

**FLUKE**

**MODEL 8502A**

**DIGITAL MULTIMETER**

**OPERATING AND SERVICE  
MANUAL**

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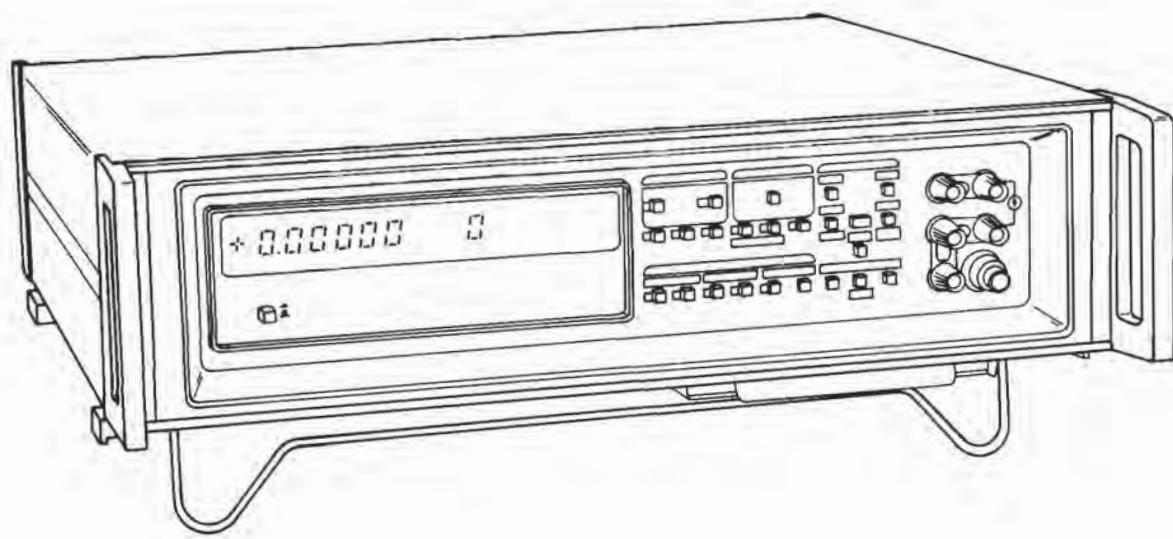
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8502A



Model 8502A Digital Multimeter

## Section 1

# Introduction & Specifications

### 1-1. INTRODUCTION

1-2. This manual comprises eight modular sections. You will find herein up-to-date information for installing, operating and maintaining the Fluke Model 8502A Digital Multimeter. Generally, complete descriptions and instructions are provided for the 8502A mainframe, modules necessary for DC Volts and DC Ratio measurement, and for any optional modules (AC Converter, Ohms Converter, etc.) that you may have ordered with your 8502A. Specifically, each section contains:

1. Section 1 — General description, specifications.
2. Section 2 — Operating instruction, capabilities.
3. Section 3 — Theory of operation, including simplified schematic and functional block diagrams.
4. Section 4 — Maintenance, adjustments and troubleshooting.
5. Section 5 — List of replaceable parts, with parts locators.
6. Section 6 — Option and accessory information, including complete information on any option ordered with the 8502A. As the need arises to broaden your 8502A's capabilities, the most recent information will be included with any options you order.
7. Section 7 — General information (list of abbreviations, federal supply codes, Service Centers, and Sales Representatives).
8. Section 8 — Schematic diagrams.

### 1-3. DESCRIPTION

1-4. The Model 8502A Digital Multimeter is a 6 1/2 digit instrument employing microprocessor control and a bus structure. Memory programming either from the front panel or through a remote interface permits a number of operations to be performed on the measured input before it is displayed. The standard configuration allows for measurement of dc volts in 5 ranges. Four ranges are available for ac volts when either optional ac converter is installed. Resistance can be measured in 8 ranges. Current can be measured in 5 ranges.

### 1-5. Modular Construction

1-6. Considerable versatility is realized through the 8502A's unique construction. All active components are contained in modules which plug into a mainframe motherboard. This module-motherboard mating, combined with bus architecture and microprocessor control, yields both ease of option selection and reduced downtime.

### 1-7. Microprocessor Control

1-8. All modules function under direct control of a microprocessor based controller. Each module is addressed by the controller as a memory location. External reference values and offsets can be applied separately, stored in memory, and automatically used as factors in all subsequent readings. Digital filtering utilizes averaged samples for each reading.

### 1-9. Recirculating Remainder A/D Conversion

1-10. The 8502A adapts Fluke's patented recirculating remainder ( $R^2$ ) A/D conversion technique to microprocessor control. This combination provides fast, accurate, linear measurements and long-term stability.

## 1-11. Options and Accessories

1-12. Remote interfaces, AC converters, a current converter and an ohms converter are among the numerous options and accessories available for the 8502A. Refer to Tables 1-1 and 1-2 for complete listings. AC conversion can be accomplished with either an ac averaging module (-01) or a true RMS module (-09A). Any one of three remote interface modules (-05, -06, -07) may be installed at one time; the isolator module (-08A) must then be installed to maintain guarding of analog and high quality busses during remote operations. Maximum interfacing with digital systems is thus realized. Calibration downtime is reduced through the use of a calibration memory module (-04); correction factors may be entered from the front panel, providing automatic correction for further measurements.

Table 1-1. 8502A Options

Option No.	Name	Notes
01	AC/DC Converter (Averaging)	1, 3
02	Ohms Converter	
03	Current Shunts	3
04	Calibration Memory	
05	IEEE Standard 488-1975 Interface	2
06	Bit Serial Asynchronous Interface	2
07	Parallel Interface	2
08A	Isolator	4
09A	AC/DC Converter (True RMS)	1, 3
16	Front-Rear Switchable Input	5
17	Rear Input	
1)	Options 01 and 09A cannot be installed simultaneously.	
2)	Only one of Options 05, 06, and 07 can be installed at any time.	
3)	For the AC portion of Option 03 to operate, either Option 01 or 09A must be installed.	
4)	Option 08A must be installed for remote operations.	
5)	Option 16 must be factory installed.	

Analog inputs from a remote position are permitted when Rear Input (Option-17) is installed. Selectable front or rear analog inputs are available with Option -16.

## 1-13. SPECIFICATIONS

1-14. Mainframe specifications with DC Volts and DC Ratio measurement capability are presented in Table 1-3. Optional function specifications are supplied with the respective option modules and included in Section 6. The table of specifications presented here is divided into three parts:

1. General Specifications.
2. Accuracy.
3. Instrument Operating Characteristics.

Table 1-2. 8502A Accessories

Model or Part No.	Name
M04-205-600	Rack Ear Mounting Assembly
M00-260-610	18-inch Rack Slides
M00-280-610	24-inch Rack Slides
80F-5	High Voltage Probe
80F-15	High Voltage Probe
81RF	High Frequency Probe
82RF	High Frequency Probe
KDM1	Keyboard Display Module w/Cable
Y8001	IEEE Std. Cable, 1 Meter Length
Y8002	IEEE Std. Cable, 2 Meter Length
Y8003	IEEE Std. Cable, 4 Meter Length
MIS-7011K*	Extender Assembly
MIS-7190K*	Static Controller
MIS-7191K*	Test Module
MIS-7013K*	Bus Interconnect and Monitor

\*For use during service or repair

Table 1-3. Specifications

GENERAL SPECIFICATIONS								
DIMENSIONS			TEMPERATURE RANGE					
H            L            W			Operating	0°C to 50°C				
cm	10.8	x	42.5	x	43.2			
Inches	4.25	x	16.75	x	17			
WEIGHT			Non Operating	-40°C to 70°C*				
Basic            Fully Loaded			*0°C to 50°C operating and non-operating with calibration memory option (-04) installed.					
kg	9.1							
Lbs	20							
10.92			HUMIDITY RANGE (Operating to Full Accuracy)					
24			0°C to 18°C	80% RH				
OPERATING POWER			18°C to 40°C	75% RH				
Basic Instrument 12 watts 115V ac or 230V ac ±10%			40°C to 50°C	60% RH				
Fully Loaded 24 watts 50-60 Hz			OVERLOAD					
WARM-UP			LO to Guard	127V max				
2 hours to rated accuracy			Guard to Chassis	1000V max				
SHOCK AND VIBRATION			HI Sense to HI Source	127V max				
Meets requirements of MIL-T-28800 for Class 5 style E equipment.			LO Sense to LO Source	127V max				
			HI Sense to LO Sense	1000V max				
			HI Source to LO Source	280V max				
ACCURACY								
<i>Note</i> The stated accuracies are valid under the following environmental conditions. Temperature: 18°C to 28°C (Except 24 hour: 22°C to 24°C) Humidity: ≤75% Line Regulation: 90V to 110V, 103.5V to 126.5V, or 207V to 253V @ 45 to 66 Hz								
DC Volts	Normal Resolution (5 1/2 digits)							
	Range	Full Scale	Resolution	Accuracy ± (% of Input + Number of Digits)				
				24 Hours	90 Days			
				1 Year				
100 mV	312 mV	1 uV	0.002 + 4	0.003 + 5				
1 V	2.5 V	10 uV	0.001 + 1	0.002 + 1				
10 V	20 V	100 uV	0.001 or 1*	0.001 + 1				
100 V	160 V	1 mV	0.001 + 1	0.004 + 1				
1000 V	1200 V	10 mV	0.001 + 1	0.004 + 1				
*Whichever is greater.								

Table 1-3. Specifications (cont)

ACCURACY (Continued)						
DC Volts (Continued)	High Resolution ( HI RES or CAL - 6 1/2 digits)					
	Range	Full Scale	Resolution	Accuracy $\pm$ (% of Input + Number of Digits)		
				24 Hours	90 Days	1 Year
	1 V	2.5 V	1 $\mu$ V	0.001 + 6	0.002 + 8	0.004 + 9
	10 V	20 V	10 $\mu$ V	0.0006 or 6*	0.001 + 8	0.002 + 9
	100 V	160 V	100 $\mu$ V	0.001 + 6	0.002 + 8	0.004 + 9
	1000 V	1200 V	1 mV	0.001 + 6	0.002 + 8	0.004 + 9
<i>*Whichever is greater.</i>						
DC Ratio	Ext. Ref. Voltage			Accuracy		
	$\pm 20V$ to $\pm 40V$			$\pm(A + B + 10 \text{ ppm})$		
	$\pm V_{\min}^*$ to $\pm 20V$			$\pm \frac{A + B + 200 \text{ ppm}}{ V_{xref} }$		
<i>A = 10V dc Range Accuracy</i> <i>B = Input Signal Function and Range Accuracy</i> <i><math>V_{\min}</math> = Minimum Allowable External Reference Voltage</i> <i><math> V_{xref} </math> = Absolute Value of External Reference Voltage</i>						
<i>*The formula for determining <math>V_{\min}</math> is included in Instrument Operating Characteristics</i>						
Example Calculations for External Reference Accuracy: (90 days, 5½ digits)						
1. Input = $+ 90.000V$ , Ext. Ref. Input = $30.000V$ ( $+ 15V$ to Ext. Ref. HI, $-15V$ to Ext. Ref. LO) A = .001% + 1 Digit      B = .001% + 1 Digit Ratio Accuracy = $\pm(A + B + 10 \text{ ppm}) = \pm(.001\% + 1 \text{ Digit} + .001\% + 1 \text{ Digit} + .001\%) = \pm(.003\% + 2 \text{ Digits})$ Reading may be between 3.0003 and 2.9997						
2. Input = $1.20000V$ ,      Ext. Ref. Input = $.12000 (V_{\min} \text{ for } 1V \text{ Range})$ A = .001% + 1 Digit,      B = .001% + 1 Digit, $\frac{200 \text{ ppm}}{ V_{xref} } = \frac{.02\%}{.12} = .1667\%$ Ratio Accuracy = $\pm(.001\% + 1 \text{ Digit} + .001\% + 1 \text{ Digit} + .1667\%) = \pm(.1687\% + 2 \text{ Digits})$ Reading may be between .998313 and 1.001686.						
INSTRUMENT OPERATING CHARACTERISTICS						
DC Volts	TEMPERATURE COEFFICIENT ( $0^\circ\text{C}$ to $18^\circ\text{C}$ and $28^\circ\text{C}$ to $50^\circ\text{C}$ )		INPUT IMPEDANCE			
	Range	Temperature Coefficient	Range	Input Impedance		
	100 mV	$\pm(3 \text{ ppm}/\text{reading} + 0.5 \text{ digit})/\text{ }^\circ\text{C}$	100 mV	$> 10,000$	M $\Omega$	
	1V	$\pm(3 \text{ ppm}/\text{reading} + 0.1 \text{ digit})/\text{ }^\circ\text{C}$	1V	$> 10,000$	M $\Omega$	
	10 V	$\pm(2 \text{ ppm}/\text{reading} + 0.05 \text{ digit})/\text{ }^\circ\text{C}^*$	10 V	$> 10,000$	M $\Omega$	
	100 V	$\pm(3 \text{ ppm}/\text{reading} + 0.1 \text{ digit})/\text{ }^\circ\text{C}^*$	100 V	10	M $\Omega$	
	1000 V	$\pm(3 \text{ ppm}/\text{reading} + 0.05 \text{ digit})/\text{ }^\circ\text{C}^*$	1000 V	10	M $\Omega$	
<i>*For High Resolution Multiply Digits by 10.</i>						
INPUT BIAS CURRENT						
Bias Current	At time of Cal	30 Days ( $23^\circ\text{C} \pm 1^\circ\text{C}$ )	Temperature Coefficient			
	$< \pm 5 \text{ pA}$	$< \pm 50 \text{ pA}$	$\pm 3 \text{ pA}/\text{ }^\circ\text{C}$			

Table 1-3. Specifications (Cont)

INSTRUMENT OPERATING CHARACTERISTICS (Continued)						
DC Volts (Continued)	RESPONSE TIME					
	Digitizing Time		Analog Settling Time Within Voltmeter			
	Reading Rate *		Digitizing Time	Filter Mode	Step Input to 0.01% of Change	Step Input to 0.001% of Change
	50 Hz line	4 Samples/Rdg	22 ms	Filter, Fast	40 ms	50 ms
		32 Samples/Rdg	162 ms	Bypass	2 ms	20 ms
		128 Samples/Rdg	642 ms	Bypass	2 ms	20 ms
	60 Hz line	4 Samples/Rdg	18 ms	Filter, Slow	400 ms	500 ms
		32 Samples/Rdg	136 ms	Bypass	2 ms	20 ms
		128 Samples/Rdg	546 ms	Bypass	2 ms	20 ms
*Number of samples per reading is programmable from 1 ( $2^0$ ) to 131,072 ( $2^{17}$ ) in 18 binary steps.						
ZERO STABILITY				OVERLOAD		
Better than 5 $\mu$ V for 90 days after a one hr. warm-up. Front Panel pushbutton auto zero is provided. The zero correction is stored in memory until power is interrupted or the 8502A is RESET. If calibration memory Option -04 is installed, the zero correction is retained.				$\pm 1200$ V DC, 1200V peak to 60 Hz, or 1400V peak above 60 Hz may be applied continuously to any dc range without permanent damage. Maximum common mode rate of voltage rise is 1000V/ $\mu$ sec.		
NOISE REJECTION						
Normal Mode				Common Mode		
Line/Filter Frequency	4 Samples/Rdg	32 Samples/Rdg	128 Samples/Rdg	True	Effective	
50 Hz Fast Filter	60 dB	70 dB	75 dB	100 dB at 60 Hz for 1 K $\Omega$ unbalance	Sum of Common Mode Rejection and Normal Mode Rejection	
50 Hz Slow Filter	85 dB	90 dB	95 dB			
60 Hz Fast Filter	60 dB	70 dB	75 dB			
60 Hz Slow Filter	90 dB	95 dB	100 dB			
128 SAMPLES/READING						
Typical Performance with 60 Hz Line (Combined digital and analog filtering)						
Cusps shown are at multiples of 60 Hz line frequency. Similar cusps (not shown) occur every 7½ Hz.						
----- Slow Filter ——— Fast Filter						

Table 1-3. Specifications (Cont)

INSTRUMENT OPERATING CHARACTERISTICS (Continued)					
DC Ratio	INPUT IMPEDANCE		SOURCE IMPEDANCE		
	Ext Ref HI or LO > 10,000 MΩ relative to Ohms Guard* or Sense LO		Resistive Unbalance (Ext Ref HI to LO) < 4 kΩ Total Resistance Sense LO from either HI or LO < 20 kΩ		
BIAS CURRENT		OVERLOAD (Ext Ref HI or LO)			
Ext Ref HI or LO relative to Ohms Guard* or Sense LO < 5 nA		± 180 volts peak, 127V rms (relative to Ohms Guard* or Sense LO) X (360V peak HI to LO)			
<i>* Ohms Guard available through rear input (-16 or -17 Option)</i>					
NOISE REJECTION					
Normal Mode		Common Mode, All Inputs Driven			
Sense Input—Same as dc volts		Sense Input—Same as dc volts			
Ext Ref Input—dc, line frequency and 2x line frequency > 100 dB		Ext Ref Input—Line frequency and 2x line frequency, 75 dB			
RESPONSE TIME					
Setting Time	Sense Input				
	Line Volt	Approx. Rdg. Rate	Digitizing Time		
Digitizing Time  <i>NOTE</i> <i>The Sense Input is measured prior to measuring Ext Ref HI and LO.</i>	60 Hz	4½ rdg/s 1½ rdg/s	136 ms 536 ms		
	50 Hz	3½ rdg/s 1¼ rdg/s	162 ms 642 ms		
Ext Ref Input—Each input HI and LO  90 ms at 60 Hz line frequency 107 ms at 50 Hz line frequency  Ext Ref Calibration—12 ms	60 Hz	4 samples/rdg	18 ms		
	50 Hz	4 samples/rdg	22 ms		
EXT REF VOLTAGE RANGE					
Maximum Ext Ref Voltage = ± 40V between Ext Ref HI and LO terminals, providing neither terminal is greater than ± 20V relative to the Sense LO or Ohms Guard terminals.					
Minimum Ext Ref Voltage = ± 0.0001V, or $\frac{V_{\text{input}}}{10^9}$ (whichever is greater)					
MAXIMUM DISPLAY—Ratio, Scaling or Offset Mode = ± 1.00000 × 10 <sup>9</sup> in all Ranges					

## Section 2

# Operating Instructions

### 2-1. INTRODUCTION

2-2. Installation and operation of the 8502A Digital Multimeter are explained in this section. The 8502A's full capabilities may be realized by thoroughly reading and understanding these operating instructions. Explanations and applications are provided for all standard functions and operations. Read them. Should any difficulties arise, contact your nearest Fluke Sales Representative (list in Section 7), or the John Fluke Mfg. Co., Inc. (P.O. Box C9090, Everett, Wa., 98206; tel. (206) 342-6300).

### 2-3. SHIPPING INFORMATION

2-4. The 8502A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included with the shipping container.

2-5. If reshipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

### 2-6. INSTALLATION

2-7. Non-marring feet and a tilt-down bail are installed on the instrument for field or bench use. A rack-mounting kit and rack slides are available for use with standard 19-inch equipment racks. Information regarding installation or rack-mounting accessories is contained in Section 6.

2-8. The 8502A operates from either 115V ac  $\pm 10\%$  or 230V ac  $\pm 10\%$ , 50 or 60 Hz (10% tolerance translates to high and low limits of: 103.5 to 126.5V ac, 207 to 253V ac).

### WARNING

TO AVOID ELECTRICAL SHOCK, PROPERLY GROUND THE CHASSIS. A GROUND CONNECTION IS PROVIDED IN THE THREE-PRONG POWER CONNECTOR; IF PROPER GROUND IN YOUR POWER SYSTEM IS IN DOUBT, MAKE A SEPARATE GROUND CONNECTION TO THE REAR PANEL CHASSIS BINDING POST. OTHERWISE, THE POSSIBILITY OF ELECTRICAL SHOCK MAY EXIST IF HIGH VOLTAGE IS MEASURED WITH THE LEADS REVERSED (INPUT HI GROUNDED).

### 2-9. OPERATING FEATURES

2-10. Display, control, and terminal locations on the 8502A can be found in Figure 2-1. Table 2-1, will then detail respective functions. In addition, a convenient set of condensed operating instructions is provided under the instrument's front right side. Just pull out the tab.

### 2-11. OPERATING NOTES

#### 2-12. Input Power

2-13. A binding post on the rear panel has been provided as an earth ground connection. Power supply switching (115V or 230V ac) is explained in Section 4. With the exception of slower reading rates and filter time outs, operation at 50 Hz is identical to that at 60 Hz.

2-14. The line fuse (.5A MDL Slow Blow) is located on the rear panel, near the heatsink. The current protection fuse (1.5A AGC) is located in the lower right-hand corner of the front panel.

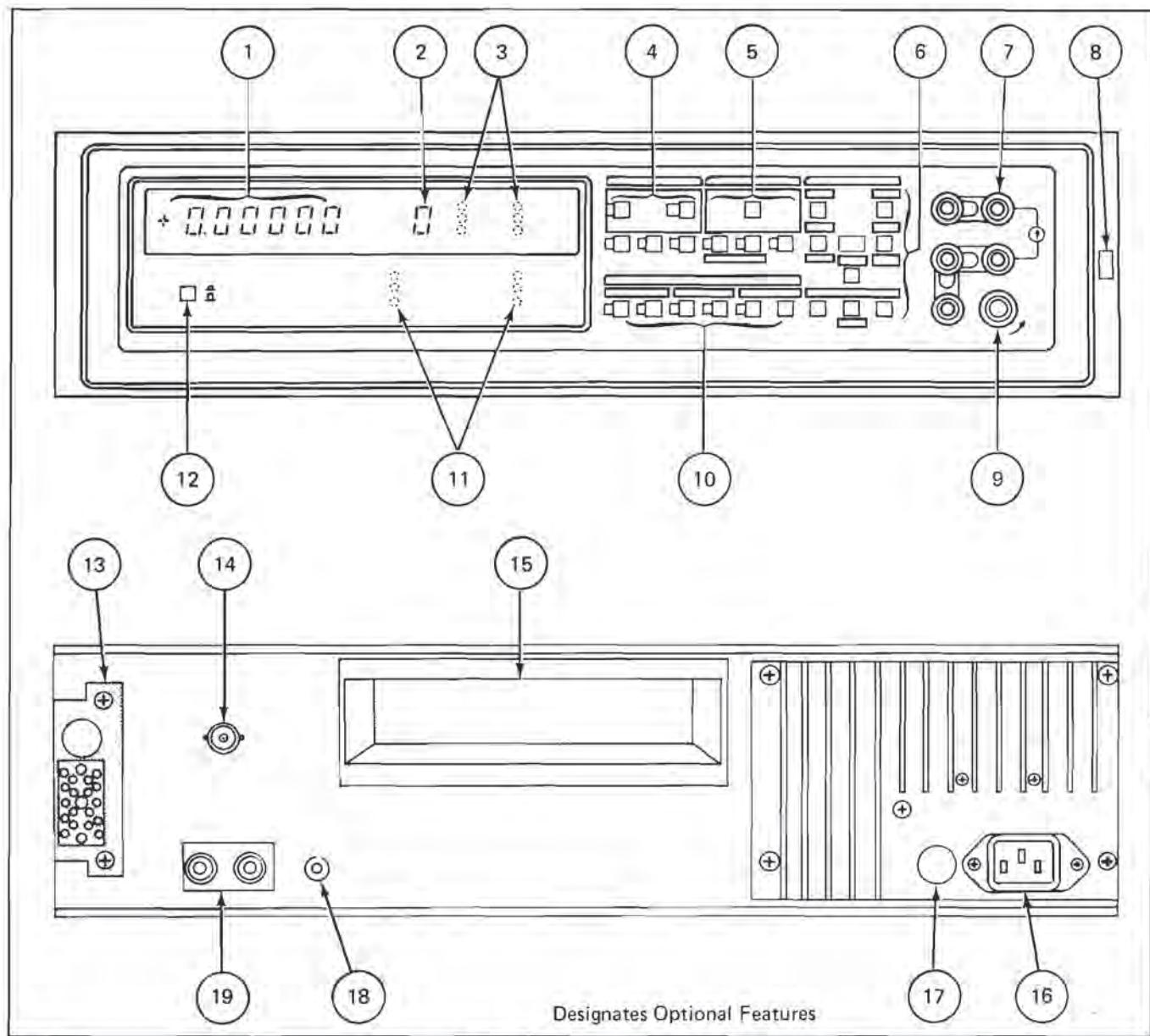


Figure 2-1. 8502A Controls and Indicators

Table 2-1. 8502A Controls and Indicators

REF. NO.	NAME	FUNCTION
1	Digit Display	Displays 5 1/2 digits with polarity and properly positioned decimal point. When instrument is in Hi Res mode, the exponent display will be used as an extra digit (for 6 1/2 digits).
2	Exponent Display	Displays polarity and value of exponent for engineering notation.
3	Range and Function Indicators	LED's illuminate to identify function and autoranging selection.
4	FUNCTION Controls	Push to select volts (VDC, VAC), current (A DC, A AC), or OHMS. Serve as dual function controls for numeric entries.

Table 2-1. 8502A Controls and Indicators (cont)

REF. NO.	NAME	FUNCTION
5	RANGE Controls	Manually shift range up or down. Enter high resolution mode. Select auto or manual ranging. Recall (HI, LO) peak or limit. Store (HI, LO) limit values. Serve as dual function controls for numeric entries.
6	MEMORY Controls	Toggle into/out of LIMITS, PEAK, CAL, OFFSET or SCALING. RECALL Memory values. Manual TRIGGER, STORE applied values, numerics. ENTER or clear (CE) numerics.
7	INPUT Terminals	SENSE INPUT HI and LO for volts, ohms, INPUT SOURCE HI and LO for amps, ohms. Guard Current protection fuse. GUARD.
8	(REAR INPUT IN)	Optional (-16)
9	Current Fuse	Use AGC 1.5A
10	MODIFIER Controls	RESET RESUME REMOTE EXT REF FILTER SAMPLE Numerics
11	Status Display	LED's light for: Slow filter Sample (flashes at reading rate) SCALING selected REMOTE selected OFFSET selected PEAK selected LED's flash if CAL or EXT REF selected
12	Power Switch	Push on/Push off
13	(Rear Input Connector and Fuse)	Optional connections for remote input and external reference terminals (-16, -17).
14	(External Trigger Input)	Optional (-08A)
15	(Interface Connectors and Switches)	Optional remote interface module accessible in this area (-05, -06, -07)
16	Power Connector	Three-prong connector accepting line cord with ground wire.
17	Line Fuse	Use MDL .5A (slow blow).
18	Chassis Ground	Binding post for ground interconnections.
19	External Reference Terminals	Apply external reference voltage. (40V max between HI and LO).

**2-15. Display****NOTE****2-16. DESCRIPTION**

2-17. The 8502A's display consists of a digit readout, exponent, and LED annunciators for indication of instrument function and status. Specifically, these features provide:

1. 5 1/2 or 6 1/2 digit display with polarity, automatic reading and decimal placement.
2. Exponent display with polarity for readings in engineering notation. Serves as an extra digit of resolution in Hi Res and Cal modes.
3. Function and autoranging indicators light for function selected and for autoranging.
4. Status indicators give a constant illumination to signify selection of REMOTE, OFFSET, PEAK, SCALING, slow FILTER. Dual function LED's will flash to indicate selection of CAL or EXT REF. SAMPLE LED will flash at the reading rate selected (with more than 128 samples per reading, the LED will flash at the same rate to denote a reading in progress).
5. Power ON LED.

**2-18. WARNING INFORMATION**

2-19. The digit and exponent displays will provide warning indications and error codes.

1. "HHHHHH" will flash at the reading rate if the input voltage exceeds the full scale value for the range selected. Full scale values are included with the specifications in Section 1.
2. "H" will flash in the exponent display should an input voltage greater than 40V occur when in the Scaling, External Reference or Offset modes.
3. These flashing indications will not be seen when in the Cal mode.

**NOTE**

*Flashing indicators in the digit or exponent display are a warning only; they have no effect on instrument operation.*

4. Error codes will be provided in the digit and exponent displays when appropriate. Consult Table 2-2 for applicable meanings.

*Error codes will not be displayed in Cal mode. Random readings will then be the only indication of an invalid function or faulty module.*

**Table 2-2. Error Codes**

CODES	FAULT
Error	System error — if this error message appears prior to the introductory messages at power initialization or reset, the problem is with the calibration memory module.
Error 0	VDC/Ohm Zero Error — either a VDC/Ohm Zero was attempted in a range other than 100 mV or 10 ohms, or an overrange was entered.
Error 1	Store during overload condition attempted.
Error 2	Filter module error — the module is faulty or not installed.
Error 3	DC Signal Conditioner error — the module is faulty or not installed.
Error 4	Ohms or Current error — excessive voltage applied to the selected module, shorting links not properly connected, or the selected module is faulty.
Error 5	R <sup>2</sup> A/D error — the recirculating remainder analog to digital converter module is faulty or not installed.
Error 6	Numeric display overflow error.
Error 7	External Reference error — the magnitude of one of the external reference inputs is greater than 20V dc.
Error 8	Controller error — the module is faulty or not installed.
Error 9	Function Selection error — the function module selected, other than dc volts, is faulty or not installed.
Error C	Invalid switch sequence during Recall or Store operations.

**2-20. SPECIAL CONSIDERATIONS****2-21. Cal**

2-22. Use of the Cal mode will significantly change normal display indications. As noted above, no warning indications will be displayed. Further, the exponent display will now serve as an extra digit of resolution (yielding 6 1/2 digit resolution).

**2-23. Hi Res**

2-24. The exponent display will be used as an extra digit of resolution in the High Resolution mode (not used in the 100 mV or 100 uA ranges). No exponent will be displayed.

Although not visible in Hi Res, the exponent remains in effect; care should be exercised when interpreting readings. To avoid confusion, remember that an exponent in the exponent display will always have its own polarity sign; a high resolution digit will not.

## 2-25. Input Terminals

### 2-26. TERMINAL INTERCONNECTIONS

2-27. For dc voltage measurements, both INPUT HI terminals may be left strapped together. The INPUT LO terminals may likewise remain strapped. For most measurements, it is sufficient to strap GUARD to INPUT LO. Refer to Figure 2-2, for recommended input terminal strapping.

#### CAUTION

The guard terminal should not be left disconnected. Instrument damage can occur if common mode voltage exceeds the LO to GUARD maximum voltage rating (127V).

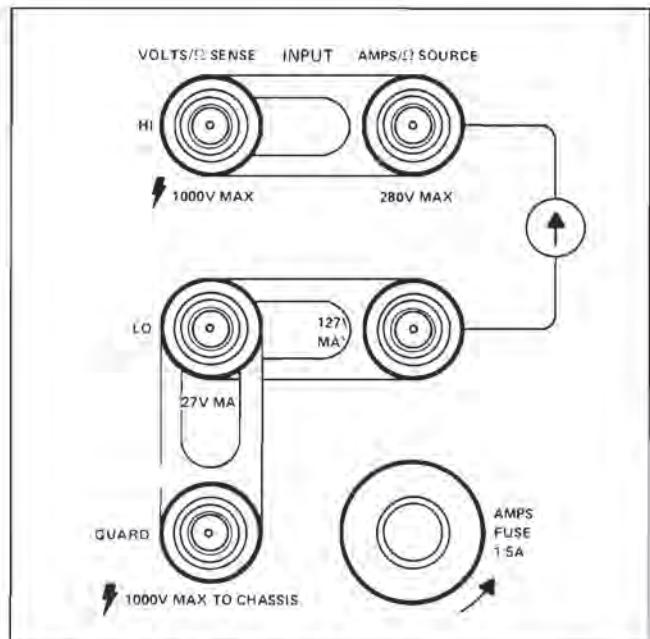


Figure 2-2. Front Panel Terminal Interconnections

## 2-28. GUARDING

2-29. Common mode voltages, resulting from currents and voltage drops between two points otherwise electrically common, may produce significant errors. Proper use of a floating, guarded voltmeter will minimize these errors and allow representative reading of normal mode voltages (actual source voltage and noise).

2-30. Correct use of the 8502A's guard terminal will both protect the instrument and provide more accurate readings. Since the LO to GUARD maximum voltage rating is 127V, the guard terminal should always be connected either to the INPUT LO terminal or to a point in the source circuit to be measured. For accurate readings, connect the guard to minimize common mode currents flowing through any resistance which helps determine the voltage being measured. See Figure 2-3, for suggested guard connections.

