Section 6
Option Information

TABLE OF CONTENTS

6-1. INTRODUCTION

2. This section of the manual contains service information for the 8860A options. Each option has its own subsection which includes: a theory of operation, trouble-shooting information. and a list of replaceable parts. The schematics for the options are located in Section 8. The option number is used in the page and paragraph numbers of each option. For instance, option -004 starts on page 004-1.

Option -004
Calculating Controller

004-1. THEORY OF OPERATION

004-2. The Calculating Controller, Option (-004) is composed of the following four circuit boards. The schematic diagram for each circuit board is located in Section 8. A simplified block diagram is shown in Figure 004-1.

- Calculator/Printer PCB Assembly
- Rear Interface PCB Assembly
- Memory Cartridge PCB Assembly
- Control Keyboard PCB Assembly

004-3. The first two boards listed are connected with a ribbon cable and are installed inside the 8860A chassis. The latter two boards are external to the chassis and plug into the connectors on the Rear Interface board. The Calculating Controller main board is described first.

004-4. Local/Remote Switching

004-5. Selecting the local or remote control function switches the program memory which directs the out-guard microprocessor. In local, the local program memory is in control. When remote is selected, the option program memory is in control.

004-6. The local program memory directs the operations mentioned under Out-guard Processor Software in the Theory of Operation for the basic instrument. The additional operations required by the Calculating Controller option are directed by the option program memory when the remote control function is selected.

004-7. In remote, the option program memory calls parts of the local program memory as subroutines. For example, the option program memory calls on the local program memory routine to scan the keyboard and strobe the display. When the 8860A is switched back to local, control returns to the local program memory.

004-8. Option Program Memory

004-9. The program memory is split between two ROMs (U19 and U10) on the Calculating Controller main board. The active ROM is determined by a group of gates (U17). The out-guard microprocessor controls these gates via P26. The ROMs are custom devices, mask-programmed with the Calculating Controller software. Table 3-2 shows how the two ROMs are accessed using ports P23, P26, and P50.

004-10. Calculator

004-11. The number-oriented processor (U5) executes all the math functions and contains the XYZT stack. A divide-by-5 circuit (U16) provides a 400-kHz clock for U5. Processor U5 interfaces to the out-guard microprocessor through U2, an I/O Expander with RAM. For example, when the square root function is executed, U5 performs the calculation and U2 reports the result back to the out-guard microprocessor for display. U2 also receives and responds to switch closures from the handheld Control Keyboard. A 256-byte RAM in U2 holds the contents of the addressable registers R10-R49 and the print buffer.

004-12. The two ports of U10 communicate with the rear panel Data Port. The Data Port is the interface for the optional printer or the user I/O functions, R50-R57. Tri-state buffers U7, U11, U12, and U13 provide bi-directional data buffering to the Data Port. U10 also contains a 2 kbyte ROM.

004-13. Data Bus and Address Bus

004-14. The out-guard microprocessor communicates over the data bus DB0-DB7 with the ROM and I/O expanders (U2, U10, and U19), the Memory Cartridge, the optional printer, and the User I/O. Control lines which identify and route each byte on the data bus are ALE (address latch enable), $\overline{PSEN}$ (program store enable), $\overline{RD}$, and $\overline{WR}$.

- ALE (address latch enable) is a steady 400 kHz.
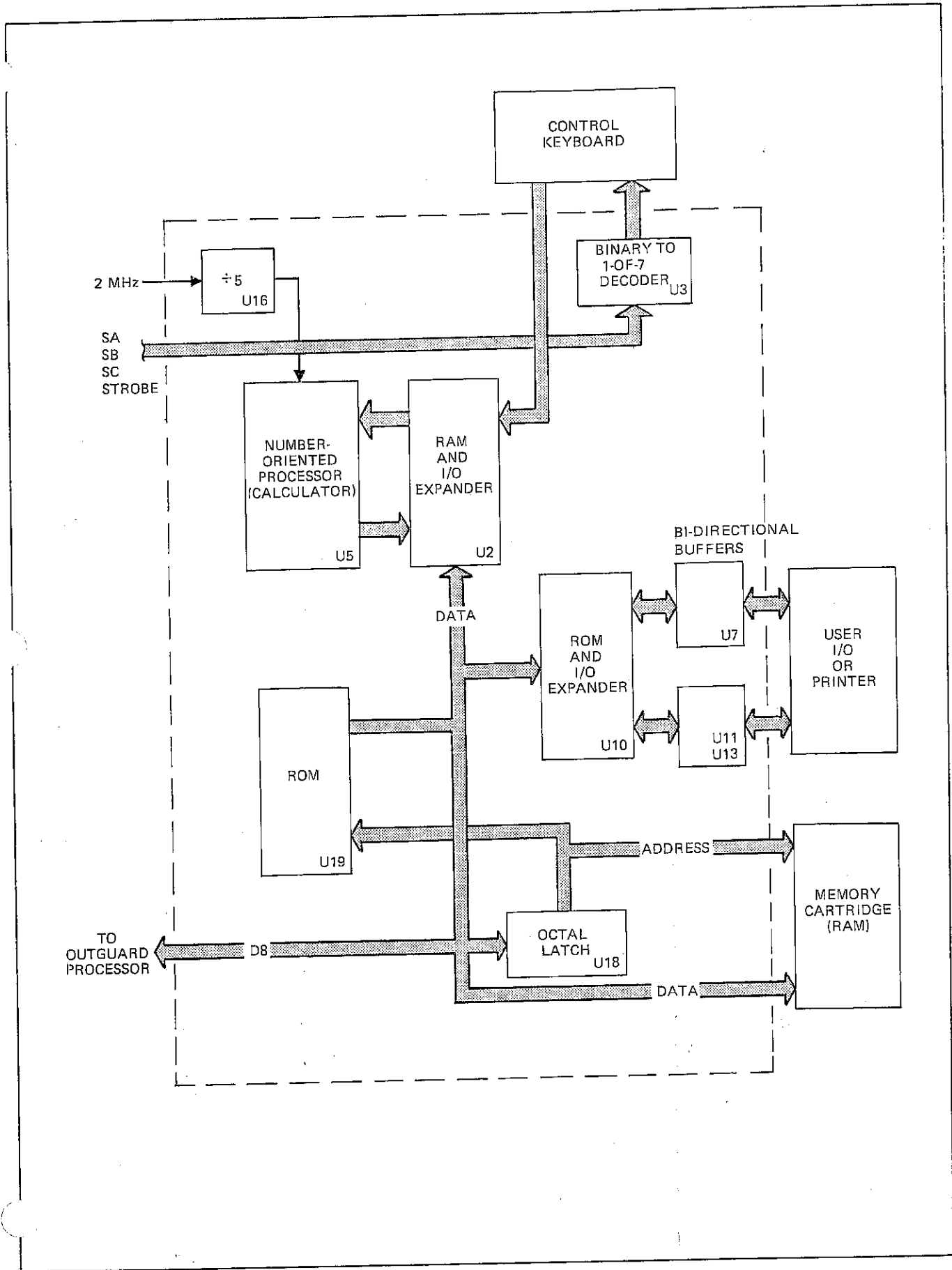- PSEN (program select enable) is active whenever

Figure 004-1. Calculating Controller Option-004 Block Diagram

the processor is reading its program ROM, which it does regularly.

- RD (read) and WR (write) are used only when Option -004 or -005 is installed. They are active when the processor is using the data bus for communication other than reading the program memory. For instance, they are active when the processor is reading the Control Keyboard.

004-15. The address and data for ROM U10 are multiplexed over the data bus. By contrast, the address and data for ROM U19 and the Memory Cartridge RAM are carried on separate lines. The 8-bit latch U18 stores the address for these latter two devices. The upper four bits of address, A8-A11, travel on their own lines, P20-P23, to U19 and U10.

004-16. Power Supply
004-17. All circuits operate off the +5V out-guard supply. IC U5, the only P-channel MOS device, requires an additional -4V supply derived through CR1, CR2, CR3, Q1, and the power transformer secondary.

004-18. Three level shifters in U4 convert a TTL level (0V to 5V) to a PMOS level (-4V to +5V) for pins 7, 9, and 11 of U5.

004-19. Memory Cartridge (Schematic 8860A-1013)
004-20. The Memory Cartridge contains two CMOS RAM devices to hold addressable registers R00 through R09 and all of programmable memory, steps 00 through 99. All data and address lines are pulled to ground through 100 kΩ resistors to keep the current drain at a minimum.

004-21. Two silver-oxide watch batteries (TB1, TB2) supply power to the RAMs when the cartridge is not receiving power from the 8860A. Three diodes (CR1 on the memory Cartridge board; CR4 and CR5 on the Calculating Controller main board) prevent the +5V supply from attempting to charge the batteries. The RAM devices draw a current of 50 nA to 1 uA from the batteries at approximately 2.5V.

004-22. Jumper W1 at pin 22 of U1 allows power to be removed from U1 during troubleshooting. If it is discovered that the Memory Cartridge is drawing an excessive amount of current from the batteries, remove this jumper to identify the faulty RAM.

004-23. TROUBLESHOOTING THE CALCULATING CONTROLLER
004-24. Table 004-1 contains troubleshooting information for the Calculating Controller. Before using the table, remove the Option -004 PCB from its slot in the 8860A, and check the operation of the basic DMM. If the DMM is operating properly, reinstall the PCB, and refer to the table.

004-25. The troubleshooting table is a series of symptoms and solutions. Check the unit for the symptoms in sequence. When a symptom is identified, clear the fault using the solutions listed for that fault. All devices mentioned in the table are located on the Calculating Controller PCB.

CAUTION
To avoid instrument damage, remove power from the 8860A before unplugging the circuit board or removing plug-in devices.

004-26. LIST OF REPLACEABLE PARTS
004-27. A list of replaceable parts for the Calculating Controller is given in Table 004-2. Refer to Section 5 of this manual for ordering information.

CAUTION ⊗
Indicated devices are subject to damage by static discharge.

Table 004-1. Calculating Controller Troubleshooting

SYMPTOM	INSTRUCTIONS
1. The 8860A does not operate in local when the -004 Option PCB is installed, but works when the board is removed.	• Suspect the Memory Cartridge, U19, U2 or U10. • Remove these devices one at a time, until the basic instrument operates normally (in local). These devices are all in sockets and all sit on the internal bus. Replace the device which clears the fault.
2. With the option installed, the 8860A operates in local but not in remote.	• Replace U10, U19, U2, and U5. • Check U17 (pin 6 is high when pins 4 and 10 are both high). • Check U18 as described in step 7. • Check U12 for high state at pin 9. • Check U16 for 2 MHz at pin 1, and 400 kHz at pin 8. • Check U4 for 400 kHz at pin 2, +4.5V to -3.5V swing. • Check U5, pin 21, for a dc voltage between -3.5V and -4.5V (negative supply). • Check U5, pin 11, for a dc voltage between -3.5V and -4.5V (release of initial reset). • Check U2, pin 28, for a low state (drives U5, pin 11).
3. Cannot store or recall Memory Cartridge data	• Check Q2, Q3, U14 (on Option -004 mainboard); pin 11 of U14 should be high after initial turn-on delay. • Check U15, pin 11, for continuous switching. • Check control lines as described in step 8.
4. User I/O and/or Print functions do not work.	• Replace U10. Check U7, U11, and U13 as follows (with nothing connected to the data port): ·RCL 50 causes pin 1 of U7 and U11 to go low. ·ST0 50 causes pin 1 of U13 and U7 to go low. • Check U12. pins 13 and 14, and U10 pin 31 for a low state when nothing is connected to the data port. • With the printer connected (make sure the printer is a 2020A with Option -001 installed; Option -004 or a Model 2030A Printer will also work): U12, pins 14 and 13, and U10 pin 31 should all be high when the printer is on. Pins 1, 6, and 7 of U7 and pin 1 of U11 should remain low for the duration of a print function (Print X, for example). During this time, 18 pulses should occur on pins 4, 5, 9, and 10 of U7 and on pins 37 and 39 of U10.
5. Control Keyboard cannot be read	• Check U3; outputs should sequentially pulse low. • Replace U2 if pins 33 through 36 switch, but are not affected when a key is pressed.
6. Math Functions and XYZT Stack are inoperative.	• Check the following points for switching when a key is pressed (x-exchange-y key, for instance): • Pin 10 of U2, $\overline{WR}$ (normally high), for one negative pulse. • Pin 6 of U15 (normally low) for one positive pulse. • Pin 8 of U15 (normally high) for approximately 12 pulses. • Pins 1 and 3 of U14 (normally high) for approximately 12 pulses. • Pin 4 of U14 (normally high) for one negative pulse. • Pin 5 of U12 (normally high) for approximately 12 pulses. • Check pin 9 of U12 (normally low) to go high on Err 99.
7. Faulty Address Latch (U18)	• Check U18 with a dual-trace scope. Trigger the scope on ALE and look at the input and output of each latch. If ALE and the latch are working properly, then the latch output follows the latch input when ALE is high. The latch input is stored when ALE goes low.
8. Faulty Control Line	• Check $\overline{PSEN}$, pin 20 of U19, for continuous switching. • Check ALE, pin 11 of U2, for continuous switching. • Check $\overline{RD}$, pin 9 of U2, for continuous switching.

