduction

This chapter contains a Block Diagram Description, Troubleshooting and Repair information, and the Theory of Operation. This information will help you service the 9878A I/O Expander.

If you have difficulty repairing the I/O Expander or if you would rather have HP repair it, contact the nearest Sales and Service Office for assistance; office locations are listed at the back of this manual.

Recommended Equipment

The following is a list of equipment that will aid in troubleshooting the I/O Expander.

1. Voltmeter, accuracy $\pm 1\%$ on +5 and ± 12 volt range
2. Oscilloscope or logic probe
3. Extender Board 98241-67901
4. Clip leads

Any general purpose oscilloscope or logic probe that will indicate the presence of TTL level signals can be used for troubleshooting.

Block Diagram Description

The I/O Expander Block Diagram has three major sections:

- Power Supply
- Initialization Circuit
- Data and Control Line Buffers

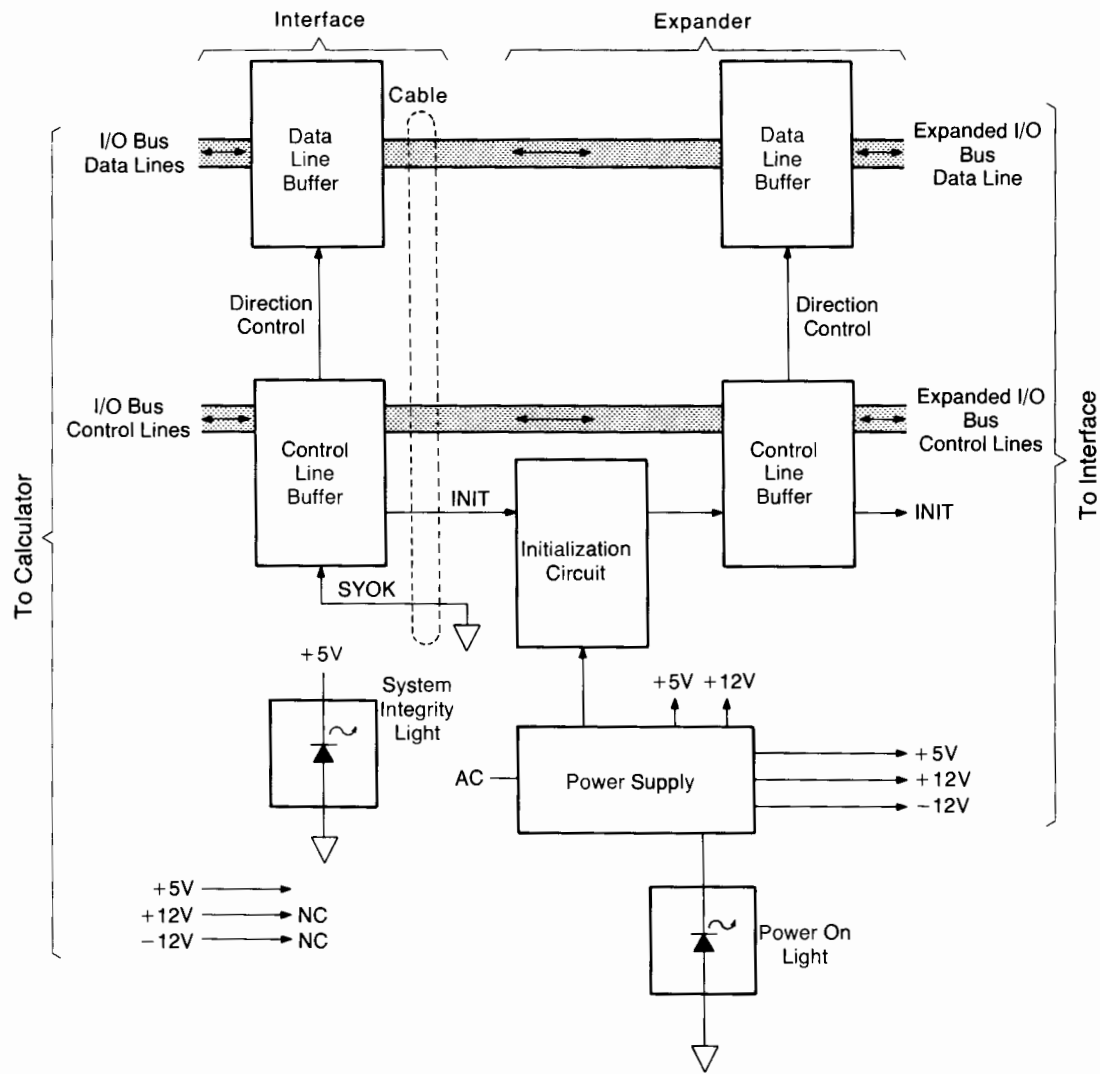


Figure 3-1. I/O Expander Block Diagram

Power Supply

The Power Supply provides power to the I/O Expander main chassis and to the interfaces that are plugged into it. Power for the I/O Expander's interface is provided by the calculator.

Initialization Circuit

The Initialization Circuit insures that the interfaces are initialized independently of the order in which the calculator and I/O Expander are turned on.



Data and Control Line Buffers

The Data and Control Line Buffers ensure that the presence of the I/O Expander does not affect the operation of the calculator or the peripherals.

Troubleshooting

After you have determined that the failure of the calculator system is associated with the I/O Expander (refer to Electrical Inspection), disconnect the expander from the system. The following procedures will allow you to test each of the logic lines within the expander. Refer to the schematic and note that the logic line goes from the expander's interface to the back panel connector or in the reverse direction. The test procedures will take advantage of the accessibility of the logic lines at these end points.

Set Up

To make the following test or checks it is necessary to connect the I/O Expander's interface to the Extender board. The pins on the Extender board serve as test points for the interface; the pins on the I/O slot connectors serve as test points on the back panel.