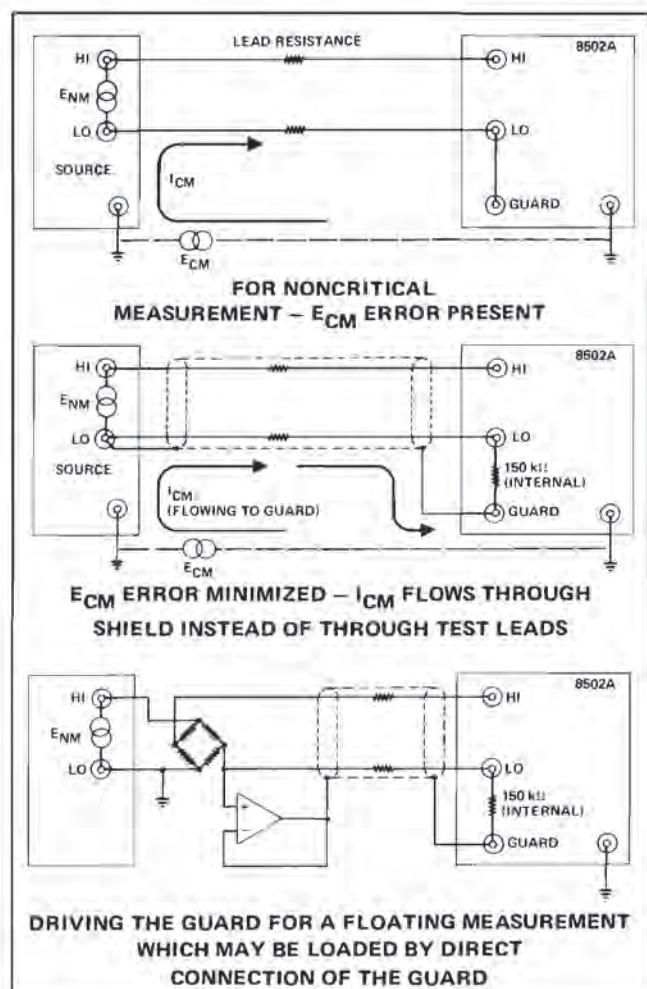


Figure 2-3. Guard Connections

2-31. Generally, guarding should be used in the following situations:

1. When long signal leads are used.
2. When signal source impedance is high.
3. When making measurements near high-level radiated noise, particularly at the power line frequency.
4. When making floating measurements.

**NOTE**

*Errors due to thermal EMF's should be considered when making low level, high resolution measurements. Thermal EMF's (voltages produced by temperature differences between contacts of two dissimilar metals or by temperature gradients along a length of material) may cause differences in potential of several microvolts. Since the 8502A utilizes gold-plated input terminals, the use of low EMF, shielded cables with gold-plated spade lugs will minimize thermal EMF errors.*

**2-32. Front Panel Controls**

2-33. Most front panel controls are momentary contact switches. If held in continuously, such switches will be read only one time. In addition, some of these switches will hold a particular reading in the 8502A's display for as long as they are held depressed. Front panel switches may have 1, 2, or 3 functions; switch sequencing will determine which function is in effect for multi-function switches. Refer to "OPERATING DIRECTIONS" later in this section for detailed front panel control procedures.

**2-34. Function**

2-35. The DC volts function is standard with this instrument; optional modules must be included for all other functions. Complete information for any options included with your 8502A can be found in Section 6 of this manual. If a function is selected for which the appropriate module is not installed, "Error 9" will appear in the display.

**2-36. Range**

2-37. DC volts can be measured on five successive ranges from 100 mV to 1000V. Respective resolutions vary from 1 uV to 1 mV. Input impedance on the 100V and 1000V ranges is 10 Mohms. On the lower three ranges it is greater than 10,000 Mohms. Overrange capabilities, DC voltage accuracies, and overload protection conditions are detailed in Section 1 of this manual.

**2-38. Modifiers**

- 2-39. FILTER
- 2-40. The 8502A has five filter modes.
  - 1. F – slow filter, no time out – FILTER LED on.
  - 2. F0 – fast filter, no time out.
  - 3. F1 – filter bypass.
  - 4. F2 – slow filter, with time out (550 msec, settling time) – FILTER LED on.

- 5. F3 – fast filter, with time out (50 msec, settling time).

("Fast" and "slow" refer to the respective filter's settling time.)

2-41. The slow filter will provide better line frequency rejection; the fast filter discriminates against higher frequency and harmonically related line noise. Time outs are always inserted before the first reading is taken in a newly selected function or range. With F2 or F3 selected, time outs will always be inserted before each subsequent reading in that function or range.

**2-42. SAMPLE**

2-43. Samples taken in the 8502A can be synchronous or asynchronous to the line frequency. Line frequency noise rejection can be increased by averaging more samples per displayed reading (refer to NOISE REJECTION specifications in Table 1-3 of this manual.) Provision is therefore made to change the number of samples taken for each reading (display update). Setting the samples per reading will yield a specific reading time. Additional time per reading will be necessary whenever memory operations (Offset, Scaling, etc.) are involved. Ohms measurements will also require more time due to the multiple readings involved.

2-44. For example, if rate 7 is selected, 128 samples will be taken and averaged per reading. With no memory operations involved, digitizing time for a dc volts reading will therefore take 533 ms. Sample rate designations (such as 7) are actually the number of samples per reading expressed as exponents of 2; rate 7 =  $2^7 = 128$  samples per reading.

**2-45. EXTERNAL REFERENCE**

2-46. An external reference dc voltage can be used to divide the inputs in any function. A true ratio measurement is then computed by the Controller.

$$\text{Reading} = \frac{\text{Input}}{\text{dc Ext. Ref. Input}}$$

2-47. A pair of external reference terminals will be found either separately on the rear panel or together in the optional rear input connector.

- 1. The applied external reference voltage may be a maximum of  $\pm 20$ V at either external reference HI or LO or 40V between HI and LO, with respect to SENSE LO (or to Ohms Guard in the rear input connector).

2. The minimum voltage applicable to the external reference terminals is the greater of either  $\pm 100 \mu V$ , or a value found with the following formula:

$$V_{min} = \frac{\pm |V_{in}|}{10^9}$$

3. The resistance between either EXT REF terminal and INPUT LO should be less than 20 Kohms. Normally, EXT REF LO will be tied to INPUT LO.

#### 2-48. REMOTE

2-49. If an optional remote interface is installed, the REMOTE switch may be used to toggle into or out of remote control. With the IEEE (Option -05) Interface installed, only toggling out of remote control is permitted from the front panel. When in remote control, only the remote switch and the power switch will have any effect on the instrument's operation. A reset caused by power interruption will return the instrument to local control.

2-50. Remote control does not affect analog inputs on the High Quality Bus. With Rear Input (Option -17) or Switchable Front - Rear Inputs (Option -16), separate Sense Hi and Lo, Source Hi and Lo, Guard, Ohms Guard, and External Reference connections must be made remotely.

#### 2-51. Memory

2-52. The 8502A provides considerable versatility in measurement manipulations through both front panel and remote programming. Displayed numbers are computed from measured data according to the following general equation, where:

$y$  = the displayed number

$m$  = the scaling factor or external reference

$x$  = the actual input (averaged samples)

$b$  = the offset factor (subtracted)

Thus:

$$\left[ y = \frac{x}{m} - b \right]$$

2-53. Either displayed values or numeric sequences may be stored as memory factors.

#### NOTE

*Storing a value in memory does not select a mathematical operation. The operation must be selected separately before or after the value is stored.*

#### 2-54. LIMITS

2-55. Any currently displayed value may be stored as a limit value. With such values stored as references, the 8502A (toggled into the Limits mode) will yield a display of:

1. HI if the reading is greater than the high limit.
2. PASS if the reading is less than or equal to the high limit and greater than or equal to the low limit.
3. LO if the reading is less than the low limit.

#### NOTE

*HI, LO, and PASS describe the normally displayed reading, with all math operations completed, relative to the limit values.*

2-56. Only one set of limits may be stored at a time. A function change will exit the Limits mode but retain stored values.

#### 2-57. PEAK

2-58. Highest and lowest values displayed in any series of measurements may be stored when in the Peak mode. Toggle in and out of this mode by depressing the PEAK switch. Peak values will be retained after the mode is deactivated but lost should the instrument be reset or the mode reselected.

#### 2-59. CALIBRATION MODE

2-60. The CAL switch will be found on the front panel behind a small plastic cover which pulls out and hinges down. Sliding the switch down places the 8502A in the Calibration mode. This mode is designed primarily to be used with the Calibration Memory (Option -04). When this module is installed and the instrument is in the Calibration mode, correction factors can be stored at the decade point for each range and function. Refer to Section 6 of this manual for complete Calibration Memory procedures.

2-61. If the Calibration Memory is installed, inadvertent use of the STORE switch will store the last reading as a calibration factor and erase calibration factors for the function and range in use at the time. To correct this possible mistake without a calibration standard, disconnect the input, short the input terminals, and press STORE again.

2-62. Whether or not the Calibration Memory module is installed, entry into the Calibration mode (CAL LED flashes) necessitates consideration of the following alterations to the 8502A's display:

1. The exponent is replaced with an extra digit of resolution.
2. Error codes are disabled. Only spurious readings will now denote selection of an invalid function.
3. The overrange indication is disabled.

**NOTE**

*When changing from one function to another, or upon entering the Cal mode, memory modes will be deactivated. Stored values will be retained. Use of RESET or interruption of power to the 8502A will erase memory entries.*

**2-63. OFFSET**

2-64. The Offset mode can be used to automatically subtract a number from the measured input and display the result. The subtracted offset number may be:

1. Any currently displayed value.
2. A programmed numeric entry (ranging from  $+10^9$  to  $-10^9$ ).

2-65. The displayed reading in Offset mode will exhibit no increase in digit resolution. Only one offset factor at a time can be stored. A function change will deactivate Offset mode; the stored value will be retained. A flashing H will appear in the exponent display should more than 40V appear between the input terminals when in Offset mode.

**2-66. SCALING**

2-67. The Scaling mode may be used to automatically divide a measured input by a programmed number or by an applied value. This feature essentially provides the ability to program an external reference without standard external reference limitations in range. In fact, scaling values may range from  $+10^9$  to  $+10^{-9}$  and from  $-10^9$  to  $-10^{-9}$ . A scaling factor of 0 is not allowed. Scaled readings will contain 3 significant digits if the original reading had 3 or less significant digits. For more than 3 significant digits in the original reading, the scaled reading will display the same number of significant digits. Only one scaling factor may be stored at a time. A function change will deactivate the Scaling mode but retain the stored factor.

**NOTE**

*If the 8502A is in both Scaling and Offset, the scaling factor will be applied first; the scaled displayed values will then be offset.*

**2-68. ZEROING**

2-69. There are two methods of zeroing the 8502A. Either method may be used in the 100 mV range or the 10 ohm range.

**2-70. VDC/Ohms Zero**

2-71. Correction for internal dc drift can be made by applying a good quality, low thermal short between HI and LO terminals (not between test leads). If necessary, repeat this operation once the instrument has warmed up. Only dc volts zero factors may be recalled.

**2-72. Zeroing with OFFSET**

2-73. After zeroing for internal drift, separate dc volts and 2-wire ohms measurement corrections can be made by shorting the test leads and storing the reading as an offset factor.

**2-74. Systems Use of the 8502A**

2-75. The availability of optional interface modules makes the 8502A adaptable to a large variety of digital systems. Operating and programming instructions related to remote operation are included with the appropriate optional module. Overall information on remote interfacing can be found in Fluke Application Bulletin -25 "System Use of the Fluke Model 8500A". Specific information about the IEEE interface (-05 Option) may be found in Fluke Application Bulletin -36. Application Bulletin -37 "Unique Measurements Using the 8500 Series Digital Voltmeter" will also be useful for both local and systems use of the 8502A.

**2-76. OPERATING DIRECTIONS****2-77. Initial Settings**

2-78. Upon applying power to the 8502A, the display will read:

"HI - 2.0.Y"

("Y" will be the number of the software version employed in your instrument.) Then:

"CXXXXX"

("X" will be identifying numbers for installed options.)

The instrument will now assume the following status:

1. V DC function
2. 1000V range
3. Slow reading rate (7)
4. Fast filter (F0)

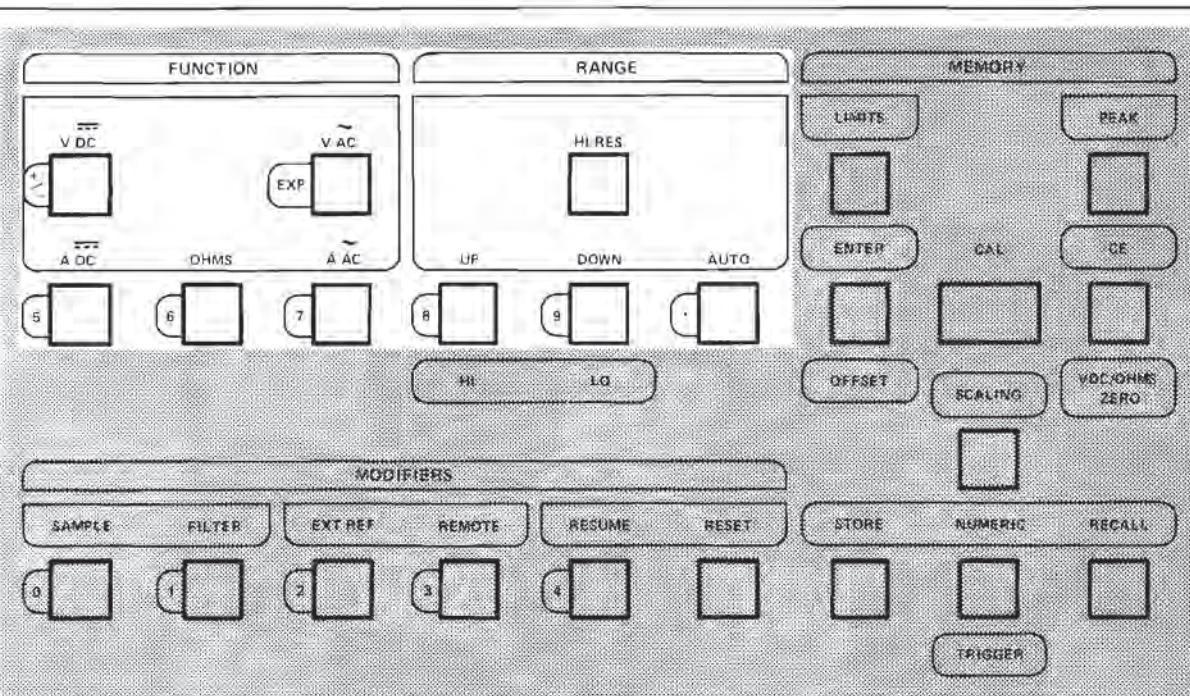
5. Offset – off and zeroed
- Scaling – off and set to 1
- Peaks – off and set to 0
- Ext Ref – off
- Trigger – Auto
- VDC/Ohm<sub>x</sub> Aero – zeroed
- Remote – out, in local.

2-79. Allow a 1 hour warm-up to insure rated accuracy.

## 2-80. Front Panel Control Usage

2-81. Figures 2-4, 2-5, 2-6, and 2-7 will describe 8502A front panel control usage. When initially setting these controls, use the following grouping sequence:

FUNCTION → RANGE → MODIFIERS → MEMORY



### FUNCTION

Depress the switch for the desired function. The 8502A will assume autoranging (AUTO LED on) and retain any modifier (sample, filter, etc.) or memory (scaling, offset, etc.) mode already in use. If a function is selected for which the module is either faulty or not installed, Error 9 will appear in the display. Press RESET or select another function to clear this error indication. Otherwise, the appropriate function LED will come on when one of the following functions is selected:

1. DC VOLTS (V DC) – Standard, 5 ranges.
2. AC VOLTS (V AC) – Optional, 4 ranges.
3. DC CURRENT (A DC) – Optional, 5 ranges.
4. AC CURRENT (A AC) – Optional, 5 ranges.
5. Resistance (OHMS) – Optional, 8 ranges.

Figure 2-4. Function and Range

**RANGE**

Range switching in the 8502A can be either manual or automatic.

UP

Advances 8502A to the next higher range with each application. UP will have no effect at the top of the range. If the 8502A is in autoranging, application of UP will both shift to manual range and change the range.

DOWN

Steps 8502A to the next lower range each time it is depressed. DOWN will have no effect at the bottom of the range.

AUTO

Toggles the 8502A into/out of the Autoranging mode.

HIGH RESOLUTION

Depress the HI RES switch to enter this mode (not available in 100 mV DC or 100 mA range). Depress it a second time to exit the mode. Don't forget that, although the exponent is not displayed, it does remain in effect.

Figure 2-4. Function and Range (cont)

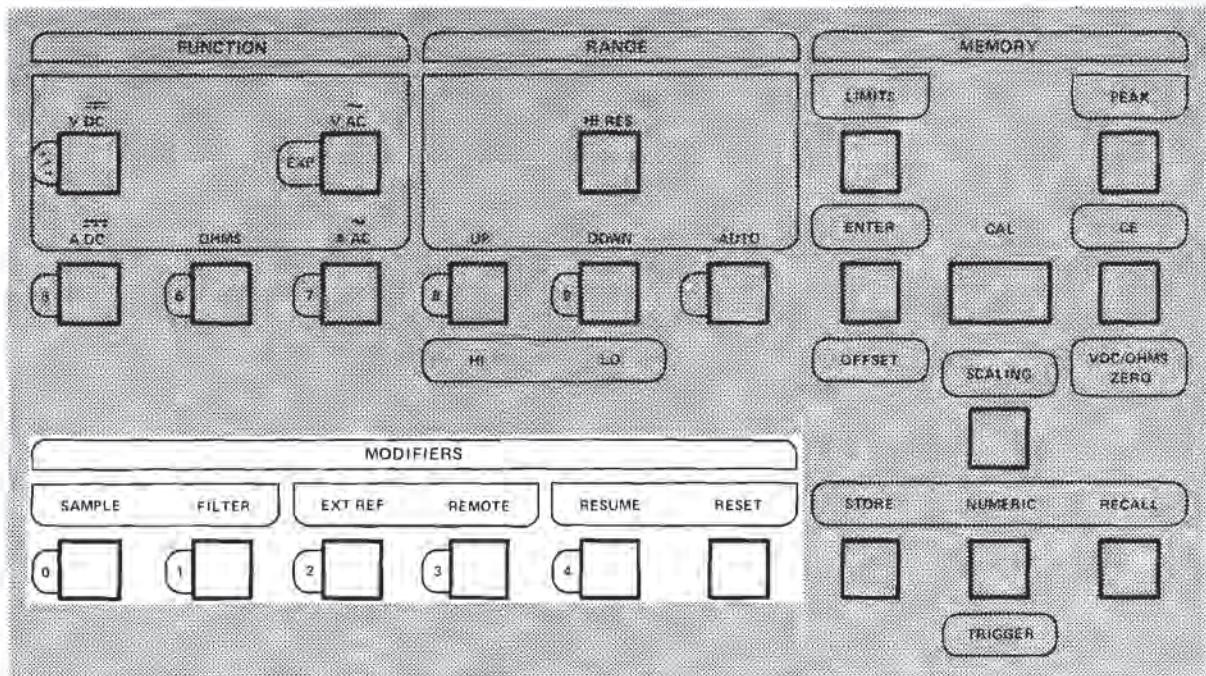


Figure 2-5. Modifiers



RESUME

Use RESUME to exit Manual or External Triggering modes.

RESET

Use RESET to put the 8502A back to the power on status:

1. V DC function.
2. 1000V range.
3. F0 filter.
4. 7 sample.
5. No other modifiers or memory modes in effect.
6. Memory entries lost. (Calibration Memory (Option -04) entries will not be lost.)

Figure 2-5. Modifiers (cont)

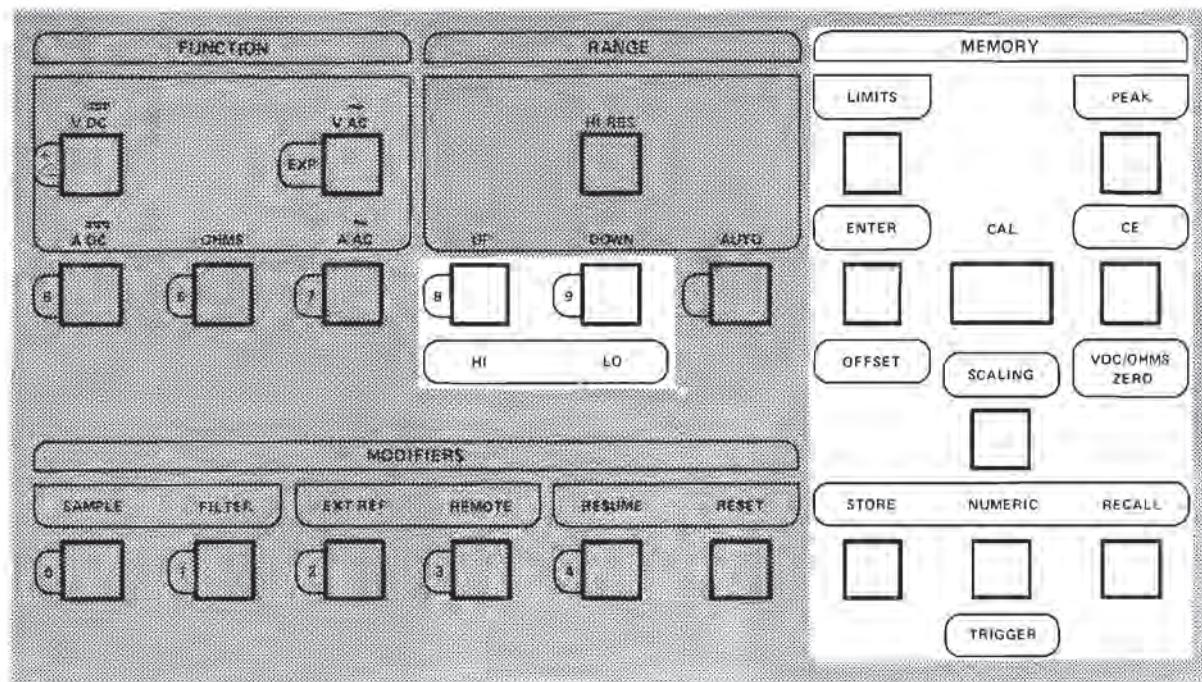
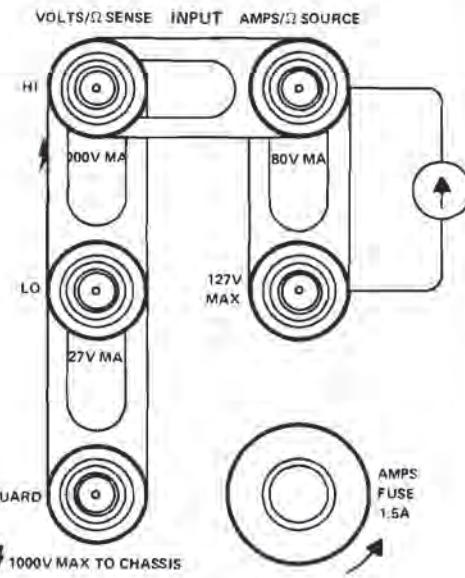


Figure 2-6. Memory



VDC/OHM ZERO

- Correct for internal drift by shorting the input terminals as illustrated. Use a good quality, low thermal short. The instrument must be in the 100 mV or 10 ohm range.



Now use the switches:

STORE → VDC/OHM ZERO

The value will be displayed as long as VDC/OHM ZERO is held depressed. The display will be zeroed once VDC/OHM ZERO is released.

- To display the stored zero correction (for dc volts only), press:

RECALL → VDC/OHM ZERO

The value will be displayed as long as VDC/OHM ZERO is held depressed.

OFFSET

- Enter the Offset mode by pressing OFFSET (OFFSET LED will come on). Exit this mode by again depressing OFFSET.

- Store any currently displayed value with the following procedure:

STORE → OFFSET

- To enter a programmed numeric value as an offset, use the following procedure:

STORE → NUMERIC → OFFSET → (numbers) → ENTER

- To use OFFSET as a zeroing feature, first perform VDC/OHM ZERO. Then, short test leads used in dc volts or 2-wire ohms measurements. Press:

STORE → OFFSET

The value will be displayed as long as OFFSET is held depressed. Push OFFSET a second time to enter Offset mode.

Figure 2-6. Memory (cont)

**□ SCALING □**

1. Press SCALING to enter this mode (SCALING LED will come on). Pressing the switch a second time will exit the mode.
2. Store any currently displayed value as a scaling factor by pressing:

STORE → SCALING

Read the value as long as SCALING is held depressed. Enter the mode by again depressing SCALING.

3. Enter a programmed numeric as a scaling factor by pressing:  
STORE → NUMERIC → SCALING → (numbers) → ENTER
- Press SCALING to enter the mode.

4. Display a stored scaling factor by pressing:

RECALL → SCALING

**□ CAL □**

1. Enter the Cal mode by sliding the CAL switch down (the CAL LED will flash). This switch will be found behind a small plastic cover which pulls out and hinges down. Use a small screwdriver or equivalent to slide the switch.
2. To enter calibration factors for each range and function, the optional Calibration Memory must be installed. Refer to Section 6 for applicable operating instructions.

**□ TRIGGER □**

1. Press TRIGGER to activate both manual triggering mode and external triggering operation (-08A Option installed). The 8502A will now accept either:

- a. A manually triggered reading with each subsequent depression of TRIGGER, or
- b. An external trigger applied through the rear panel connector (part of Option -08A).

Manual triggering from the front panel will take precedence if a simultaneous external trigger is received.

2. Exit manual/external triggering by pressing RESUME.
3. When you press a switch it is acted upon immediately, and the reading is aborted. Thus, if the instrument is in manual trigger and a switch is pressed during the reading, the 8502A will halt. It will then be necessary to press TRIGGER again to take the reading.

**□ CE □**

Use this switch to clear a numeric entry prior to entry into memory.

Figure 2-6. Memory (cont)

ENTER 

Use this switch to enter a numeric into memory.

 STORE 

Use to initiate a numeric entry sequence.

 RECALL 

Use to initiate recall and display of stored values.

## CORRECTING ENTRY ERRORS

There are a number of methods to correct memory entry errors. Choices include staying in the entry sequence, exiting the sequence and retaining memory, or exiting the sequence and losing memory.

1. Stay in sequence: CE — erases only numbers before entry.
2. Exit sequence, retain memory: Generate any invalid switch sequence that will result in "Error C".
3. Exit sequence, lose memory: RESET or power interruption causes 8502A to assume V DC 1000V, F0, sample 7, blank memory (optional Calibration Memory not affected).

Figure 2-6. Memory (cont)

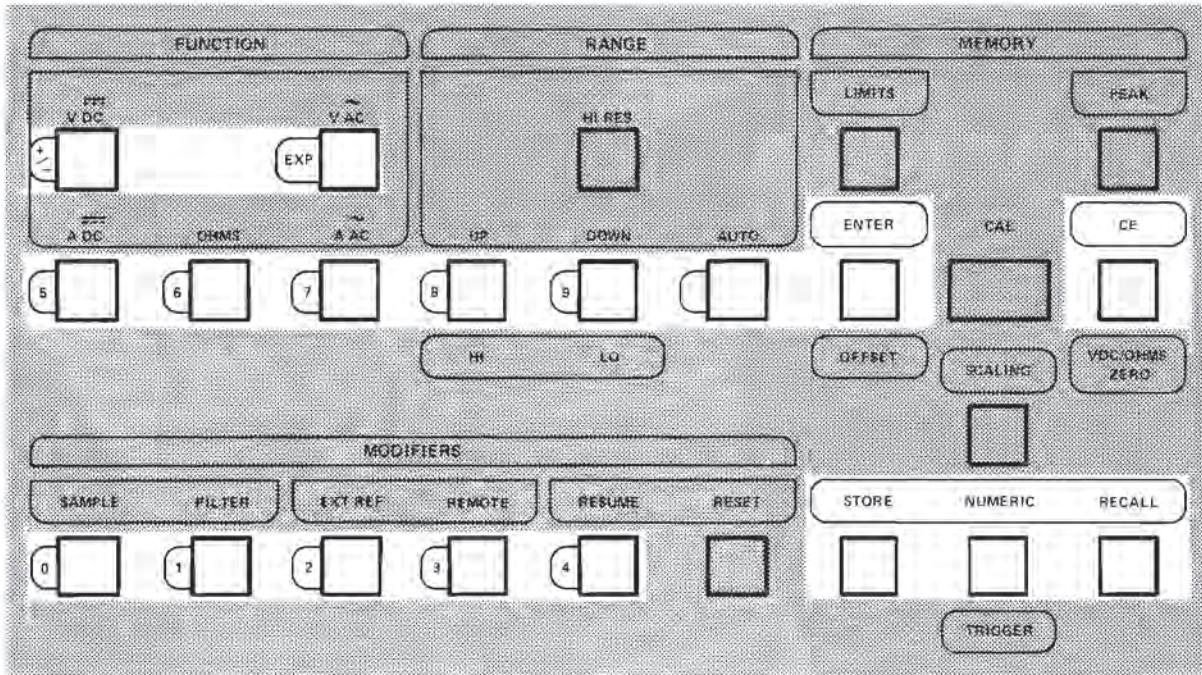


Figure 2-7. Numerics

STORE

Use the numeric sequence whenever entering a value (as in Offset) or a particular mode (as in Filter) into the 8502A's memory. Use the following procedural steps:

1. Initiate the numeric entry. Press:

STORE	("?" appears in display)
NUMERIC	(YES? appears in display)

2. Select the desired use for the numeric entry. Press:

OFFSET	(Go appears in display)
(SCALING FILTER, SAMPLE, HI or LO for LIMITS).	

3. Select the desired numbers. Numbers will appear in the display from left to right as they are entered.

**NOTE:** Press CE if an error is made during the following number, polarity and exponent entry steps. The 8502A will then display Go. Start entries again from this point.

- a. For Filter, enter the mode number (-, 0, 1, 2, or 3).
  - b. For Sample, enter the exponent of 2 for samples averaged in each reading (0 through 17).
  - c. For Offset, enter the number(s) for the offset factor.
  - d. For Scaling, enter the number(s) for the scaling factor.
  - e. For Limits (HI, LO), enter the numeric values desired.
4. To change the polarity of the numeric entry, press:  
  
+/-
  5. To add an exponent to the numeric entry, press:  
  
EXP
  6. To change polarity for the exponent, now press:  
  
+/-
  7. To finalize storing of the entry and exit the numeric sequence, press:  
  
ENTER
  8. The value is now stored. For Filter or Sample entries, the value is now also in effect. For Offset, Scaling or Limits, the value will not become effective until the appropriate mode is selected.

- 2-82. Measurement Instructions**
- 2-83. DC VOLTAGE (V DC)**
- 2-84. Use the following procedure when measuring dc volts:
1. Select the VDC function.
  2. The 8502A will go to autoranging. If desired, select manual ranging and one of the five available ranges (1000V, 100V, 10V, 1V, or 100 mV).
  3. Perform DC Zero, if needed (100 mV range only).
  4. Select desired modifiers and memory operations.
  5. Connect the dc voltage to the HI and LO SENSE INPUT terminals.
  6. A dc voltage reading should now appear in the display.
- 2-85. DC ZERO**
- 2-86. For dc zeroing, use the following steps:
1. Select the V DC function and either autoranging or the 100 mV manual range.
  2. Place a good quality, low thermal short across the HI and LO INPUT terminals.
  3. Depress the STORE switch. "?" will appear in the display.
  4. Depress the VDC/OHMS ZERO switch; value applied to input terminals will now be displayed as long as the switch is held depressed.
  5. Release of the switch will activate V DC/Ohms Zero mode, applying the value read in step 4 as a zero reference for subsequent readings.
- 2-87. AC VOLTAGE (V AC)**
- 2-88. Use the following procedure when measuring ac volts:
1. An AC Converter module must be installed (Option -01, or -09A).
  2. Select the VAC function.
  3. The 8502A will go to autoranging; manual ranging can be selected if necessary. There are four available ranges; 1000V, 100V, 10V, 1V.
4. Perform DC ZERO, if necessary. No additional zero procedure is needed for ac voltage.
  5. Select desired modifiers and memory operations.
  6. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.
  7. Connect the ac voltage to the HI and LO SENSE INPUT terminals.
  8. The ac voltage should be read in the display.
- 2-89. AC VOLTAGE ON A DC LEVEL (V DC and V AC)**
- 2-90. Use the following procedure when measuring ac and dc voltage:
1. The RMS AC Converter module must be installed.
  2. Depress both V DC and V AC switches simultaneously.
  3. The 8502A will go to autoranging; manual ranging can be selected if necessary. There are four available ranges: 1000V, 100V, 10V or 1V.
  4. Select desired modifiers and memory operations.
  5. Connect the unknown voltage to the HI and LO SENSE INPUT terminals. The reading displayed will be the rms value of the two voltages combined.
- 2-91. DC CURRENT (A DC)**
- 2-92. Use the following procedure when measuring dc current:
1. The Current Shunts module must be installed.
  2. Select the A DC function.
  3. The 8502A will go to autoranging; manual ranging can also be utilized to select one of five available ranges (100 uA, 1 mA, 10 mA, 100 mA, or 1A).
  4. Select desired modifiers and memory operations.
  5. Connect dc current to HI and LO INPUT SOURCE terminals.
- 2-93. AC CURRENT (A AC)**
- 2-94. Use the following procedure when measuring ac current:
1. The Current Shunts module must be installed.

2. Select the A AC function.
3. Follow steps 3-5 listed for DC Current measurements.
- 2-95. OHMS
- 2-96. Use the following procedure for resistance measurements:
1. The Ohms Converter module must be installed.
  2. Select the OHMS function.
  3. The 8502A will go to autoranging; manual ranging can be selected if necessary. There are eight resistance ranges available: 100M, 10M, 1M, 100K, 10K, 1K, 100 and 10 ohms.
  4. If necessary, perform the ohms zero procedure described below (10 ohm range only).
  5. Select desired modifiers and memory operations.
  6. Connect the unknown resistance to the HI and LO INPUT terminals (see Section 6 for 2-wire and 4-wire connection methods).
- 2-97. OHMS ZERO
- 2-98. For ohms zeroing, use the following steps:
1. The Ohms Converter module must be installed.
  2. Select the Ohms function.
  3. Select the 10 ohms range.
  4. Short input terminals as described in zeroing instructions.
  5. Depress the STORE switch; "?" will appear in the display.
  6. Depress the V DC/OHMS ZERO switch; the value of residual resistance will be displayed for as long as the switch is held depressed.
  7. Release of the zero switch will activate the Ohms Zero mode.