Table 004-2. Calculating Controller Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-004	CALCULATING CONTROLLER ASSEMBLY FIGURE 004-2 (8860A-004)	ORDER	BY	OPTION -004			
	CONTROL KEYBOARD	533588	89536	533588	1		
	MEMORY CARTRIDGE	Y8833	89536	Y8833	1		
	CALCULATOR/PRINTER PCB ASSEMBLY	516328	89536	516328	1		
H1	HARDWARE KIT	512400	89536	512400	2		
MP1	PANEL, (SUB) CAL PRINTER	531038	89536	531038	1		
MP2	INSULATOR	541862	89536	541862	1		
MP3	CUP	541888	89536	541888	1		

MP2

H1

DETAIL 1

CALCULATOR/PRINTER
PCB ASSEMBLY

MP3

REAR INTERFACE PCB ASSY.

REAR PANEL (REF)

H1

C2(REF)

J4(REF)

MEMORY
CARTRIDGE
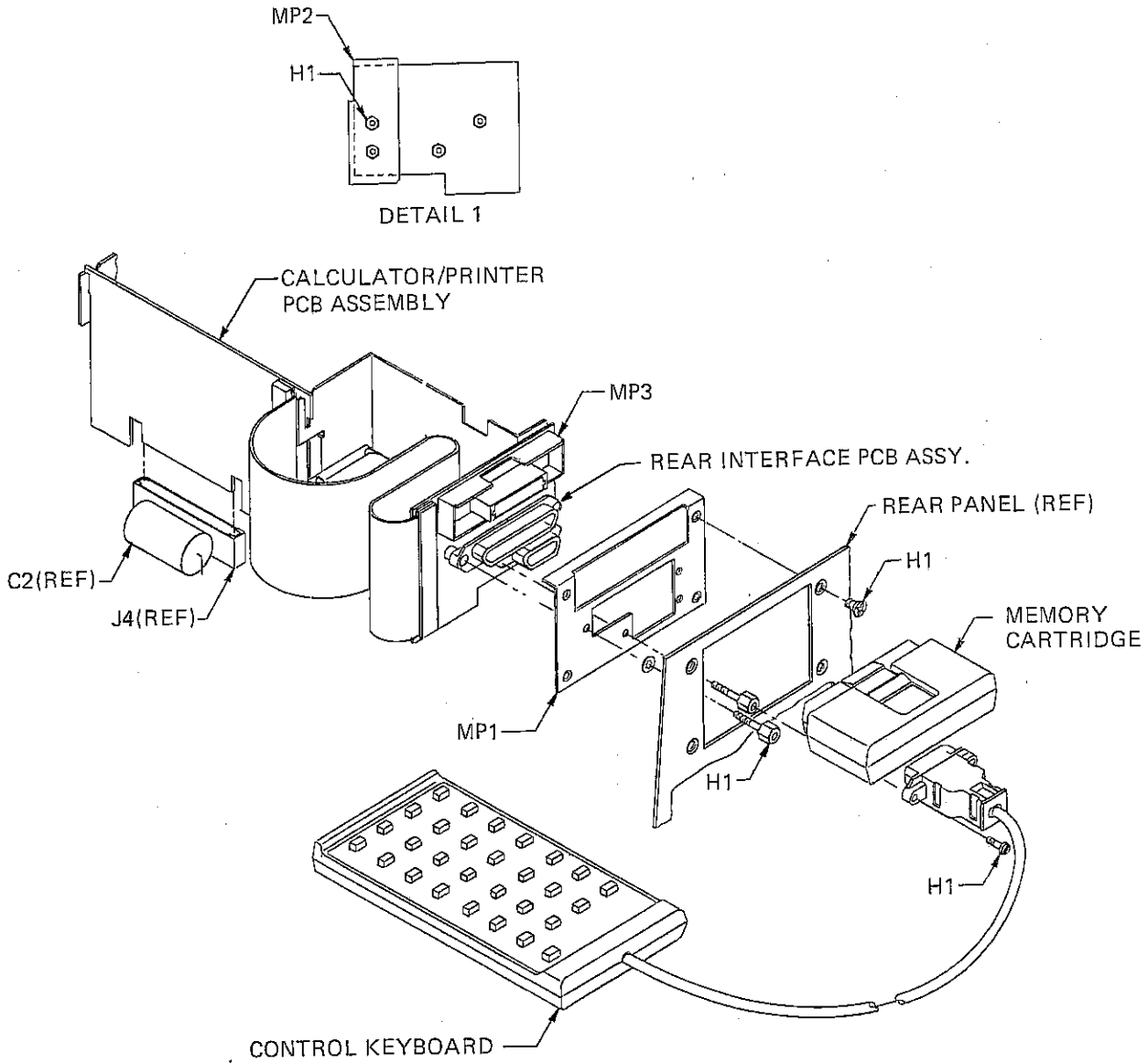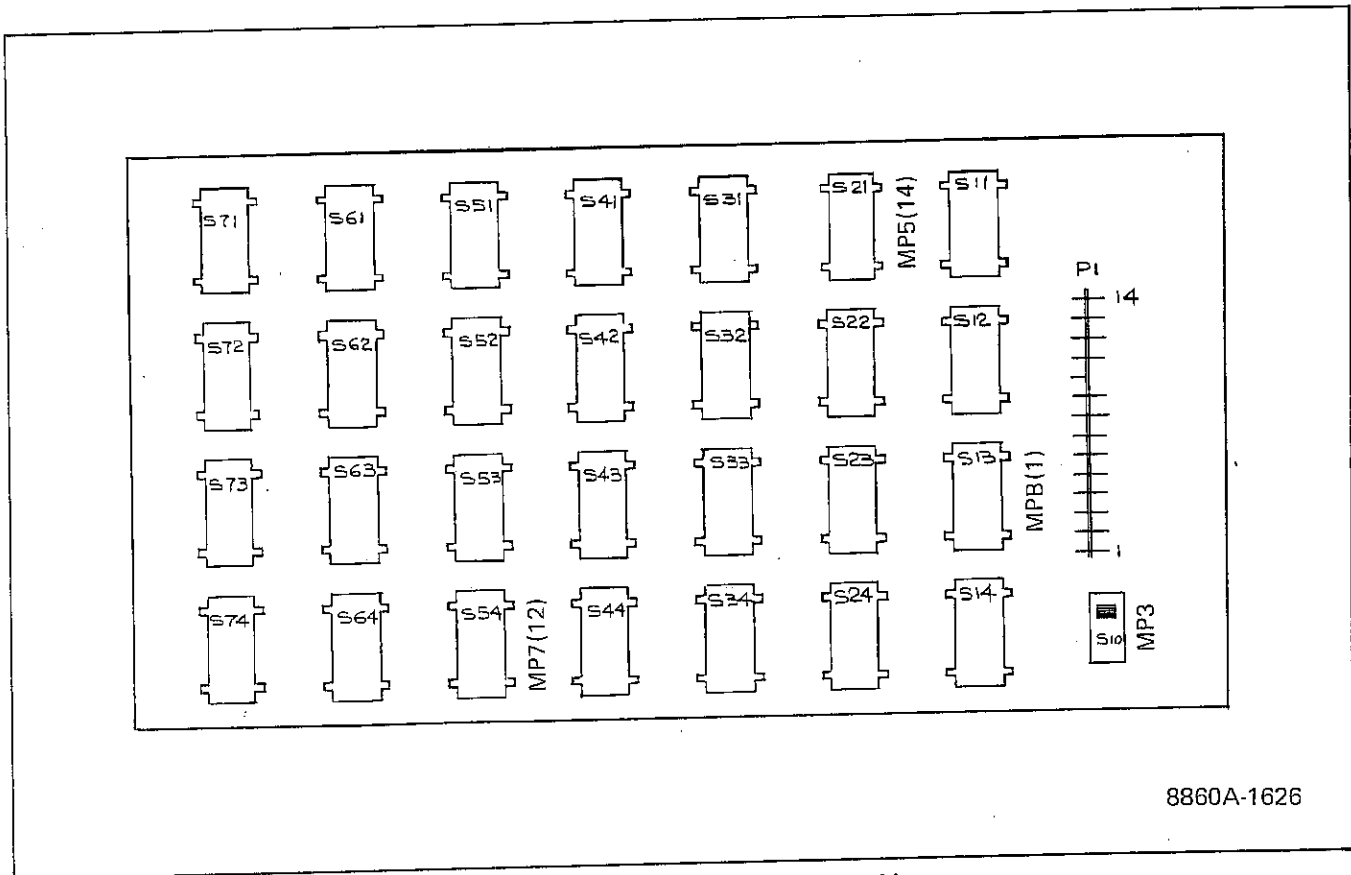
MP1

H1

H1

CONTROL KEYBOARD

8860A-004

Figure 004-2. Calculating Controller Assembly

Table 004-3. Control Keyboard Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	CONTROL KEYBOARD ASSEMBLY FIGURE 004-3 (8860A-4026)	533588	89536	533588	REF		
H1	SCREW, FHP, 4-40 X 7/16	542225	89536	542225	2		
MP1	CASE, FRONT	509406	89536	509406	1		
MP2	CASE, REAR	509281	89536	509281	1		
MP3	BUTTON, SLIDE SWITCH (W/S10)	509331	89536	509331	1		
MP4	FOOT, CASE	507624	89536	507624	4		
MP5	BUTTON, GREY	509398	89536	509398	14		
MP6	BUTTON, ORANGE	509364	89536	509364	1		
MP7	BUTTON, WHITE	509372	89536	509372	12		
MP8	BUTTON, DARK GREY	509257	89536	509257	1		
MP9	DECAL	507616	89536	507616	1		
MP10	SPRING (ALL SWITCHES)	414516	00779	62353-3	28		
MP11	CONTACT, FIXED (ALL SWITCHES)	416875	00779	62380-4	28		
P1	HEADER, 14-PIN	519652	22526	65521-114	1		
S10	SWITCH, SLIDE (W/MP3)	477984	79727	GS-115	1		
W1	CALCULATOR CABLE	534099	89536	534099	1		
X	CALCULATOR KEYBOARD PCB	ORDER	NEXT	HIGHER ASSY.			