Remove the top cover from the I/O Expander by sliding it back after loosening the retaining screw (refer to Figure 3-2):

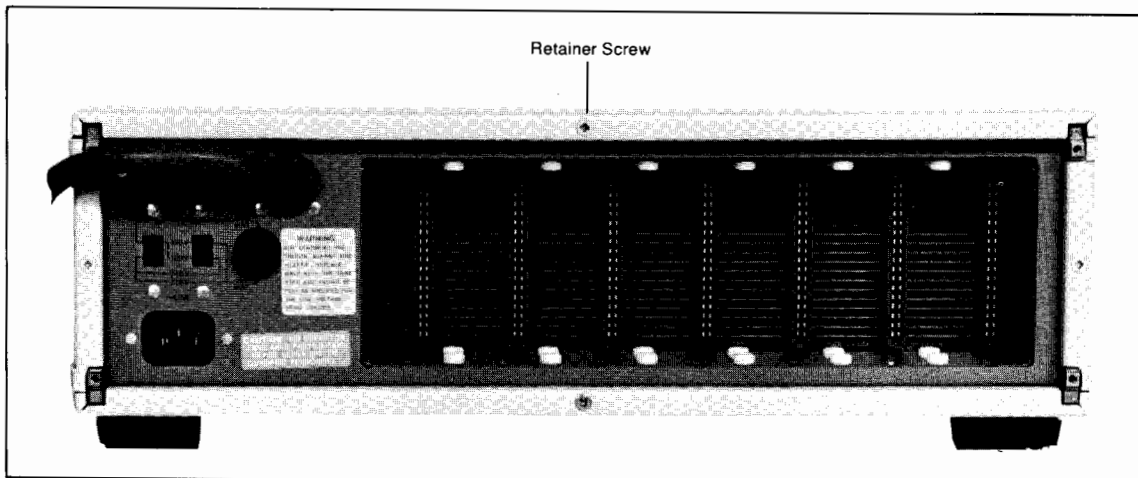


Figure 3-2. Top Cover Removal

Connect a clip lead from the +5 volt test point (refer to Figure 3-4) to pin A on the extender board, this will apply power to the interface.

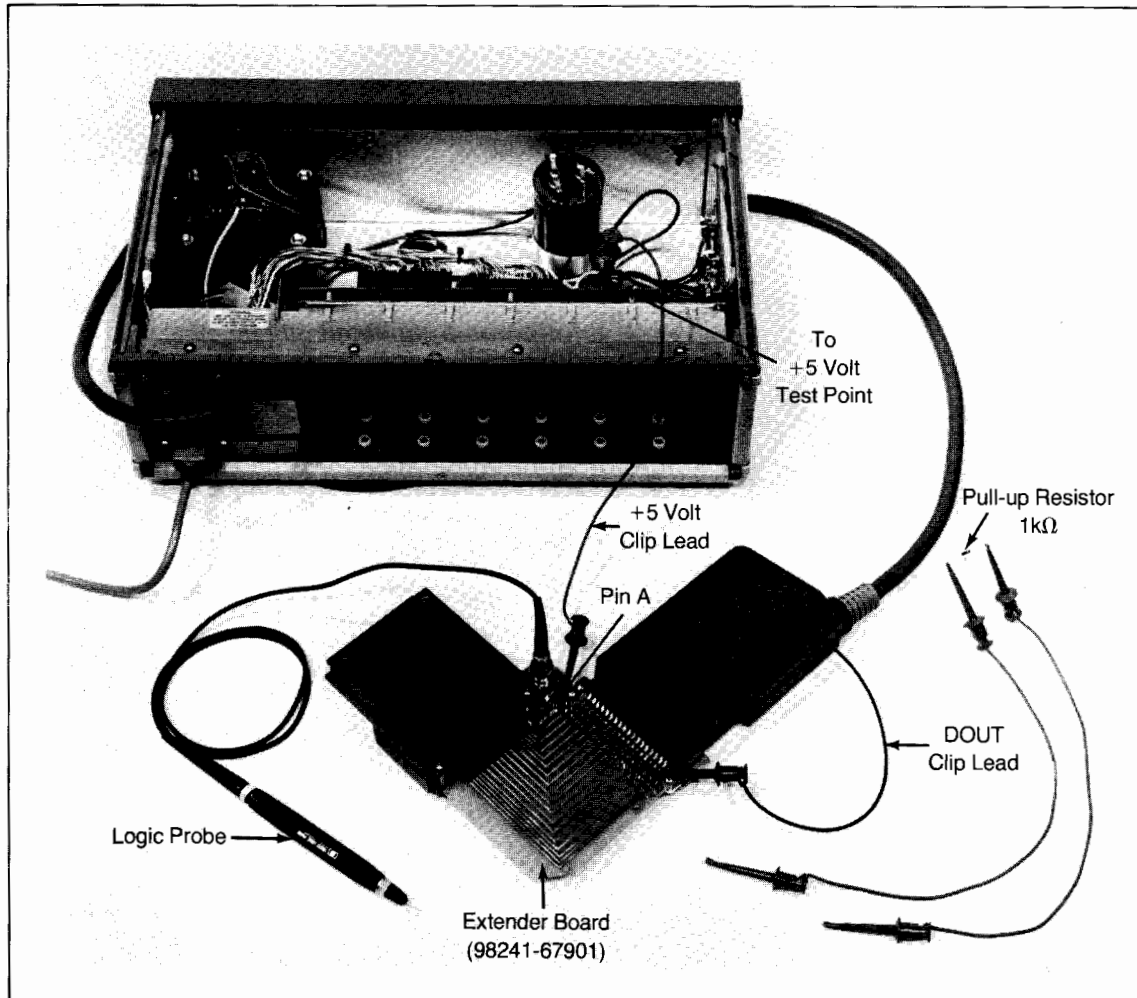


Figure 3-3. Test Set Up

When the I/O Expander is plugged in and switched ON, the line and integrity indicators should light.

If the indicators do not come on, check the connections, fuse, power cord, and line voltage switches (refer to Chapter 2).

If the lights still do not come on refer to the power supply theory of operation and the following information.

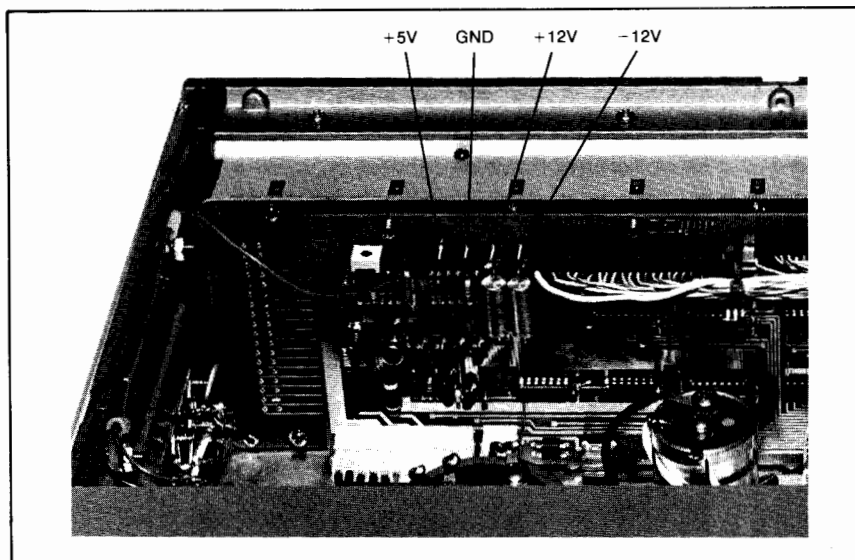


Figure 3-4. Power Supply Test Points

Power Supply

Check the power supply for the proper voltage at the test points on the A2 assembly (refer to Figure 3-4).