## 2-99. APPLICATIONS

- 2-100. The applications presented in Table 2-3 presuppose an initial power on or reset instrument status, i.e.,
1. V DC function.
  2. 1000V range.
  3. Sample - 7.
  4. Filter - F0.
  5. No stored values (excepting the Calibration Memory).

Table 2-3. Applications

STORING A DISPLAYED VALUE	
<b>STORE</b> → { OFFSET VDC/OHM ZERO SCALING HI LO	
APPLICATION 1	
REQUIREMENT:	Monitor the stability of a power supply in terms of its deviation in volts from a present output of +5.03V.
METHOD:	Store the present output as an offset. Press:  STORE → OFFSET → OFFSET  Initial use of OFFSET places the displayed value into memory (value will be viewed as long as switch is held depressed). The second use of OFFSET places the instrument in Offset mode. The display will now read only the deviation from +5.03V.

Table 2-3. Applications (cont)

APPLICATION 2																				
REQUIREMENT:	Monitor the stability of a power supply as a decimal ratio to its present reading of -20.08V. DC zeroing appears to be necessary.																			
METHOD:	<p>Perform V DC Zeroing for internal drift. Apply low thermal short between INPUT HI and LO (at the terminals). Press:</p> <p>STORE → VDC/OHMS ZERO</p> <p>The value stored will be displayed as long as VDC/OHMS ZERO is held depressed. Release of the switch will activate the Zero mode. Revise terminal interconnections for dc volts measurements. Connect the dc voltage.</p> <p>Apply power supply reading of -20.08V as a scaling factor. Press:</p> <p>STORE → SCALING → SCALING</p> <p>Initial use of SCALING places the displayed value (which is seen as long as the switch is held depressed) into memory. The second use of SCALING places the 8502A into Scaling mode.</p> <p>Display will now yield the ratio of subsequent readings to the scaling factor, e.g., an input of 22.08V yields a ratio of:</p> $\frac{22.088}{20.08} = 1:1$																			
STORING A NUMERIC ENTRY																				
STORE → NUMERIC →	<table border="0"> <tr> <td rowspan="4" style="vertical-align: middle;">STORE → NUMERIC →</td> <td>OFFSET</td> <td>→ (value number)</td> <td>→ ENTER</td> </tr> <tr> <td>SCALING</td> <td>→ (value number)</td> <td>→ ENTER</td> </tr> <tr> <td>HI</td> <td>→ (value number)</td> <td>→ ENTER</td> </tr> <tr> <td>LO</td> <td>→ (value number)</td> <td>→ ENTER</td> </tr> <tr> <td>FILTER</td> <td>→ (-, 0, 1, 2, 3)</td> <td>→ ENTER</td> </tr> <tr> <td>SAMPLE</td> <td>→ (0 thru 17)</td> <td>→ ENTER</td> </tr> </table>	STORE → NUMERIC →	OFFSET	→ (value number)	→ ENTER	SCALING	→ (value number)	→ ENTER	HI	→ (value number)	→ ENTER	LO	→ (value number)	→ ENTER	FILTER	→ (-, 0, 1, 2, 3)	→ ENTER	SAMPLE	→ (0 thru 17)	→ ENTER
STORE → NUMERIC →	OFFSET		→ (value number)	→ ENTER																
	SCALING		→ (value number)	→ ENTER																
	HI		→ (value number)	→ ENTER																
	LO	→ (value number)	→ ENTER																	
FILTER	→ (-, 0, 1, 2, 3)	→ ENTER																		
SAMPLE	→ (0 thru 17)	→ ENTER																		
APPLICATION 3																				
REQUIREMENT:	Determine which of a group of power supplies have a tolerance of 15V ± 100 mV.																			
METHOD:	<p>Set high and low limits. Press:</p> <p>STORE → NUMERIC → HI → 1 → 5 → . → 1 → ENTER</p> <p>STORE → NUMERIC → LO → 1 → 4 → . → 9 → ENTER</p> <p>Select LIMITS. The 8502A will now display "HI", "LO", or "PASS" for each power supply.</p>																			

Table 2-3. Applications (cont)

APPLICATION 4	
REQUIREMENT:	For a group of 20V power supplies, determine the deviation in volts.
METHOD:	Offset the displayed reading by 20. Press:  STORE → NUMERIC → OFFSET → 2 → 0 → ENTER  Select OFFSET. Any value displayed now will equal the deviation from 20V.
APPLICATION 5	
REQUIREMENT:	Display the input error voltage for an operational amplifier by measuring the dc output error. Gain = $2.6847 \times 10^4$ .
METHOD:	Divide the measured dc output error by a scaling factor (the op amp gain). Press:  STORE → NUMERIC → SCALING → 2 → - → 6 → 8 → 4  7 → EXP → 4 → ENTER  Select SCALING. The 8502A will now divide the measured input by the gain of the op amp and display the input error voltage.
APPLICATION 6	
REQUIREMENT:	Make a series of measurements in a noisy environment. Speed of measurement is not important. Display only the deviation in volts.
METHOD:	Allow for extra settling between readings. Press:  STORE → NUMERIC → FILTER → 3 → ENTER  (Increase digital filtering (average more samples per reading). Press:  STORE → NUMERIC → SAMPLE → 9 → ENTER  Offset by the nominal output (e.g., 15V). Press:  STORE → NUMERIC → OFFSET → 1 → 5 → ENTER  Select OFFSET

Table 2-3. Applications (cont)

RECALLING	
RECALL →	OFFSET VDC/OHMS ZERO EXT REF SAMPLE RATE SCALING FILTER PEAK HI } → { PEAK LO }      LIMIT
APPLICATION 7	
<b>REQUIREMENT:</b>	
Determine the highest and lowest readings encountered in measuring a group of 28V power supplies.	
<b>METHOD:</b>	
Press PEAK to record measurement extremes. When required measurements are complete, use the following sequence to recall high and low values. Press:	
RECALL → LO → PEAK	
RECALL → HI → PEAK	
(Hold PEAK in to read the recorded values.)	

## Section 3

# Theory of Operation

### 3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation for the 8502A mainframe, which includes the modules necessary for DC Volts and DC Ratio measurements. Block Diagram descriptions give an overview of the operation of the modules and an explanation of the bus structure. Circuit Analyses give a more detailed description of the circuitry. Optional modules are described in Sect. 6.

### 3-3. BLOCK DIAGRAM DESCRIPTION

### 3-4. Bus Structure

3-5. The 8502A is constructed with a bus architecture similar to a computer. Figure 3-1 is an overall block diagram of the instrument with optional modules drawn in dashed lines. Figure 3-2 is a block diagram illustrating signal flow. A microprocessor-based controller module controls information flow on the three buses. The controller sets up

each of the analog modules for a measurement by addressing the modules as memory locations. An unguarded digital interbus is used to connect the controller to the front panel and to digital option modules such as the calibration memory and a remote I/O (input/output) interface.

3-6. The unguarded digital bus consists of the following lines:

1. Address/Control (IC) lines -7.
2. Bidirectional data (ID) lines -8.
3. Real time (RT) lines -7.
4. Handshake lines (INT-interrupt, ACK-acknowledge, INA-interrupt acknowledge).
5. Power Supply lines.

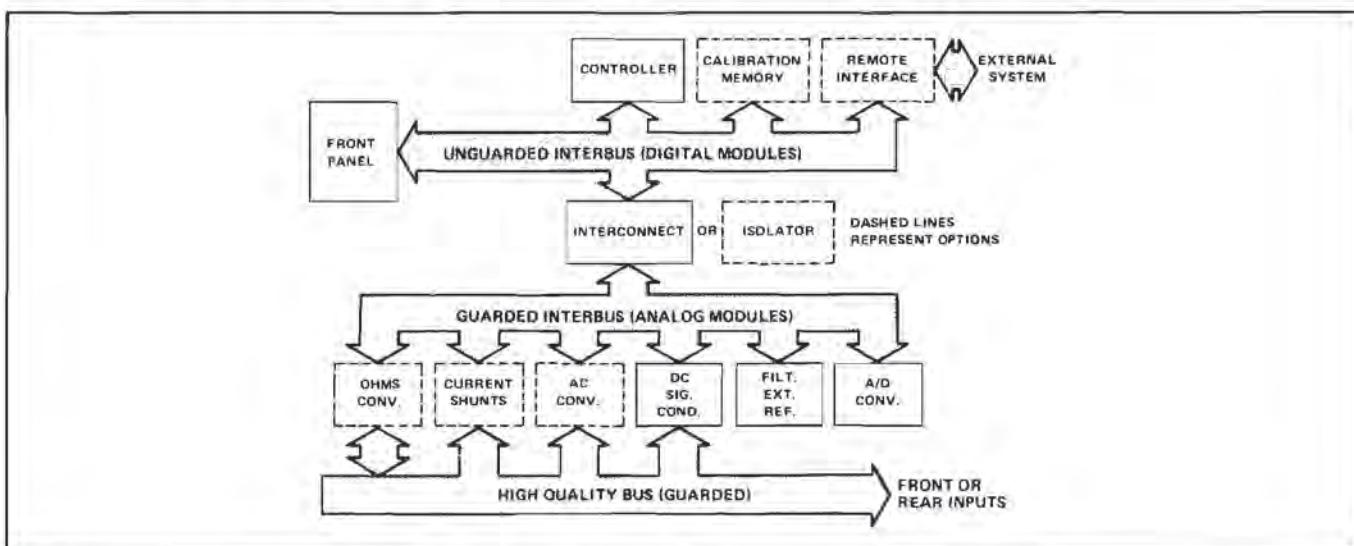


Figure 3-1. 8502A Block Diagram

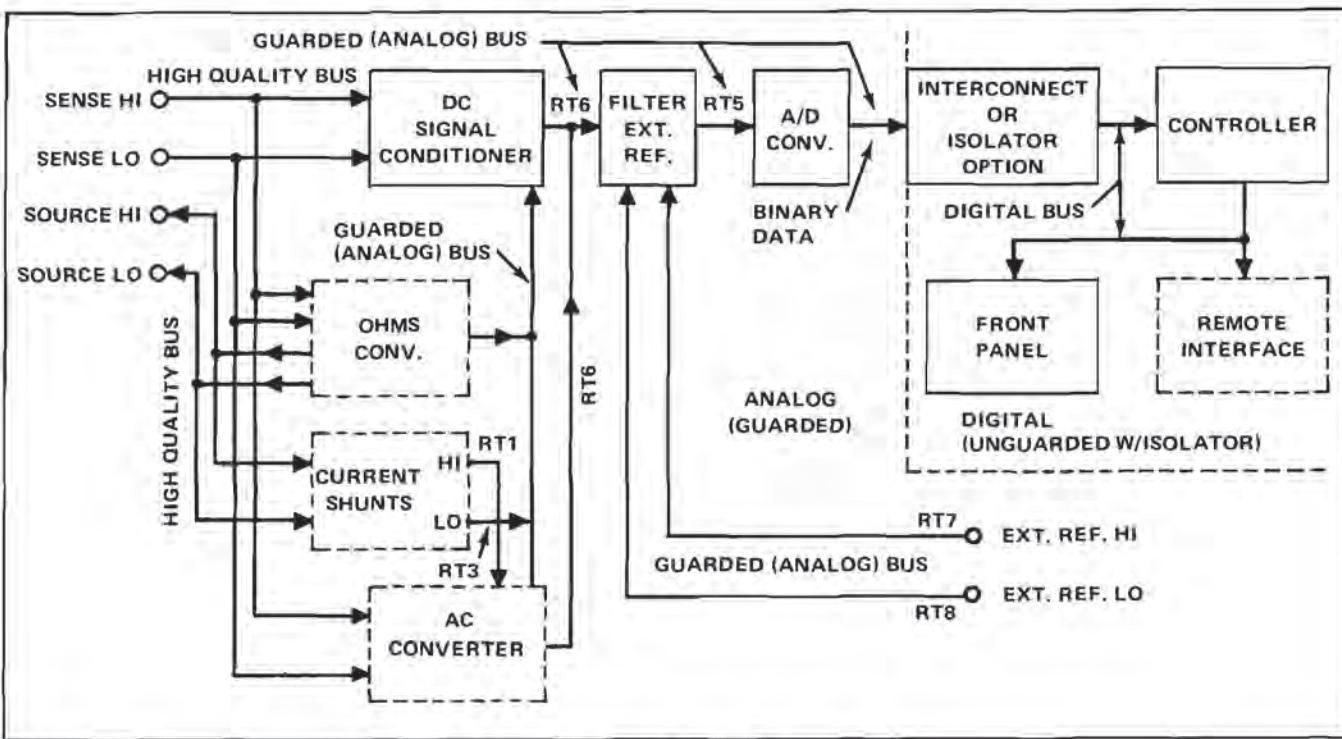


Figure 3-2. 8502A Analog Signal Flow

3-7. The guarded bus connects the controller to the analog modules through the Bus Interconnect Board or through the optional Isolator module; the Isolator must replace the Interconnect Board if an optional remote interface is installed. The guarded bus consists of the following lines:

1. Address/Control (IC) lines -7.
2. Bidirectional data (ID) lines -8.
3. Real time lines -9.
4. Handshake line (ACK) -1.
5. Power Supply lines.

3-8. The address, handshake, and data lines of the two buses serve the same functions. The real time and power supply lines may have differing functions. For example, the RT lines in the unguarded bus are unused except for RT5 (frequency reference). The RT lines in the guarded bus form an analog bus which carries all the conditioned and converted analog signals between the analog modules. The external reference input lines are part of the analog bus (RT7 and RT8). Logic supply lines (Vcc and Vss) will be different in the two busses if an isolator option is installed. In the guarded bus, Vcc and Vss are always -15V and -20V with respect to analog common. In the unguarded bus with an interconnect pcb installed Vcc and Vss are diode coupled to the guarded bus. But with the isolator option installed, Vcc and Vss are isolated from analog common.

3-9. The high quality bus consists of lines connecting the input switch (Sense HI and LO, source HI and LO, Guard, Ohms Guard) to the signal conditioning and converting modules (AC converters, Ohms converter, etc.). Ohms guard is only available through the rear inputs.

### 3-10. Controller

3-11. Under the direction of the software program, the controller addresses and sets up each of the modules necessary to perform a function. Two types of addresses are used: direct and indirect. An indirect address requires a previous direct address to set up the indirect address response logic. Data transfers are accomplished with a handshake between the address (IC) lines and the acknowledge (ACK) line. When the controller addresses a module, it places data on the data (ID) lines or receives data from the addressed module. The addressed module must respond with an ACK signal signifying that it is receiving or sending data.

3-12. The controller directs the R<sup>2</sup> A/D converter in taking a sample and receives the sample data from the converter. The controller stores range and function information for application to the sample data. Using the arithmetic capability of the microprocessor, the software processes the data to arrive at a binary 2's complement number which represents the polarity and value of the measurement. This number is made available to an optional remote interface either as is or after further processing to ASCII code. The number is further processed by the controller for application to the front panel display in a seven segment LED format.

3-13. The software program consists of two parallel processes. A background process (Figure 3-3) is responsible for interrupt driven activities such as updating the display digits and directing the A/D converter in taking a sample. The foreground process (Figure 3-4) is responsible for the measurement cycle including accumulating data from the background process and performing required calculations.

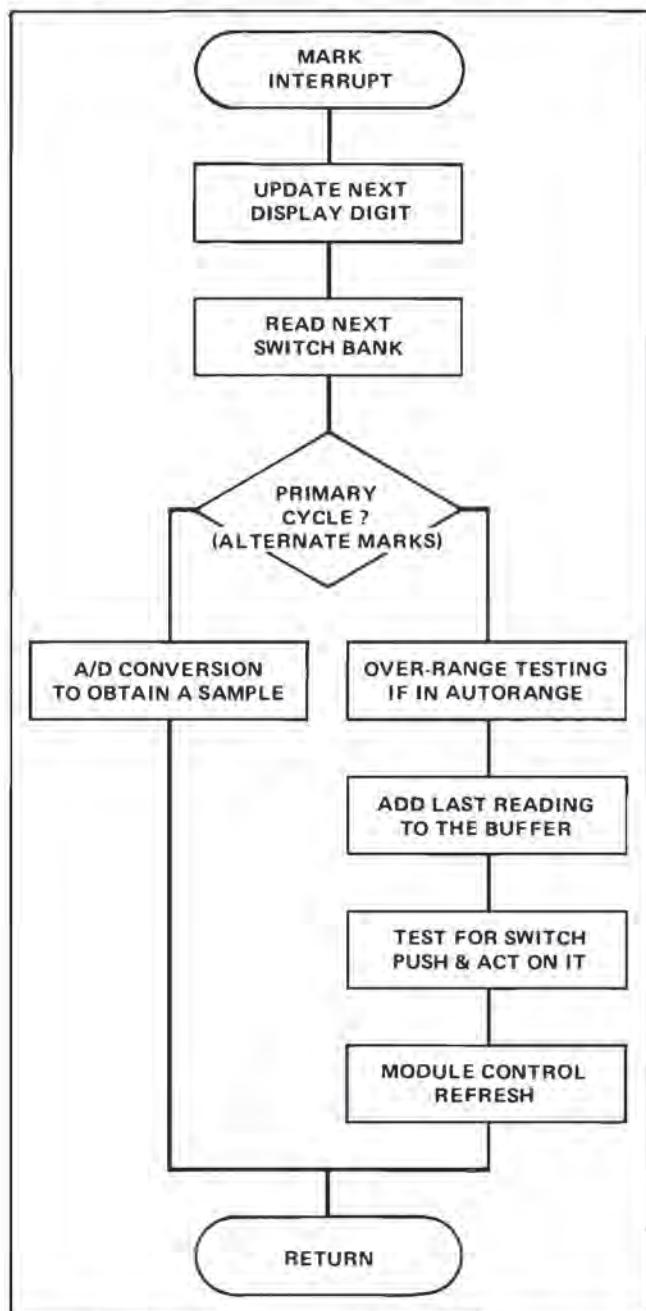


Figure 3-3. Background Software Process

3-14. The controller is structured around the Intel 8080 microprocessor. Figure 3-5 is a block diagram of the controller module. Hardware control functions have been minimized by careful software design. Sequences of events are timed from two sources. Basic operations of the microprocessor are run from a 1.7 MHz clock. The other source is

generated by shaped line frequency pulses, which are applied to a phase-locked loop. The phase-locked loop multiplies the line frequency by eight. This signal is used to generate mark interrupts which time the background process.

3-15. Software for the 8502A is stored in five ROM's. These read only memories are mounted on a "piggy-back" board, which is connected to the main controller pcb at the socket for U25. Four RAMs (random access memory) are used for temporary storage of data by the microprocessor. Data lines (DB0-DB7) are used for bidirectional data flow. Address lines (A0-A15) determine the source or storage location of data. Since other modules of the 8502A system are addressed as memory locations, address and data I/O controls are used for access to the external bus structure.

3-16. Interrupts are used to divert the microprocessor from the main program to service other routines. Interrupts are synchronized to an appropriate time in the microprocessor cycle through interrupt control, where assigned priorities vector module identity data onto the data bus. Module identity data words direct the microprocessor to the memory location containing the next instruction. Two interrupts are internally generated: ACK INT and MARK INT (priorities one and six respectively). ACK INT is generated when an acknowledge signal is not returned. MARK INT is used to synchronize A/D samples and display digit updates to the line frequency.

3-17. An interrupt may be externally requested by pulling the INT line low. When the microprocessor is ready to accept the interrupt, the interrupt acknowledge (INA) signal is generated. The requesting module must respond with an ACK and a data bit (on ID1-ID4) which is used as a priority vector by INT CONTROL.

3-18. Two types of resets may occur: software and hardware. Software resets are a result of front panel or remote requests. Hardware resets occur at power up or power down. Line frequency pulses from RTS are sensed by the reset logic. At power up the reset signal assures that the microprocessor will start from program location zero. At power down the reset signal assures that the controller will not call up wrong modules.

3-19. The microprocessor control logic is responsible for latching up a status word at the beginning of each instruction cycle and for telling the microprocessor when to enter and exit wait states. Microprocessor sequences are divided into machine states (one clock period, 588 nsec), machine cycles (from three to five states) and instruction cycles (from one to five machine cycles). Status words are used to control and synchronize data I/O, memory read/write, and some of the interrupt control signals. The microprocessor must be instructed to enter a wait state after addressing an external module and after being interrupted to allow the external module time to respond.

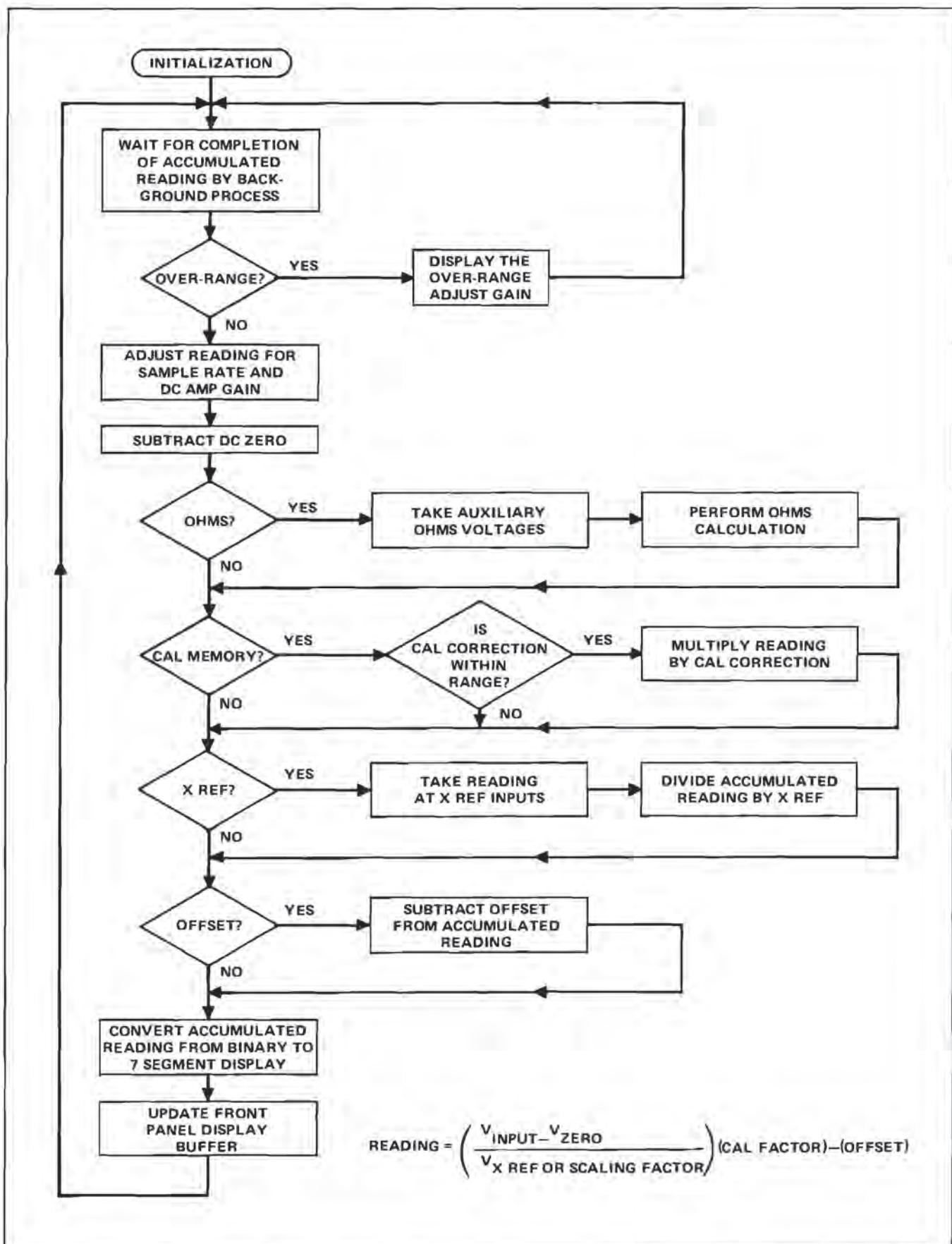


Figure 3-4. Foreground Software Process

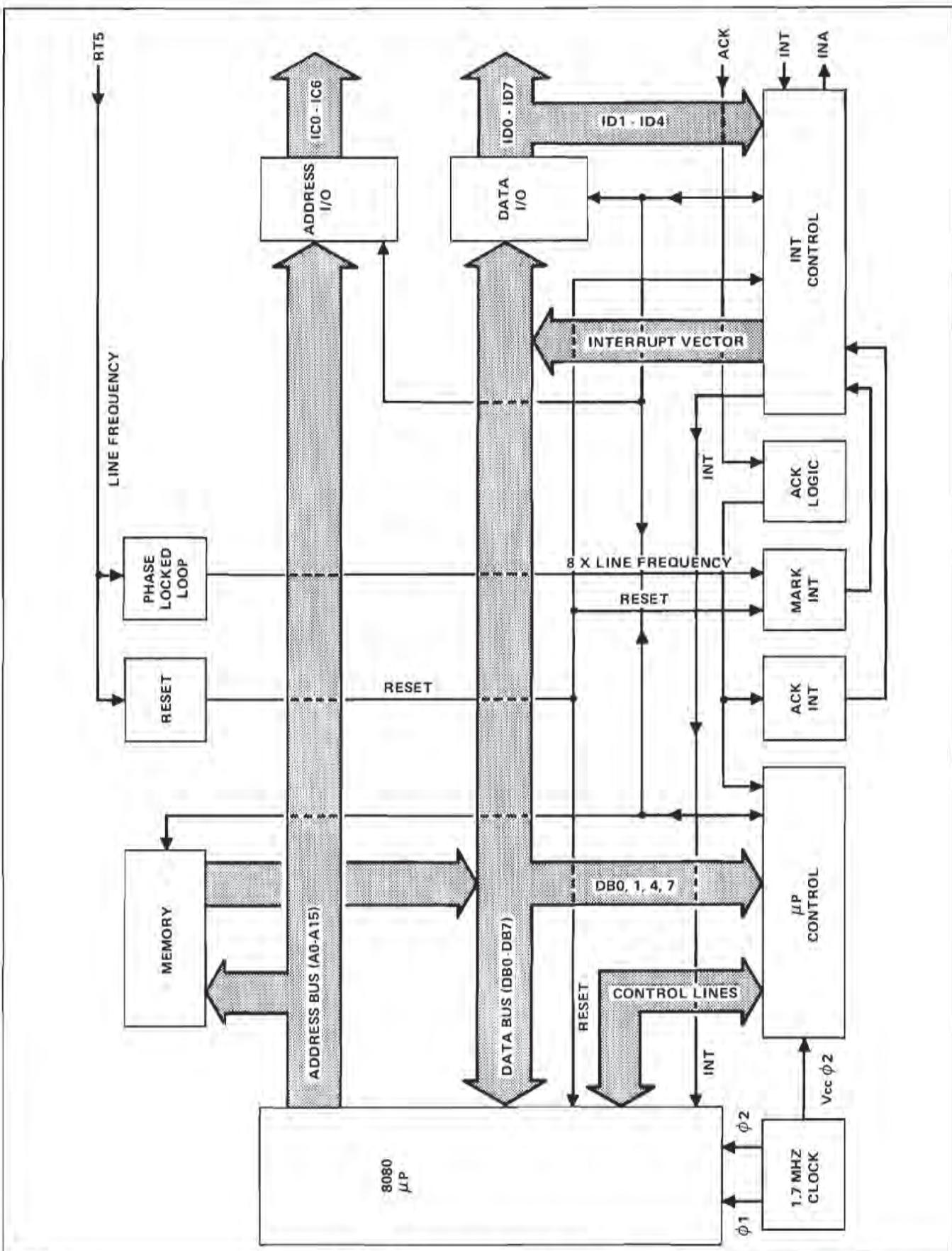


Figure 3-5. Controller Block Diagram

### 3-20. Front Panel

3-21. The front panel serves as an interface between the operator and the 8502A controller. The display is multiplexed by the controller by means of addressing the front panel for each digit. One direct address, two indirect addresses, and the accompanying data determine which digit or annunciator and which segments will light. An indirect address requires a previous, valid direct address to set up the indirect response. Another direct address enables the switch matrix to be read to determine if any function changes are desired. The cycle of updating each digit and annunciator and reading the switch matrix requires approximately 28 msec and is a continual cycle. Input terminals, J1-J5, are physically located on the front panel but have no electrical interaction with the front panel.

### 3-22. DC Signal Conditioner

3-23. DC signals from either the input terminals or optional signal conditioners (Ohms or Current Shunts) are

routed through the DC Signal Conditioner to be brought within the range of the A/D Converter ( $\pm 20V$ ). Figure 3-6 is a block diagram of the DC Signal Conditioner. For ease in arithmetic manipulations in the microprocessor, all gains and attenuations in the 8502A are powers of eight. Gain or attenuation factors are selected by the microprocessor addressing the module. Data from the data bus is latched into the control circuitry and used to select relays in the attenuator and switches in the amplifier feedback circuit. The combination of the attenuator and feedback-controlled amplifier give gain or attenuation factors of one, eight, or sixty-four.

### 3-24. Active Filter

3-25. The purpose of the Active Filter module is to multiplex dc signals to the A/D Converter and to switch analog filters into the signal conditioner inputs. Figure 3-7 is a block diagram of the Filter/External Reference module. Five filter modes may be selected from the front panel. For

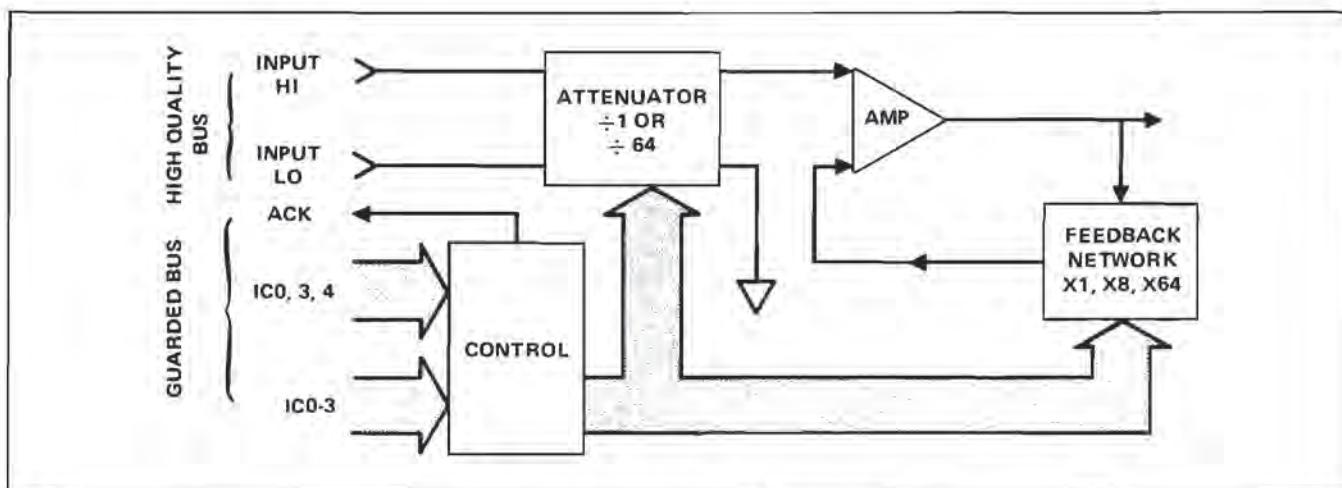


Figure 3-6. DC Signal Conditioner Block Diagram

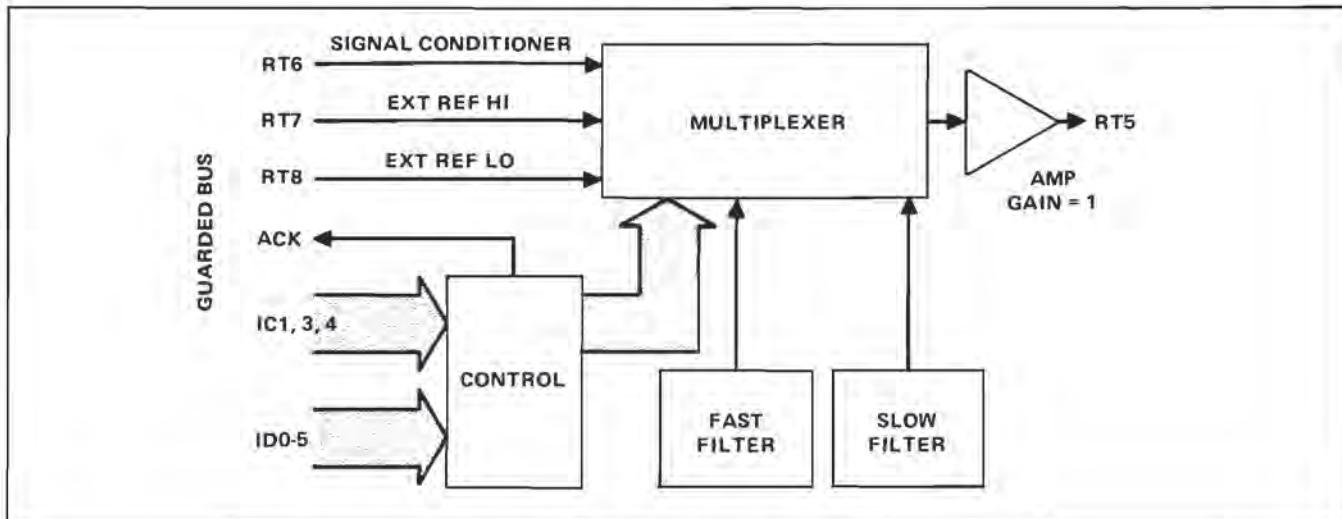


Figure 3-7. Active Filter Block Diagram

external reference measurements, the signal conditioner input, the External Reference HI input and the External Reference LO input are multiplexed to the A/D Converter. Samples are taken of each input and arithmetically manipulated by the Controller to arrive at a reading. Outputs from the optional AC converter modules are applied to the Active Filter module, bypassing the DC Signal Conditioner.