8860A-1626

Figure 004-3. Control Keyboard PCB Assembly

H1(2)

MP4(4)

MP2

NOTE KEYING POSITION

W1

MP1(REF)

CALCULATOR/PRINTER
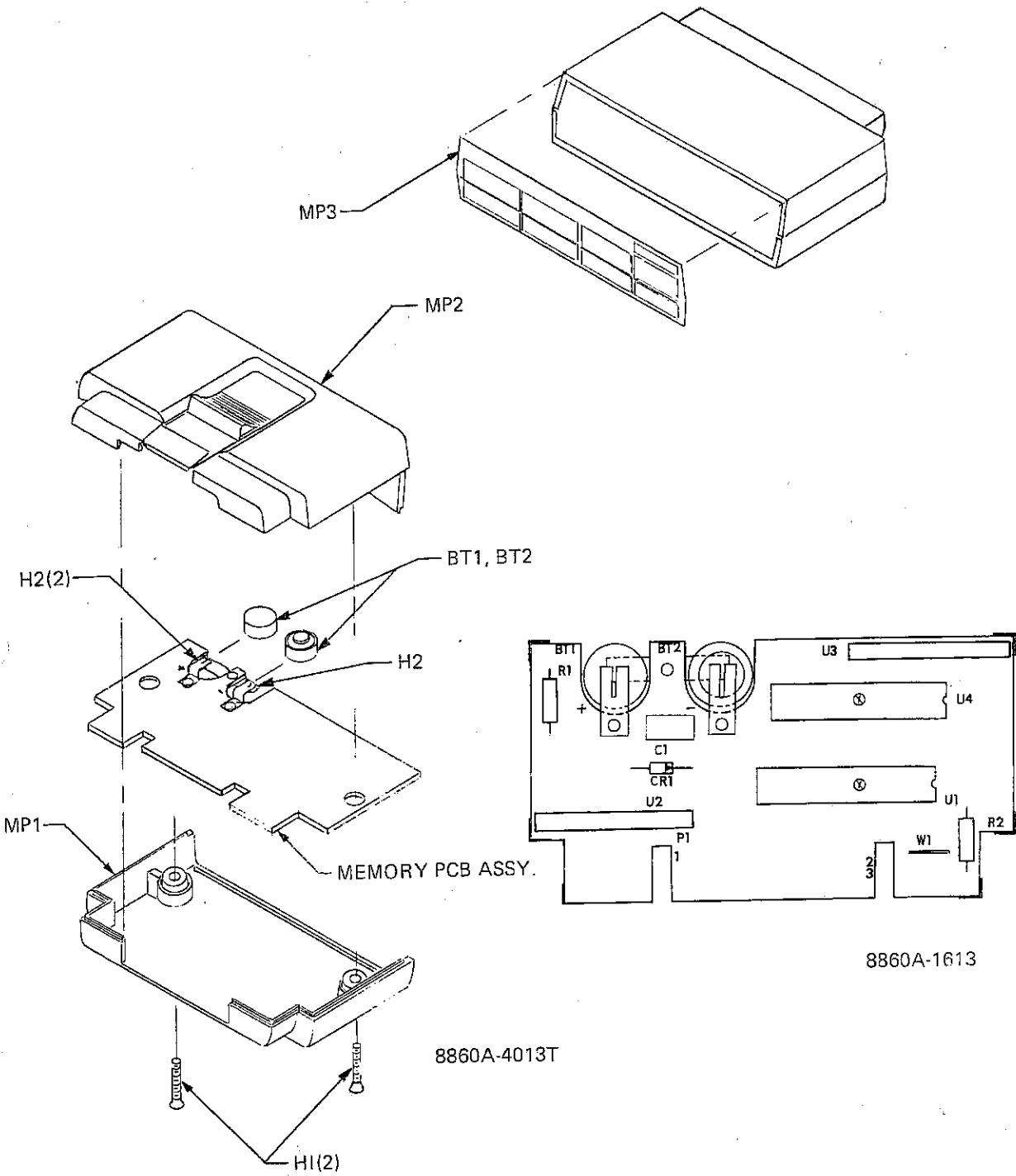PCB ASSY.

MP3(REF)

MP1

MP9
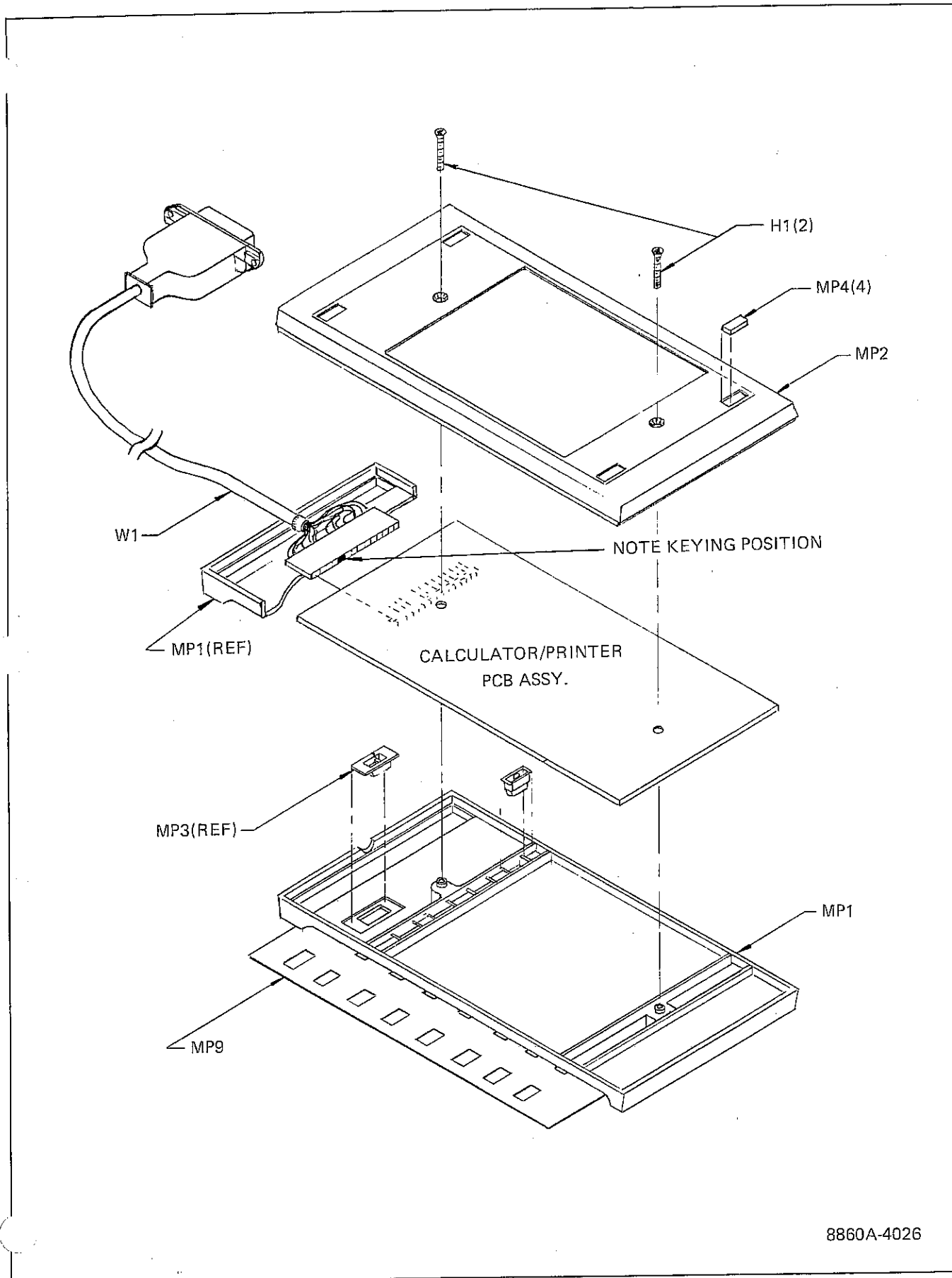
8860A-4026

Figure 004-3. Control Keyboard PCB Assembly (cont)

Table 004-4. Memory Cartridge

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	⊗ MEMORY CARTRIDGE	ORDER	BY	Y8833			
	FIGURE 004-4 (Y8833)						
	MEMORY PCB ASSEMBLY						
BT1	BATTERY, SILVER OXIDE	520221	89536	520221	2 REF		A
BT2	BATTERY, SILVER OXIDE	520221	89536	520221	1		B
C1	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1	1	B
CR1	DIO, SI, HI-SPEED SWITCHING	203323	07910	1N4448	2		
H1	SCREW FHP, 6-20 X 5/8	529479	89536	529479			
H2	SPRING, BATTERY CONTACT	525287	89536	525287	1		
MP1	CASE, BOTTOM	509240	89536	509240	1		
MP2	CASE, TOP	509323	89536	509323	1		
MP3	DECAL, MEMORY MODULE	534438	89536	534438	1		B
MP4	SPRING CONTACT (NOT SHOWN)	525287	89536	525287	1		
P1	BOARD CONNECTION	348920	89536	348920	2 REF		B
R1	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	89536	348920			B
R2	RES, DEP. CAR, 100K +/-5%, 1/4W	429860	89536	MCM51L01P65	2	1	B
U1	⊗ IC, C-MOS, STATIC RAM, 3-STATE OUTPUT	461038	89536	461038	2	1	B
U2	RESISTOR NETWORK, 100K				REF		B
U3	RESISTOR NETWORK, 100K	461038	89536	461038	REF		B
U4	⊗ IC, C-MOS, STATIC RAM, 3-STATE OUTPUT	429860	89536	MCM51L01P65			B
W1	JUMPER WIRE	529271	89536	529271			

A   WARNING, DO NOT RECHARGE!
      BATTERIES MAY EXPLODE OR LEAK.

B   ITEMS ON MEMORY PCB ASSEMBLY.

MP3

MP2

BT1, BT2

H2(2)

H2

MP1

MEMORY PCB ASSY.

8860A-4013T

H1(2)

BT1 R1 BT2 U3

U4

C1
CR1

U2

P1

W1 R2

1

2
3

U1

8860A-1613

CAUTION
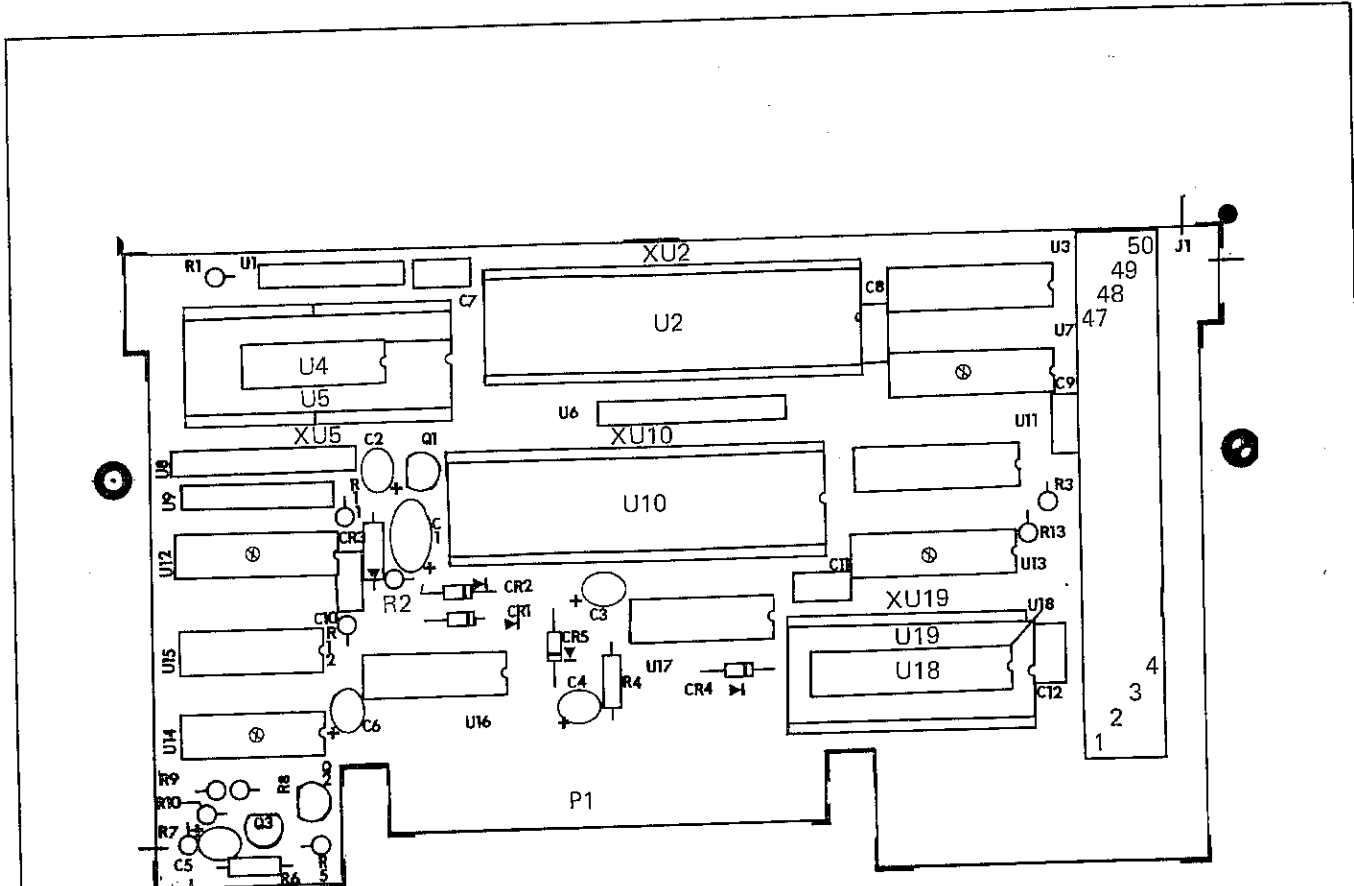SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