The +5V power supply voltage should be within $\pm .15$ volts of nominal. This supply is adjustable. If out of tolerance, adjust this voltage to 4.95 volts.

The adjustment is located as shown below.

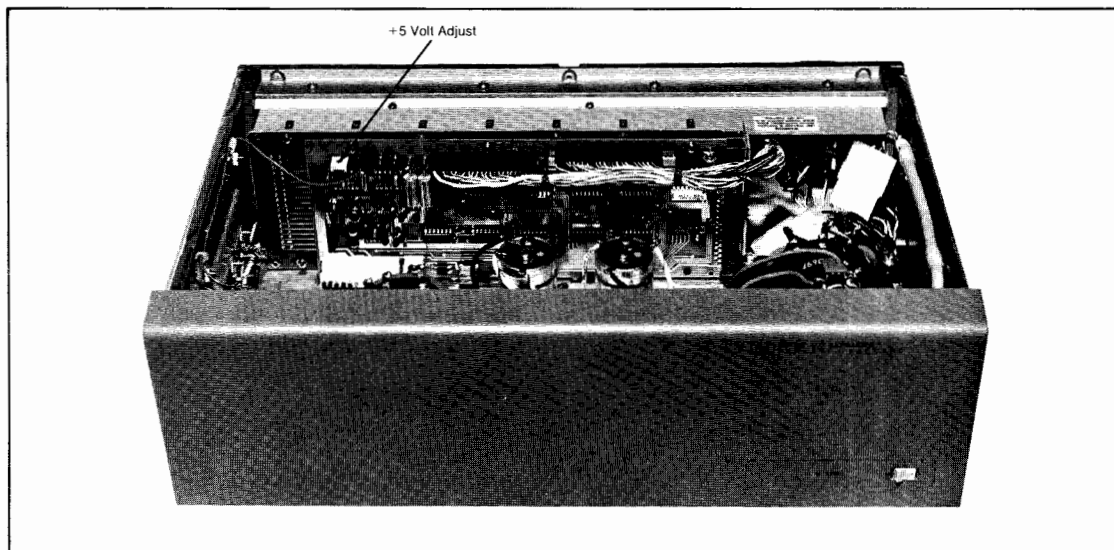


Figure 3-5. +5 Volt Adjustment

The ± 12 volt supplies should be within $\pm .5$ volts of nominal. These supplies are not adjustable so they should be repaired or replaced if out of tolerance.

Data and Control Lines

Each of the logic lines can be checked for proper operation by alternately applying ground and +5 volts to its input and checking the output. Notice that the pin number for a given line is the same on the interface and on the back panel connector (refer to the schematic).

The data lines (DIO0 thru DIO15) are bi-directional lines. The direction of the data line is controlled by the DOUT line. Grounding the DOUT line (at the interface end) causes signals to be transferred from the interface to the back panel I/O slots; applying +5 volts to the DOUT line reverses the direction.

NOTE

When checking signals at the interface end connect a $1k\Omega$ resistor from +5 volts to the logic line in question. The resistor serves as a pull-up for the open-collector drivers.

When a logic line is found to be faulty, troubleshoot and repair the associated defective circuit.

Input Test (Extender Pins)

When the DOUT line (at the Extender board) is connected to +5 volts, the following output lines on the interface (Extender board's pins) should change states when their inputs (the same pin number on the back panel connector) are alternately connected to +5 volts and grounded. Refer to the note above.

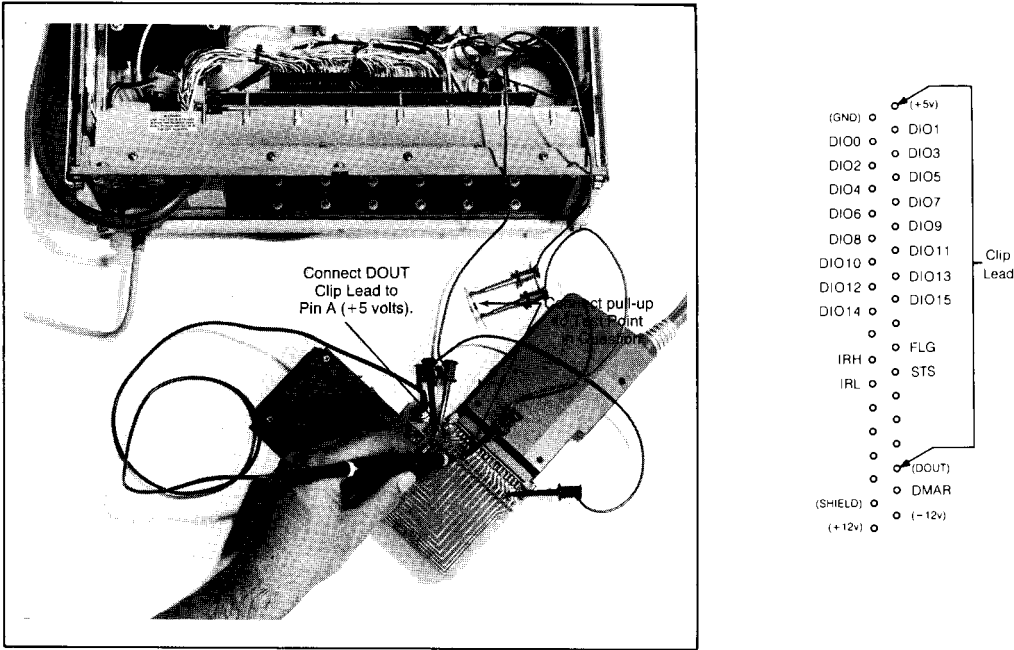


Figure 3-6. Lines to Test at Extender Pins
(DOUT Line Connected to +5 volts)

Output Test (Back Panel)

When the DOUT line (at the Extender board) is connected to ground, the following output lines (on the back panel) should change states when their inputs (at the interface) are alternately connected to +5 volts and grounded.