### 3-26. Fast R<sup>2</sup> A/D Converter

3-27. The Fast R<sup>2</sup> A/D Converter employs Fluke's patented recirculating remainder (R<sup>2</sup>) technique for converting a dc input signal into a binary, bit-serial data stream. The R<sup>2</sup> technique has been modified for microprocessor control. Obtaining a sample is a five-step process. Each step consists of a decision period of five decisions and a subtraction period. Set-up of the converter, decisions, and reset are initialized by the Controller addressing the A/D Converter. Figure 3-8 is a block diagram of the R<sup>2</sup> A/D Converter.

3-28. During the first step, the input signal is applied to the Summing Node. The polarity of the input is detected and the resulting bit of information is transmitted to the Controller. On the basis of the returned polarity, the A/D module selects which reference polarity is required: positive for negative inputs, negative for positive inputs. The first of five precision currents is switched into the Summing Node and a polarity bit returned. If the polarity is changed,

the first current is switched off. If not, it is left on. Then the next current is switched into the Summing Node and another polarity bit returned. Another decision is made and so on until all five currents have been switched into the Summing Node and five decisions have been made. This completes the first decision period. The five precision currents are related by powers of two. The fifth current has a resolution of thirty-two.

3-29. Following the decision period is a subtraction period. Feedback through the Remainder Storage nulls whatever remainder was left after the five currents have been switched into the summing node. The remainder is amplified by 16 in the Remainder Amp and is stored on a capacitor in Remainder Storage. This completes the first step. The input is now switched out of the Summing Node and the amplified remainder switched in for the next step. There are two remainder channels in Remainder Storage and they are alternated in the four subsequent steps. Since the fifth current has a resolution of thirty-two and the Remainder Amp has a gain of 16, the first bit of a step has the same significance as the last bit of the previous step.

3-30. Of the five steps required to complete a sample, the first uses the input signal for decision and subtraction periods. The four subsequent steps alternate remainder channels to use the amplified remainder of the preceding step for decision and subtraction periods. Polarity bits

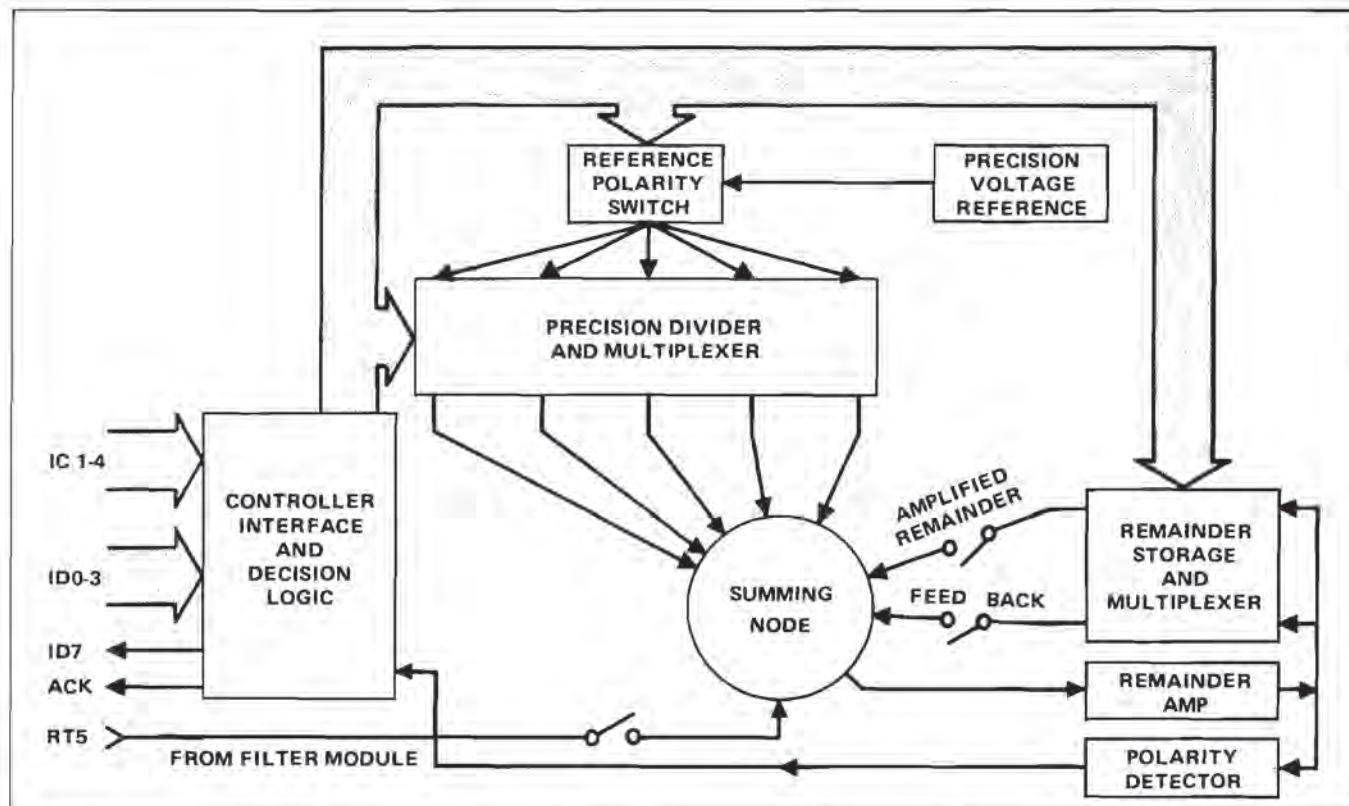


Figure 3-8. R<sup>2</sup> A/D Converter Block Diagram

returned at each decision are accumulated by the Controller and assembled into a 24-bit word describing the polarity and magnitude of the input.

### 3-31. CIRCUIT ANALYSIS

#### 3-32. Introduction

3-33. Detailed circuit descriptions for each module in the standard 8502A mainframe will be presented in the following paragraphs. Optional modules are covered in Section 6. Block Diagram Description should be read first to get an understanding of the overall functioning of the instrument. Simplified schematic diagrams are located in Section 8 (Section 6 for optional modules). Table 3-1 is a list of mnemonic definitions used in the Controller schematic.

#### 3-34. Controller

#### 3-35. TIMING

3-36. The 8080 microprocessor requires two 12V clock inputs whose phase relationship must fall within certain limits (Figure 3-9). The period of the  $\phi_1$  clock (588 nsec) governs the duration of a machine state (3 to 5 states required for a machine cycle, 1 to 5 machine cycles required for an instruction cycle). A 1.7 MHz crystal oscillator is RC coupled through buffers and gates to provide the two-phase clock signal. R1 controls the positioning of the  $\phi_1$  clock pulse (with respect to time) during the  $\phi_2$  pulse. The  $\phi_2$  clock pulse is inverted and translated to 5 volt TTL levels for other timing functions in the control circuitry.

3-37. Shaped line pulses are applied to a phase-locked loop (U26) which runs at 8 times the line frequency 480 Hz for 60 Hz line, 400 Hz for 50 Hz line). The output of U26 is divided by 8 (U34) and applied to a phase comparator (U26). Line synchronization is achieved using the output of the phase-locked loop to time the internal interrupt, MARK INT.

#### 3-38. ADDRESS and DATA BUSSES

3-39. Sixteen address lines are used for addressing memory locations and external modules. Refer to the Controller schematic in Section 8. Internal scratch pad memory locations use A0-A7, with A8, 9, 11, 12, 13 decoded as a RAM chip select. Internal ROM locations use A0-A10, A11, 12, 13 decoded as a ROM chip select. ROM/RAM select uses A14 for RAM (high for RAM). External addresses use A8-A14 with A15 used as external/internal select (high for external). These address lines are inverted when driving the IC lines on the Interbus. The data bus is eight lines (DB0-7) connected directly to memory and to the external data bus (ID0-7) through tristate I/O buffers.

**Table 3-1. Mnemonic Definitions**

ACK	— acknowledge
ACK LAT	— acknowledge late
AR	— analog return
DB	— data bus
DBIN	— data bus input signal (from $\mu$ P)
DLD ACK	— delayed ACK
EN INT	— enable interrupt
HLDA	— hold acknowledge
IB ADX	— interbus address
IBIN	— interbus input signal
IC	— interbus control
ID	— interbus data
IINT	— internal interrupt
INA	— interrupt acknowledge (from controller)
INT	— interrupt
INTA	— Interrupt acknowledge (status word from $\mu$ P)
INTE	— interrupt enable (from $\mu$ P)
MEM RD	— memory read
MS ADDR BYTE	— memory select address byte
$\phi_1$	— clock pulse
$\phi_2$	— clock pulse
$\phi_{LL}$	— phase-locked loop
RAM	— random access memory
ROM	— read only memory
RRDY	— reset ready
RST	— reset
RT	— real time
R/W	— read/write
$\mu$ P	— microprocessor
VA	— analog supply voltage
$V_{CC} \phi_2$	— 5V clock pulse
$V_{DD} \phi_2$	— 12V clock pulse
SRDY	— set ready
SYN IINT	— synchronized internal interrupt
TTL PU	— TTL pull-up
WO	— write out
WR	— write

#### 3-40. RESET

3-41. Shaped line frequency pulses are applied to U36 and U34 to provide a reset on power up or power down (Figure 3-10). U36 is a retriggerable one-shot multivibrator which is cleared on power up by Delayed Vcc. Clearing U36 sets U35 to the Reset condition. After the clear on U36 is

removed (Delayed V<sub>CC</sub> high), U34 clocks U35 out of the reset condition on the eighth line pulse. At power down, U36 changes state at a time determined by R18 and C22, setting U35 to the reset state.

### 3-42. STATUS LATCH

3-43. During the first state of every machine cycle, the microprocessor sends a status word out on the data bus. This is at the same time and duration as the SYNC output. SYNC  $\phi_2$  clocks the status word into a hex "D" latch, U18. Outputs from U18 (Figure 3-11) are used in various portions of the control circuitry.

### 3-44. WAIT LOGIC

3-45. When the microprocessor addresses an external module (A15 high) or is interrupted, the WAIT logic causes the microprocessor to enter a wait state by pulling the ready

(RDY) line low (Figure 3-12). Set Ready (SRDY), normally high, is pulled low to exit the wait state. Reset ready (RRDY), normally low, goes high to enter the wait state. For an external address, A15 TTL is high; therefore RRDY will go high at SYNC TTL (derived from the microprocessor). For interrupts, the interrupt enable (INTE) signal is inverted for application to U8. INTE enables INT and is removed before INT falls low (due to an RC delay in the INT CONTROL circuit) so the INT and INTE are high long enough to clock U1 for a wait signal.

3-46. Three possible combinations will cause the microprocessor to exit a wait state. If an ACK signal is missing, ACK INT TTL will pull SRDY low. For external addresses, and external interrupts, A15 + INTA and ACK LAT will pull SRDY low. For internal interrupts SYN IIINT and INTA

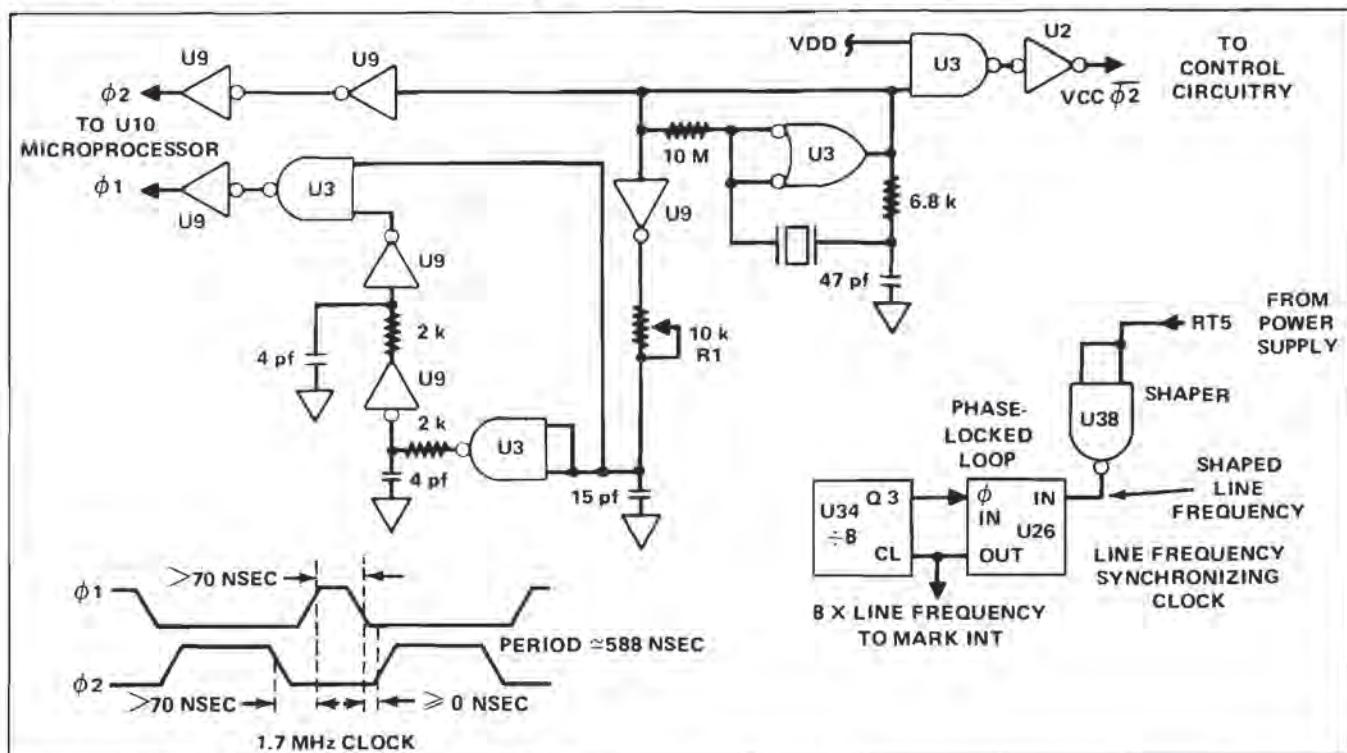


Figure 3-9. Timing Circuits

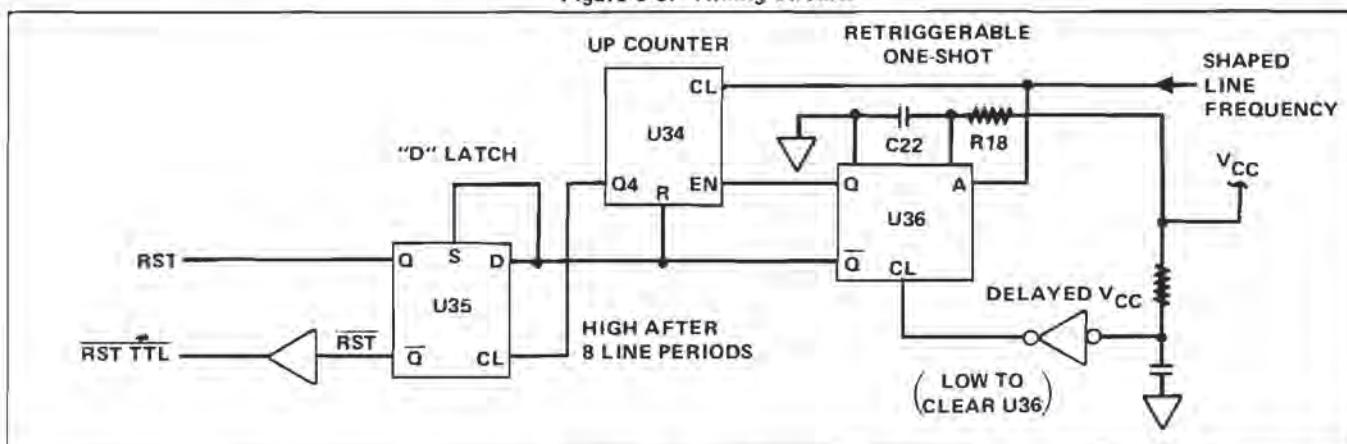


Figure 3-10. Reset Logic

remove the wait state limiting the wait time to a single machine state.

### 3-47. ACK LOGIC

3-48. When a module is addressed by the Controller, or enabled for interrupt identification by INA from the Controller, it must return an ACK (high) signal. Refer to Figure 3-13. Either INTA (for interrupts) or A15 (for external addresses) together with the delayed ACK signal produce DLD ACK for U38, DLD ACK resets the ACK interrupt logic, which is timing the wait for ACK, and produces the ACK LAT signal through U15 and U27. RRDY must be low to get ACK LAT. This synchronizes ACK LAT to the SYNC TTL signal. ACK LAT (or ACK INT TTL if an ACK is missing) causes the microprocessor to exit the wait state.

### 3-49. INTERRUPTS

3-50. Two internal interrupts and four possible external interrupts are applied to the interrupt (INT) control logic (Figure 3-13). A low on OR gate U17 places a high on NAND gate U38. When INTE is high from the microprocessor (during the last state of an instruction cycle), U38 outputs a low through an RC delay network to U32. U32 inverts the signal and places a high on the INT line to interrupt the microprocessor. The microprocessor drops INTE low, then puts out an interrupt acknowledge (INTA) as a status word which is latched up in the Status Latch, U18. Then the microprocessor enters a wait state until the interrupt and its priority are identified through INT VECTOR, U28 (Controller schematic, Section 8).

3-51. Internal interrupts are ACK INT and MARK INT (Figure 3-14). ACK INT logic consists of a retriggerable

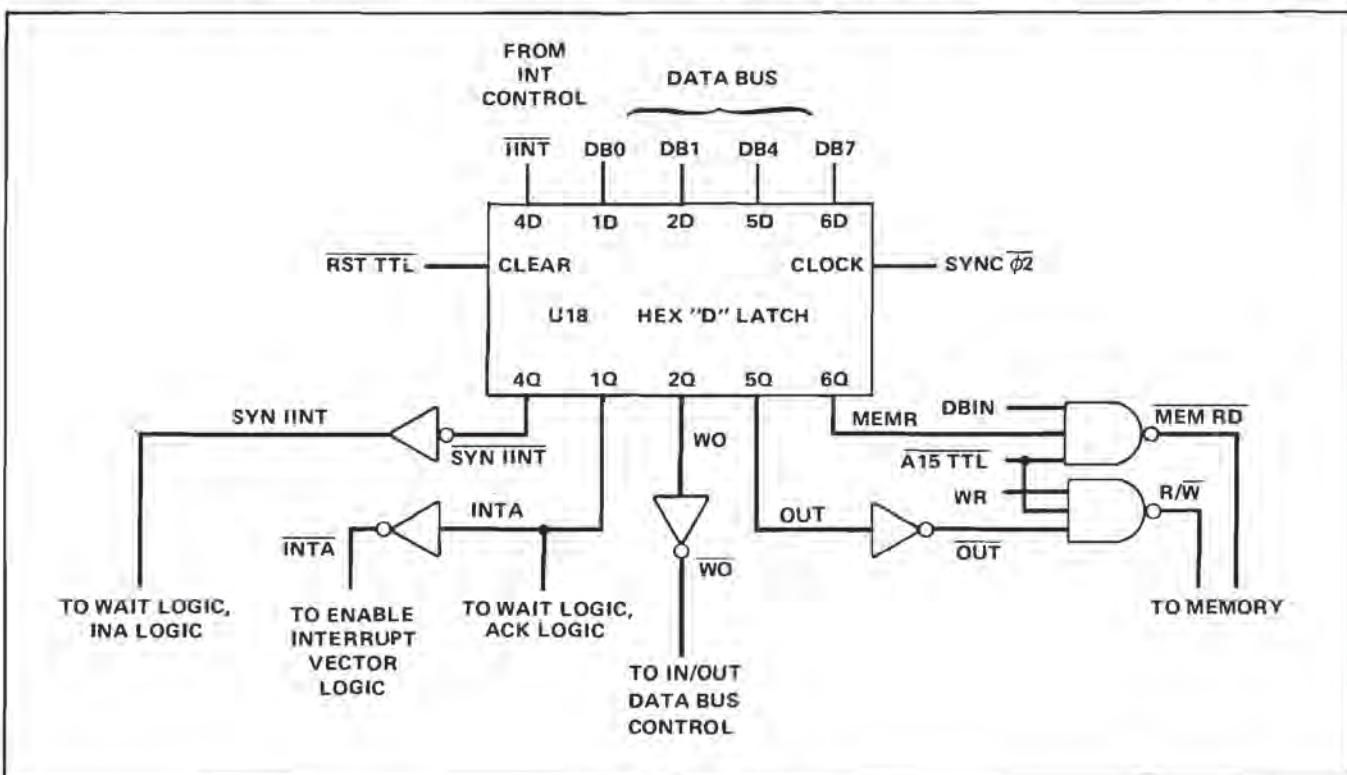


Figure 3-11. Status Latch

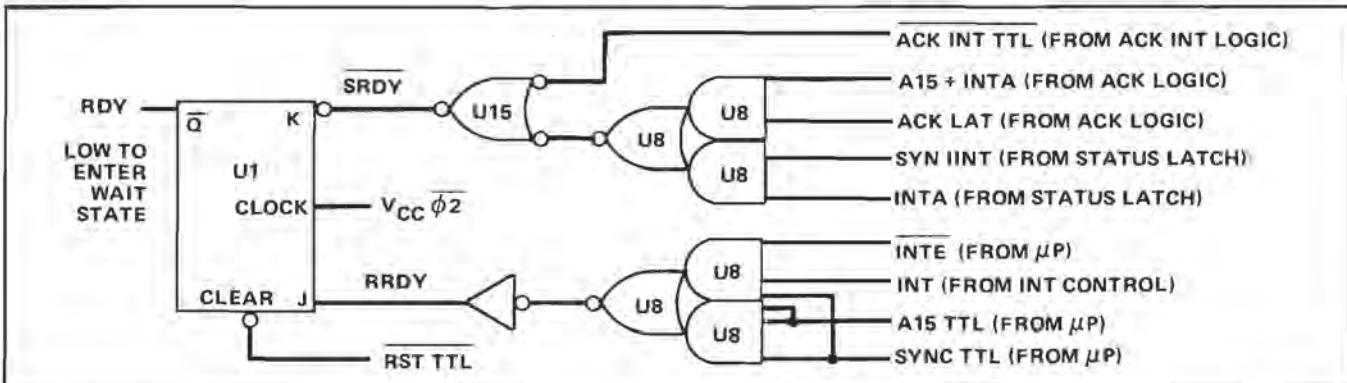


Figure 3-12. Wait Logic

monostable multivibrator, U36, and a "D" type flip-flop, U14. U36 is triggered by A15 TTL and SYNC  $\phi_2$ . If DLD ACK does not occur within the time constant of U36, U36 will clock U14 to generate ACK INT. ACK INT TTL is also generated by U14 to end the wait state resulting from the external address.

3-52. The MARK INT logic is armed by an internal address keyed to RAM. A15 TTL is high indicating an internal address. DB4 is high as part of the status word indicating an address to an output device. A15 TTL and DB4 (both high) with SYNC  $\phi_2$  clock U1 through U31-12. A14 is low for a RAM address so U1-7 is clocked high. Although the address which arms the mark is keyed to RAM, no data transfer takes place between the microprocessor and RAM. The write signal (R/W) is disabled by OUT from the STATUS LATCH. MEM RD (memory read) is disabled by DBIN (from the microprocessor) and MEMR

(from the STATUS LATCH) both being low. After ARM MARK (U1-7) is clocked high, the next pulse from the phase-locked loop timing circuit clocks U14 to generate the MARK INT signal.

3-53. Interrupts are prioritized through INT VECTOR (refer to Controller schematic, Section 8). Before entering a wait state after an interrupt, the microprocessor puts out a DBIN signal, signifying that it is ready to receive data. DBIN and INTA produce EN INT through U37 to enable the Interrupt Vector (U28). Internal interrupts are applied directly to U28 and have priorities of one (highest) for ACK INT and six (lowest) for MARK INT. For an internal interrupt, IINT is generated by one section of U38 (Figure 3-13) and, when latched into the Status Latch (U18), is used to end the wait state. For an external interrupt, SYN IINT is low and with EN INT low, INA is generated on the interbus. The interrupting module must respond with an

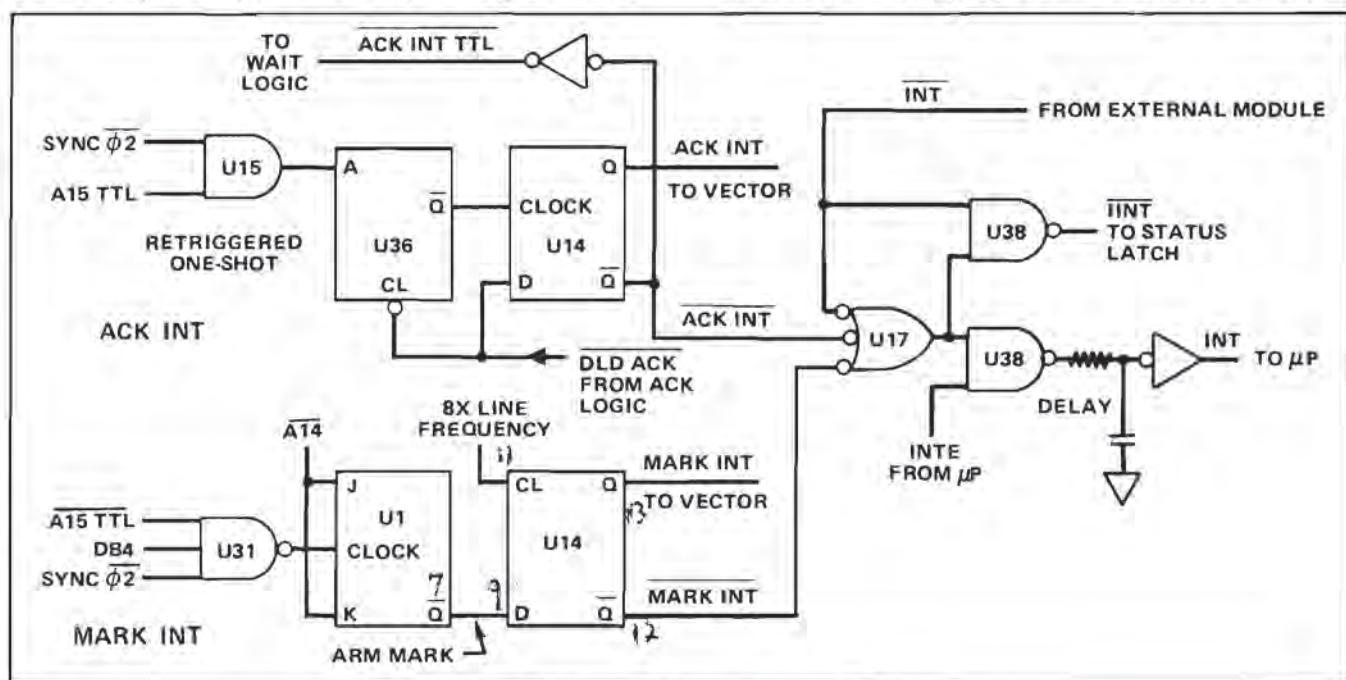


Figure 3-13. Internal Interrupts and INT Control

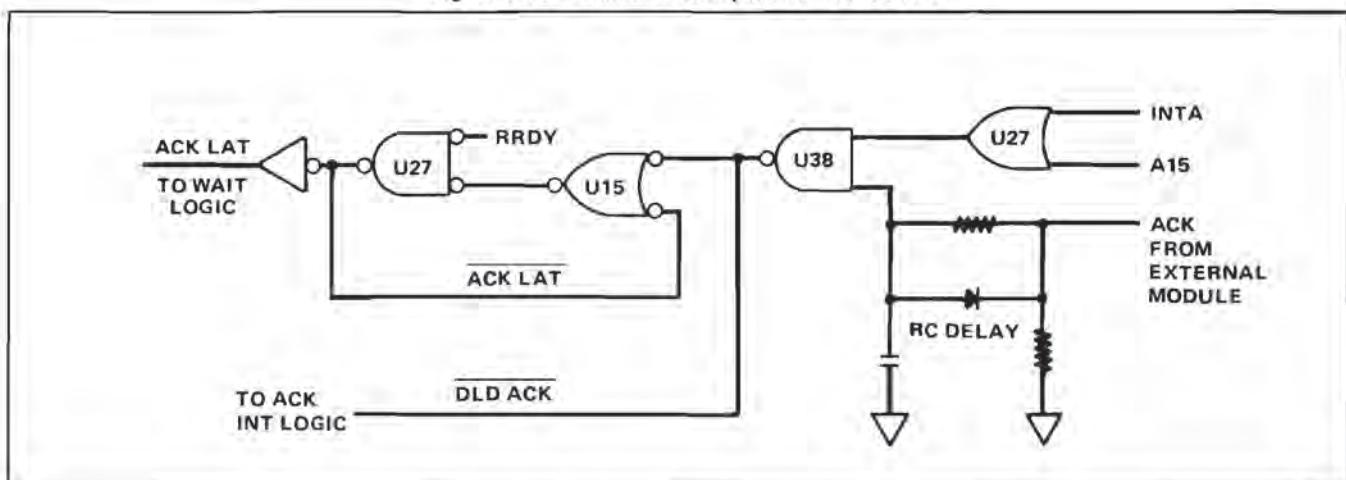


Figure 3-14. ACK Logic

ACK and a data bit on ID1-4. The returned ACK ends the wait state and the data bit is applied to INT VECTOR, U28. The complement of the output from U28 is placed on the data bus to instruct the microprocessor where to go for the next instruction.

### 3-54. Front Panel

3-55. Annunciator segment data is clocked into register one by the direct address, IC0, 1, 5 high. Refer to Figure 3-15. Data output from the switch matrix is also a direct address—IC0, 1, 6 high. For either direct address, the condition of ID7 (high for disable) is latched into U23 to enable an indirect address. Digit segment address—IC1, 5 high, and digit-annunciator select address—IC0, 5 are both indirect addresses. Data is clocked into the registers upon termination of the address. An update sequence is as follows:

1. Register one is addressed with all data lines low to blank the annunciator display and enable indirect addressing.
2. Register two is addressed indirectly with data lines low to blank the digit display.
3. Register three is addressed indirectly with all data lines high to turn off all LEDs, disable the switch matrix, and disable indirect addressing.
4. Register one is addressed with ID7 low to enable indirect addressing and with annunciator segment data on ID0-6. The data is latched and applied to the annunciator LEDs.
5. Register two is addressed with digit segment data on ID0-7 (U23 is not clocked by this address so ID7 may be high without disabling indirect addressing). The data is latched and applied to the digit LEDs.
6. Register three is addressed with ID7 high (disable indirect addressing) and one of the data lines, ID0-6, low to enable one digit LED and one annunciator LED. One bank of the switch matrix is also enabled.
7. The output buffer is addressed enabling the data from the previously enabled switch bank to be placed on the data bus. One or more lines low indicates a change is desired. This address also keeps the kill circuit charged.

3-56. The seven steps just outlined are required for one digit-annunciator-switch bank update. The process is repeated seven times for a complete update. The kill circuit is used to blank the display if the Controller discontinues addressing the front panel. Otherwise, segments would be left on continuously and would soon burn out.

### 3-57. DC Signal Conditioner

3-58. Relays K1 and K2 control the input to the DC Signal Conditioner and the attenuation of the input (Figure

3-16). If both relays are energized, the input is from the Volt/ $\Omega$  input terminals with  $\pm 64$  attenuation. If just K1 is energized, the input is from the Volt/ $\Omega$  input terminals with no attenuation. If just K2 is energized, the input is from RT1 (optional signal conditioners). Q10, Q11, CR3, and CR4 provide overvoltage protection.

3-59. A differential amplifier (Q18, Q19) drives U3. FET switches (Q14, Q15, Q16) control the gain of Q18, and Q37. An output voltage swing of  $\pm 20V$  is achieved through bootstrapping; U4 provides a bootstrap for Q38 and Q37, and U5 and U6 provide a bootstrap for U3 and U4. Current sink and source for Q18 and Q19 are provided by Q38 and Q37 respectively.