Figure 004-4. Memory Cartridge

Table 004-5. Calculator/Printer PCB Assembly

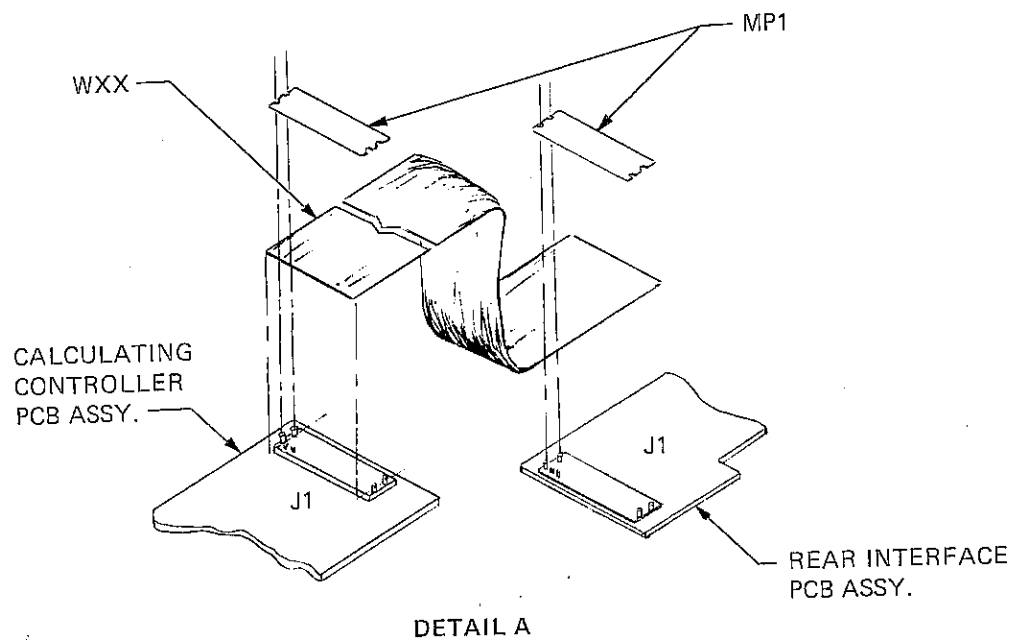| REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	⊗ CALCULATOR/PRINTER PCB ASSEMBLY FIGURE 004-5 (8860A-4014T)	516328	89536	516328	REF		
	REAR INTERFACE PCB ASSEMBLY	ORDER	NEXT	HIGHER ASSEMBLY			
C1	CAP, TA, 47 UF +/-20%, 20V	348516	56289	A96D476X0020KE4	1		
C2	CAP, TA/DISC, 10 UF +/-20%, 10V	176214	56289	196D106X0010KA1	1		
C3	CAP, TA, 15 UF, 20V	519686	56289	196D156X0020KE4	1		
C4	CAP, TA, 68 UF, 6V/8V	519702	56289	196D686X0008KE4	1		
C5	CAP, TA, 39 MF +/-20%, 6V	163915	56289	196D394X0020KA1	1		
C6	CAP, TA/DISC, 4.7 UF +/-20%, 20V	161943	56289	196D476X0020KA1	1		
C7	CAP, CERAM, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-022	6		
C8	CAP, CERAM, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-022	REF		
C9	CAP, CERAM, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-022	REF		
C10	CAP, CERAM, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-022	REF		
C11	CAP, CERAM, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-022	REF		
C12	CAP, CERAM, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-022	REF		
CR1	DIODE, SIL RECTIFIER, 1A, 100V	343491	03877	1N4002	2	1	
CR2	DIODE, SIL RECTIFIER, 1A, 100V	343491	03877	1N4002	REF		
CR3	DIODE, ZENER, 400 MW, 4.7V	524058	14552	1N751	1	1	
CR4	DIODE, SI, HI-SPEED SWITCHING	203323	06001	1N4448	2	1	
CR5	DIODE, SI, HI-SPEED SWITCHING	203323	06001	1N4448	REF		
J1	CONN, 50-PIN	519918	52152	3426-0000T	1		
MP1	COVER, CONN (TO J1)	519934	89536	519934	2		
P1	BOARD CONNECTION						
P26	BOARD CONNECTION						
Q1	XSTR, SI, PNP	195974	64713	2N3906	3	1	
Q2	XSTR, SI, PNP	195974	64713	2N3906	REF		
Q3	XSTR, SI, PNP	195974	64713	2N3906	REF		
R1	RES, DEP. CAR, 27K +/-5%, 1/4W	441501	89536	441501	1		
R2	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	89536	343434	1		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	89536	348839	2		
R4	RES, DEP. CAR, 82 +/-5%, 1/4W	442277	89536	442277	1		
R5	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	89536	348888	1		
R6	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	89536	441469	1		
R7	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	89536	442400	1		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	89536	348839	REF		
R9	RES, DEP. CAR, 1.1K +/-5%, 1/4W	348797	89536	348797	1		
R10	RES, DEP. CAR, 270 +/-5%, 1/4W	348789	89536	348789	1		
R11	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	89536	386490	1		
R12	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	89536	442350	1		
R13	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	89536	348920	1		
U1	RESISTOR NETWORK, SIP, 3.6K +/-2%, 1/8W	478818	89536	478818	1	1	
U2	IC, 2K X 8 BIT RAM, PROGRAMMABLE TIMER	524884	34649	P8155	1	1	
U3	IC, DEMULTIPLEXER	508473	01295	SN74LS156N	1	1	
U4	IC, LIN, QUAD COMPARATOR	387233	12040	LM339N	1	1	
U5	MICROCOMPUTER, PROCESSOR, MOS/LSI	524066	12040	MM57109	1	1	
U6	RESISTOR NETWORK, 10K	412924	89536	412924	1	1	
U7	⊗ IC, C-MOS, HEX NON-INVERT BUFFER	407759	12040	MM80C97N	3	1	
U8	RESISTOR NETWORK, 5.1 X 1K	519694	89536	519694	1	1	

Table 004-5. Calculator/Printer PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
U9	RESISTOR NETWORK, 10K	500876	89536	500876	1	1	
U10	IC, DIGITAL 2KX8 BIT ROM	524876	34649	P8355	1	1	
U11	IC, 3-STATE BUFFER	454819	07263	4009PC	1	1	
U12	⊗ IC, C-MOS, HEX NON-INVERT BUFFER	407759	12040	MM80C97N	REF		
U13	⊗ IC, C-MOS, HEX NON-INVERT BUFFER	407759	12040	MM80C97N	REF		
U14	⊗ IC, C-MOS, QUAD 2-IN & GATE	408401	02735	CD4081BE	1	1	
U15	IC, QUAD 2-IN POS-OR GATE	393108	01295	SN74LS32N	1	1	
U16	IC, TTL MSI, DECADE COUNTER	402545	01295	SN74LS90N	1	1	
U17	IC, TTL MSI, QUAD 2-IN POS-NAND GATE	393033	07263	74LS00PC	1	1	
U18	IC, TTL, OCTAL "D"TYPE F/F	504514	01295	SN74LS373	1	1	
W1	CABLE, 50-STRAND FLAT	404822	89536	404822	1		
XU2	SOCKET, 40-PIN	429282	09922	DILB40P-108	2		
XU5	SOCKET, 7-PIN	520809	30035	SS-109-1-07	4		
XU10	SOCKET, 40-PIN	429282	09922	DILB40P-108	REF		
XU18	SOCKET, 12-PIN	417733	30035	SS-109-1-12	2		
XU19	SOCKET, 12-PIN	417733	30035	SS-109-1-12	REF		

8860A-1614

WXX

MP1

CALCULATING
CONTROLLER
PCB ASSY.

J1

J1

REAR INTERFACE
PCB ASSY.

DETAIL A

8860A-1614

Figure 004-5. Calculator/Printer PCB Assembly

Table 004-6. Rear interface PCB Assembly

| REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	REAR INTERFACE PCB ASSEMBLY FIGURE 004-6 (8860A-4024)	ORDER	NEXT	HIGHER ASSEMBLY	REF		
J1	CONNECTOR, 50-POSITION	519918	52152	3426-0000T	1		
J2	CONNECTOR, 24-POSITION	519397	01295	H421121-18	1		
J3	CONNECTOR, 36-POSITION	479261	00779	552235-1	1		
J4	CONNECTOR, 14-POSITION	512392	00779	552212-1	1		
U1	IC, RES. NETWORK, 56K +/-2%, 1/8W	529131	89536	529131	1	1	