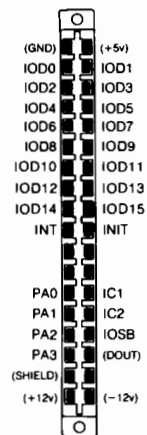
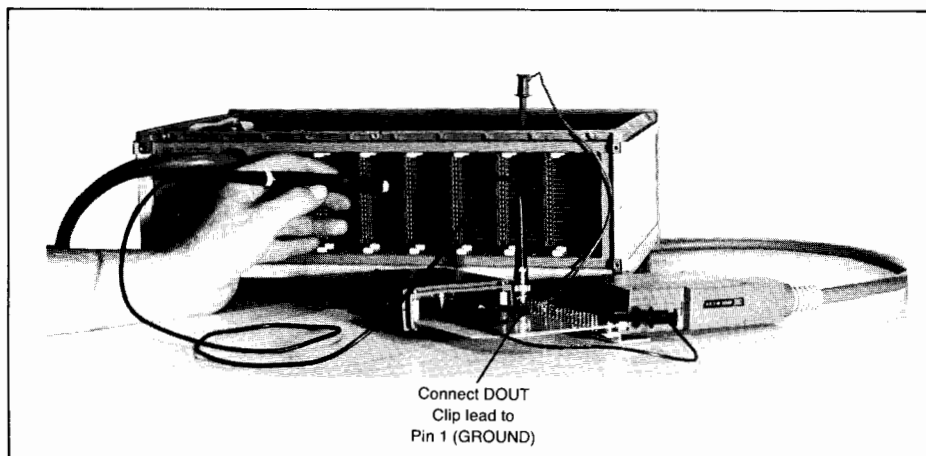


Figure 3-7. Lines to Test at Back Panel
(DOUT Line Connected to Ground)

Theory of Operation

This section describes the operation of the 9878A I/O Expander; refer to the block diagram and schematic. The four major sections of the block diagram and schematic are:

1. Data lines
2. Control lines
3. Initialization Circuit
4. Power Supply

Data Lines

The data lines are bi-directional lines, the direction is controlled by the DOUT control line from the calculator. The DOUT line drives A4U7E and A2U6B, which control the tri-state enable line on each of the data line buffers. When the DOUT line is low the data line buffers (e.g., A4U1E and A2U3E) from the calculator to the interfaces are enabled. When the DOUT line is high the buffers (e.g., A2U4E and A4U2A) from the interfaces to the calculator are enabled.

Control Lines

Except for the DOUT and INIT lines the control lines effectively pass straight through the I/O Expander. Each line is buffered for drive capability and to provide the proper load to the inputs.

The DOUT line controls the direction of the bi-directional data lines. When DOUT line is high, data can be transferred from the interfaces to the calculator and when the DOUT line is low data can be transferred in the opposite direction. A low on the System OK line (SYOK) enables the DOUT line for operation within the I/O Expander. SYOK is low when the I/O Expander and calculator are properly connected and switched on.

The INIT line is described in the next section.



Initialization Circuit

The interfaces which are plugged into the I/O Expander check for a high state on the INIT line to indicate when the voltage levels are sufficient for proper operation. Three circuits control this line to the interfaces:

- The buffered INIT signal from the calculator
- The +12 volt monitor
- The +5 volt monitor



Before the calculator or I/O Expander are ready for operation one or more of the three circuits will hold the interfaces' INIT line in the low state.

The buffered INIT signal from the calculator will normally change from low to high within seconds after the calculator is turned on, thus causing A2Q7 to turn off.

The I/O Expander's +5 and +12 voltage monitors will turn off their respective output transistors (A2Q5 and A2Q4) when the input voltages exceed the zener diodes (CR3 and CR2) voltage by .6 volts.

When all three circuits have their output transistors turned off R8 pulls the interfaces' INIT line to the high state.

Power Supply

The I/O Expander's internal power supply provides three voltages to the main chassis and to the interfaces that are plugged into the I/O Expander. The calculator provides the power for the I/O Expander's interface. Refer to the schematic when reading the following information.

+5 Volt Supply

The +5 volt supply is a series-pass voltage regulator with current limiting and current foldback. The diode bridge (CR1) and filter capacitor (C1) develop raw +10 volts from the power transformer. Q1 is the pass element for the +5 volt supply. The base of Q1 is controlled by the drive transistor (pins 6 and 7) in U10, which supplies Q1 with a regulated drive. This internal drive transistor is controlled by a differential amplifier in U10. The differential amplifier compares the output voltage (+5 volts) of the pass transistor Q1 with a reference voltage. The reference voltage is obtained from U10 pin 4.

R24 is in the voltage sense circuit to allow the A2 board to operate when disconnected from the rest of the system (e.g., in at test fixture) by providing a feed back path to the differential amplifier. R24 is shorted out when the A1 and A2 boards are connected in the system.

R22, C6, and the internal transistor (pins 1 and 10 of U10) form the current limiter for the +5 volt supply. If the current through R22 becomes excessive, the internal transistor turns on due to the voltage differential across its base-emitter junction. This sinks base current away from the internal drive transistor reducing the base current supplied to the pass transistor, Q1, thus reducing the output voltage and limiting the current. C6 prevents the current limiting circuit from oscillating.

A2Q2, R4 and R3 form the current foldback portion of the regulator. If the drive to Q1 should become excessive (e.g., a short circuit on the +5 volt line) a large voltage differential will be present between the base of Q1 and the emitter of A2Q2. This draws current away from the base of the internal drive transistor in a manner similar to the current limiting circuit discussed above. Since the current foldback occurs after current limiting takes effect, the Q1 base drive is doubly reduced. This causes a reduction of the output voltage beyond that caused by the current limiter alone. The effect is to greatly reduce the output current.

If the pass transistor Q1 shorts out, the output voltage of the +5 volt supply could become excessive. To prevent the destruction of the TTL components, a crowbar circuit is provided to short the +5 volt supply to ground. If the output voltage exceeds 5.9 volts, the thyristor (A2Q1) conducts, clamping the output voltage to .7 volts. This can be reset only by removing power from the circuit.

± 12 Volt Supplies

CR4, C5, and C6 provide the unregulated voltages for the ± 12 volt supplies. U1 and U2 are self-contained 12 volt regulators which provide current limiting and thermal overload protection for these supplies.