3-60. The DC Signal Conditioner is addressed by IC0, 3, 4 high. Data on ID0-3 is latched up and decoded to determine which switches and relays will be energized. Figure 3-16 includes an example of the relay driver used to minimize thermal changes in the relays between the on and off states. RC coupling between the decoder and the relay driver provide voltage swings up to 4V or down to 0V to ensure positive relay action. Steady state voltages of 1.45V (off) and 2.75V (on) minimize current differences between the on and off states while maintaining the relay state under all conditions.

### 3-61. Filter/External Reference

3-62. All inputs to the A/D Converter are routed through the Filter/External Reference module. Refer to Figure 3-17. External reference measurements are made by multiplexing the three Filter module inputs to the A/D Converter. Q18, Q19, and Q20 switch the signal conditioner input, the external reference LO input, and the external reference HI input respectively. Data controlling the switches is latched into U1 upon termination of the address (IC1, 3, 4 high).

3-63. Three-pole, active Bessel filters (U3 and U4) have different settling times and cut-off points. Either filter may be selected from the front input panel for application to the signal conditioner input. Bypass is automatically selected for external reference inputs or may be remotely selected for signal conditioner inputs. The combination of Q32, Q25, Q23, Q24, or Q21, Q22 is turned on to select a filter mode.

3-64. A dual, super-beta transistor in a differential configuration (Q27) drives U5. A current source (Q26) and sink (Q30) bias Q27. Enough current is drawn through R19 by Q26 to bootstrap the input amplifier, Q27, 5V above the output. Gain of the amplifier is set at one by the combination of R21 and the input resistors. The external reference inputs have additional series resistors located at the rear panel terminals.

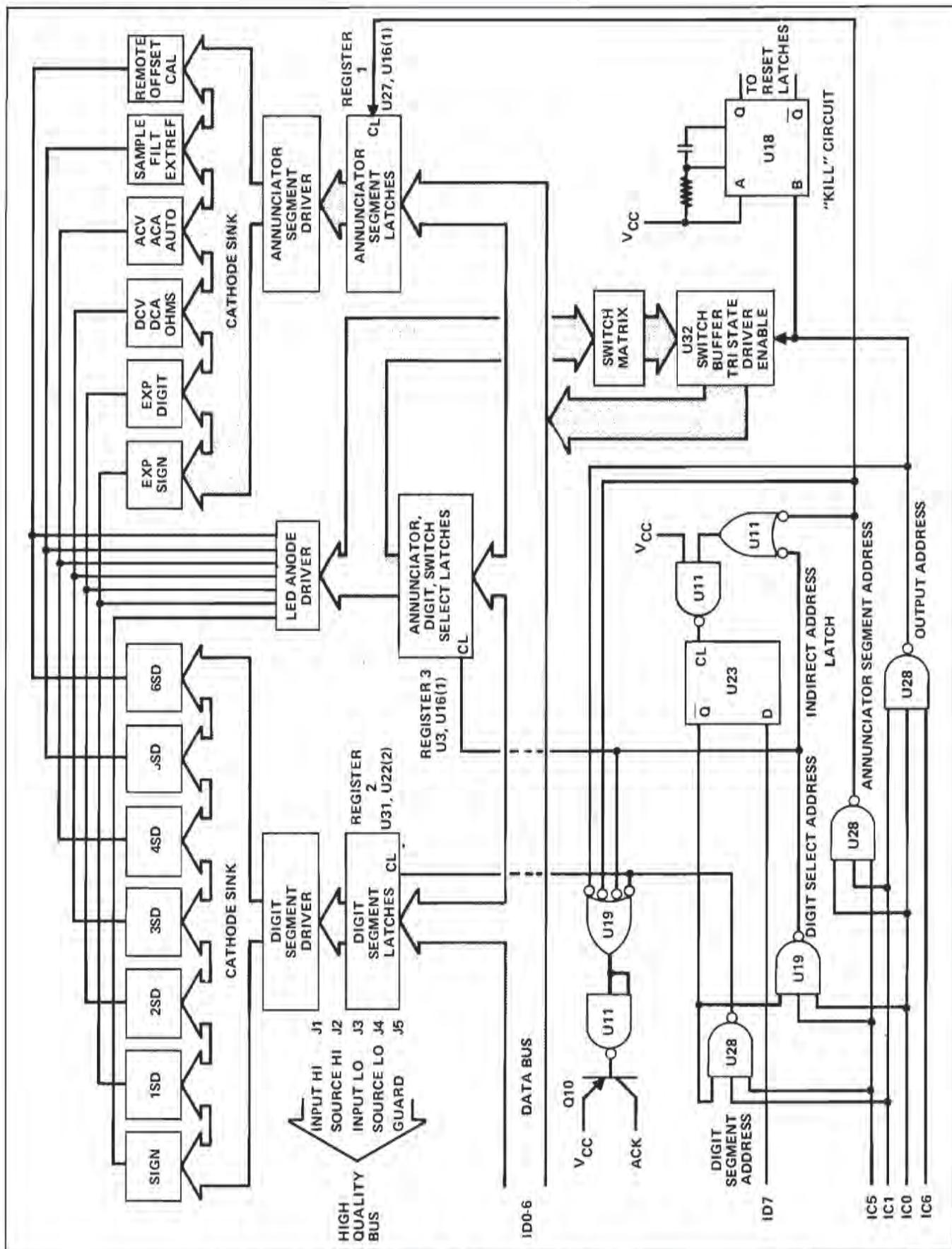


Figure 3-15. Front Panel

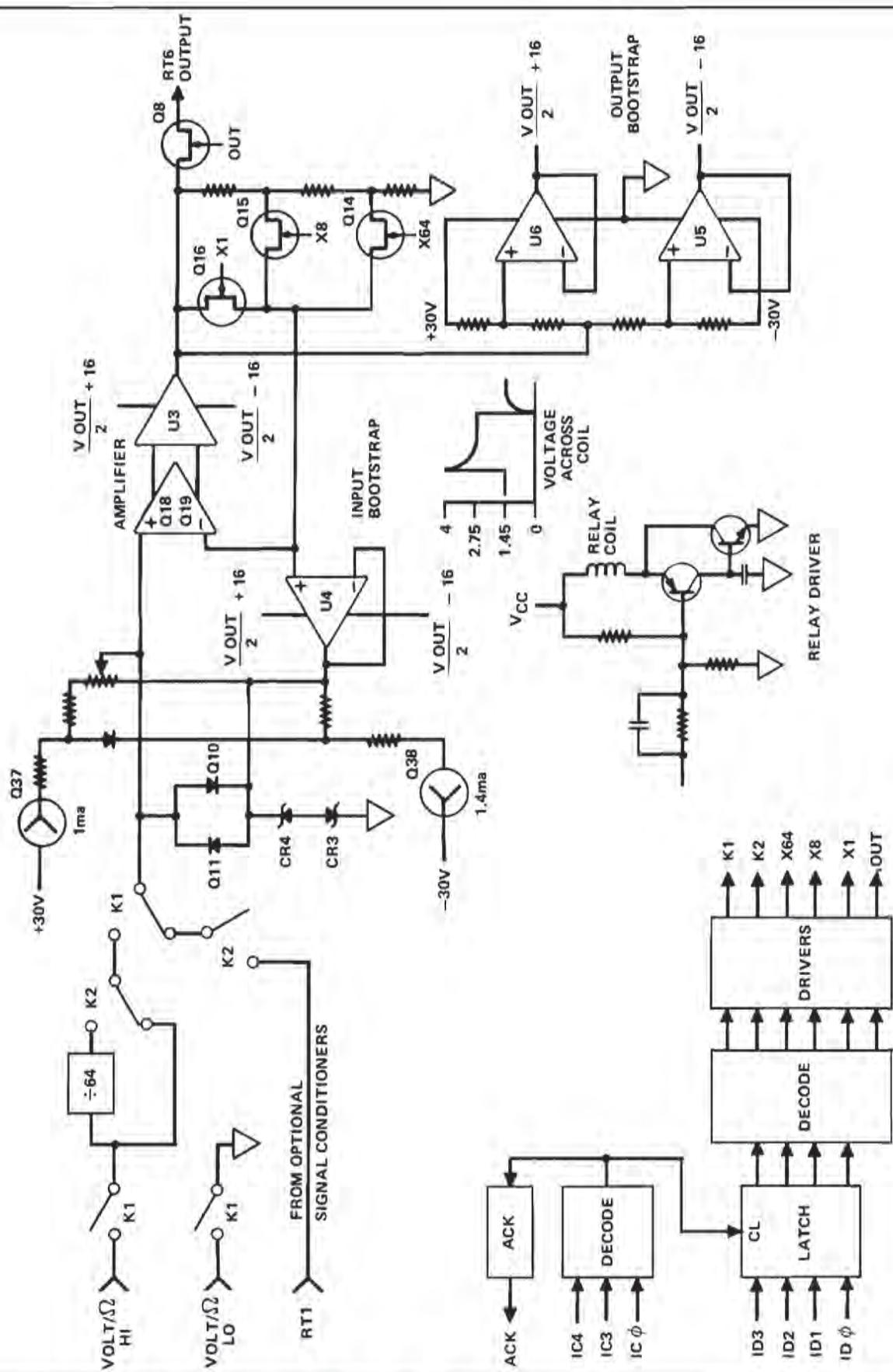


Figure 3-16. DC Signal Conditioner

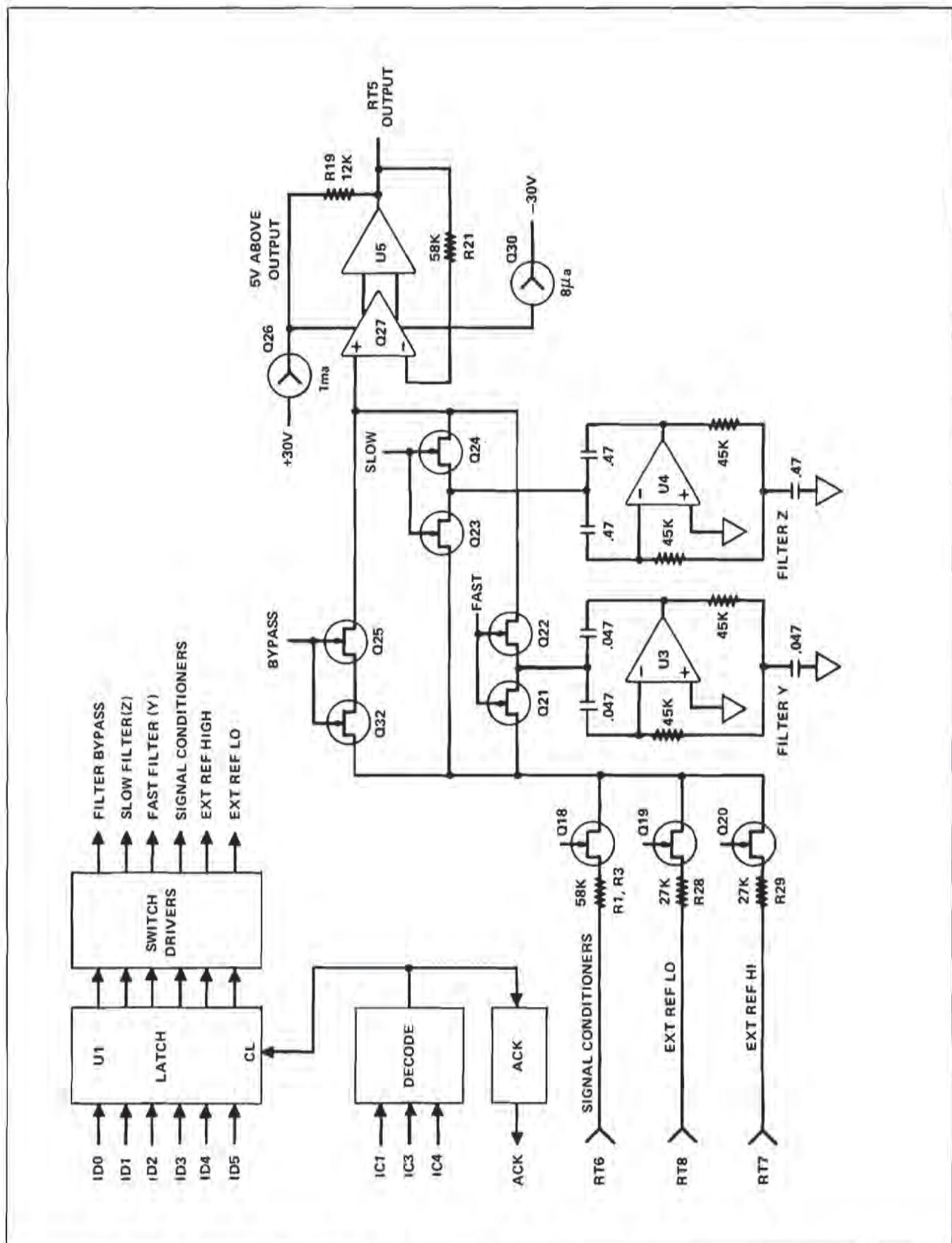


Figure 3-17. Filter/External Reference

### 3-65. Fast R<sup>2</sup> A/D Converter

3-66. The Fast R<sup>2</sup> A/D Converter may be separated for analysis into two component groups: Analog and Digital. Analog circuitry is responsible for producing a voltage reference, for summations, and for remainder amplification and storage. Digital circuitry interfaces the analog circuitry to the Controller and is responsible for reference selection, decisions in the summation process, remainder channel control, and autozeroing. Since functions within the A/D Converter are either directly controlled by the Controller module via the data bus or are clocked through their operations by the Controller addressing the A/D module, the A/D conversion program could be considered a functional part of the A/D Converter.

#### 3-67. ANALOG

3-68. Figure 3-18 is a simplified schematic of the analog portion of the A/D Converter. For clarity, switches are shown as a circle enclosing a letter designator. U1 is a reference and reference amplifier controlling U2, a current source. The -7V reference is set by R9 and R14. U3 serves as a highly regulated collector and zener supply for U1. Operation of the A/D Converter requires both a positive and negative reference (for negative and positive inputs, respectively). Q9 and U4 are a precision unity gain amplifier whose input is controlled by switches A1 and A2. With A1 open and A2 closed, Q9 and U4 are configured as an inverting amplifier producing a positive reference. With A1 closed and A2 open, Q9 and U4 are a noninverting amplifier.

3-69. An input signal is applied to the summing node of the remainder amplifier (Q27, U7) through switch I. Q27 and U7 are an inverting amplifier with two gain configurations. During the decision period, switch G is closed, applying the output of U7 to polarity detector Q28 and forming a feedback path through CR5 and CR6. Q28 sends a polarity bit to the digital portion of the circuitry. On the basis of this first polarity bit, a reference polarity is selected.

3-70. Switches B, C, D, E, and F are closed, one at a time, to switch a precise amount of current into the summing node. When a switch is closed, the opposite switch is opened and vice versa. For example, when D is closed, D is opened. After a switch is closed, a polarity bit is returned. If the polarity changed with respect to the original polarity selected for a step, the switch is opened; otherwise it is left closed. The next switch is closed, a polarity bit returned and a decision made, and so on until all five switches have been closed (and possibly opened again). This constitutes a decision period.

3-71. Following the decision period is the subtraction period. Switch G is opened and switches X and SX are closed

to form a feedback path for the remainder amplifier through the X channel. A 400K resistor, R35, sets the gain of Q27 and U7 at sixteen. The feedback current completes the summation process and the amplified remainder is stored on C10 in the X channel.

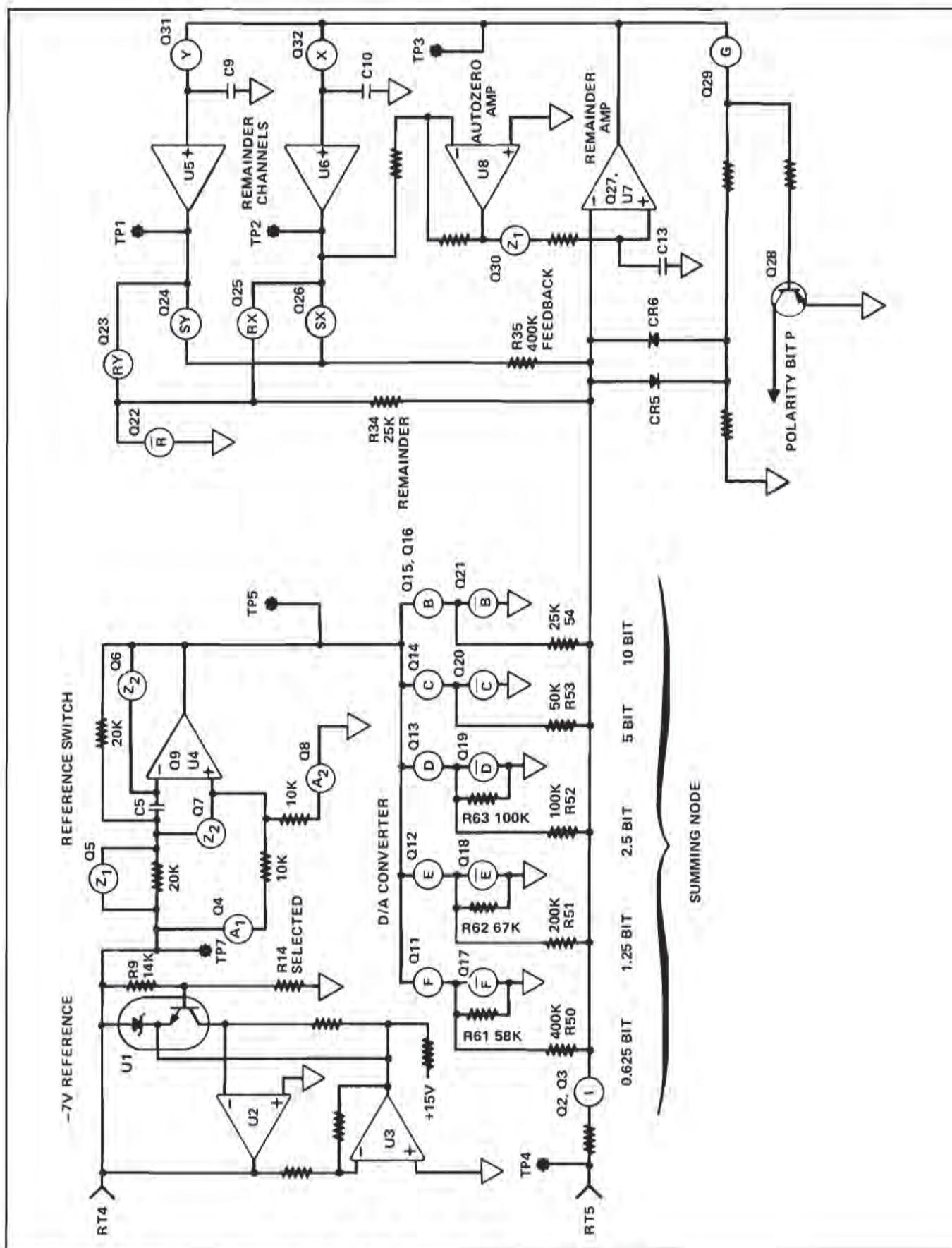
3-72. For the next decision period switches SX and X are opened and switches RX and G are closed. Since Q27 and U7 form an inverting amplifier, the opposite polarity reference from the original selection is automatically selected. The amplified remainder is applied to the summing node through U6 and R34. Five decisions are made, followed by a subtraction period using channel Y for feedback and remainder storage. The first decision-subtraction period applies the input signal to the summing node. The four following steps apply an amplified remainder, alternating between channel X and channel Y.

3-73. When a sample is complete, the circuits are auto-zeroed. U8 zeros the remainder amplifier through channel X. Any offset is stored on C13 at the noninverting input of Q27. The switching reference, Q9 and U4, is zeroed by first closing A1 and opening A2 to decrease settling time. Then A1 and A2 are both opened and the Z1 and Z2 switches are closed, storing any offset error on C5.

#### 3-74. DIGITAL

3-75. For the following discussion, refer to the Digital Fast R<sup>2</sup> A/D schematic in Section 8. Direct address IC2, 3, 4 latches data into U34 and U35 controlling input switch I, remainder channel switches, autozero, and reset (digital). U31, a ring counter, is clocked to the C1 state enabling the indirect address decoder (U33) and the polarity detector (switch G). A polarity bit is returned and applied to U6.

3-76. Indirect address IC1, 2 latches the polarity bit in U6, enables the tristate transmitter, U5, and clocks U31 to the C2 state. The transition of U31 from C1 to C2 clocks the polarity into U11 (the uppermost section) whose output determines whether switch A1 or A2 will be closed (reference polarity). At the same time, U1 (uppermost section) is clocked to set the other section of U11, closing the first reference switch, B, of the A/D Converter. The next indirect address clocks a new polarity bit (a result of closing the first reference switch B) into U6. If the polarity changed, the output of U6 will cause a reset of the previous switch latch, opening the previous switch. At termination of the address the next switch is closed. One direct address and six indirect addresses are required to complete a step. The last indirect address resets the control logic to the C0 state.

Figure 3-18. Fast  $R^2$  A/D Converter (Analog)

3-77. Switch selections are made through switch drivers which rely on Vcc and Vss being at -15V and -20V with respect to analog common. This allows simple transition from TTL levels to FET off voltages. D/A Converter switches are selected on transition of U31 from one state to the next. The transition clocks the first of two "D" flip-flops which sets the second. The output of the second latch resets the first and selects the switch. If the polarity does not change after closing a switch, the output of U6 plus the output of U11 (reference select) will place two highs on the input of one section of AND gate U25. Through OR gate, U16, a one will be applied to the D input of that switch latch. The next transition of U31 will clock

the latch, keeping the switch closed. If the polarity had changed, a zero would be applied to the D input, opening the switch.

3-78. After the last step, at completion of a sample, the Controller addresses the A/D Converter for autozero. U31 is clocked to the C7 state causing a digital reset. When U6, storage capacitor disable, is reset, autozero is enabled. RC coupled gates delay the zero switch controls so that switch A1 may be closed and A2 opened in the reference switching circuit. This provides a faster settling time for the reference switching amplifier. Both A1 and A2 are opened during the autozero time.

## Section 4

# Maintenance

### WARNING!

**THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.**

### 4-1. INTRODUCTION

4-2. This section of the manual contains performance tests, calibration procedures, and maintenance information including general maintenance and troubleshooting. Calibration intervals may be determined by the user according to the accuracy desired (specifications are listed in Section 2). One year is the recommended maximum calibration interval. Test equipment recommended for performance tests, calibration adjustments, and troubleshooting is listed in Table 4-1. If the recommended equipment is not available, equipment of equivalent specifications may be used.

### 4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of 1 year upon delivery to the original purchaser. The warranty terms are located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of domestic service centers is located in Sec-

tion 7 of the manual. Shipping information is given in Section 2. If requested, the customer will be provided an estimate before any work begins on instruments that are beyond the Warranty period.

### 4-6. GENERAL MAINTENANCE

#### 4-7. Line Voltage Selection

4-8. Input line voltage is switch selectable between 115V ac and 230V ac (check Section 2 for line voltage and frequency limitations). Removal of the top cover of the instrument allows access to the switch, located in the left front corner on the power supply board. Turn off the power and disconnect the line cord before removing the cover.

#### 4-9. Fuse Replacement

4-10. The line fuse (MDL .5A) is found near the heat sink, on the rear panel. On the front panel, the front input current/ohms protection fuse (AGC 1.5A) is located in the lower right corner.

Table 4-1. Test Equipment

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC Source	High Short-Term Stability Range: 0 – 1100V	Fluke Model 335A
Null Detector	10 $\mu$ V Full-Scale Resolution	Fluke Model 335A
Reference Divider	$\pm .001\%$ Division Accuracy	Fluke Model 750A
Kelvin-Varley Divider	Linearity: $\pm .1$ PPM of Input	Fluke Model 720A
Standard Cell Enclosure	Guildline 91	Guildline 9152 (R)
Oscilloscope	General Purpose with 10M $\Omega$ Probe	Tektronix 465
Digital Multimeter	Voltage Accuracy: .01% Input Impedance: 1000 M $\Omega$	Fluke Model 8800A
Low EMF, Shielded Connector Cables	Gold-plated Spade Lug Connectors	
Extender Card		Fluke Model MIS-7011K
Bus Monitor		Fluke Model MIS-7013K
Static Controller		Fluke Model MIS-7190K
Test Module		Fluke Model MIS-7191K
<b>AS REQUIRED BY INSTALLED OPTIONS</b>		
AC Calibration System	Voltage Range: 0 – 1000V ac Frequency Range: 10 Hz – 300 kHz Accuracy: 10 Hz – 30 Hz: .1 % 30 Hz – 20 kHz: .02% 20 kHz – 100 kHz: .05% 100 kHz – 300 kHz: .33%	Fluke Model 5200A with Fluke Model 5215A or with Fluke Model 5205A
Current Calibrator with 200 k $\Omega$ Resistor	Accuracy: $\pm .02\%$ $\pm .01\%$	Fluke Model 382A
Standard Resistors	10 $\Omega$ at 30 ppm; 100 $\Omega$ , 1.9k $\Omega$ , 10k $\Omega$ , 100 k $\Omega$ , 250k $\Omega$ , 1 M $\Omega$ , 4 M $\Omega$ at 10 ppm; 10 M $\Omega$ at 50 ppm; 100 M $\Omega$ at 100 ppm	ESI SR-1010 ESI SR-1050
Terminating Load	1 M $\Omega$ $\pm 10\%$ /0.22 $\mu$ F Nonpolarized Parallel Load	

#### 4.11. Module Installation and Removal

4.12. Use the following procedure for module installation or removal.

1. Turn off the power and disconnect the line cord.
2. Remove the instrument's top cover.
3. The 8502A allows some choice in the placement of modules. For example, the ohms converter (Option 02) may be placed in slot A, B, C, or D. But the A/D converter will only function in slot H. A complete listing of preferred and permissible slots is offered in Figure 8-2. Slots A – N run from front to rear. Figure 8-1 provides accurate information on slot location (e.g., J11C, J12C, and J13C form slot C). When installing any module, slide it vertically between the module guides and press firmly into place.

4. Open the hinged module top.

*NOTE*

*Make sure the leaf spring, attached to one half of the module shield, is resting firmly over the flange of the opposite half of the module shield.*

5. For removal, grasp the module at both ends and pull up. An end-to-end rocking motion may be used to free the module from the connector.

#### **4-13. Module Disassembly**

4-14. All modules in the 8502A are mounted in shielded cases which may be disassembled, using the following procedure. Avoid using excessive force to prevent breaking the plastic.

1. Pop open the lid by using the indentations at either end and lifting up. Hinge the lid back.
2. Orient the module with one of the guides up.
3. Press down on the end of the case half above the words "OPEN.. while pulling up lightly on the lip of the module guide and just separate that end.
4. Repeat step 3 for the other end.
5. Open the top of the module and the bottom catch will automatically come apart.
6. Press down on the top of the pcb while pulling out to free the pcb from the case half.

4-15. Use the following procedure for module reassembly.

1. Insert the pcb in the case half bottom first and lightly press down on the top to snap it in place.
2. Ensure that the spring shield connection is not caught behind the pcb.
3. Align the bottom center catch of the case halves, making sure the shields at either end fit together properly.
4. Close the two halves together, snapping the module guides closed.
5. Using a small screwdriver or similar tool, lift and position the leaf spring, attached to one half of the module shield, so that it rests firmly over the flange of the opposite half of the module shield.

#### **4-16. Front Panel PCB Removal and LED Replacement**

4-17. To remove the Front Panel PCB from the instrument for troubleshooting, repair, or LED replacement, use the following procedure:

1. Ensure that the power cord is disconnected from the 8502A.
2. Remove any shorting links from the input terminals.

3. Snap the bezel loose from the frame by depressing and pulling out the top lip. Remove it from the instrument.
4. Remove any defective LEDs from their sockets and replace.
5. If only LED replacement is required, reassemble in the reverse order. If removal of the Front Panel PCB is required, remove the top cover, remove the pcb retainer from the instrument, then unplug the front panel pcb from the motherboard and remove it from the instrument through the front framework.
6. Reassemble the Front Panel in the reverse order.

#### **4-18. Power Supply Removal**

4-19. Remove the Power Supply from the 8502A using the following procedure:

1. Ensure that the power cord is removed from the 8502A. Remove the top cover.
2. Remove the four screws positioned around the heat sink that secure the power supply to the rear frame.
3. Pull the Power Supply straight back, using a gentle rocking motion to disconnect it from the card edge connector on the interconnect pcb.
4. Reassemble in the reverse order.

#### **4-20. Power Supply Interconnect PCB Removal**

4-21. Remove the Power Supply Interconnect PCB from the 8502A using the following procedure:

1. Remove the Front Panel pcb and power supply as described above, if not already done.
2. Remove the three screws securing the interconnect pcb to the framework.
3. Disconnect the pcb's card edge connector from the motherboard connector. Lift the pcb out through the front framework, taking care not to damage the power switch.
4. Reassemble in the reverse order.

## 4-22. Motherboard PCB Removal

4-23. Remove the Motherboard PCB from the 8502A using the following procedure:

1. Remove the modules, the front panel pcb, and power supply interconnect pcb from the instrument if not already done.
2. Remove the eight screws that secure the motherboard to the bottom framework and lift the motherboard out through the front framework of the instrument.
3. Reassemble in the reverse order.

## 4-24. Cleaning Instructions

4-25. Periodically (at least every 90 days) clean the 8502A using the following procedure:

1. Ensure that the power is removed from the 8502A.
2. Remove the top and bottom covers from the instrument.
3. Disconnect the modules from the motherboard and remove them from the instrument.
4. Clean the interior of the 8502A using low pressure clean, dry air or a vacuum cleaner.
5. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.
6. Replace the modules and covers if access to the instrument interior is no longer required.

## 4-26. PERFORMANCE TEST

### 4-27. Introduction

4-28. The following paragraphs contain a performance verification test which compares the operation of the instrument to the specifications in Section 1 of this manual. The test may be used to verify calibration of the equipment between scheduled calibration periods or as an aid in troubleshooting.

4-29. The test equipment required for the Performance Test is listed in Table 4-1. If the recommended equipment is not available, replacements with equivalent specification may be substituted.

4-30. If the instrument does not meet the specifications listed in the Performance Test, either the calibration procedure or corrective maintenance should be performed, as determined by the symptoms. The test should be performed when the ambient temperature is between 18° and 28° Celsius and the relative humidity less than 75% to attain maximum accuracy.

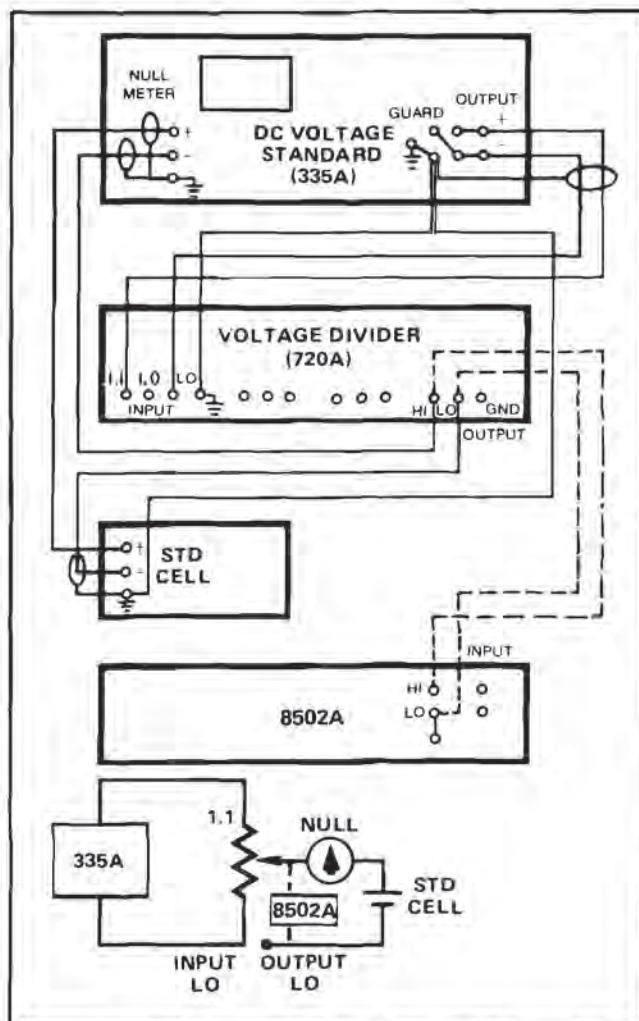


Figure 4-1. Connections For Low Range DC Voltage Tests

### 4-31. DC Performance Test

#### 4-32. LOW RANGE DC VOLTAGE TESTS

4-33. Perform the Low Range Tests as follows:

1. Connect the equipment shown with solid lines in Figure 4-1. Do not connect the 8502A at this time.
2. Verify that the test equipment is operating properly and their respective warmup periods, as stated in the applicable manuals, have expired.