8860A-1624
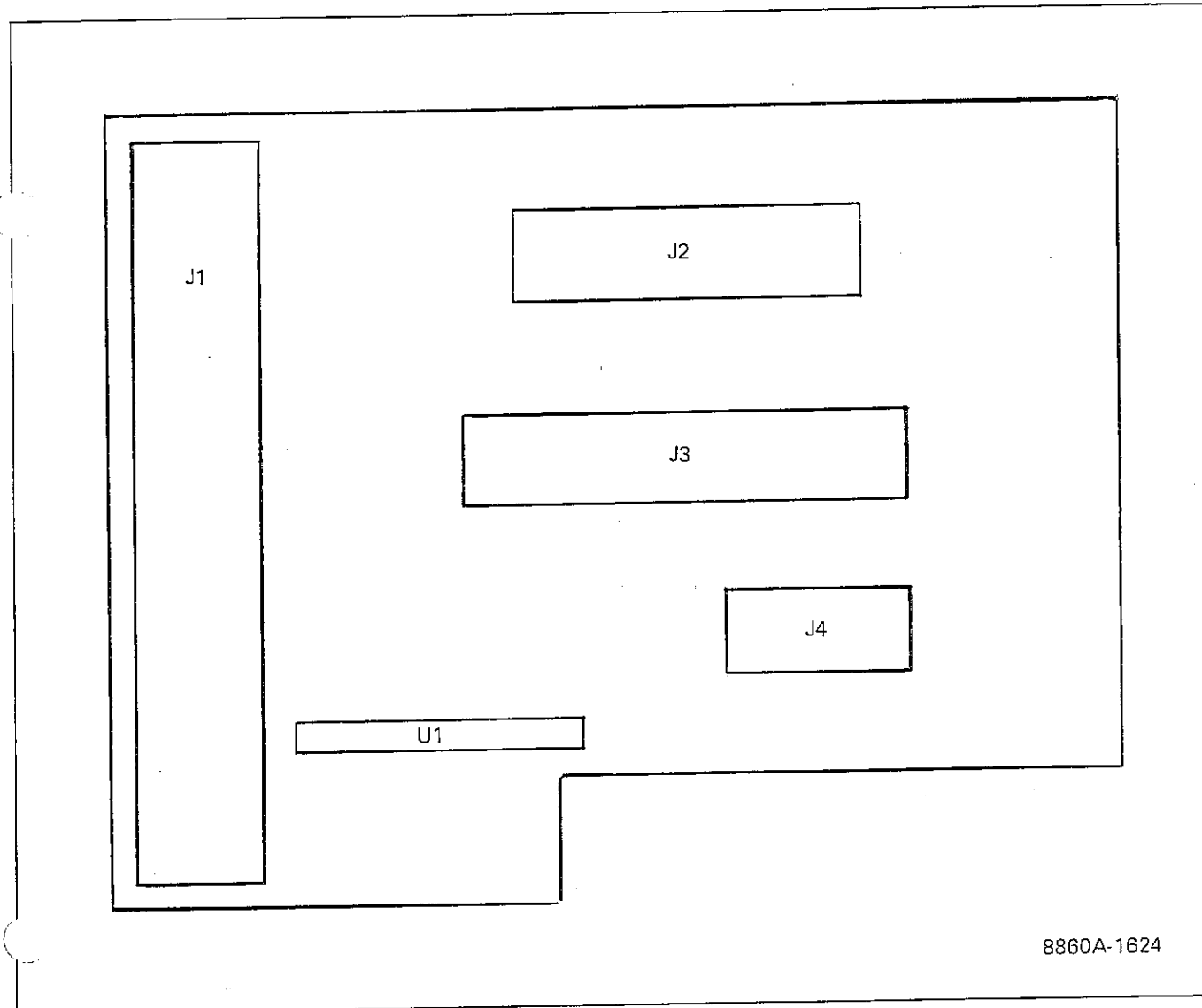
Figure 004-6. Rear Interface PCB Assembly

Option -005

IEEE-488 Interface

005-1. THEORY OF OPERATION

005-2. The IEEE-488 Interface, Option -005, consists of two circuit boards: the IEEE-488 Interface PCB (Schematic 8860A-1015) and the Rear Interconnect PCB (Schematic 8860A-1025). These boards are connected with a ribbon cable. The IEEE connector and the six IEEE address switches are located on the Rear Interconnect PCB. The schematic diagram for each of the two circuit boards is located in Section 8.

005-3. A simplified schematic of the IEEE-488 Interface is shown in Figure 005-1. The IEEE-488 Bus is located at the left, the 8860A basic instrument is at the right.

005-4. Local/Remote Switching

005-5. When the IEEE-488 Interface is installed, the option program memory (U4) is in control for both local and remote operation. Control can be passed to the local program memory (U9 on the Controller PCB), but is always returned to the option program memory. For example, the option program memory calls on the local program memory to perform the measurement routine. When the measurement cycle is finished and the result is obtained, the option program memory again becomes active.

005-6. General Purpose Interface Adapter

005-7. The main device on the IEEE-488 Interface PCB is U1, the general purpose interface adapter (GPIA). This device is designed specifically to interface 8-bit microprocessor data and address buses to the IEEE-488 bus. The GPIA handles the bus protocol functions, including the bus handshake. The GPIA communicates with the bus through two bidirectional bus transceivers (U2 and U5).

005-8. The GPIA contains the serial poll register where the present 8860A measurement status is stored. When a serial poll occurs, the contents of this register are loaded directly onto the IEEE-488 bus.

005-9. Data Bus and Address Bus

005-10. The internal 8-bit data bus, DB0 through DB7,

carries information between the devices (GPIA, ROM, RAM) and the out-guard microprocessor. The 8-bit address used by each of these devices is latched by U10. Gates U6 and U8 are used to enable devices (U1, U3, and/or U4) to read or write on the internal bus.

005-11. The rear panel IEEE address switches and the Talk-Only switches connect to the data bus through a hex inverter (U11). The tri-state outputs are enabled by a line from U1. The switch output is read at regular intervals.

005-12. Option Program Memory

005-13. The program memory is contained in U4. Figure 3-2 in Section 3 of this manual shows how the ROM is partitioned and how it is accessed from ports P23, P26, and P50. This ROM (U4) is a custom device that is mask-programmed with the IEEE-488 Interface software.

005-14. DATA STORAGE RAM

005-15. A 128-byte RAM (U3) is used for storing I/O data that appears on the data bus. It contains the input buffer for handling input commands, the output buffer for handling output data, and locations for other data storage.

005-16. TROUBLESHOOTING THE IEEE-488 OPTION

005-17. The following troubleshooting procedure requires that the basic 8860A is working properly. Before starting the procedure, remove the IEEE-488 Interface from its slot in the 8860A, and check the operation of the basic DMM. If the 8860A is operating properly, reinstall the option pcb and proceed with the troubleshooting information given in Table 005-1.

005-18. The troubleshooting table is a series of symptoms and solutions. Check the unit for the symptoms in sequence. When a symptom is identified, clear the fault using the solutions listed for that fault. All devices mentioned in the table are located on the IEEE-488 Interface PCB.
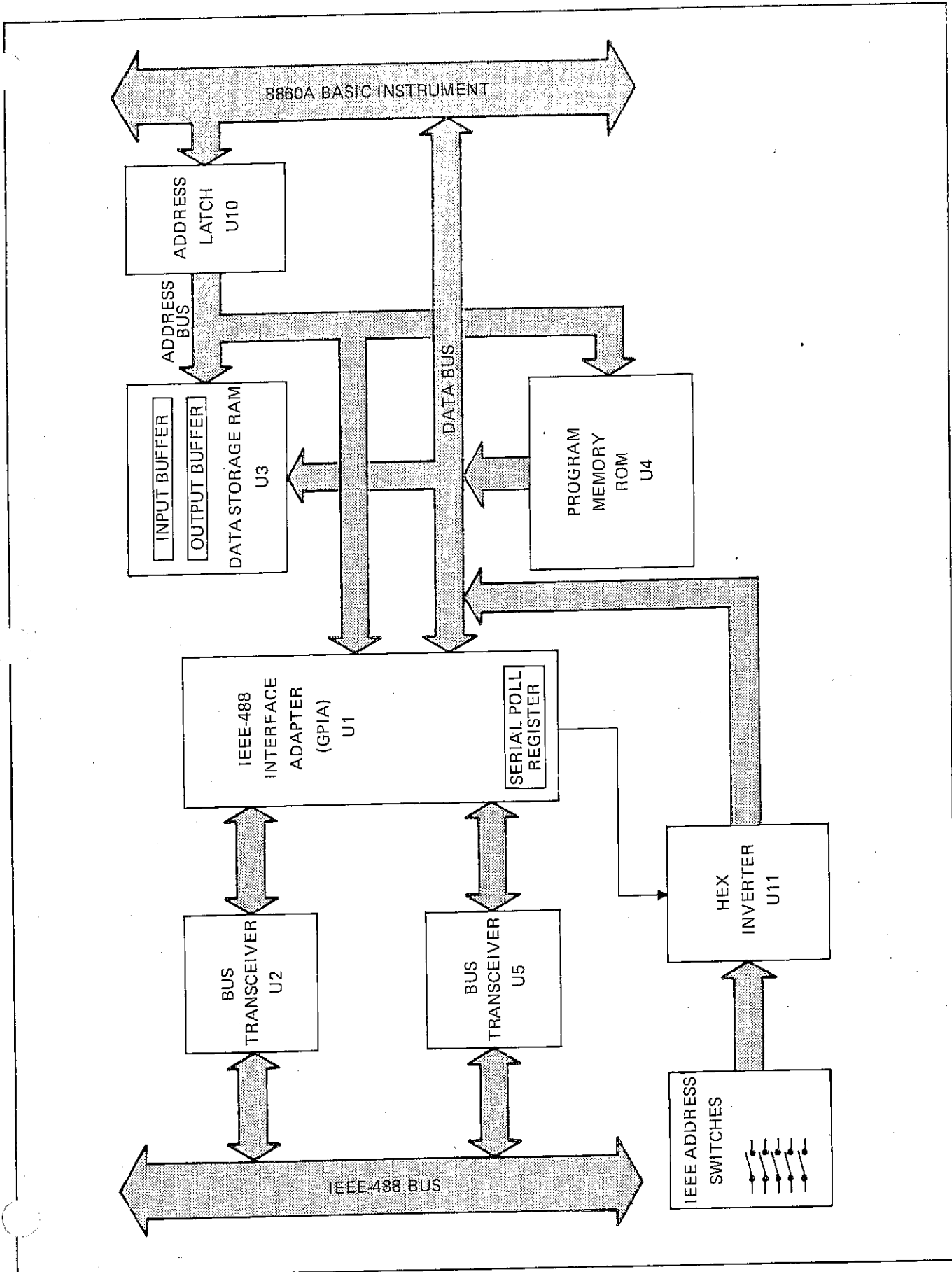
Figure 005-1. IEEE-488 Interface Block Diagram

Table 005-1. IEEE-488 Interface Troubleshooting

SYMPTOM	INSTRUCTIONS
1. Any fault—(initial check)	• Check ALE at U10-11 for 400 kHz. • Check for a high state (+5V) at U1-19 to ensure that reset is released. • Check for a high state (+5V) at U1-4 ($\overline{ASE}$, address switch enable).
2. The 8860A does not respond to front panel local controls (or IEEE-488 bus commands) when the -005 Option is installed.	• Suspect, U1, U3, U4, U6, U8, or U11. Remove these devices one at a time, until the 8860A returns to proper operation. These devices are socketed (except U11) and all sit on the internal bus.
3. The 8860A operates properly from the front panel (with the -005 Option installed), but will not respond to IEEE-488 but commands.	• Suspect U1, U3, U2, U5, U6, U8 (in that order).
4. The displayed IEEE address (using PROG SEL) is different than that selected at the rear panel IEEE switches.	• Suspect faulty IEEE address switches or U11.
5. Faulty Address Latch (U10)	• Check U10 with a dual-trace scope. Trigger the scope on ALE and look at the input and output of each bit. If ALE and the latch are working properly, then the output follows the input value when ALE is high and latches when ALE goes low.

CAUTION

To avoid instrument damage, remove power from the 8860A before unplugging the circuit board or removing plug-in devices.

005-19. LIST OF REPLACEABLE PARTS

005-20. A list of replaceable parts for the IEEE-488 Interface is given in Table 005-2. Refer to Section 5 of this manual for ordering information.

CAUTION ⚠

Indicated devices are subject to damage by static discharge.