Table 3-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	09878-66501		I/O Connector Board		
J1-J7	1251-2026		Conn. 36 Pin		
A2	09878-66502		I/O Transceiver Board		
C1	0180-0100		C: fxd, 4.8 μ f 35V		
C2,C3,C16	0180-0097		C: fxd 4.7 μ f 35V		
C4,C6	0160-0575		C: fxd, .04 μ f 20V		
C5	0160-0362		C: fxd, 510pf 300V		
C7-C15	0160-3847		C: fxd, .01 μ f 25V		
C17,C18	0160-0128		C: fxd, 2.2 μ f 25V		
CR1	1902-0041		DIO: ZNR 5.11V		
CR2	1902-3171		DIO: ZNR 11V		
CR3	1902-3073		DIO: ZNR 4.32V		
CR4	1902-0364		DIO: Assembly		
J2	1251-3691		Conn.		
J3	1251-3691		Conn.		
J4	1251-3902		Conn.		
J5	1251-4246		Conn.		
J6	1251-3691		Conn.		
R1	2100-3273		R: Var. 2k Trimpot		
R2 R10 R26	0683-1515		R: fxd 150 ohm 5%		

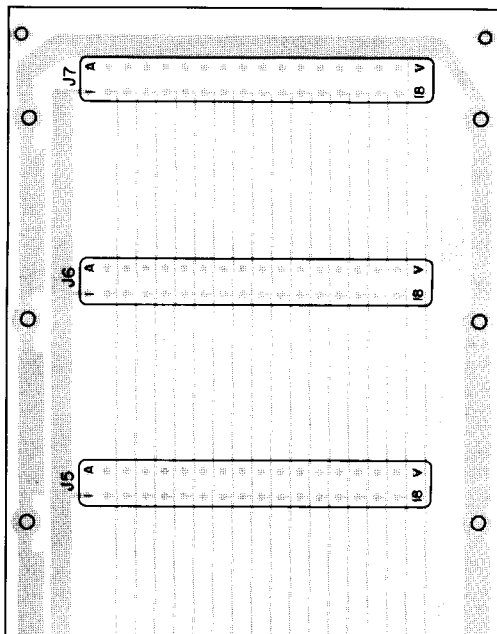
REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A5	09878-66505		Control Transceiver Board		
C1-C4	0160-3847		C: fxd .01 μ f 25V		
C5	0180-0061		C: fxd 100 μ f 15V		
XA4P1	1251-4217		Conn. (15 of 36 pins)		
XA4P2	1251-4215		Conn. (6 pins)		
R1-R6	1810-0075		R: fxd-Network		
R7	0683-3315		R: fxd 330 ohm 5%		
R8,R9	1810-0203		R: fxd-Network		
U1,U2	1820-1492		IC: 74LS368N		
U3	1820-0471		IC: 7406N		
U4	1820-1416		IC: 74LS14N		
A6	09878-66506		Line Indicator Board		
CR1	1990-0485		DIO: LED		
R1	0683-3315		R: fxd 330 ohm 5%		
A7	09878-61601		Power Switch Assembly		
A8	9100-3875		Line Filter		
			Main Frame Electronics		
C1	0160-0128		C: fxd 2.2 μ f 25V		
C2	0180-2397		C: fxd 18,000 μ f 25V		
C3,C4	0180-2181		C: fxd 1300 μ f 50V		
C5-C8	0160-0170		C: fxd .22 μ f 25V		
CR1	1901-0525		DIO: Assembly		
Q1	1854-0566		XSTR: NPN		
U1	1826-0117		IC: 7812 Voltage Regulator		
U2	1826-0123		IC: LM320-12 Voltage Regulator		
T1	9100-0697		Power Transformer		
			Mainframe Miscellaneous		
	09878-04101		Cover, Top		
	09878-04102		Cover, Bottom		
	09878-31001		Cover, Side (set, std)		
	09878-00101		Deck		
	09878-00201		Rear Panel		
	09878-06601		Frame, I/O Support		
	2110-0543		Fuse Holder		
	2110-0545		Fuse Holder Cap		
	5020-8804		Casting, Rear		
	5020-8834		Casting, Corner Strut		
	09878-40201		Front Panel		
	5040-7201		Foot		
P4	1251-3070		Conn.		
P5	1251-4144		Conn.		
			Interface Miscellaneous		
	5040-7801		I/O Front Housing, left		
	5040-7802		I/O Front Housing, right		
	5040-7836		Spring-Latch		
	1480-0292		Pin, Dwl		
	5040-7803		I/O Rear Housing, left		
	5040-7954		I/O Rear Housing, right		
W2	09878-61602		I/O Cable Assembly		
	1400-0560		LED, Clip and Ring		
	1990-0521		LED		

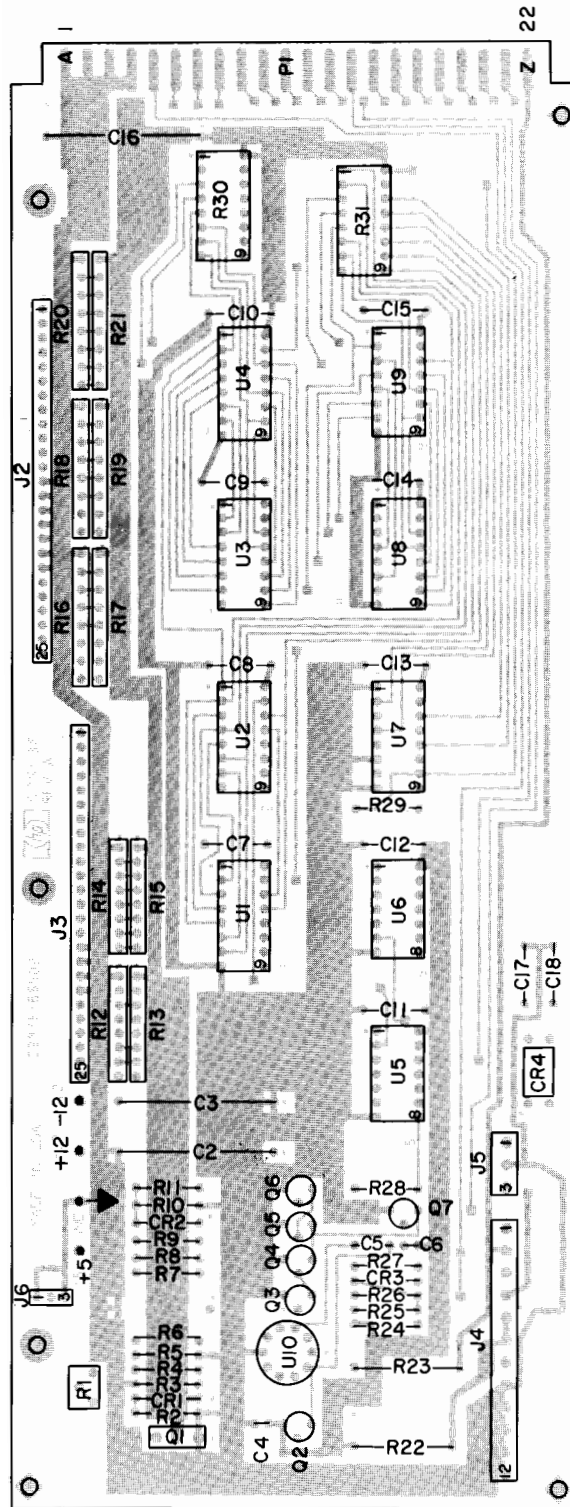
MS	1880-0251 2040-0402 2040-0401		GED I/O Front Housing, right I/O Front Housing, left		
	1400-0280 09878-61605 2040-0404 2040-0403 1480-0292 2040-0401 1990-0521		Interface Miscellaneous GED, Clip and Ring I/O Cable Assembly I/O Rear Housing, right I/O Rear Housing, left Pin, Dwl Spring-Latch LED		