3. Verify that the 8502A warm-up period of two hours has elapsed. Ensure that the VDC and AUTO indicators are illuminated, the SAMPLE indicator flashes approximately eight times per second (32 samples per reading), and all other indicators are extinguished.
4. Set the Voltage Divider controls for one-tenth the standard cell certified value. Adjust the DC Voltage Standard output for a null on the null meter.
5. Disconnect the leads at the Voltage Divider output terminals and connect the 8502A as shown with the broken lines in Figure 4-1.
6. Perform the test listed in Table 4-2, setting the Voltage Divider to the listed outputs. Do not change the output setting of the DC Voltage Standard. After voltage has been applied to the 8502A but prior to the first reading, toggle the instrument into manual ranging.
7. Reverse the leads at the 335A output terminals (lead previously connected to the HI terminal now connected to the LO terminal and vice versa) and repeat the test listed in Table 4-2, ensuring that the listed outputs are now negative.
4. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 10 volts.
5. Set the DC Voltage Standard to approximately 10 volts, then adjust its output for a null reading on the null meter.
6. The 8502A reading displayed is between +9.999 and +10.001.
7. Set the Reference Divider input and output controls to 100 volts.
8. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null reading on the null meter.
9. The 8502A reading displayed is between +99.997 and +100.003.
10. Increment the 8502A range manually to 1000 volts.
11. The 8502A reading displayed is between +99.99 and +100.01.
12. Set the Reference Divider input and output controls to 1000 volts.
13. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null reading on the null meter.
14. The 8502A reading displayed is between +999.97 and +1000.03.
15. Set the DC Voltage Standard to standby.
16. Reverse the leads at the DC Voltage Standard and standard cell terminals (lead previously HI to LO and vice versa).
17. Set the DC Voltage Standard to operate and repeat steps 4 through 15, ensuring that the listed outputs are now negative.

Table 4-2. Low Range DC Voltage Tests

RANGE	DIVIDER SETTING	8502A READING	
		LOW	HIGH
100 mV	.0010000	+ 9.995 (1-3)	+ 10.005 (-3)
100 mV	.0100000	+99.992 (-3)	+100.008 (-3)
1 V	.0100000	+ 0.09999	+ 0.10001
1 V	.1000000	+ 0.99997	+ 1.00003
10 V	.1000000	+ 0.9999	+ 1.0001
10 V	1.0000000	+ 9.9998	+ 10.0002

## 4-34. HIGH RANGE DC VOLTAGE TESTS

4-35. Perform the High Range Test as follows:

1. Connect the equipment as shown in Figure 4-2.
2. Verify that the test equipment is operating properly and any warmup period required has expired.
3. Verify that the 8502A warm-up period of two hours is complete. Ensure that the VDC function is selected with the VDC indicator illuminated and that the instrument is in manual ranging in the 100 volt range. The SAMPLE indicator should be flashing approximately eight times per second (32 samples per reading) and all other indicators should be extinguished.

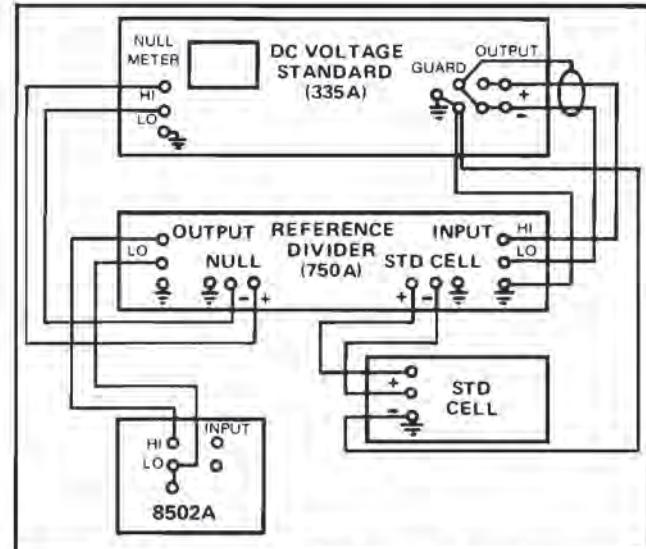


Figure 4-2. Connections For High Range DC Voltage Tests

## 4-36. AUTORANGING TEST

4-37. Test the autoranging capability of the 8502A with the following procedure:

1. Verify that the DC Volts and Autoranging modes are selected on the 8502A.
2. Connect the 8502A input directly to the DC Voltage Standard output.
3. Vary the output of the voltage source through its range, checking that the instrument autoranges approximately at the points indicated in Table 4-3.

Table 4-3. Autoranging

8502A CHANGES RANGE		NOMINAL READING
FROM	TO	
100 mV	1 V	312.5 mV
1 V	10 V	2.5 V
10 V	100 V	20 V
100 V	1000 V	160 V
1000 V	100 V	120 V
100 V	10 V	15
10 V	1 V	1.875
1 V	100 mV	0.234375

## 4-38. DC EXTERNAL REFERENCE

4-39. Test the DC four-wire true ratio, using the following procedure:

1. Connect the test equipment to the 8502A as shown in Figure 4-3.
2. Select the VDC function and Autoranging on the 8502A.
3. Set the DC Voltage Standard controls for +10.0000 volt output and the Voltage Divider controls to 1.000000.
4. Depress and hold the EXT REF switch. As long as the switch is held, the 8502A display reads the External Reference input of 10 volts (between 9.9998 and 10.0002).
5. Release the EXT REF switch. The 8502A computes the ratio ( $V_{IN}/V_{REF}$ ) and displays a reading between 0.99996 and 1.00004.
6. Set the Voltage Divider controls to 0.1000000.
7. The 8502A displays a reading between 99.995 (-3) and 100.005 (-3).
8. Depress the EXT REF switch to toggle the 8502A out of the External Reference mode.
9. Remove power from the test equipment and disconnect it from the 8502A.

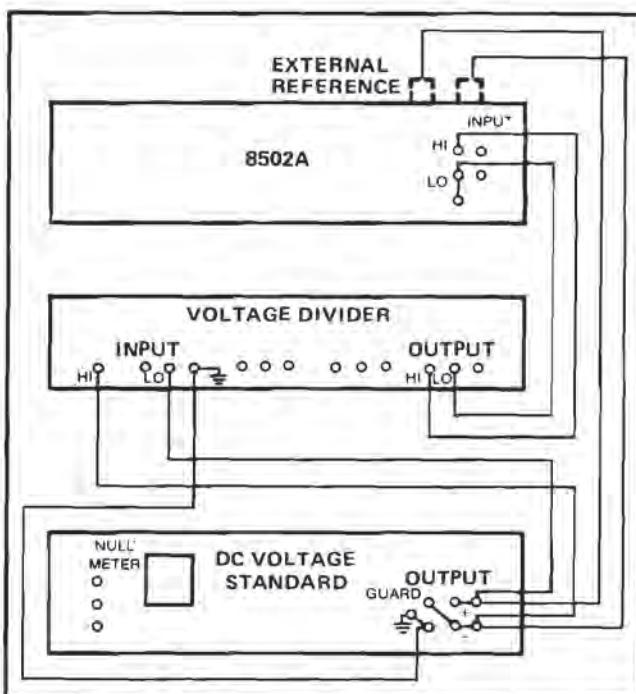


Figure 4-3. DC External Reference Test

## 4-40. CALIBRATION ADJUSTMENTS

## NOTE

The standards called out in the following procedure are required to meet the published accuracy specifications. If published accuracy is not required for a particular function (e.g., Resistance, DC Current, etc), standards with a lower rated accuracy may be used.

## 4-41. Introduction

4-42. The 8502A should be calibrated every 90 days or 1 year, as required to meet the applicable accuracy specifications. It should also be recalibrated any time that repairs are made to the instrument. When performing the calibration, the ambient temperature should be  $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$  and the relative humidity should be less than 75%. Refer to Table 4-1 for the recommended test equipment. Check the instruction manuals for the various pieces of test equipment for the correct warm-up periods. Power Supply adjustments are shown in Figure 4-4. Adjustments and test points on the remaining PCBs are accessible on the top edge of the board by popping open the hinged module top. Adjustments are labeled on the underside of the module top.

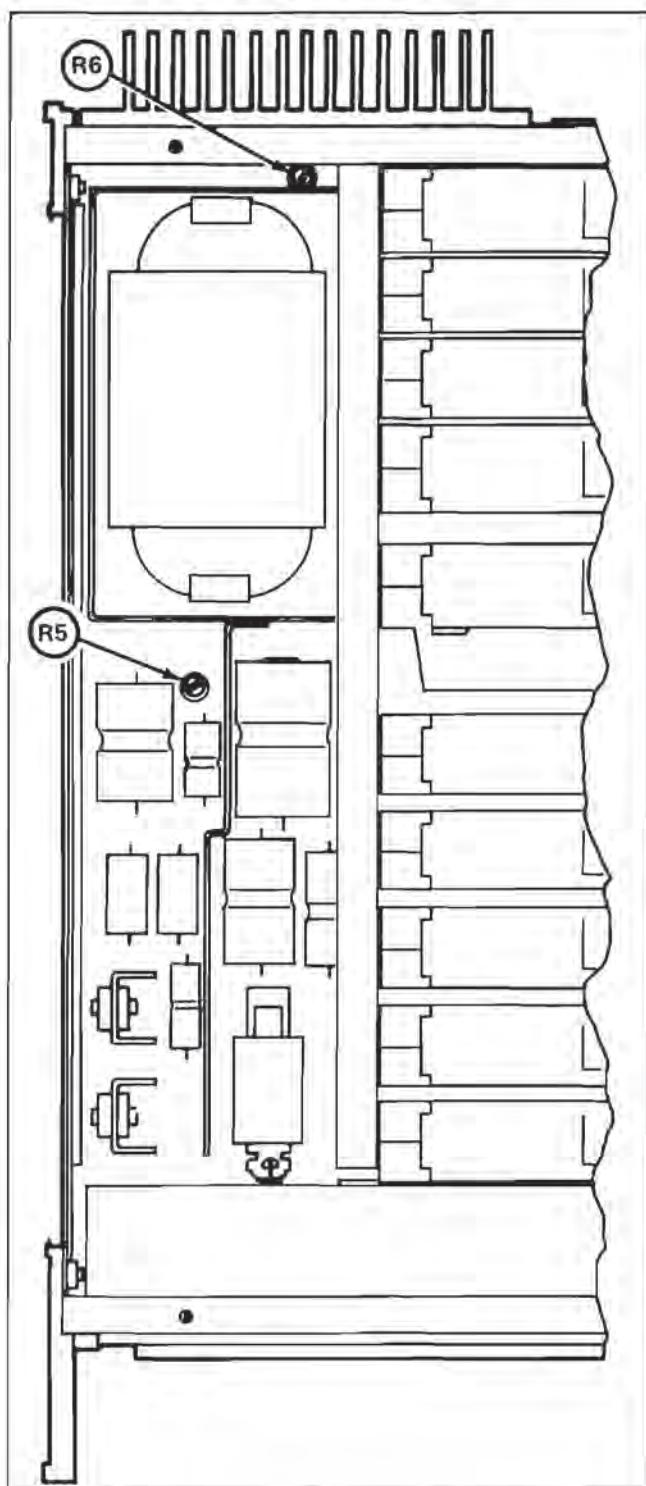


Figure 4-4. Power Supply Adjustments

#### 4-43. Initial Procedure

4-44. With the POWER switch OFF, replace the Isolator or Bus Interconnect, whichever is installed, with the Bus Interconnect and Monitor Board, MIS-7013K. Remove the CAL Memory if installed. After completing calibration,

reinstall the CAL Memory and enter new calibration factors (should be zeros). Set the POWER switch to ON and allow the instrument to warm-up for at least 1 hour before continuing with the calibration.

#### 4-45. Power Supply

4-46. Perform the Power Supply checks and adjustments as follows:

- CAUTION!**  
Do not use the 8502A to check its own supplies.
1. Connect the test DMM HI input to Vcc on the Bus Interconnect and Monitor Board and the LO input to Vss.
  2. Adjust R6 for a reading between +5.00 and +5.10V dc to set the Logic Supply.
  3. Transfer the HI DMM input lead to VA2.
  4. Adjust R5 for a reading between +5.00 and +5.10V dc to set the Analog Supply.
  5. Verify that the voltages in Table 4-4 are within the prescribed limits.
  6. Prepare the test DMM to read AC volts and verify that the voltage between LINE and Vss reads between 13 and 17V ac.
  7. Turn the POWER switch to OFF, remove the Bus Interconnect and Monitor Board, and return the Isolator or Bus Interconnect to the Instrument.
  8. Reapply power to the 8502A.

Table 4-4. Power Supply Verifications

TEST POINTS		VOLTAGE RANGE (Vdc)		SUPPLY
HIGH	LOW	FROM	TO	
V <sub>DD</sub>	V <sub>SS</sub>	+ 11.4	+ 12.6	Logic
V <sub>GG</sub>	V <sub>SS</sub>	- 11.4	- 12.6	Logic
VA1	AR	+ 14.25	+ 15.75	Analog
VA2	AR	- 14.25	- 15.75	Analog
VA3	AR	+ 29.7	+ 31.7	Analog
VA4	AR	- 29.7	- 31.7	Analog

#### 4-47. DC Calibration Procedure

4-48. There are two methods of performing dc calibration in the 8502A. If the Calibration Memory (Option -04) is installed, separate factors for each range and function may be entered from the front panel. This procedure is fully explained in Section 6. Alternately, dc calibration can be performed in the 100 mV range through the following adjustments on the DC Signal Conditioner module. If this procedure is followed, either the Calibration Memory

module must be physically removed or the stored memory factors must be removed. To remove these factors:

1. Place the CAL switch down (CAL LED on).
2. Apply a good quality short across the input terminals (INPUT SENSE HI to LO).
3. Press STORE for each range (manually select ranges with UP and DN switches).

**4-49.** The offset adjustment, R14, in the Active Filter does not require adjustment unless Q27 or U5 have been replaced. There are no other adjustments in the Active Filter. Refer to troubleshooting, Figure 4-9, in this section for adjustment procedures for R14.

#### 4-50. DC CONDITIONER ADJUSTMENTS

**4-51.** All adjustments and test points in the following procedures are on the DC Signal Conditioner. Perform the subtest, using the following procedure:

1. Select V DC, the 100 mV range, the slow filter (indicator on), samples per reading rate 7, and the CAL switch ON (CAL LED flashes).
2. Short the 8502A front input terminals.
3. Adjust R53 for a reading of exactly 0  $\mu$ V.
4. Remove the short from the input terminals and apply a  $1 \text{ M}\Omega/0.22 \mu\text{F}$  parallel load.
5. Adjust R52 for a reading between -0.002 and +0.002V dc ( $0 \pm 2 \mu\text{V}$ ).
6. Repeat steps 2 through 5 until both readings are present without an adjustment.

#### 4-52. A/D CONVERTER CALIBRATION PROCEDURES

**4-53.** Use the following procedures to calibrate the A/D Converter. All test points and adjustments are on the A/D Converter.

**4-54.** This paragraph contains the adjustment procedure for R64. R64 requires adjustment only if R54 in the tens bit ladder has been replaced during repair. Unless R54 has been replaced, go on to the next paragraph.

1. Connect the test DMM HI to TP7, LO to TP6.
2. Adjust R1 for a test DMM reading of -7.000X V.
3. Remove the test DMM.

4. Using the test connections in Figure 4-1, apply 10.10000 volts dc to the 8502A input terminals.
5. Adjust R64 for an 8502A reading of +10.10000  $\pm 5$  cal digits.
6. Continue with the following adjustments.

#### 4-55. A/D Zero Adjustment

**4-56.** Using the following steps to adjust auto zero in the A/D Converter:

1. Select the 10V range on the 8502A.
2. Short the 8502A input terminals.
3. Adjust R8 for a reading of 0.0000-0  $\pm 1$  cal digit.

#### 4-57. A/D Calibrator Settings

**4-58.** Prepare the DC Voltage Standard for use during the A/D Calibration using the following procedure:

1. Connect the equipment, as shown with the solid lines in Figure 4-1. Do not connect the 8502A at this time.
2. Set the Voltage Divider controls at one-tenth the standard cell certified value (standard cell value  $\times 0.1$ ).
3. Adjust the DC Voltage Standard output for a null on the null meter.
4. Record the dial setting of the DC Voltage Standard as "Control Setting A." This setting will be used later in the procedure, in addition to the following paragraph.
5. Disconnect the leads at the Voltage Divider output terminals from the null meter and standard cell and connect the 8502A as shown with the broken lines in Figure 4-1.

#### 4-59. A/D Ladder Adjustments

**4-60.** Use the following steps when adjusting the A/D Ladder:

1. Select the 10V manual range on the 8502A.
2. Set the Voltage Divider controls for a ratio of 1.0100000.
3. Adjust R1 for a reading between +10.0999-9 and +10.1000-1 ( $+10.1000-0 \pm 1$  cal digit).

4. Reverse the polarity of the dc voltage at the DC Voltage Standard for a negative input to the 8502A.
5. Adjust R2 for a reading between -10.0999-9 and -10.1000-1 (-10.1000-0  $\pm 1$  cal digit). If these adjustments cannot be made, perform A/D Converter Calibration Procedures.
6. Return the polarity of the dc voltage to a positive output from the DC Voltage Standard input at the 8502A.
7. Set the Voltage Divider controls for a ratio of .0500000.
8. Adjust R7 for a reading between +0.4999-9 and +0.5000-1 (+0.5000-0  $\pm 1$  cal digit).
9. Repeat steps 2 through 8 until all readings are within tolerance without making an adjustment.
10. Set the Voltage Divider controls for ratio of .5100000.
11. Adjust R6 for a reading between +5.0999-9 and +5.1000-1 (+5.1000-0  $\pm 1$  cal digit).
12. Set the Voltage Divider controls for a ratio of .2600000.
13. Adjust R5 for a reading between +2.5999-9 and +2.6000-1 (+2.6000-0  $\pm 1$  cal digit).
14. Set the Voltage Divider controls for a ratio of .1400000.
15. Adjust R4 for a reading between +1.3999-9 and +1.4000-1 (+1.4000-0  $\pm 1$  cal digit).
16. Set the Voltage Divider controls for a ratio of .0750000.
17. Adjust R3 for a reading between +0.7499-9 and 0.7500-1 (0.7500-0  $\pm 1$  cal digit).
18. Repeat steps 2 through 17 until all steps are within the stated tolerance.
3. Set the DC Voltage Standard for an output of approximately 100 volts and adjust its output for a reading between +19.9999-9 and +20.0000-1 on the 8502A.
4. Set the Voltage Divider controls for a ratio of .0000000 and verify that the reading is between -0.0000-1 and +0000-1 (0  $\pm 1$  cal digit).
5. Reverse the polarity of the dc voltage at the DC Voltage Standard for negative input to the 8502A.
6. Verify that the 8502A reads between -0.0000-1 and +0.0000-1 (0  $\pm 1$  cal digit).
7. Return the polarity of the dc voltage output from the DC Voltage Standard to a positive input at the 8502A.
8. Set the Voltage Divider controls to the settings listed in Table 4-5, verifying that the readings are within the tolerances listed in the table.
9. Reverse the polarity of the DC Voltage Standard output and repeat the steps in Table 4-5, checking that the reading is negative and within the listed tolerance.
10. Set the DC Voltage Standard for the "Control Setting A" recorded earlier.
11. Set the Voltage Divider controls for a ratio of 1.0000000.
12. Verify that the 8502A reads between +9.9999-9 and +10.0000-1 (+10.0000-1  $\pm 1$  cal digit).

Table 4-5. Linearity Checks

DIVIDER SETTING	READINGS		
	MINIMUM	NOMINAL	MAXIMUM
.0100000	0.9999-5	1.0000-0	1.0000-5
.0200000	1.9999-5	2.0000-0	2.0000-5
.0300000	2.9999-5	3.0000-0	3.0000-5
.0400000	3.9999-5	4.0000-0	4.0000-5
.0500000	4.9999-5	5.0000-0	5.0000-5
.0600000	5.9999-5	6.0000-0	6.0000-5
.0700000	6.9999-5	7.0000-0	7.0000-5
.0800000	7.9999-5	8.0000-0	8.0000-5
.0900000	8.9999-5	9.0000-0	9.0000-5
.1000000	9.9999-5	10.0000-0	10.0000-5
.1100000	10.9999-4	11.0000-0	11.0000-6
.1200000	11.9999-4	12.0000-0	12.0000-6
.1300000	12.9999-4	13.0000-0	13.0000-6
.1400000	13.9999-3	14.0000-0	14.0000-7
.1500000	14.9999-3	15.0000-0	15.0000-7
.1600000	15.9999-3	16.0000-0	16.0000-7
.1700000	16.9999-2	17.0000-0	17.0000-8
.1800000	17.9999-2	18.0000-0	18.0000-8
.1900000	18.9999-2	19.0000-0	19.0000-8
.2000000	19.9999-2	20.0000-0	20.0000-8

#### 4-61. Linearity Verification

4-62. Use the following procedure to check linearity for the 8502A:

1. Verify that the 8502A reading rate is set at 128 samples/reading and the 10V manual range is selected.
2. Set the Voltage Divider controls for a ratio of .2000000.

## 4-63. RANGE ADJUSTMENTS

**NOTE**

If the Calibration Memory option is included with the unit, refer to Section 6 for reinstallation and setup.

4-64. All adjustments and test points in the following procedure are on the DC signal conditioner. Perform the subtests using the following procedures.

4-65. Use the following steps to adjust the 100mV range:

1. Ensure that the DC Voltage Standard is set for "Control Setting A."
2. Set the Voltage Divider controls for a ratio of .0000000.
3. Select the 100 mV range on the 8502A.
4. If required, readjust R53, for a reading of  $0 \pm 0 \mu\text{V}$ .
5. Set the Voltage Divider controls for a ratio of .300000.
6. Adjust R49 for a reading between +299.999 and +300.001 ( $+300.000 \pm 1$  digit).

4-66. Use the following procedure to adjust the 1V range:

1. Select the 1V range on the 8502A.
2. Set the Voltage Divider controls for a ratio of .2500000.
3. Adjust R48 for a reading between +2.49999-9 and +2.50000-1 ( $+2.50000-1 \pm 1$  cal digit).

4-67. Use the following procedure to adjust the 100V range:

1. Connect the equipment as shown in Figure 4-2.
2. Select the 100V range on the 8502A.
3. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 100 volts.
4. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null on the null meter.
5. Adjust R47 for a reading between +99.999-9 and 100.000-1 ( $+100.000-0 \pm 1$  cal digit).

4-68. Use the following procedure to adjust the 1000V range:

1. Select the 1000V range on the 8502A and take the instrument out of the Cal mode by moving the CAL switch to OFF (CAL indicator extinguishes).
2. Verify that the 100 volt setting on the Reference Divider is still nulled.
3. The 8502A should read between +99.98 and +100.02 ( $+100.00 \pm 2$  digits).
4. Set the Reference Divider input and output controls to 500 volts.
5. Set the DC Voltage Standard to approximately 500 volts, then adjust its output for a null on the null meter.
6. The 8502A should read between +499.98 and +500.02 ( $+500.00 \pm 2$  digits).
7. Set the Reference Divider input and output controls to 1000 volts.
8. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null on the null meter.
9. The 8502A should read between +999.98 and +1000.02 ( $+1000.00 \pm 2$  digits).

4-69. TROUBLESHOOTING 

4-70. Static discharge can damage components contained in the 8502A. The following precautions should be observed during troubleshooting, repair, or module replacement.

1. Never connect or disconnect modules or components without first turning the 8502A's Power switch to OFF.
2. Perform all repairs at a static-free work station.
3. Minimize handling of IC's and PCB's; in no case handle them by their connectors.
4. Keep repair parts in their original containers until ready for use.
5. Use static ground straps to discharge repair personnel.

6. Use conductive foam or anti-static containers to store replacement or removed IC's and pcb's.
7. Remove all plastic, vinyl and styrafoam products from the work area.
8. Do not slide static sensitive devices over any surface.
9. Use only anti-static type solder removal tools.
10. Use grounded tip soldering irons.

4-71. A procedure for isolating faulty modules is contained in Table 4-6. It is important that the theory of operation given in Section 3 be read before attempting to troubleshoot the 8502A. The module isolation procedure involves making observations of the 8502A behavior, then removing or replacing modules to establish cause-effect relationships. DO NOT remove or replace modules with the power on. Follow the procedure step by step all the way through to assure that the fault is isolated to the correct module. Faults in some modules may cause apparent faults in other modules.

#### **WARNING**

**IF THE ISOLATOR AND THE BIT SERIAL INTERFACE ARE INSTALLED, REPLACEMENT OF THE ISOLATOR BY THE BUS INTERCONNECT MONITOR BOARD MAY ALLOW A HAZARDOUS COMMON MODE VOLTAGE TO APPEAR ON THE OUTPUT CONNECTOR OF THE INTERFACE.**

4-72. Figures 4-5 through 4-11 contain symptom analysis troubleshooting information for each of the modules and pcb's contained in the mainframe 8502A. The possible failures are listed in order of probability. Troubleshooting information for optional modules is contained in Section 6.

#### **4-73. Troubleshooting Notes**

4-74. Error codes are disabled in the CAL mode. Selection of a function for which the module is either faulty or missing will then result in random readings.

4-75. If interaction between modules is a problem during troubleshooting, use of either the Static Controller (MIS-7190K) or the Test Module (MIS-7191K) could be helpful. With the Static Controller, bus IC, ID, and handshake signals may be applied separately to most analog and digital modules. The Test Module may be used to either check or troubleshoot the Controller module. Complete use information and troubleshooting techniques are provided with these test modules.

4-76. Use the Bus Interconnect and Monitor Board (MIS-7013K) to access lines on either the digital (unguarded) or analog (guarded) interbus. In using the Bus Interconnect Monitor Board, note that RT1 physically does not extend to the Isolator-Interconnect slot. RT1 is accessible with the Monitor Board installed in any of the first four slots (J11A, B, C, or D). The output of the optional Ohms Converter and Current Shunts modules are on RT1.

#### **CAUTION**

**Do not apply an input directly to the A/D Converter module. Damage to the A/D Converter may result. The DC Signal Conditioner may be bypassed by applying a signal directly to the Active Filter module, as outlined in the module isolation procedure.**

4-77. Care should be exercised when soldering on multi-layer printed circuit boards. Excessive heat can be especially ruinous. Note the following considerations:

1. Excessive heat can cause unseen damage to board laminations and through-hole plating.
2. Soldering tip temperatures above 700°F should, in all cases, be avoided.
3. Whenever possible, alternate soldering tool usage between divergent areas on a board. Concentration of heat in any one area will thereby be minimized.

#### **4-78. Non-recurring Adjustments**

#### **4-79. POWER SUPPLY ASSEMBLY**

4-80. Variable resistor R9 in the U3 Regulator circuit of the A4 Power Supply Assembly (Rev. E and subsequent) is set at the factory and should not require additional adjustment. If any components in the circuit are replaced during troubleshooting it can be adjusted or verified using the following procedure:

1. Connect a test DMM between -15V (VA2) and ANALOG RETURN (AR) on pins 5,14 and 7,16 of the Guarded Bus connector (P1) respectively.
2. Record the value of the reading.
3. Connect the test DMM between +15V (VA1) and AR on pins 6,15 and 7,16 of P1 respectively.
4. Adjust R9 until the test DMM reads within  $\pm 0.25\text{V}$  of the reading recorded in step 2 above.
5. Recheck the -15V and +15V supplies at the points given in steps 1 and 3 above respectively and verify that they read  $-15 \pm 0.75\text{V}$  and  $+15 \pm 0.75\text{V}$ . If either is outside the stated tolerance repeat steps 1 through 4 until both values are within tolerance.

Table 4-6. Faulty Module Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1.	Turn the power ON. The following should be displayed. HI-2.0.Y (Y=Program number) then C XXXXX (X = installed option number) then 0.00 ±.05 (DC Volts, 1000V range, Fast sample rate)		
2.	Is the display blank?	6	3
3.	Is the initial display other than HI-2.0.Y?	42	4
4.	Is the reading other than 0.00 ±.05	59	5
5.	Are the first three displays normal?	78	2
DISPLAY BLANK AT POWER ON			
6.	Remove bus interconnect (or Isolator if installed).		
7.	Turn power ON. Is HI-2.0.Y displayed?	8	11
8.	Was the isolator installed?	9	11
9.	Install interconnect-monitor in the Isolator slot. Is HI-2.0.Y displayed?	10	13
10.	Bad Isolator. Go to Section 6 under Isolator.		
11.	Is the power indicator on?	17	12
12.	Check the fuse. Is it bad (replace)?	1	17
13.	Remove Cal Memory and remote interfaces if installed. Is HI-2.0.Y displayed?	14	17
14.	Replace Cal Memory. Is HI-2.0.Y displayed?	16	15
15.	Bad Cal Memory. Go to Section 6 under Calibration Memory.		
16.	Bad Remote Interface. Go to Section 6 under the appropriate interface.		
17.	Install the interconnect-monitor PCB in the Isolator slot.		
18.	Check power supply voltages as follows. Test DMM Common to VSS. V <sub>DD</sub> = +11.4 to +12.6      V <sub>CC</sub> = +5.15 to 5.25 V <sub>GG</sub> = -11.4 to -12.6      LINE = 13V ac to 17V ac		
19.	Are the power supplies within tolerance?	26	20
20.	Remove all modules except the Front Panel.		
21.	Recheck power supplies. Within tolerance?	22	23
22.	Replace modules one at a time (start with Controller), rechecking supplies after replacing each module. The last one put in when the supplies go bad is the problem. Go to the appropriate figure for that module.		
23.	Remove the front panel. Recheck supplies. Within tolerance?	25	24
24.	Problem on power supply, motherboard, or power supply interconnect.		
25.	Bad Front Panel. Go to Figure 4-7.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
26.	Remove Cal Memory and the remote interface if installed.		
27.	Check IC 6, 5, 1, 0 on interbus. All moving?	28	30
28.	Check ACK line. Moving?	29	30
29.	Check ID0 – 7. All moving?	32	30
30.	Check Controller clock, TP2, TP3 (TP1 = gnd). Is 12V, 1.7 MHz signal present?	33	31
31.	Bad Controller. Go to Figure 4-6.		
32.	Bad Front Panel. Go to Figure 4-7.		
33.	Remove analog modules, leaving only Controller, Front Panel, and Interconnect. Is the display normal?	34	35
34.	Faulty Analog Module. Replace one at a time – last one in is the problem. Go to the appropriate figure for that module		
35.	Remove Front Panel, replace DC Signal Conditioner, Filter, A/D Converter.		
36.	Check IC lines, ACK line, ID lines. All moving?	38	37
37.	Bad Controller. Go to Figure 4-6.		
38.	Bad Front Panel. Go to Figure 4-7.		
INITIAL DISPLAY OTHER THAN HI-2.0.Y			
39.	Remove Interconnect PCB (or Isolator if installed).		
40.	Apply power. Is the display as follows? HI-2.0.Y C XXXXX Error 9	41	44
41.	Was the Isolator installed?	42	47
42.	Install Interconnect-monitor PCB in Isolator slot. Is display normal?	43	48
43.	Bad Isolator. Go to Section 6.		
44.	Are Cal Memory or remote interface installed?	45	47
45.	Remove Cal Memory and remote. Display normal?	46	47
46.	Replace one at a time. Go to appropriate figure.		
47.	Install Interconnect-Monitor PCB.		
48.	Check for shorts between the IC and the ID lines. Shorts?	49	51
49.	Remove all modules except Front Panel. Removed short?	50	57
50.	Reinstall modules one at a time (start with Controller), checking for shorts between modules. Last one in is the problem. Go to the figure for the appropriate module.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
51.	Are any of the IC, ID, or ACK lines always high or always low?	53	52
52.	Remove all modules except Front Panel and Controller. IC and ID moving?	56	53
53.	Remove Front Panel. Reinstall dc analog modules if removed.		
54.	Are the IC, ID, and ACK lines moving?	57	55
55.	Bad Controller. Go to Figure 4-6.		
56.	Is the display normal?	58	57
57.	Front Panel bad. Go to Figure 4-7.		
58.	Faulty Analog module. Replace one at a time until symptoms recur. Last one in is faulty. Go to the figure for the appropriate module		
READING NOT ZERO AT TURN ON			
59.	Remove all optional modules (except Isolator if installed), leaving Controller, (Isolator), DC Signal Conditioner, Filter, A/D, Front Panel.		
60.	Apply power. Is the reading zero?	61	62
61.	Replace modules one at a time until reading is not zero. Last one in is the problem. Go to Section 6.		
62.	Is the Isolator installed?	63	65
63.	Replace Isolator with Interconnect-Monitor PCB. Is the reading zero?	64	65
64.	Bad Isolator. Go to Section 6.		
65.	Install Interconnect Monitor if not already installed. Check supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to +15.75 V   VA4 = -29 to -32 V VA2 = -14.25 to -15.75V   V <sub>CC</sub> = -15V } Difference must equal VA3 = +29 to +32V      V <sub>SS</sub> = -20V } 4.9 to 5.2V		
66.	Supply voltages in tolerance?	70	67
67.	Remove all modules except Front Panel. Supplies in tolerance?	69	68
68.	Repair power supply. Go to Figure 4-5.		
69.	Replace modules one at a time, checking supplies between modules. Last one in is faulty. Go to the appropriate figure.		
70.	Remove Filter module. CAL switch on. Select DC Volts, 1000V range.		
71.	Is the reading zero?	72	77
72.	Replace Filter module; remove DC Signal Conditioner.		
73.	Place a jumper (short) between RT2 and RT6.		
74.	Is the reading zero (disregarding CAL digit)?	75	76