Table 005-2. IEEE-488 Interface

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-005	IEEE-488 INTERFACE FIGURE 005-2 (8860A-005)	ORDER	BY	OPTION -005			
	IEEE-488 INTERFACE PCB ASSEMBLY	516310	89536	516310	1		
	REAR INTERCONNECT PCB ASSEMBLY	521294	89536	521294	1		
H1	HARDWARE KIT	543736	89536	543736	1		
MP1	PANEL, (SUB) IEEE INTERFACE	531020	89536	531020	1		

REAR PNL (REF)

REAR INTERCONNECT PCB

MP1

H1

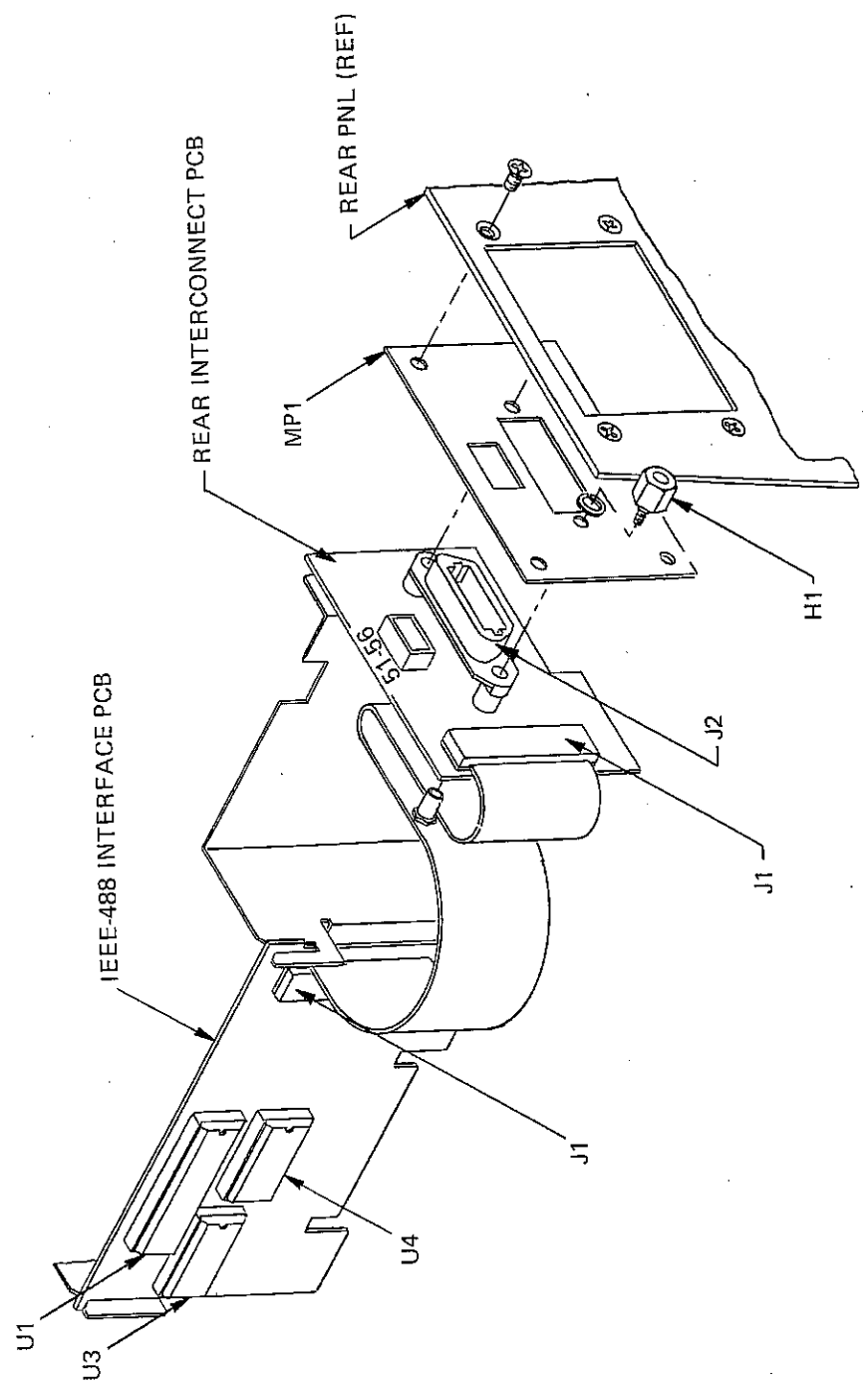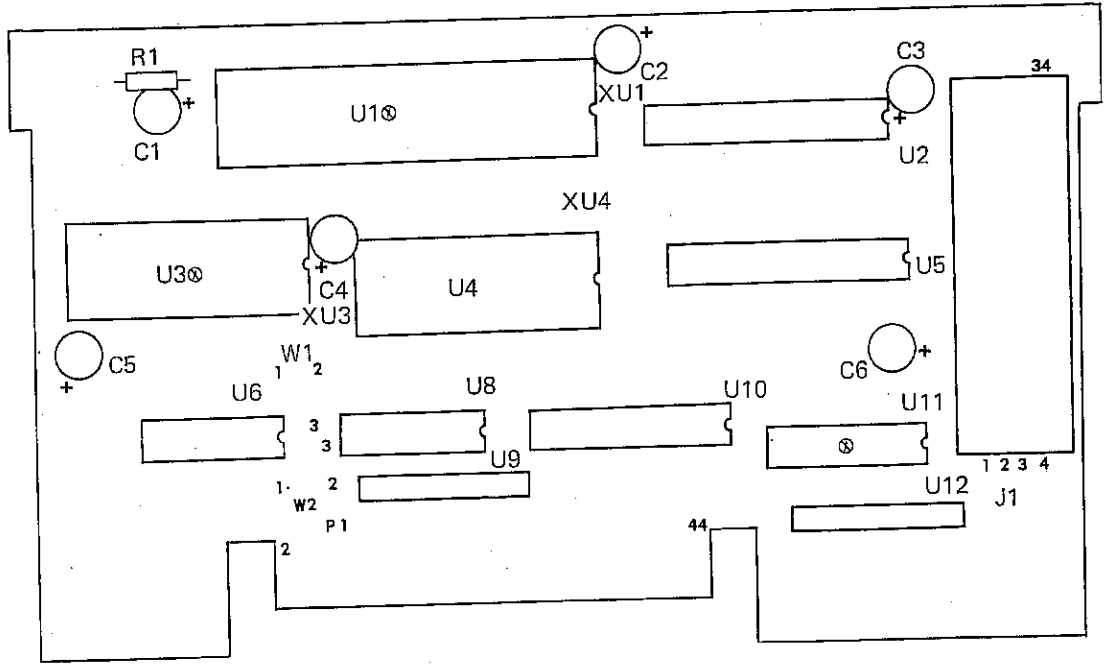IEEE-488 INTERFACE PCB

51-56

J2

J1

J1

U4

U1

U3

8860A-005

Figure 005-2. IEEE-488 Interface Assembly

Table 005-3. IEEE-488 Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	⊕IEEE-488 INTERFACE PCB ASSEMBLY FIGURE 005-3 (8860A-4015T)	516310	89536	516310	REF		
C1	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0020JA1	6		
C2	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0020JA1	REF		
C3	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0020JA1	REF		
C4	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0020JA1	REF		
C5	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0020JA1	REF		
C6	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0020JA1	REF		
J1	CONNECTOR BODY	295337	52152	3402-0000T	1		
MP1	COVER, CONNECTOR (TO J1)	295329	52152	3402-0001T	2		
MP2	MYLAR INSULATOR (NOT SHOWN)	443903	89536	443903	1		
R1	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7T	1		
U1	⊘IC, MOS, N-CHANNEL, SI	477794	04713	MC68488P	1	1	
U2	IC, BUS TRANSCIEVER, DIGITAL	524835	04713	MC3447P	2	1	
U3	⊗IC, MOS RAM, 128 X 8 BIT	524843	07263	F6810PC	1	1	
U4	IC, DIGITAL, 4K X 8 BIT, MOS ROM	535070	55576	SYP233	1	1	
U5	IC, BUS TRANSCIEVER, DIGITAL	524835	04713	MC3447P	REF		
U6	IC, POS NOR, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	1	1	
U8	IC, TTL, QUAD, 2-INPUT, POS, NAND GATE	393033	01295	SN74SL00N	1	1	
U9	RES. NETWORK, SIP, 33K +/-2%, 1/8W	484741	89536	484741	1	1	
U10	IC, TTL, OCTAL "D" TYPE F/F	504514	01295	SN74LS373	1	1	
U11	⊗IC, C-MOS, 3-STATE, INVERTER BUFFER	454819	07263	40098PC	1	1	
U12	RES. NETWORK, SIP, 4.7K +/-2%, 1/8W	412916	89536	412916	1	1	
W1	CABLE, 34 STRAND	519926	89536	519926			
XU1	SOCKET, IC, 40 PIN	429282	09922	DILB40P-108	1		
XU3	SOCKET, IC, 24 PIN	376236	91506	324-AG39D	2		
XU4	SOCKET, IC, 24 PIN	376236	91506	324-AG39D	REF		

Figure 005-3. IEEE-488 Interface PCB Assembly

CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

8860A-1615

Table 005-4. Rear Interconnect PCB Assembly

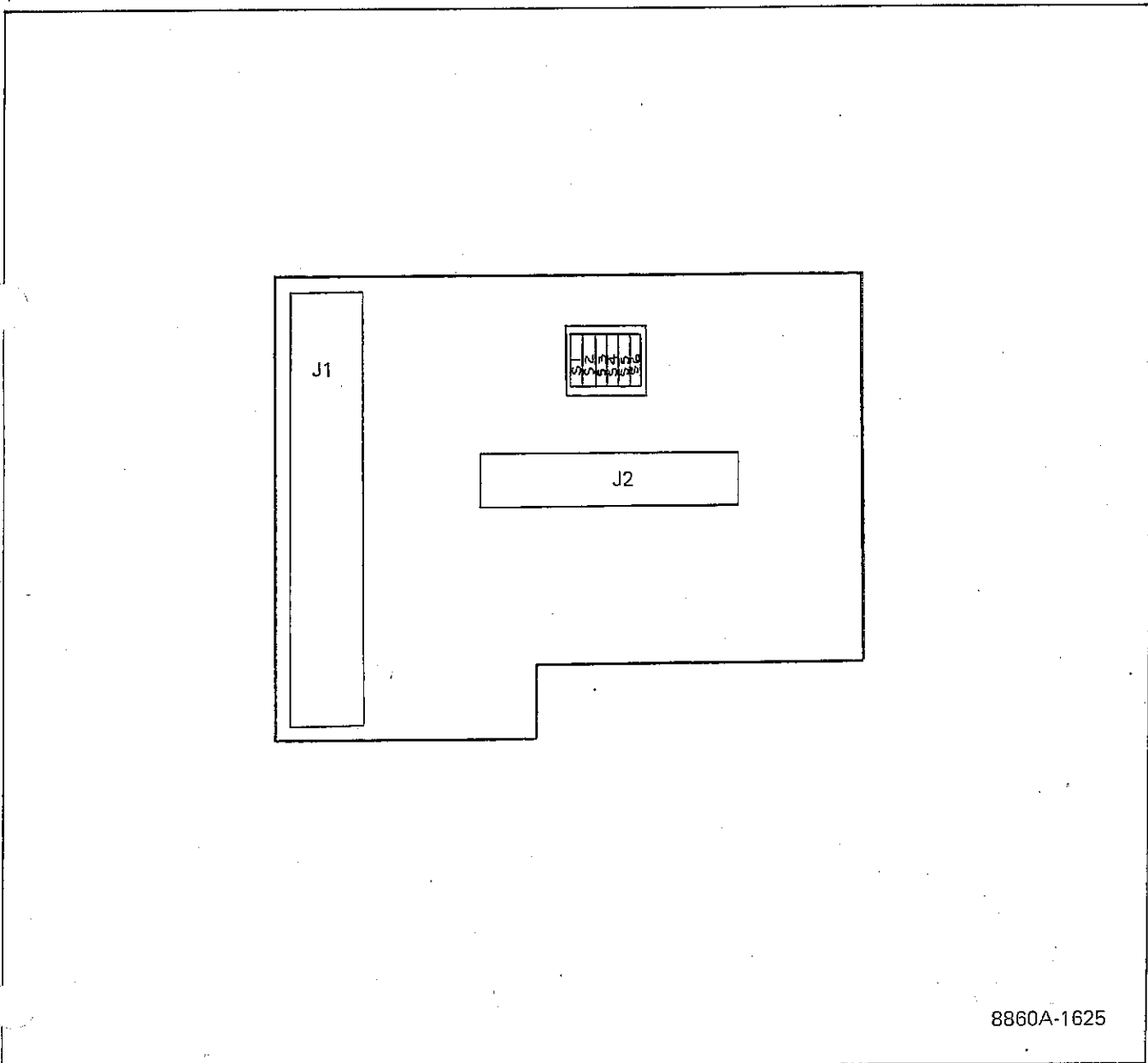| REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	N O T E
	REAR INTERCONNECT PCB ASSEMBLY FIGURE 005-4 (8860A-4025)	521294	89536	521294	REF		
J1	CONNECTOR, 34 POS	295337	52152	3402-0000T	1		
J2	CONNECTOR, 24 POS	513234	00779	552224-1	1		
S1-6	SWITCH, DIL, 6-POS, SPST, ASSY	454124	00779	435166-4	1	1	

8860A-1625

Figure 005-4. Rear Interconnect PCB Assembly

Option -006

Rear Input

006-1. THEORY OF OPERATION

006-2.   The Rear Input, Option -006, consists of a circuit board and a 20-pin connector. The circuit board mounts on the A/D and Ohms PCB. A schematic diagram for the option is shown in Figure 006-1.