W2			Interface Miscellaneous		
	5040-7801 5040-7802 5040-7836 1480-0292 5040-7803 5040-7954 09878-61602 1400-0560		I/O Front Housing, left I/O Front Housing, right Spring-Latch Pin, Dwl I/O Rear Housing, left I/O Rear Housing, right I/O Cable Assembly LED, Clip and Ring		

MS	1880-0251 2040-0402 2040-0401		GED I/O Front Housing, right I/O Front Housing, left		
	1400-0280 09878-61605 2040-0404 2040-0403 1480-0292 2040-0401 1990-0521		Interface Miscellaneous GED, Clip and Ring I/O Cable Assembly I/O Rear Housing, right I/O Rear Housing, left Pin, Dwl Spring-Latch		

Component Locators



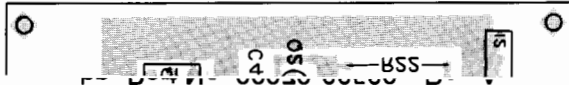


COMPONENT SIDE

A2

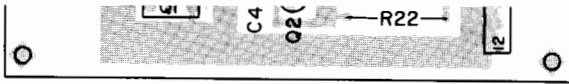
-hp- Part No. 09878-66502 Rev A

REV A 09876-0050Z Part No. 09876-0050Z



SA

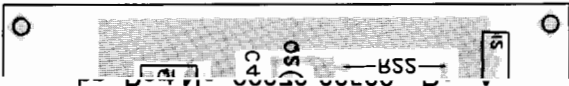
COMPONENT SIDE



COMPONENT SIDE

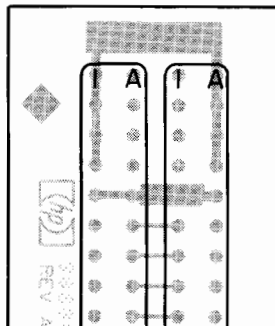
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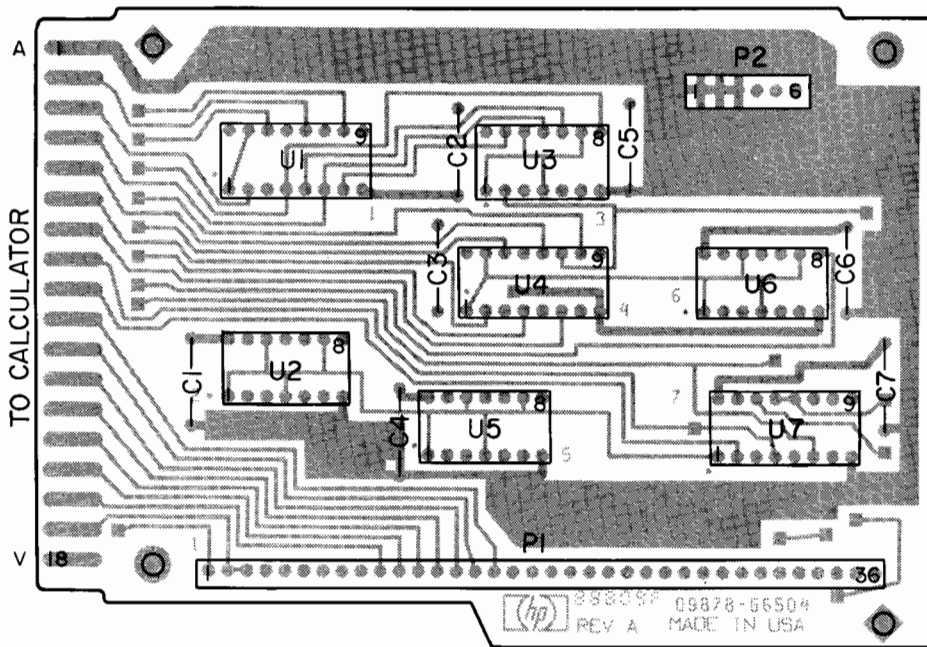
REV A 09876-0050Z Part No. 09876-0050Z