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
75.	DC Signal Conditioner bad. Go to Figure 4-8.		
76.	Filter module bad. Go to Figure 4-9.		
77.	A/D converter bad. Go to Figure 4-10.		
78.	Do the Performance Tests earlier in this section.		
79.	Is the unit within the tolerances given?		80
80.	Is the Cal Memory installed?	81	83
81.	Remove the Cal Memory. Is the unit now within tolerance?	82	83
82.	Faulty Cal Memory. Go to Section 6.		
83.	Is the Isolator installed?	84	87
84.	Replace Isolator with Interconnect-monitor PCB.		
85.	Is unit within tolerance?	86	87
86.	Bad Isolator. Go to Section 6.		
87.	Is the failure in DC Volts Performance Test?	89	88
88.	Go to Section 6 for the appropriate faulty function.		
89.	Remove all optional modules, leaving Front Panel, Controller, DC Signal Conditioner, Active Filter, and A/D Converter.		
90.	Do the DC Volts Performance Test. Is the unit within tolerance?	91	92
91.	Reinstall options one at a time, rechecking DC Volts tolerance. Last module installed when unit becomes out of tolerance is faulty. Go to Section 6.		
92.	Check supply voltages according to the following chart. VA1 = +14.25 to +15.75V    VA4 = -29 to -32V VA2 = -14.25 to -15.75V    V <sub>CC</sub> = -15V    ) Difference = 4.9 to 5.2V VA3 = +29 to +32V            V <sub>SS</sub> = -20V    )		
93.	Are the supplies within tolerance?	97	94
94.	Remove all modules except Controller and Front Panel. Are the voltages correct?	95	96
95.	Replace modules one at a time until the voltages go bad. Last one in is the problem. Go to the appropriate figure.		
96.	Repair power supply. Go to Figure 4-5.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response																																													
		YES	NO																																												
97.	<p>Connect the test DMM LO to RT2 and HI to RT6. Apply known voltages to the 8502A input to test the DC Signal Conditioner. The following voltages are suggested inputs:</p> <table> <thead> <tr> <th>8502A RANGE</th> <th>GAIN DC SIG COND</th> <th>INPUT</th> <th>TEST DMM READING</th> </tr> </thead> <tbody> <tr> <td>100mV</td> <td>X64</td> <td>2mV</td> <td>128.0mV</td> </tr> <tr> <td>100mV</td> <td>X64</td> <td>200 mV</td> <td>12.80V</td> </tr> <tr> <td>1V</td> <td>X8</td> <td>125mV</td> <td>1.0V</td> </tr> <tr> <td>1V</td> <td>X8</td> <td>2V</td> <td>16.0V</td> </tr> <tr> <td>10V</td> <td>X1</td> <td>1V</td> <td>1.0V</td> </tr> <tr> <td>10V</td> <td>X1</td> <td>19V</td> <td>19.0V</td> </tr> <tr> <td>100V</td> <td>÷8</td> <td>1V</td> <td>125.0mV</td> </tr> <tr> <td>100V</td> <td>÷8</td> <td>140V</td> <td>17.50V</td> </tr> <tr> <td>1000V</td> <td>÷64</td> <td>64V</td> <td>1.0V</td> </tr> <tr> <td>1000V</td> <td>÷64</td> <td>960V</td> <td>15.0V</td> </tr> </tbody> </table>	8502A RANGE	GAIN DC SIG COND	INPUT	TEST DMM READING	100mV	X64	2mV	128.0mV	100mV	X64	200 mV	12.80V	1V	X8	125mV	1.0V	1V	X8	2V	16.0V	10V	X1	1V	1.0V	10V	X1	19V	19.0V	100V	÷8	1V	125.0mV	100V	÷8	140V	17.50V	1000V	÷64	64V	1.0V	1000V	÷64	960V	15.0V		
8502A RANGE	GAIN DC SIG COND	INPUT	TEST DMM READING																																												
100mV	X64	2mV	128.0mV																																												
100mV	X64	200 mV	12.80V																																												
1V	X8	125mV	1.0V																																												
1V	X8	2V	16.0V																																												
10V	X1	1V	1.0V																																												
10V	X1	19V	19.0V																																												
100V	÷8	1V	125.0mV																																												
100V	÷8	140V	17.50V																																												
1000V	÷64	64V	1.0V																																												
1000V	÷64	960V	15.0V																																												
98.	Are the readings correct (noise or drift in the DC Signal Conditioner will show up on the Test DMM readings)?	100	99																																												
99.	DC Signal Conditioner faulty. Go to Figure 4-8.																																														
100.	Connect Test DMM HI to RT5. Repeat table in step 97. The test DMM readings should be the same.																																														
101.	Are the Test DMM readings the same?	103	102																																												
102.	Faulty Active Filter module. Go to Figure 4-9.																																														
103.	Faulty A/D Converter. Go to Figure 4-10.																																														

SYMPTOM	POSSIBLE FAILURE
<b>GUARDED SUPPLY</b>	
VA1 – BAD (+15V). Noisy	U3, BR2, or Transformer C3, BR2
VA2 – BAD (-15V) Noisy	U4, BR2, or Transformer C4, BR2
VA3 – BAD (+30V) Noisy	U2, CR4, BR1, Transformer C2, BR1
VA4 – BAD (-30V) Noisy	U1, CR3, BR1, Transformer C1, BR2
V <sub>CC</sub> (Guarded)	U5, R5, R3, C5, CR1, CR2, Transformer
VA1 and VA2 are used as a reference for VA3 and VA4. VA3 and VA4 could load down VA1 and VA2. Check by lifting the reference diodes CR3 and CR4.	
<b>UNGUARDED SUPPLY</b>	
V <sub>DD</sub> (+12V)	U6, C6, C9, C12, BR3, Transformer
V <sub>GG</sub> (-12V)	U7, C13, C10, C7, BR3, Transformer
V <sub>CC</sub> (+5V)	U8, R6, R4, C8, C13, C11, BR4, Transformer
The drawing below identifies the pins at the power supply edge connector. Input voltages to the regulators should be approximately 5V higher than the normal output voltages. If the output is higher or lower than specified and noise is not the problem, the regulator is bad.	
<p>The diagram shows a cross-section of a power supply edge connector. On the left, there is a vertical component labeled S2. Below it, there are two resistors (R1, R2), a diode (CR4), and two integrated circuits (U4, U3). On the right, there are two sets of pins labeled J1 and J2. The top set of pins, J2, is labeled "UNGUARDED" and has the following assignments:      - TOP – 60 Hz Ref, Bottom – V<sub>SS</sub>      - TOP – V<sub>DD</sub>, Bottom – V<sub>GG</sub>      - Top and Bottom – V<sub>CC</sub>      The bottom set of pins, J1, is labeled "GUARDED" and has the following assignments:      - TOP – VA3, Bottom – VA4      - VA2 (Top and Bottom)      - VA1 (Top and Bottom)      - AR (Top and Bottom)      - V<sub>SS</sub> (Top and Bottom)      - V<sub>CC</sub> (Top and Bottom)   </p>	

Figure 4-5. Power Supply Troubleshooting

## NOTE

*Due to the speed and complexity of the controller, it is recommended that, when a problem is isolated to the controller, the unit be sent to the nearest Service Center for repair. The following information will assist in troubleshooting simpler problems. Many problems require the use of a Trendar or similar tester.*

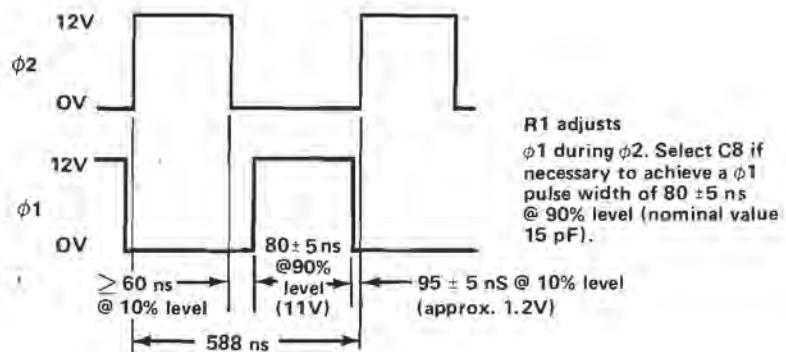
## SYMPTOM

## POSSIBLE FAILURE

Troubleshoot the Controller with only the Controller, Front Panel, and Power Supply installed.

Blank Display (most common symptom of controller failure) . . . . . Proceed with checks listed below

1. Check  $\phi_1$  and  $\phi_2$  clock at TP2, TP3



$\phi_1$  bad,  $\phi_2$  ok . . . . . U3, U9, U10

$\phi_1$  ok,  $\phi_2$  bad . . . . . U9, U10

$\phi_1$ ,  $\phi_2$  bad . . . . . U3, U9, Y1

$\phi_1$  won't adjust . . . . . R1, U3, U9, capacitors

2. Check RST (reset) line (at U10-12, U35-13)

High? Check for 400  $\mu$ sec delay on +5V at U36-13

Stuck Low? . . . . . U35, U34, U36, U38

3. Check RDT (ready) line (at U10-23, U1-9)

Pulsing - OK

Always low . . . . . clock pulse at U1-12 U1, U16, U15, U8- check inputs to U8, U18

Always high . . . . . ACK interrupt or mark interrupt not functioning properly

Figure 4-6. Controller Troubleshooting

SYMPTOM	POSSIBLE FAILURE
4. Check Bus ACK Signal.	
1-3, display clear; 4-6 new data; 7, switch read	
No pulses on ACK line	Mark interrupt circuit (U14-12, U37-3) Phase lock loop (pulses every 2 msec) IC lines output enable (U17-10) IC lines output gates (U29, U37)
ACK always high	U38, CR1, C27
5. Check IB OUT (U17-9) — is data going out?	
6. Check A15, WAIT, WR, and DBIN lines	U10, ROM enable, ROM decoders, ROM
7. Check address and data lines at U10 for being held high or low all the time.	
8. If MARKS, INT, INTE OK, INT VECTOR (U28, U19, U37) may be bad giving wrong vector information.	
<b>OTHER PROBLEMS</b>	
Won't read switches	IC6 bad (no ACK) or bad data in
Displays all modules present (CXXXXX)	ACK INT CKT, ACK held high
Wrong display	Data bad, IC line always high
Won't respond to external interrupts	U17 (INT), U37, U32 (INA) U28, U19, U23 (INT Vector wrong)

Figure 4-6. Controller Troubleshooting (cont)

SYMPTOM	POSSIBLE FAILURE
No ACK Pulse	U28, U19 (Address Decoders) U23 (Indirect F/F) U19, U11, Q10 (ACK Circuit)
No Display (ACK Pulse Present)	U18 (Kill Circuit)
No Response to Switch Pushes (Display Good)	Switch Associated With Function U32, CR1 – CR4 Open
Segment Bad In All LEDs	Check Path from Latch to Transistor Drivers to LED Cathodes
One LED Doesn't Light	Check Path From Latch To Inverter to Transistor Drivers to LED Anode
Segment or Decimal Missing On Only One LED	Bad LED
Display Gives Wrong Numbers, One LED Brighter	U11 (Reset to Indirect Address F/F, U23) Address Decoder. (Problem is Indicative of Front Panel Responding to an Invalid Address.)

Figure 4-7. Front Panel Troubleshooting

SYMPTOM	POSSIBLE FAILURE
DC Inoperative All Ranges	Digital Control Logic Q8, Q6, Q7, Open K1, Q1, Q2 Open; Q18, Q19, U3 Bad
Display Blanks	U1 or U2
Locks in OVERRANGE	U3
Reading Drifts	U4; Q14, Q15, Q16 Leaky
Won't Zero	U5 or U6
100 mV Range Bad	Q31, Q32, Q14
1V and 100V Range Bad	Q33, Q34, Q15
100V and 1000V Range Bad	K2, Q3, Q4
Random Readings	K1 Open, K2 Shorted
Nonlinear Readings	Q16, Q15, Q14 Leaky

## ADDRESS AND DATA FIELD

ADDRESS	IB DATA DURING ADDRESS				
IC4, IC3, IC0 = 1	ID3	ID2	ID1	ID0	
	0	1	1	0	100 mV Range G = 64
	1	0	1	0	1V Range G = 8
	1	1	0	1	10V Range G = 1
	1	0	0	0	100V Range G = $\div 8$ ( $\div 64 \times 8$ )
ID3 - ID4 = Control Amplifier Gain					100V Range G = $\div 64$

0 1 =  $\times 64$   
 1 0 =  $\times 8$   
 1 1 =  $\times 1$

RT1 inputs controlled as follows for OHMS &amp; ADC

ADDRESS	DATA				
IC4, IC3, IC0 = 1	ID3	ID2	ID1	ID0	
	0	1	0	1	G = $\times 64$
	1	0	0	1	G = $\times 8$
				1	G = $\times 1$

## NOTE

If R54-R57, Q18, Q19 or Q22 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-8. DC Signal Conditioner Troubleshooting

SYMPTOM	POSSIBLE FAILURE	
High Zero Offset	Q32, Q25, Q19, Q20 Shorted	
DC Inoperative	Q18 Open – Q21, Q22, Q23, Q24 Open Q27, U5 Digital Logic	
Overrange	U5 – Q19, Q20 Shorted	
Noisy		
All Ranges		
Either Filter	Q25, Q32 Leaky – Q31, U5 Bad	
Slow Filter (ON)	Q21, Q22 Leaky – U4 Bad	
Fast Filter (OFF)	Q23, Q24 Leaky – U3 Bad	
Nonlinear Readings	U5	
Display Blanks	U1 Or U2	
ADDRESS AND DATA FIELD		
ADDRESS	DATA	
IC4, IC3, & IC1 = 1	ID0 = 1 Filter By Pass (Remote Only) ID1 = 1 Z Filter (F.P. Light On) ID2 = 1 Y Filter (F.P. Light Off) ID3 = 1 Filter - Always on except In Ext. Ref. ID4 = 1 Ext. Ref. Lo ID5 = 1 Ext. Ref. Hi	
<b>Adjustment of R14</b>		
1.	Short the 8502A input terminals.	
2.	Short RT6 to RT2 on the Bus Interconnect Monitor.	
3.	Adjust R14 for a reading of $\pm .000000 \pm 2$ digits. (This requires that the A/D Converter is working accurately.)	
<b>Selection of R15 or R16.</b>		
If Q27 or U5 have been replaced, R15 and R16 will require reselection if adjustment of R14 does not zero the reading.		
1.	Only one of R15 and R16 will be installed. Replace whichever is installed with a short.	
2.	Connect the R15 short to the R16 short.	
3.	Short RT6 to RT2 on the Bus Interconnect Monitor.	
4.	Connect the test DMM HI to TP3 and LO to TP1 on the Active Filter module.	
5.	Select a resistor from the table below according to the measured offset. If the polarity is positive, install the resistor as R16; if negative as R15. (Maximum allowable offset in this step is $5200 \mu V$ .)	
OFFSET ( $\mu V$ )	RESISTOR	FLUKE PART NO.
0-400	None	
401-1200	31.6K	261610
1201-2000	63.4K	235382
2001-2800	97.6K	241380
2801-3600	133.0K	289074
3601-4400	165.0K	376186
4401-5200	205.0K	375931
6. After installing the resistor, adjust R14.		

Figure 4-9. Active Filter Troubleshooting

## DIGITAL BOARD

SYMPTOM	POSSIBLE FAILURE
Display Blanks	U33, U34, U35 (Affecting ID Lines)
Improper Readings, Inoperative A/D, Nonlinear Readings	Check Transistor Array Outputs to J1 and J2 – The Rise and Fall Times of These Switching Pulses Must be <2 $\mu$ sec.
Flickering Display	Autozero Control – U25, U34
Direct Address	
IC 4, 3, & 2 High	ID0 = 1 = Reset Counter ID1 = 1 = Auto Zero ID2 = 0 = Buffer Input ID2 = 1 = Remainder Input ID3 = 1 = Channel X (Auto Zero and Remainders 1 and 3) ID3 = 0 = Channel Y (Remainders 2 and 4)
Indirect Address	
IC 2 & 1 High (and Ring Counter Not in C0 Time period, C0 = 0)	This Indirect Address allows the ID7 Enable to bring back Polarity Bits to the Controller Module

## ANALOG BOARD

First Check TP5 – Should be switching between + and -7V. Typical failures in this circuit result in a portion of the switching slope having a slew rate less than 1V/ $\mu$ sec. A glitch at the zero point is normal.

SYMPTOM	POSSIBLE FAILURE
Noisy Readings	U1, U2, U3
Nonlinear Ladder	U4, Q9, Q10 (Q27)
Ladder Out Of Tolerance	FETS Q11 – Q15 or Q17 – Q21
All Digits Wrong	U7, Q31, Q32
Reading Locked (Doesn't Respond To Input Change) Or Always Overrange	U4, Q9, U1, U2, U3, Q2, Q3
Bad Remainders (Lesser Digits)	Q22, U4, U6
No Polarity Bit Returned	Q29, Q28
Shifty Readings (Most Or All Digits)	Autozero Settling Time Problems U8, Q30 – Q8, Q7

## NOTE

If U1, R9, R14-R16, R34, R35, R50-55, R67, Q1-Q3, Q11-Q16, Q25, or Q26 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-10. R<sup>2</sup> A/D Converter Troubleshooting

**Section 5**  
**List of Replaceable Parts**

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## 5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the mainframe instrument. A parts breakdown for each of the optional modules is contained in the subsection of Section 6 pertaining to the module. Components are listed alpha-numerically by assembly. Both electrical and mechanical components are listed first by reference designation and second by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation or Item Number.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)
5. Manufacturer's Part Number or Type.
6. Total Quantity per assembly or component.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are devi-

ations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

## 5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation or Item Number.
5. Printed Circuit Board Part Number.
6. Instrument Model and Serial Number.

## 5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY
	☒ CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. Final Assembly 15 Inch Pack

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CDDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
FINAL ASSY, 8502A 15 INCH PACK FIGURE 5-1 (8502A-5001/T&B)							
A2	MOTHER BOARD PCB ASSY	481713	89536	481713	1		
A3	BUS INTERCONNECT PCB ASSY	459636	89536	459636	1		
A4	POWER SUPPLY PCB ASSY	ORDER	FOR	APPROPRIATE SOURCE	1	1	
A5	POWER SUPPLY INTERCONNECT ASSY	401760	89536	401760	1		
A6	CONTROLLER ASSY	384024	89536	384024	1		2
A6	CONTROLLER ASSY	577072	89536	577072	1		
A7	FRONT PANEL ASSY	481689	89536	481689	1		
A8	DC SIGNAL CONDITIONER PCB ASSY	383901	89536	383901	1		
A9	ACTIVE FILTER PCB ASSY	383976	89536	383976	1		
A10	FAST R2 A/B CONVERTER PCB ASSY	383984	89536	383984	1		
E1	POST, BINDING, HEAD GRNDING	225615	20584	3575	1		
E2	POST, BINDING, GRNDING	225623	20584	3576	1		
H1	NUT, HEX, DOUBLE CHAMFER 1/4-28	110619	89536	110619	1		
H2	NUT, HEX, STOP	110841	89536	110841	1		
H3	SHORTING LINK	190728	83330	21171	3		
H5	SCREW, CAP, LO HEAD SOCKET #8	295105	74445	8-32UNRC	4		
H6	SCREW, FHP, COUNTERSUNK	114116	73734	20254	8		
H7	SCREW, PHP, 4-40 X 1/4	129882	73734	19022	11		
H8	SCREW, FH, UNDERCUT, 6-32 X 1/4	320093	89536	320093	6		
H9	SCREW, PHP, 8-32 X 5/8	293324	73734	23067	2		
H10	SCREW, PHP, SEMS, 6 - 32 X 1/2	177030	89536	177030	9		
H11	SCREW, FHP, COUNTERSINK 8 - 32 X 1/2	114355	73734	18266	3		
H12	WASHER, LOCK, INT TOOTH #8	110320	73734	1305	2		
H13	WASHER, LOCK, INTERNAL 1/4	110817	89536	110817	1		
MP1	BAIL, FULL WIDTH	231407	89536	231407	1		
MP2	BEZEL, I/O	416206	89536	416206	1		
MP3	BRACKET, INNER, CHASSIS LEFT	496372	89536	496372	1		
MP4	BRACKET, INNER, CHASSIS RIGHT	496380	89536	496380	1		
MP5	BUTTON, PLUG	101774	89536	101774	1		
MP6	BUTTON, PWR SWITCH	401646	89536	401646	1		
MP7	CHASSIS ASSY	481275	89536	481275	1		
MP8	CENTER SUPPORT ASSEMBLY	576637	89536	576637	1		
MP10	CORNER, FINISHED	394346	89536	394346	2		
MP11	CORNER, HANDLE	394304	89536	394304	2		
MP12	CONTACT STRIP	370619	30817	97-500-A	AR		
MP13	COVER, BOTTOM BLUE	383265	89536	383265	1		REF
MP14	PUTTY GREY	522722	89536	522722		REF	
MP15	COVER PLATE, INPUT	420679	89536	420679	1		
MP16	DECAL, REAR PANEL	473413	89536	473413	1		
MP17	DECAL, SIDE TRIM, FWD	525980	89536	525980	2		
MP17	DECAL, CORNER	394387	89536	394387	4		
MP18	DECAL, FRONT PANEL	477538	89536	477538	1		
MP19	DECAL, SERIAL NO.	393975	89536	393975	1		
MP20	EXTRUSION, PCB RETAINER	408476	89536	408476	1		
MP21	FOOT, BAIL STAND	292870	89536	292870	4		
MP22	FOOT, REAR PANEL	307363	89536	307363	2		

Table 5-1. Final Assembly 15 Inch Pack (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP23	HOLDER, INSTRUCTION BOOK	427534	89536	427534	1		
MP24	INSERT, FRONT PANEL	381871	89536	381871	1		
MP25	INSTRUCTION PAGE ASSY	458281	89536	458281	1		
MP26	STANOFF, INSULATED	494922	89536	494922	1		
MP27	LENS DISPLAY, SCREENED	485870	89536	485870	1		
MP28	COVER, TOP	522516	89536	522516	1		
P1	PLUG, SWITCH	437855	89536	437855	1		
TM1	INSTRUCTION MANUAL, 8502A	471466	89536	471466	1		
W1	CORD SET (NOT SHOWN)	284174	89536	284174	1		
	RECOMMENDED SPARE PARTS KIT	503599	89536	503599			AR

1 EITHER OF THE A4 PCB ASSYS. MAY BE  
INSTALLED ON THIS UNIT.

2 EITHER OF THE A6 PCB ASSYS. MAY BE  
INSTALLED ON THIS UNIT.

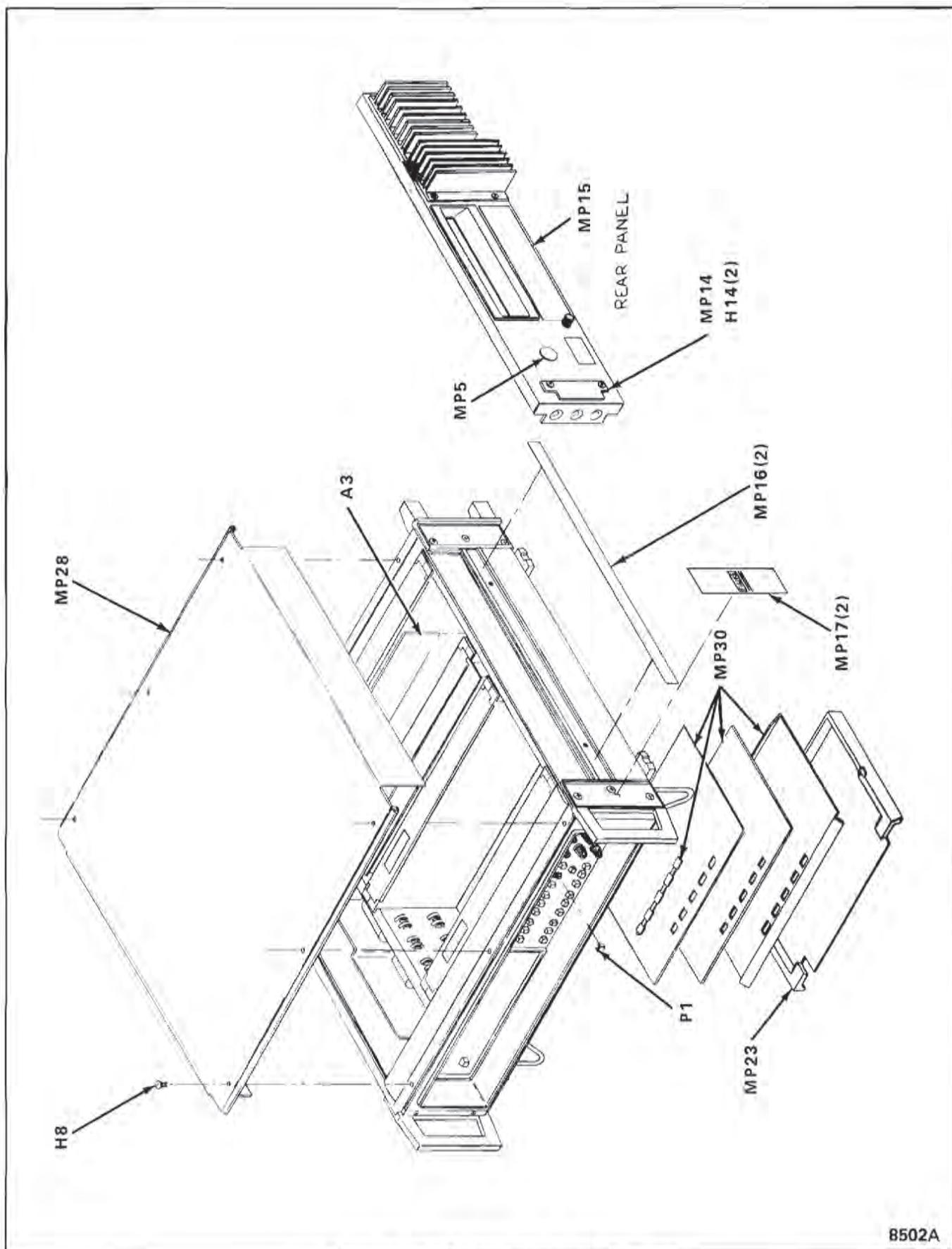


Figure 5-1. Final Assembly 15 Inch Pack

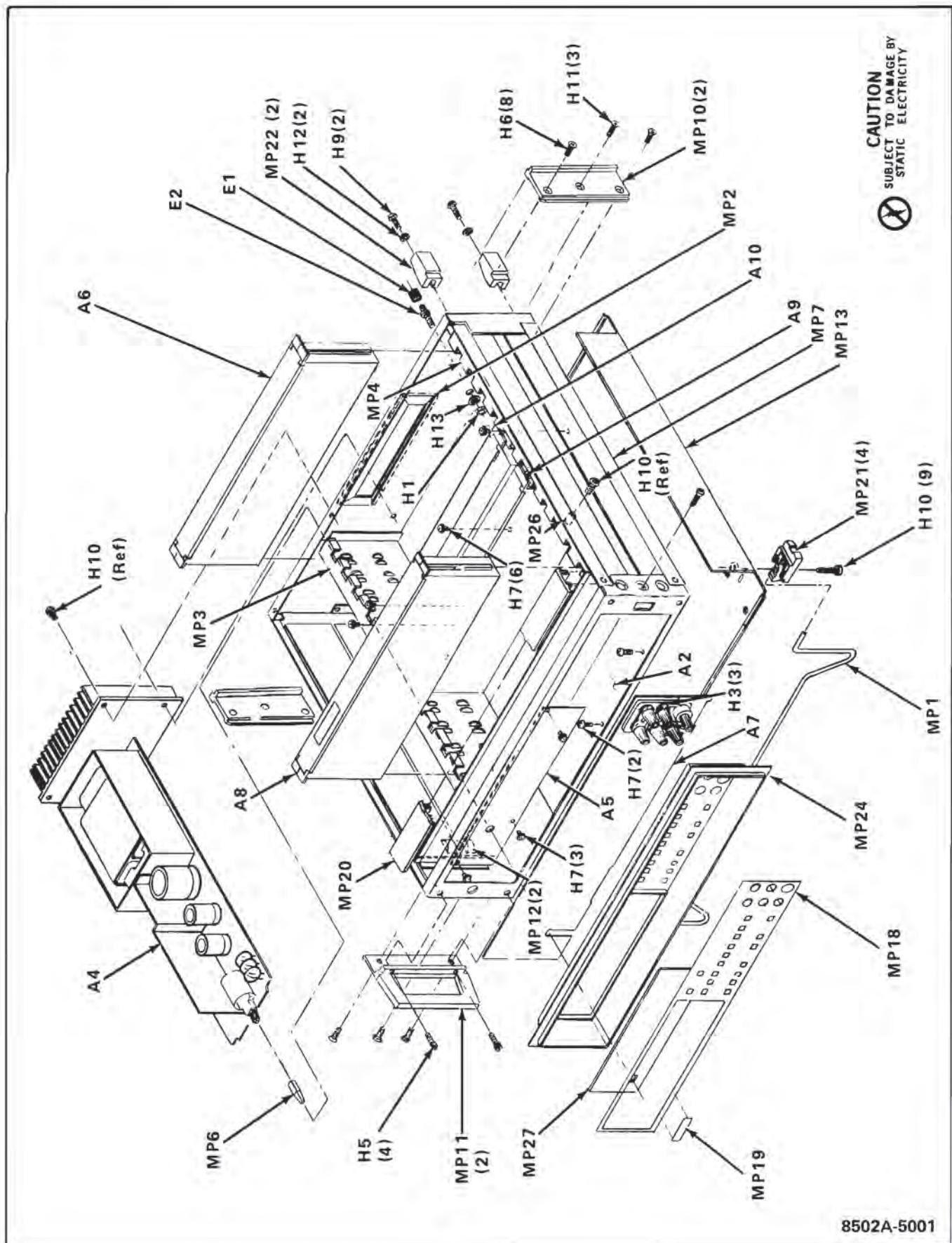


Figure 5-1. Final Assembly 15 Inch Pack (cont)

**CAUTION**  
SUBJECT TO DAMAGE BY  
STATIC ELECTRICITY

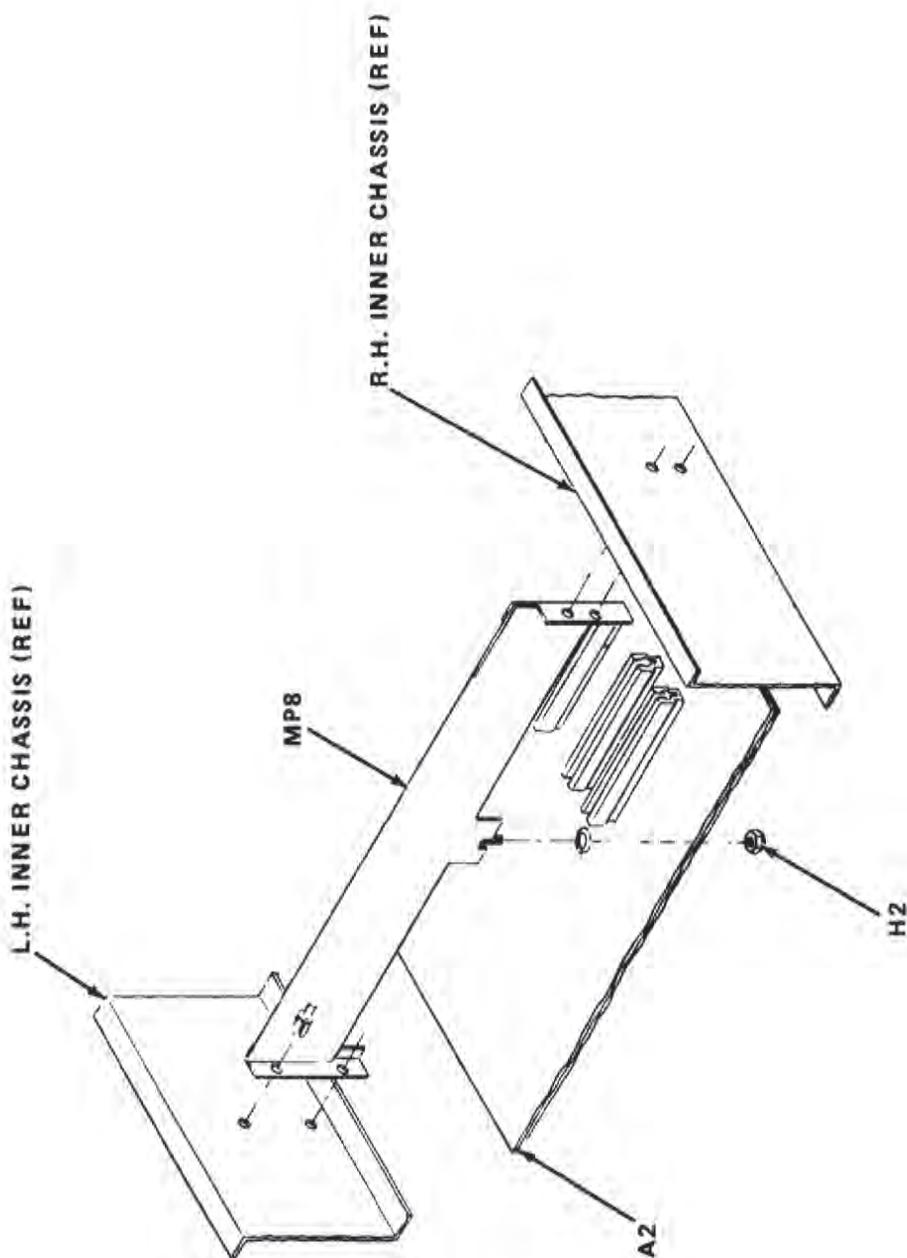


Figure 5-1. Final Assembly 15 Inch Pack (cont)