006-3.   The Rear Input option electrically relocates the five INPUT terminal connections from the front panel banana jacks to a 20-pin connector mounted to the rear panel. This enables all voltage and resistance measurement connections (both two- and four-terminal) to be made at the rear panel.

006-4. TROUBLESHOOTING

006-5.   Any fault which occurs in the Rear Input connector will usually consist of either poorly soldered connections or broken wires, which can be traced visually or with an ohmmeter. The two ceramic capacitors ensure stable readings by suppressing high voltage ac crosstalk to the A/D Converter.

006-6. LIST OF REPLACEABLE PARTS

006-7.   A list of replaceable parts for the Rear Input Assembly is given in Table 006-1. Refer to Section 5 of this manual for ordering information.

REAR IMPUT OPTION PCB

REAR
INPUT
RECEPTACLE

EXT.REF $\{$ HI — — — — K
         LO — — — — L
INPUT HI — — — — S
INPUT LO — — — — E
Ω 4T HI — — — — X
Ω 4T LO — — — — B
GUARD — — — — A

PIN NO.

68 pF

68 pF

VIOLET

GRAY

TO
EXTERNAL
REFERENCE
OPTION BOARD
(IF PRESENT)

BLUE
GUARD WIRE

FASTEN TO
CHASSIS GUARD

PINS

PUSH-ON CONNECTORS
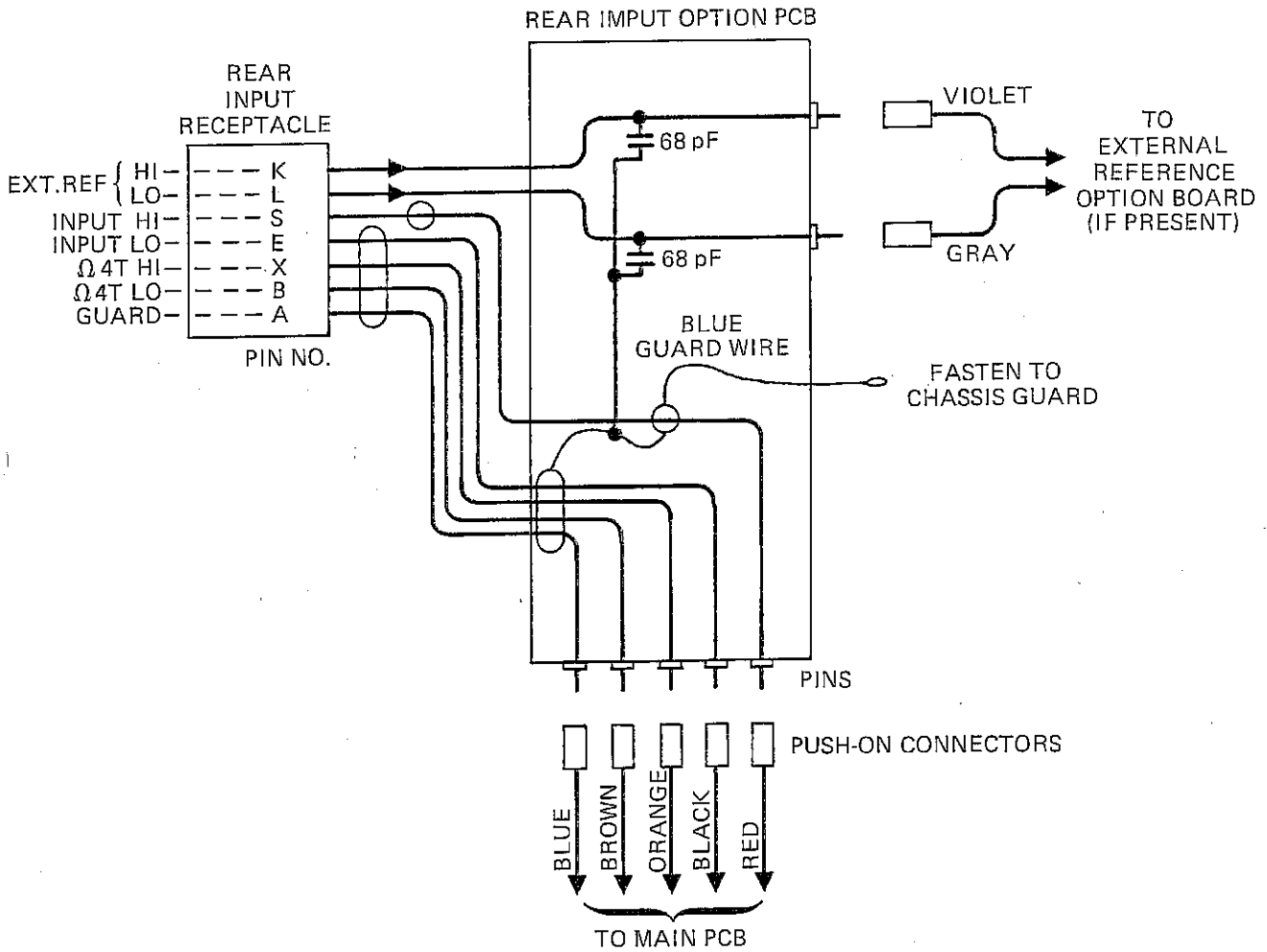
BLUE

BROWN

ORANGE

BLACK

RED

TO MAIN PCB

Figure 006-1. Rear Input Option Schematic

Table 006-1. Rear Input

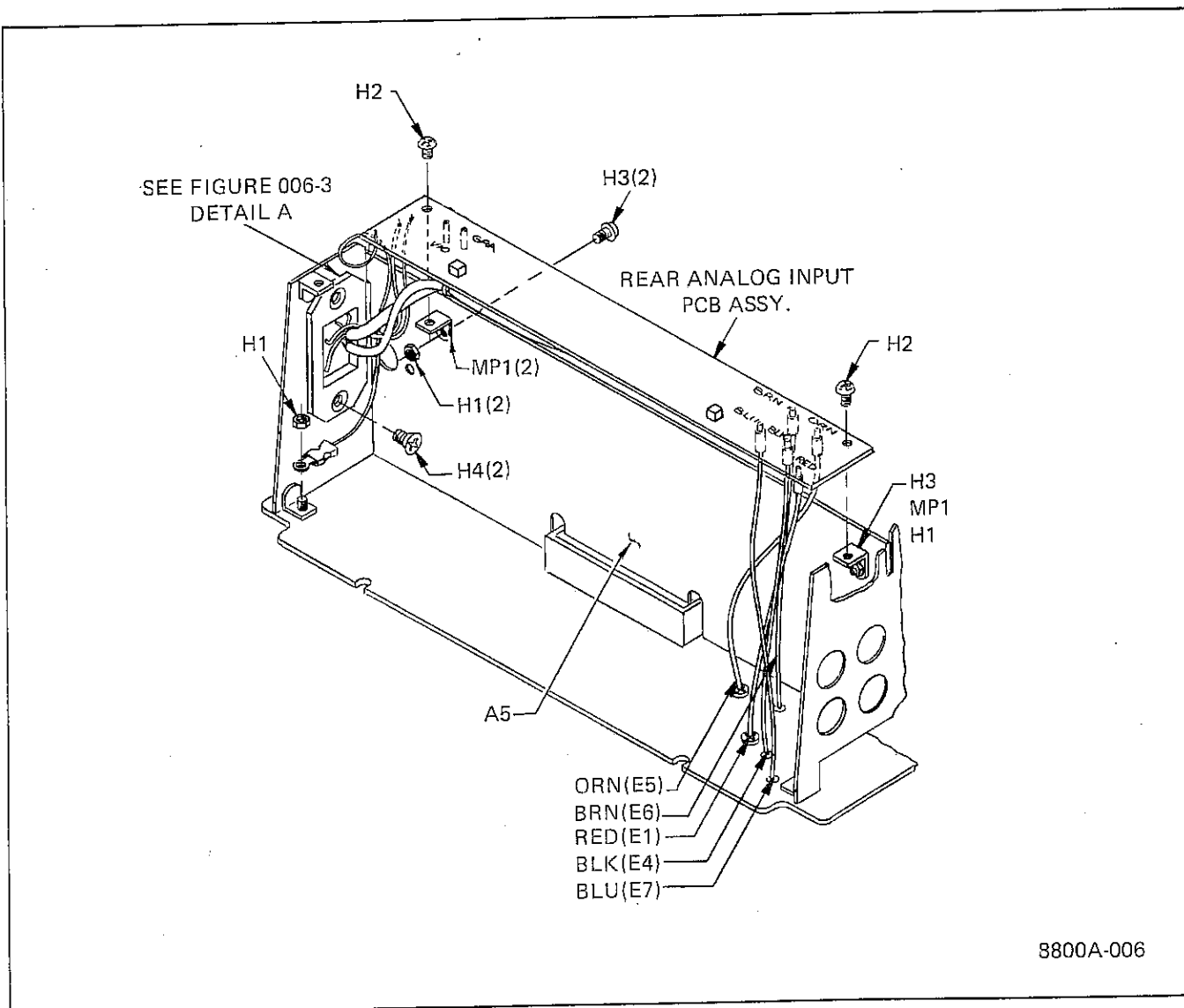| REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-006	REAR INPUT FIGURE 006-2 (8860A-006)	ORDER	BY	OPTION -006			
	REAR INPUT PCB ASSEMBLY	538264	89536	538264	1		
H1	NUT, HEX 4-40	147611	89536	147611	3		
H2	SCREW, 4-40 X 1/4 PHP	256156	89536	256156	2		
H3	SCREW, 4-40 X 3/16 PHP	149567	89536	149567	2		
H4	SCREW, 6-32 X 1/4 FH UC	320093	89536	320093	2		
KIT	HARDWARE CONNECTOR KIT	541797	89536	541797	1		
MP1	BRACKET, ANGLE 4-40	474239	89536	474239	2		