SA

COMPONENT SIDE

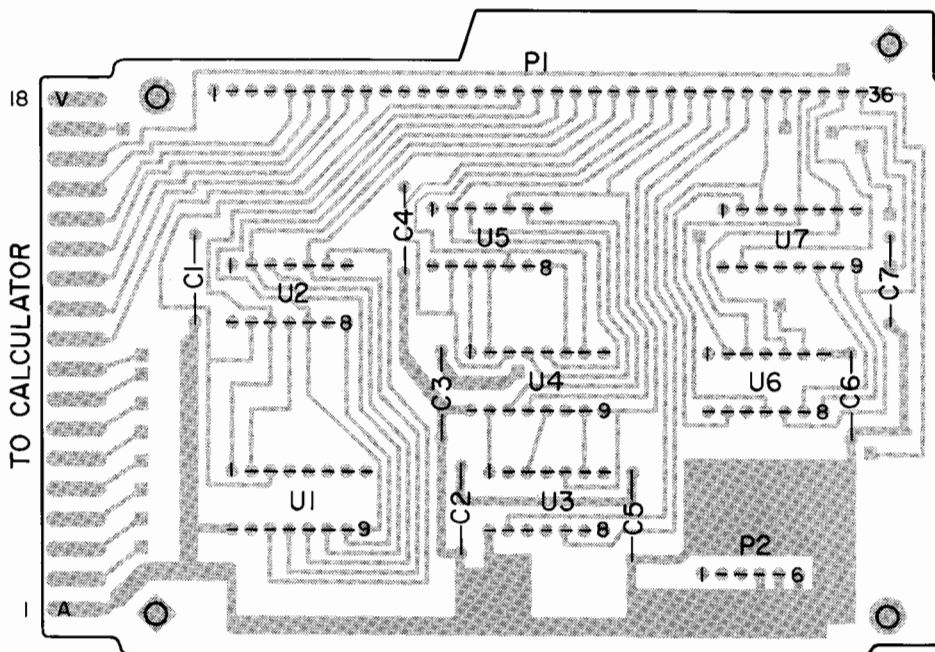




COMPONENT SIDE

A4

-hp- Part No. 09878-66504 Rev A

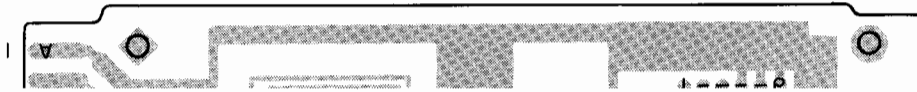


CIRCUIT SIDE

A4

-hp- Part No. 09878-66504 Rev A

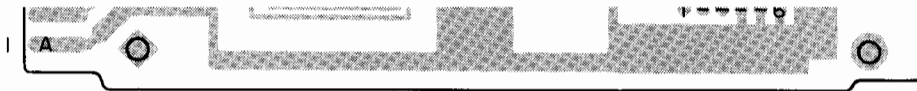
A ver A -hp- Part No. 09878-66504 Rev A



A4

CIRCUIT SIDE

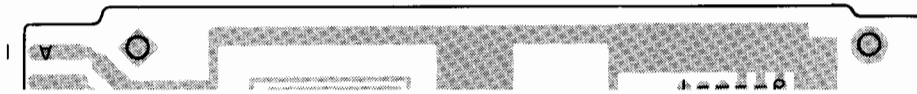
-hp- Part No. 09878-66504 Rev A



CIRCUIT SIDE

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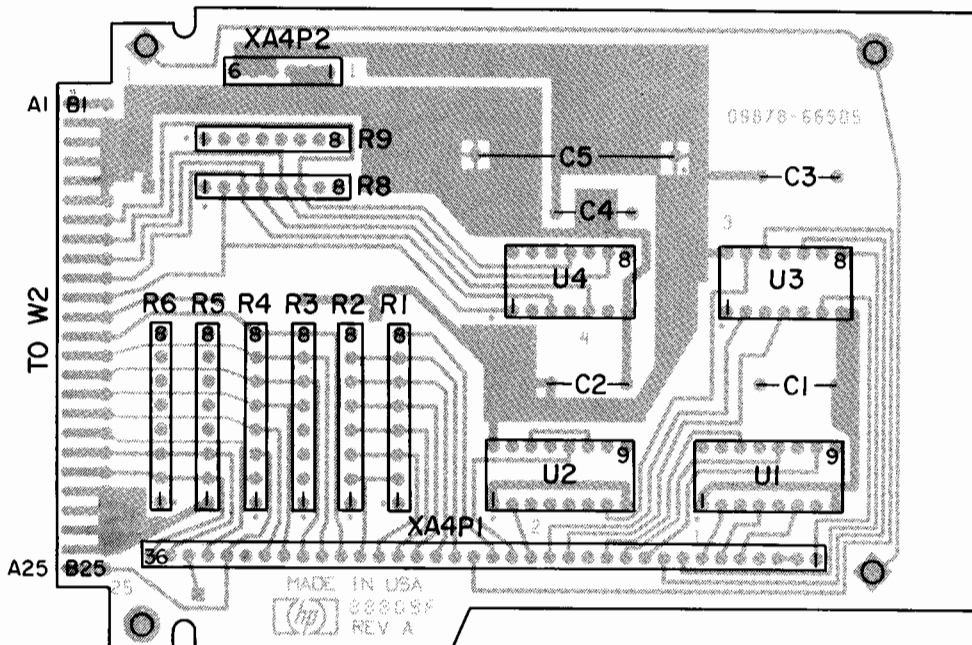
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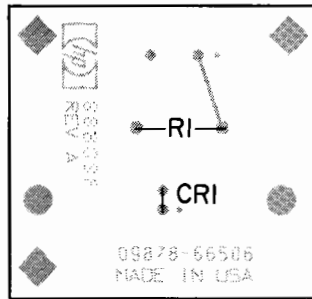


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CIRCUIT SIDE

28 Service

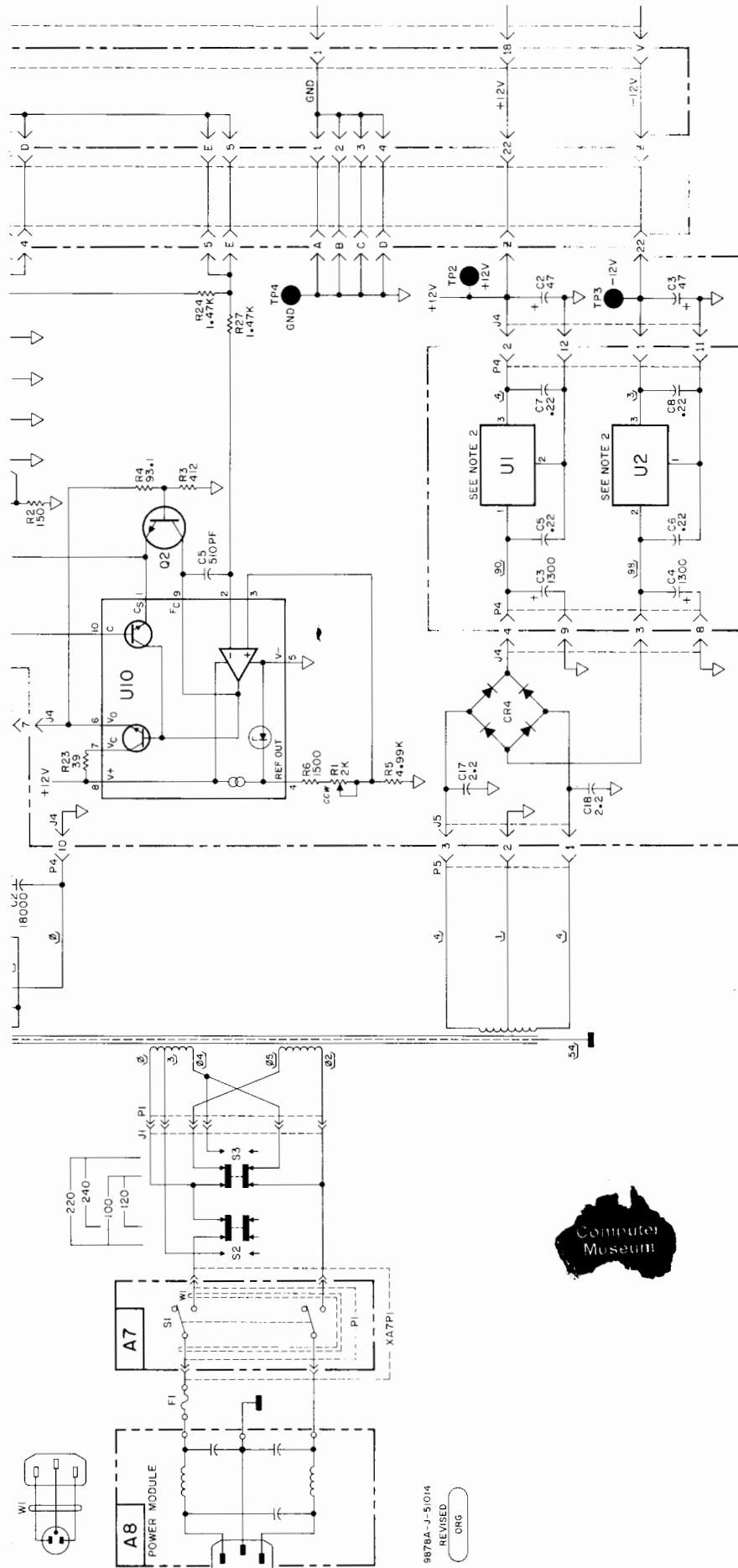




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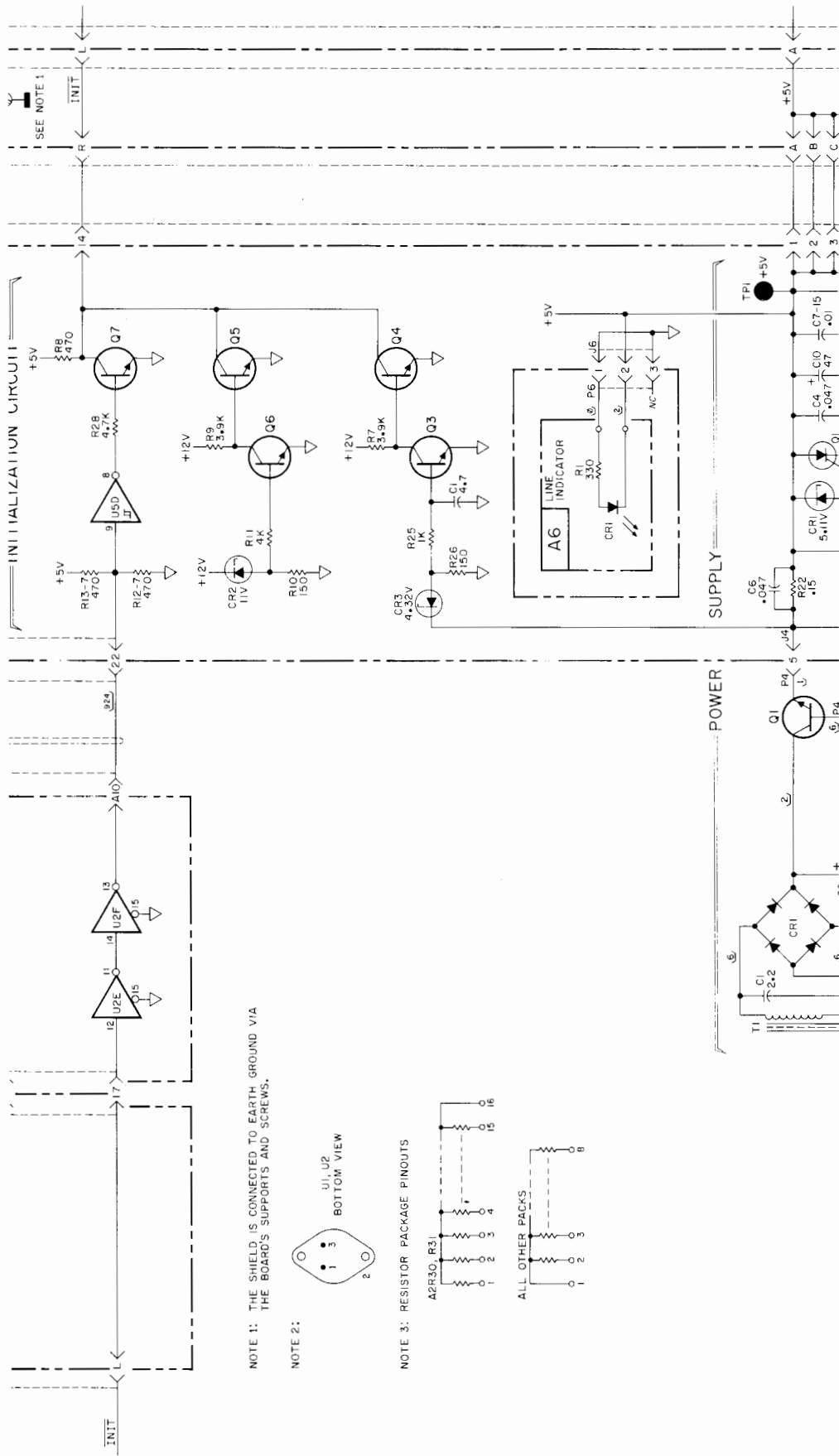
A6

-hp- Part No. 09878-66506 Rev A



9878A-J-51014
REVISED
ORG

Figure 3-8. 9878A I/O Expander Schematic



NOTE 1: THE SHIELD IS CONNECTED TO EARTH GROUND VIA THE BOARD'S SUPPORTS AND SCREWS.