Figure 006-2. Rear Input

8800A-006

Table 006-2. Rear Input PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	N O T E
	REAR INPUT PCB ASSEMBLY FIGURE 006-3 (8860A-4027)	538264	89536	538264	REF		
C1	CAP, CER, 68 PF +/-2%, 100V	519181	71590	DD-3R3	2		
C2	CAP, CER, 68 PF +/-2%, 100V	519181	71590	DD-3R3	REF		
H1	NUT, HEX, 2-56	355453	73734	67023	2		
H2	SCREW, 2-56 X 3/4	530246	89536	530246	2		
J1	CONNECTOR 20-PIN RECEPT.	369249	91662	00-8016-020-000-707	1		
MP1	CABLE TIE	172080	06383	SST-1M	2		
MP2	RECEPTACLE PIN	529263	00779	350491-1	7		
MP3	MOUNTING BLOCK	516765	89536	516765	1		
W1	CHASSIS GROUND WIRE ASSY.	537795	89536	537795	1		
W2	WIRE ASSEMBLY - SINGLE COND.	537738	89536	537738	1		
W3	CABLE ASSY. 4-COND	537712	89536	537712	1		
W4	GRAY WIRE ASSY.	537753	89536	537753	1		
W5	VIOLET WIRE ASSY.	537704	89536	537704	1		
W6	ORANGE WIRE ASSEMBLY	537720	89536	537720	1		
W7	BLUE WIRE ASSEMBLY	537746	89536	537746	1		
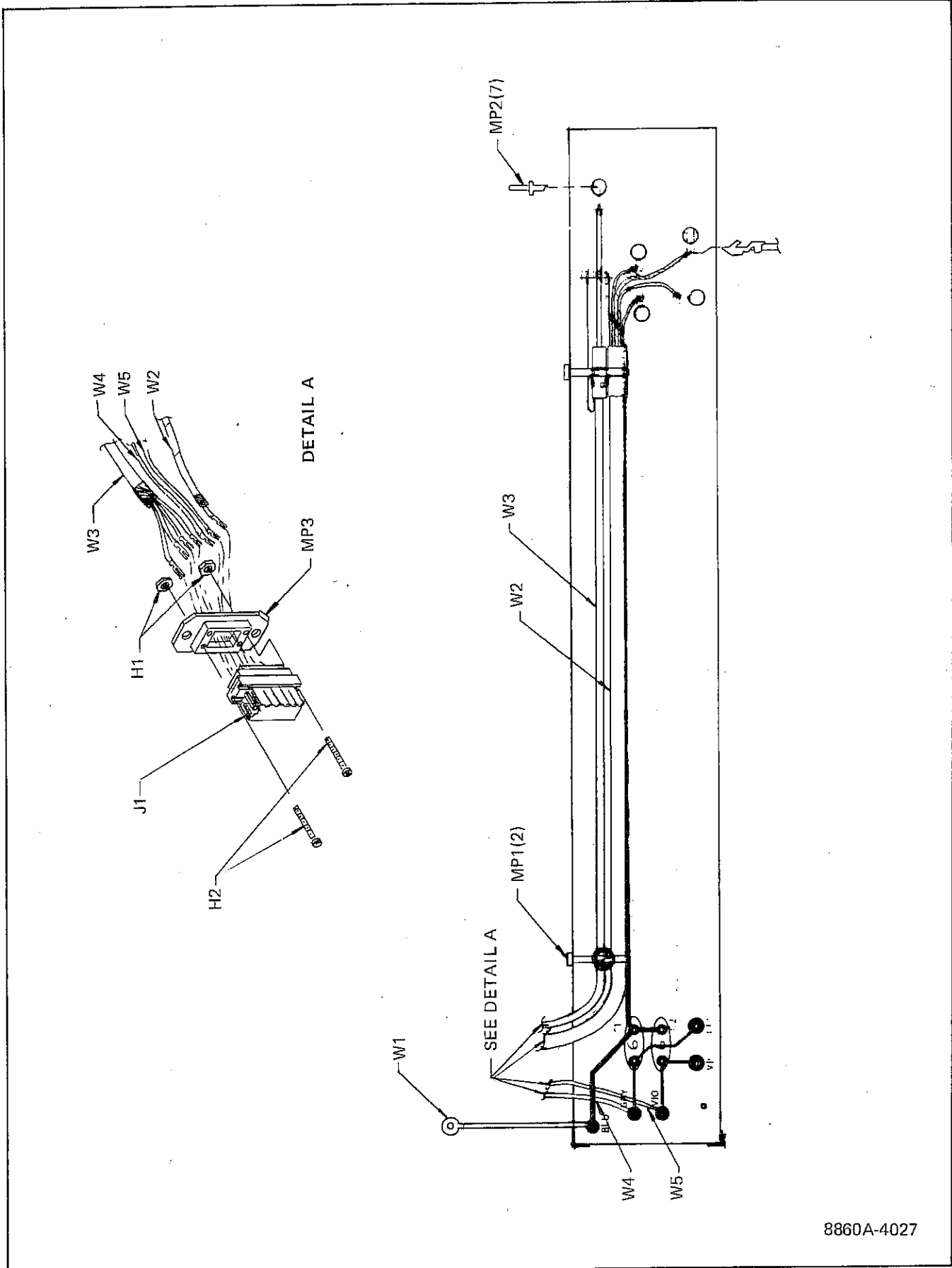
Figure 006-3. Rear Input PCB Assembly

8860A-4027

Option -007

External Reference

007-1. THEORY OF OPERATION

007-2. The External Reference, Option -007, consists of a single circuit board and a dual banana connector. The circuit board mounts on the A/D and Ohms PCB. The schematic (8860A-1016) is located in Section 8.

007-3. The External Reference is a conditioning circuit which divides an externally applied dc voltage by 10 and changes the polarity of the result. If, for example, a +10V dc signal is applied at the input, a -1V dc signal appears at the output, P1-2. The circuit contains a two-pole active Butterworth low-pass filter to give 40 dB of noise rejection at 50 Hz.

007-4. The input buffer amplifier U2 is connected with a gain of one-half in a differential-input configuration. The floating input allows the option to receive a voltage which is not ground-referenced. The output of U2 is filtered by U3, which in turn is divided by five. This is the reference voltage sent on to the A/D Converter. Precision resistor network U1 contains all of the required voltage divider networks.

007-5. Protection devices Q1 and Q2 protect against overvoltages appearing at the external reference input terminals. Variable resistor R1 helps correct for the dc offset voltages of U2 and U3. Variable resistors R4 and R5 are calibration adjustments.

007-6. When selected, the output of the external reference replaces the internal reference used to discharge the A/D integrator. The external reference polarity is detected at pin P1-5 by the in-guard microprocessor which reverses the polarity (at the A/D Converter) if necessary, in order to discharge the capacitor. Thus, the polarity is selected to be

opposite that of the applied input. Such a reversal is necessary, for instance, when the 8860A is measuring an ac voltage with a negative external reference.

007-7. Pins P1-6 and P1-7 form a shorting link to tell the in-guard microprocessor that the external reference is installed. If the option is not installed, an error message is displayed when external reference (EXT REF) is selected at the front panel.

007-8. TROUBLESHOOTING

007-9. Troubleshooting the External Reference for a failed IC is a matter of tracing the signal path. Use the A/D and Ohms Extender Card for easy circuit access.

007-10. Connect the External Reference input LO to the front panel INPUT LO. Apply a +10v dc signal at the external reference input HI. The following signals should be present on the External Reference PCB.

1. -5V dc at U2-6 and U3-6

2. -1V dc at the output, P1-2.

007-11. When a step input is applied to the External Reference, the settling time of the External Reference circuitry should not exceed 5 seconds. If either C3 or C4 is defective, the response of the external reference may be very slow.

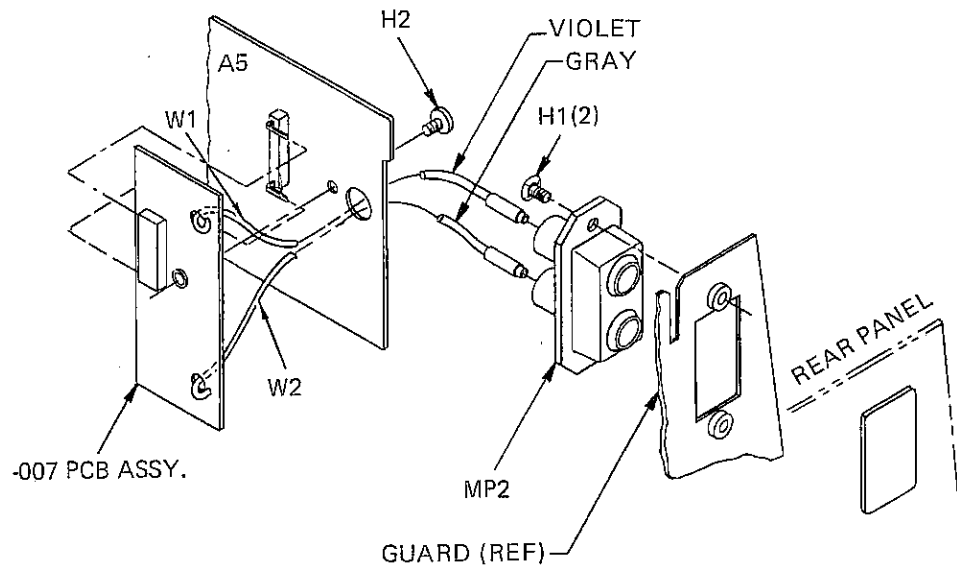## 007-12. LIST OF REPLACEABLE PARTS

007-13. A list of replaceable parts for the External Reference is given in Table 007-1. Refer to Section 5 of this manual for ordering information.

CAUTION ⊗
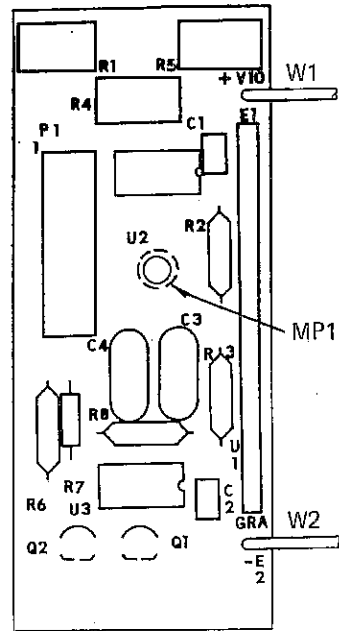**Indicated devices are subject to damage by static discharge.**

Table 007-1. External Reference

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-007	EXTERNAL REFERENCE FIGURE 007-1 (8860A-4016T)	ORDER	BY	OPTION -007			
C1	CAP, CERAM, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	2		
C2	CAP, CERAM, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	REF		
C3	CAP, MYLAR, .22 UF +/-10%, 100V	436113	73445	C280MAH/A220K	2		
C4	CAP, MYLAR, .22 UF +/-10%, 100V	436113	73445	C280MAH/A220K	REF		
H1	SCREW, FH, UC, 6-321/4	320093	89536	320093	2		
H2	SCREW, FHP/SS, 6-32 X 3/4	114504	89536	114504	1		
MP1	SPACER, CENTER	352021	89536	352021	1		
MP2	MOUNTING BLOCK	530980	89536	530980	1		
P1	CONNECTOR, 9-POSITION	519744	89536	519744	1		
Q1	XSTR, J-FET	343830	12040	NSSF50024	2	1	
Q2	XSTR, J-FET	343830	12040	NSSF50024	REF		
R1	RES, VAR, 50K +/-10%, 1/2W	288290	75378	360S-502AZ	1		
R2	RES, MTL. FILM, 150K +/-1%, 1/8W	241083	91637	CMF551503F	2		
R3	RES, MTL. FILM, 150K +/-1%, 1/8W	241083	91637	CMF551503F	REF		
R4	RES, VAR. CERMET, 1K +/-10%, 1/2W	285155	71450	360S102A	2		
R5	RES, VAR, CER, 1K +/-10%,1/2W	285155	71420	360S102A	REF		
R6	RES, MTL. FILM, 37.4K +/-1%, 1/8W	226241	91637	CMF553742F	1		
R7	RES, DEP. CAR, 1 +/-5%, 1/4W	357665	80031	CR251-4-5P1E	1		
R8	RES, MTL. FILM, 301K +/-1%, 1/8W	289488	91637	CMF553010CF	1		
U1	RESISTOR NETWORK	510990	89536	510990	1	1	
J2	IC, LIN, OP-AMP, MTL. CAN	478107	12040	308A	2	1	
J3	IC, LIN, OP-AMP, MTL. CAN	478107	12040	308A	REF		
W1	WIRE ASSEMBLY, VIOLET	538215	89536	538215	1		
W2	WIRE ASSEMBLY, GRAY	538207	89536	538207	1		

Figure 007-1. External Reference, option 007