Table 5-2. A2 Motherboard PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A2	MOTHERBOARD PCB ASSEMBLY FIGURE 5-2 (8502A-4001T)	481713	89536	481713			REF
H1	NUT, HEX DOUBLE CHAMFER 4-40	184044	73734	8002A-NP	2		
H2	SCREW, PHP, 4-40 X 1	157008	73734	19030	2		
H3	WASHER, FLAT #4	146225	86926	5710-18-32	2		
H4	WASHER, LOCK, INT TOOTH	110403	73734	99402	2		
H5	WASHER, FLAT, #8	110270	73734	1406	2		
H6	WASHER, SPLIT, LOCK	403923	89536	403923	2		
J1	CONNECTOR, BD EDGE RECPT, 8 PIN	354951	00779	583407-5	2		
J2	CONNECTOR, BD EDGE RECPT, 18 PIN	291906	00779	583650-3	1		
J6	CONNECTOR, BD EDGE RECPT, 20 PIN	291914	00779	583650-4	1		
J7	CONNECTOR, BD EDGE RECPT, 8 PIN	354951	00779	583407-5			REF
J8	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550	6		
J11A	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0	12		
J11B	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J11C	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J11D	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J12A	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1	4		
J12B	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1			REF
J12C	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1			REF
J12D	CONNECTOR, BD EDGE RECPT, 6 PIN	291625	00779	583650-1			REF
J21G	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J22H	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J23H	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J27	CONNECTOR, BD EDGE RECPT, 10 PIN	403964	00779	583407-6	1		
J28	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550			REF
J29K	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J30K	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J31A	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550			REF
J31B	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550			REF
J31C	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550			REF
J31D	CONNECTOR, BD EDGE RECPT, 4 PIN	417550	89536	417550			REF
J31L	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J31M	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J31N	CONNECTOR, BD EDGE RECPT, 40 PIN	422550	00779	2-583407-0			REF
J41	BINDING POST, BLK	493973	32767	820-45	1		
J42	BINDING POST, RED	493981	32767	820-65	1		
MP1	TERMINAL BLOCK	419663	89536	419663	1		
P43	AMP POST	267500	00779	87022-1	2		
R1	RESISTOR, MF, 1/2W, 30.9K	247569	91637	MFF1-23092F	2		
R2	RESISTOR, MF, 1/2W, 30.9K	247569	91637	MFF1-23092F			REF
R3	RES, DEP CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
XJ2	POLARIZING INSERT	293498	00779	530030-1	14		
XJ6	POLARIZING INSERT	293498	00779	530030-1			REF
XJ11A	POLARIZING INSERT	293498	00779	530030-1			REF
XJ11B	POLARIZING INSERT	293498	00779	530030-1			REF
XJ11C	POLARIZING INSERT	293498	00779	530030-1			REF
XJ11D	POLARIZING INSERT	293498	00779	530030-1			REF
XJ21G	POLARIZING INSERT	293498	00779	530030-1			REF

Table 5-2. A2 Motherboard PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
XJ22H	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ23H	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ27	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ29K	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ31L	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ31M	POLARIZING INSERT	293498	00779	530030-1	REF		
XJ31N	POLARIZING INSERT	293498	00779	530030-1	REF		

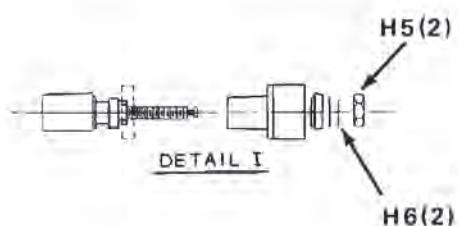
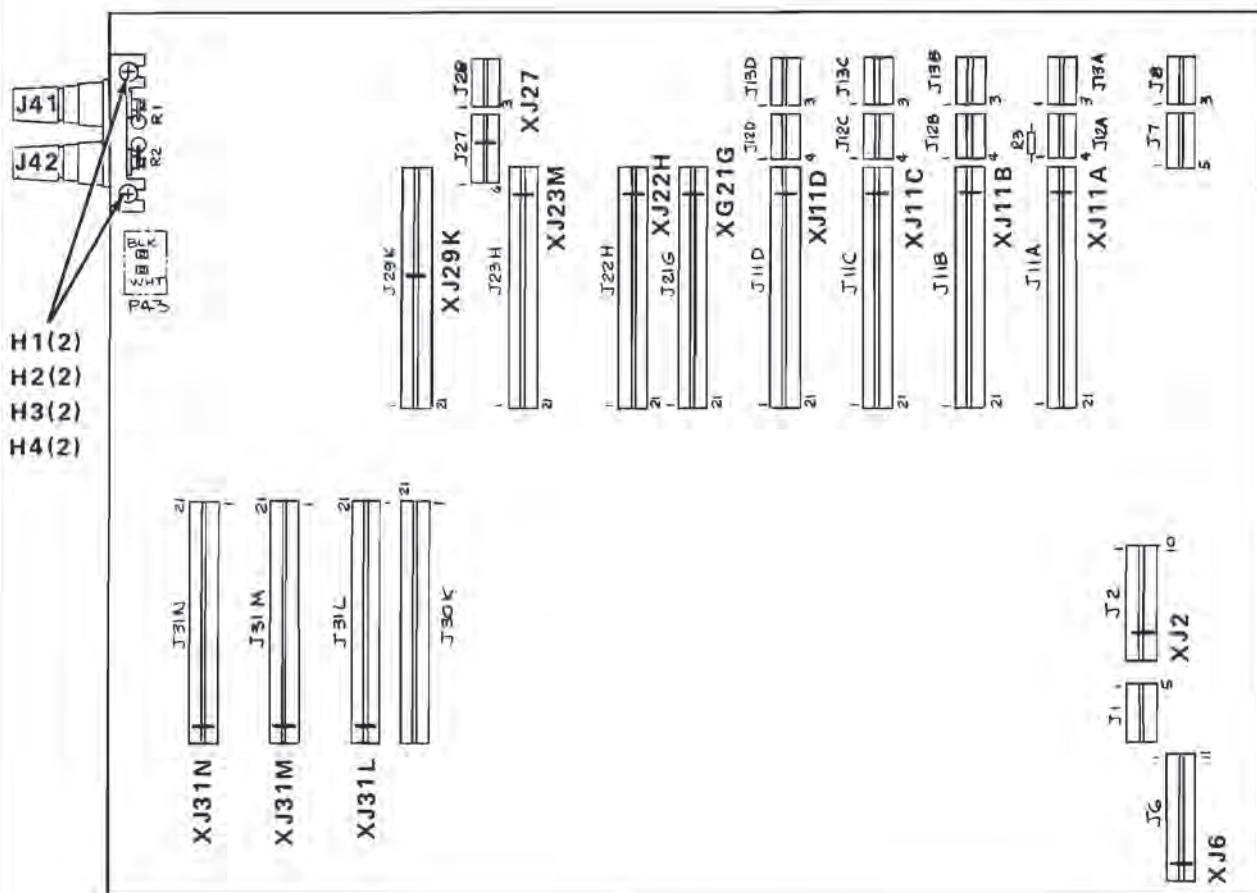


Figure 5-2. A2 Motherboard PCB Assembly

Table 5-3. A3 Bus Interconnect PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A3	BUS INTERCONNECT PCB ASSEMBLY FIGURE 5-3 (MIS-4081)	459636	89536	459636			REF
C1	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	2		
C2	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4			REF
CR1	DIODE, SI, RECT, 1 AMP	343491	01295	1N4002	1	1	

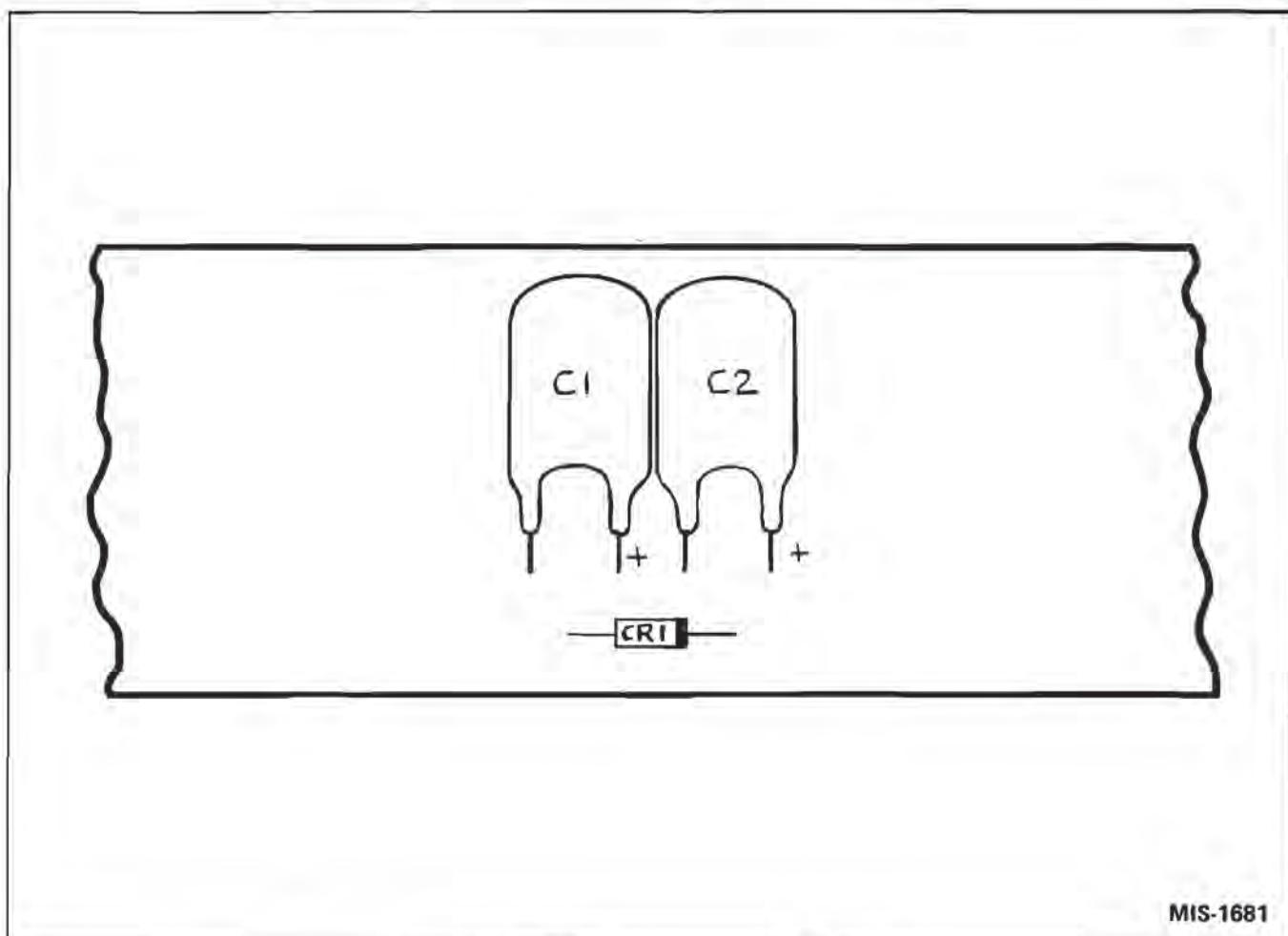


Figure 5-3. A3 Bus Interconnect PCB Assembly

MIS-1681

Table 5-4. A4 Power Supply PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
A4	POWER SUPPLY PCB ASSEMBLY POWER SUPPLY ASSY, 115/230V POWER SUPPLY ASSY, 100V FIGURE 5-4 (8500A-4041T)	ORDER 448886 456996	FOR 89536 89536	APPROPRIATE SOURCE 448886 456996	REF	1	
BR1	BRIDGE, RECTIFIER	296509	09423	FB200	3	1	
BR2	BRIDGE, RECTIFIER	296509	09423	FB200	REF		
BR3	BRIDGE, RECTIFIER	296509	09423	FB200	REF		
BR4	BRIDGE, RECTIFIER	428839	09713	MDA970-1	1	1	
C1	CAP, ELECT, 470 UF -10/+50%, 40V	185868	73445	ET471Z040-A02	2	1	
C2	CAP, ELECT, 470 UF -10/+50%, 40V	185868	73445	ET471Z040-A02	REF		
C3	CAP, ELECT, 220 UF -10/+50%, 40V	178616	80031	ET221X040-A01	2		
C4	CAP, ELECT, 220 UF -10/+50%, 40V	178616	80031	ET221X040-A01	REF		
C5	CAP, ELECT, 2200 UF -10/+100%, 25V	448126	12674	61C25BAS-252	2	1	
C6	CAP, ELECT, 4000 UF -10/+100%, 25	370734	99372	3044TS043U025	1	1	
C7	CAP, ELECT, 2200 UF -10/+100%, 25V	448126	12674	61C25BAS-252	REF		
C8	CAP, ELECT, 15000 UF -10/+100%, 15V	407940	99372	3044HA1534015	1	1	
C9	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X-0025KA1	4		
C10	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
C11	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
C12	CAP, CER, 0.1 UF +/-20%, 100V	149146	56289	33C41B6	3		
C13	CAP, CER, 0.1 UF +/-20%, 100V	149146	56289	33C41B6	REF		
C14	CAP, CER, 0.1 UF +/-20%, 100V	149146	56289	33C41B6	REF		
C15	CAP, CER, 0.005 +/-20%, 3KV	188003	71590	2DDH6R502M	2		
C16	CAP, CER, 0.005 +/-20%, 3KV	188003	71590	2DDH6R502M	REF		
C17	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
CR1	DIODE, RECT, SI, 50V	347559	05277	1N5400	3	1	
CR2	DIODE, RECT, SI, 50V	347559	05277	1N5400	REF		
CR3	DIODE, RECT, SI, 100V	343491	01295	1N4002	2	1	
CR4	DIODE, RECT, SI, 100V	343491	01295	1N4002	REF		
CR5	DIODE, RECT, SI, 50V	347559	05277	1N5400	REF		
F1	FUSE, SLO BLO, 1/2 AMP	109322	71400	MDL1-2	1	5	
H1	SCREW, PHP, 4-40 X 5/8	145813	89536	145813	2		
H2	SCREW, PHP, 8-32 X 3/8	436030	89536	436030	2		
H3	NUT, HEX, 8-32	110544	89536	110544	2		
H4	WASHER, INT/LOCK, #8	110320	89536	110320	2		
H5	SCREW, RHP, 8-32 X 3/8	114124	89536	114124	2		
H6	SCREW, PHP, 4-40 X 1/4 (NOT SHOWN)	129890	89536	129890	1		
H7	SCREW, PHP, 2-56 X 3/4	196840	89536	196840	1		
H8	SCREW, PHP, 4-40 X 1/2 (NOT SHOWN)	152132	89536	152132	2		
H9	SCREW, PHP, 4-40 X 3/8 (NOT SHOWN)	152124	89536	152124	2		
H10	WASHER, FLAT (NOT SHOWN)	110775	89536	110775	3		
H11	NUT, HEX, 4-40 (NOT SHOWN)	184044	89536	184044	8		
H12	WASHER, INT/LOCK #4 (NOT SHOWN)	110403	89536	110403	5		
H13	WASHER, SHOULDER (NOT SHOWN)	436386	86928	5607-45	5		
J1	CONNECTOR, POWER RECEPTACLE	284166	82389	EAC301	1		
MP1	DECAL (NOT SHOWN)	386250	89536	386250	1		
MP2	EXTRUSION (NOT SHOWN)	416974	89536	416974	1		
MP3	FERRITE CORE (NOT SHOWN)	420588	89536	420588	1		
MP4	INSULATOR, POWER SWITCH (NOT SHOWN)	383158	89536	383158	1		

Table 5-4. A4 Power Supply PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP5	INSULATOR, SEMICONDUCTOR MTG (NOT SHOWN)	508630	55285	7403-09-FR-51	5		
MP6	INSULATOR GASKET (NOT SHOWN)	436824	89536	436824	1		
MP7	HEATSINK (NOT SHOWN)	386235	13103	6032D	1		
MP8	HEAT DISSIPATOR (U1,U2) NOT SHOWN	414128	13103	6030B-TT	2		
MP9	NUTPLATE (NOT SHOWN)	420448	89536	420448	1		
MP10	BRACKET	166322	73734	1552	2		
MP11	LUG, SOLDER	102558	79963	124	1		
MP12	SHIELD ASSEMBLY	450502	89536	450502	1		
MP13	SCREW, CAPTIVE, 4-40 X 1/2 (NOT SHOWN)	293316	24347	FH-440-8	1		
R1	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	2		
R2	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3		REF	
R3	RES, DEP. CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	2		
R4	RES, DEP. CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E		REF	
R5	RES, VAR, CERMET, 50 +/-20%, 1/2W	320861	02111	62-1-1-500	2		1
R6	RES, VAR, CERMET, 50 +/-20%, 1/2W	320861	02111	62-1-1-500		REF	
R7	RES, DEP. CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R8	RES, DEP. CAR, 2K +/-5%, 1/4W	441493	80031	CR251-4-5P2K	1		
R9	RES, VAR, CERMET 500 +/-20%, 1/2W	226068	02111	62-1-1-501	1		1
S1	SWITCH, SLIDE, DPDT (115/230V)	376798	82389	11A1437	1		1
S2	SWITCH, POWER, DPDT	291526	89536	291526	1		1
T1	TRANSFORMER HEADER ASSEMBLY 115/230V 100V	ORDER 450403 456350	FOR 89536 89536	APPROPRIATE SOURCE 450403 456350	1		
U1	IC, LIN, VOL REG	413187	04713	MC7815CP	2		1
U2	IC, LIN, NEG, VOL REG	413179	04713	MC7915CP	2		1
U3	IC, LIN, ADJ VOLT REGULATOR	460410	12040	LM317T	1		1
U4	IC, LIN, NEG, VOL REG	413179	04713	MC7915CP		REF	
U5	IC, LIN, VOL REG	355107	04713	MC7805CP	1		1
U6	IC, LIN, VOL REG	428854	04713	MC7812CP	1		1
U7	IC, LIN, NEG, VOL REG	381665	04713	MC7912CP	1		1
U8	IC, LIN, VOL REG	428847	04713	MC7805CP	1		1
XF1	FUSEHOLDER	435628	89536	435628			
XU4	SOCKET, IC (NOT SHOWN)	402958	27264	10-18-2031	3		
XU5	SOCKET, IC (NOT SHOWN)	402958	27264	10-18-2031		REF	
XU6	SOCKET, IC (NOT SHOWN)	402958	27264	10-18-2031		REF	

1 EITHER OF THE A4 PCB ASSYS. MAY BE  
INSTALLED IN THIS UNIT.

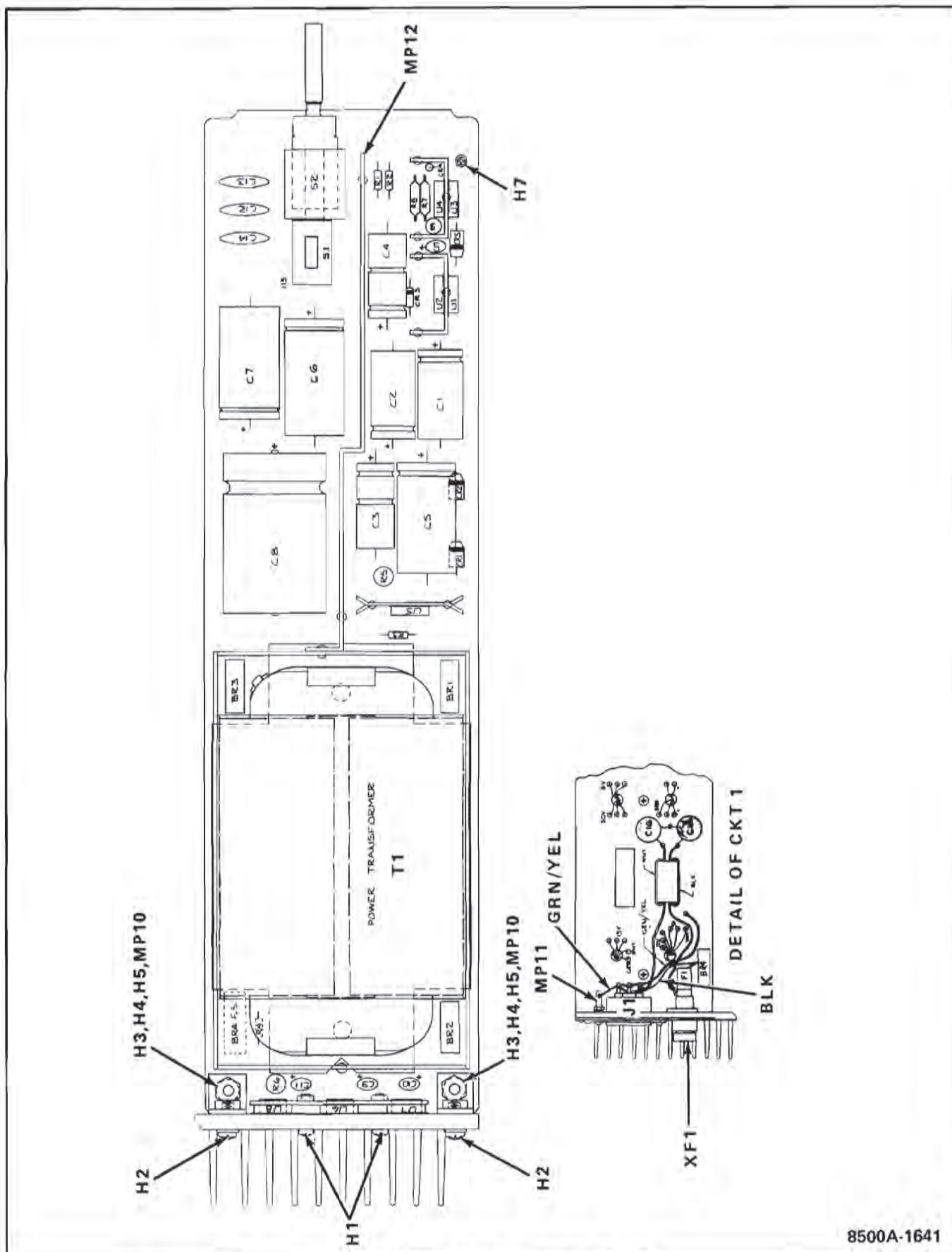


Figure 5-4. A4 Power Supply PCB Assembly

Table 5-5. A4 Power Supply PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A4	POWER SUPPLY PCB ASSEMBLY POWER SUPPLY ASSY, 115/230V MODEL POWER SUPPLY ASSY, 100V MODEL FIGURE 5-5 (8500A-4051T)	ORDER 608638 456988	FOR 89536 89536	APPROPRIATE SOURCE 608638 456988	REF	1	
BR1	BRIDGE, RECTIFIER	296509	09423	FB200	3	1	
BR2	BRIDGE, RECTIFIER	296509	09423	FB200	REF		
BR3	BRIDGE, RECTIFIER	296509	09423	FB200	REF		
BR4	BRIDGE, RECTIFIER	586115	14936	KBL 005	1		
C1	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	4		
C2	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	REF		
C3	CAP, ELECT, 330 UF -10/+25%, 50V	484436	89536	484436	2		
C4	CAP, ELECT, 330 UF -10/+25%, 50V	484436	89536	484436	REF		
C5	CAP, ELECT, 3300 UF -10/+100%, 25V	603472	89536	603472	1		
C6	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	REF		
C7	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	REF		
C8	CAP, ELECT, 15000 UF -10/+100%, 15V	603480	89536	603480	1		
C9	CAP, TA, 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	4		
C10	CAP, TA, 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
C11	CAP, TA, 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
C12	CAP, CER, 0.1UF +/-20%, 100V	149146	56289	33C41B6	3		
C13	CAP, CER, 0.1UF +/-20%, 100V	149146	56289	33C41B6	REF		
C14	CAP, CER, 0.1UF +/-20%, 100V	149146	56289	33C41B6	REF		
C15	CAP, CER, 0.005 +/-20%, 3KV	485839	89536	485839	2		
C16	CAP, CER, 0.005 +/-20%, 3KV	485839	89536	485839	REF		
C17	CAP, TA, 5.6UF +/-20%, 25V	368969	56289	196D565X-0025KA1	REF		
CR1	DIODE, RECT, SI, 50V	347559	05277	1N5400	3	1	
CR2	DIODE, RECT, SI, 50V	347559	05277	1N5400	REF		
CR3	DIODE, RECT, SI, 100V	343491	14099	SI-1	2	1	
CR4	DIODE, RECT, SI, 100V	343491	01295	1N4002	REF		
CR5	DIODE, RECT, SI, 50V	347559	05277	1N5400	REF		
F1	FUSE, SLO BLO, 1/2 AMP	109322	71400	MDL1-2	1	5	
H1	SCREW, PHP, 2-56 X 3/4	196840	89536	196840	2		
H2	SCREW, P[HP, 4-40 X 1/4 (NOT SHOWN)	129890	89536	129890	5		
H3	SCREW, PHP, 4-40 X 1/2	152132	89536	152132	2		
H4	SCREW, PHP, 4-40 X 5/8	145813	89536	145813	2		
H5	SCREW, PHP, 8-32 X 3/8	114124	89536	114124	2		
H6	SCREW, PHP, 8-32 X 3/8	436030	89536	436030	2		
H7	NUT, HEX, 4-40	184044	89536	184044	8		
H8	NUT, HEX, #8	110544	89536	110544	2		
H9	WASHER, LOCK #4	110403	89536	110403	5		
H10	WASHER, LOCK #8	110320	89536	110320	2		
H11	WASHER, SHOULDER (NOT SHOWN)	436386	89536	436386	5		
H12	WASHER, FLAT #2 (NOT SHOWN)	110775	89536	110775	3		
J1	CONNECTOR, POWER RECEPTACLE	284166	82389	EAC301	1		
MP1	DECAL (NOT SHOWN)	386250	89536	386250	1		
MP2	BRACKET	166322	73734	1552	1		
MP3	FERRITE CORE (NOT SHOWN)	420588	89536	420588	1		
MP4	INSULATOR, POWER SWITCH (NOT SHOWN)	383158	89536	383158	1		
MP5	INSULATOR, SEMICONDUCTOR MTG (NOT SHOWN)	508630	55285	7403-09-FR-51	5		

Table 5-5. A4 Power Supply PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
MP6	INSULATOR GASKET (NOT SHOWN)	436824	89536	436824	1		
MP7	NUTPLATE	420448	89536	420448	1		
MP8	HEATSINK	608752	89536	608752	1		
MP9	HEATSINK (NOT SHOWN)	386235	13103	6032D	1		
MP10	HEATSINK	416974	89536	416974	1		
MP11	SHIELD ASSEMBLY	450502	89536	450502	1		
MP12	LUG, SOLDER	102558	79963	124	2		
MP13	STUD, 4-40 X 1/2	293316	89536	293316	1		
R1	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	1		
R3	RES, DEP. CAR, 490 +/-5%, 1/4W	441543	80031	CR251-4-5P490E	2		
R4	RES, DEP. CAR, 490 +/-5%, 1/4W	441543	80031	CR251-4-5P490E	REF		
R5	RES, VAR, CERMET, 50 +/-20%, 1/2W	320861	02111	62-1-1-500	2		1
R6	RES, VAR, CERMET, 50 +/-20%, 1/2W	320861	02111	62-1-1-500	REF		
R7	RES, DEP. CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R8	RES, DEP. CAR, 2.4K +/-5%, 1/4W	441493	80031	CR251-4-5P2K4	1		
R9	RES, VAR, 500 +/-20%, 1/2W	226068	19701	501	1	1	
S1	SWITCH, SLIDE, DPDT (115/230V)	376798	82389	11A1437	1	1	
S2	SWITCH, POWER	291526	89536	291526	1	1	
T1	TRANSFORMER HEADER ASSEMBLY 115/230V	450403	89536	450403	1		
	100V	456350	89536	456350			
TP1	CONNECTOR, FASTON TAP	512889	00779	62395-1	10		
TP2	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP3	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP4	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP5	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP6	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP7	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP8	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP9	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
TP10	CONNECTOR, FASTON TAP	512889	00779	62395-1	REF		
U1	IC, LIN, VOL REG	413187	04713	MC7815CP	2	1	
U2	IC, LIN, NEG, VOL REG	413179	04713	MC7915CP	2	1	
U3	IC, LIN, ADJ VOLT REGULATOR	460410	12040	LM317T	1	1	
U4	IC, LIN, NEG, VOL REG	413179	04713	MC7915CP	REF		
U5	IC, LIN, VOL REG	355107	04713	MC7805CP	1	1	
U6	IC, LIN, VOL REG	428854	04713	MC7812CP	1	1	
U7	IC, LIN, NEG, VOL REG	381665	04713	MC7912CP	1	1	
U8	IC, LIN, VOL REG	428847	04713	MC7805CP	1	1	
XF1	FUSEHOLDER, W/NUT	375188	89536	375188	1		
	FUSE CAP	460238	89536	460238	1		
XU4	SOCKET, IC	402958	27264	10-18-2031	3		
XU5	SOCKET, IC	402958	27264	10-18-2031	REF		
XU6	SOCKET, IC	402958	27264	10-18-2031	REF		

1 EITHER OF THE A4 PCB ASSYS. MAY BE  
INSTALLED IN THIS UNIT.

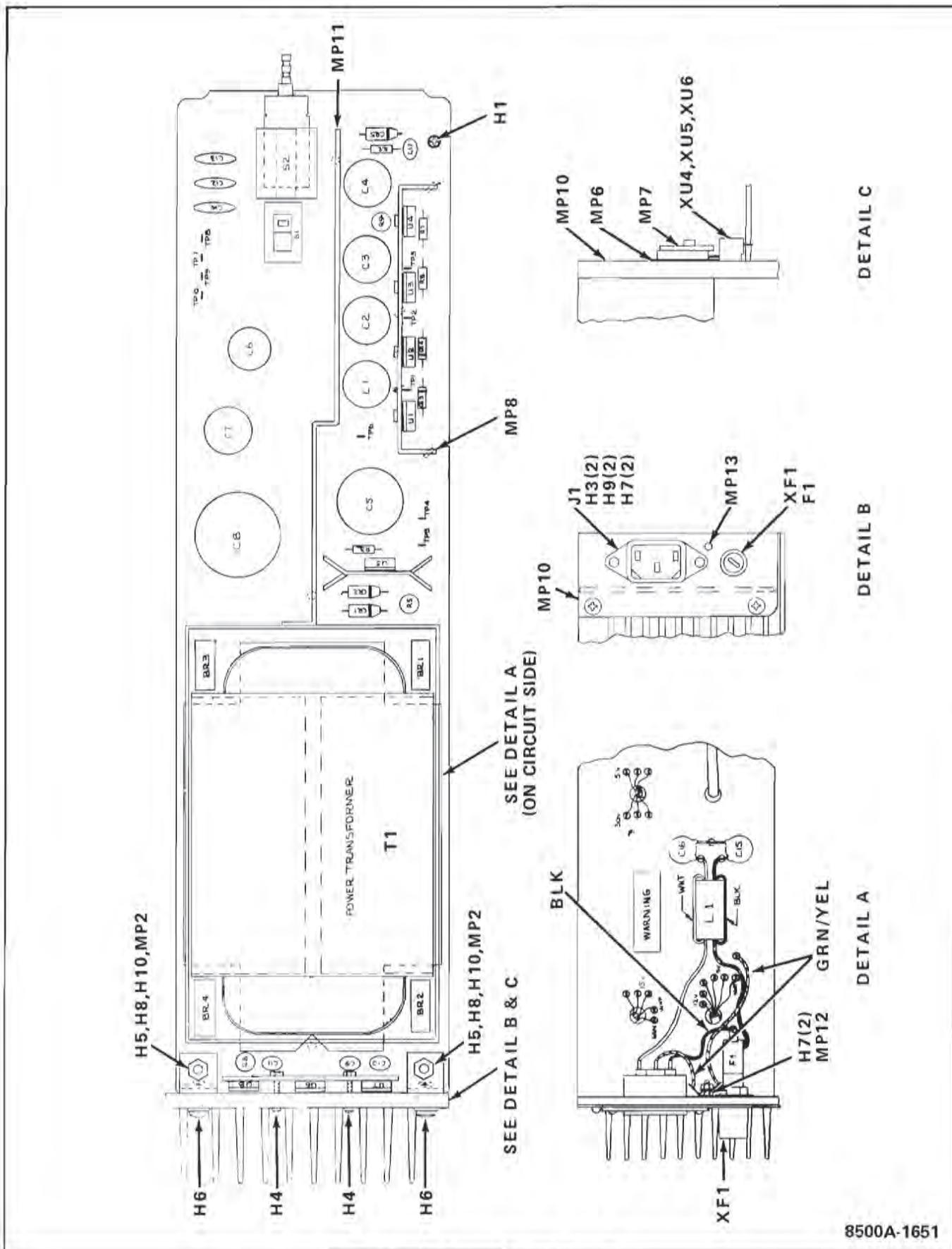
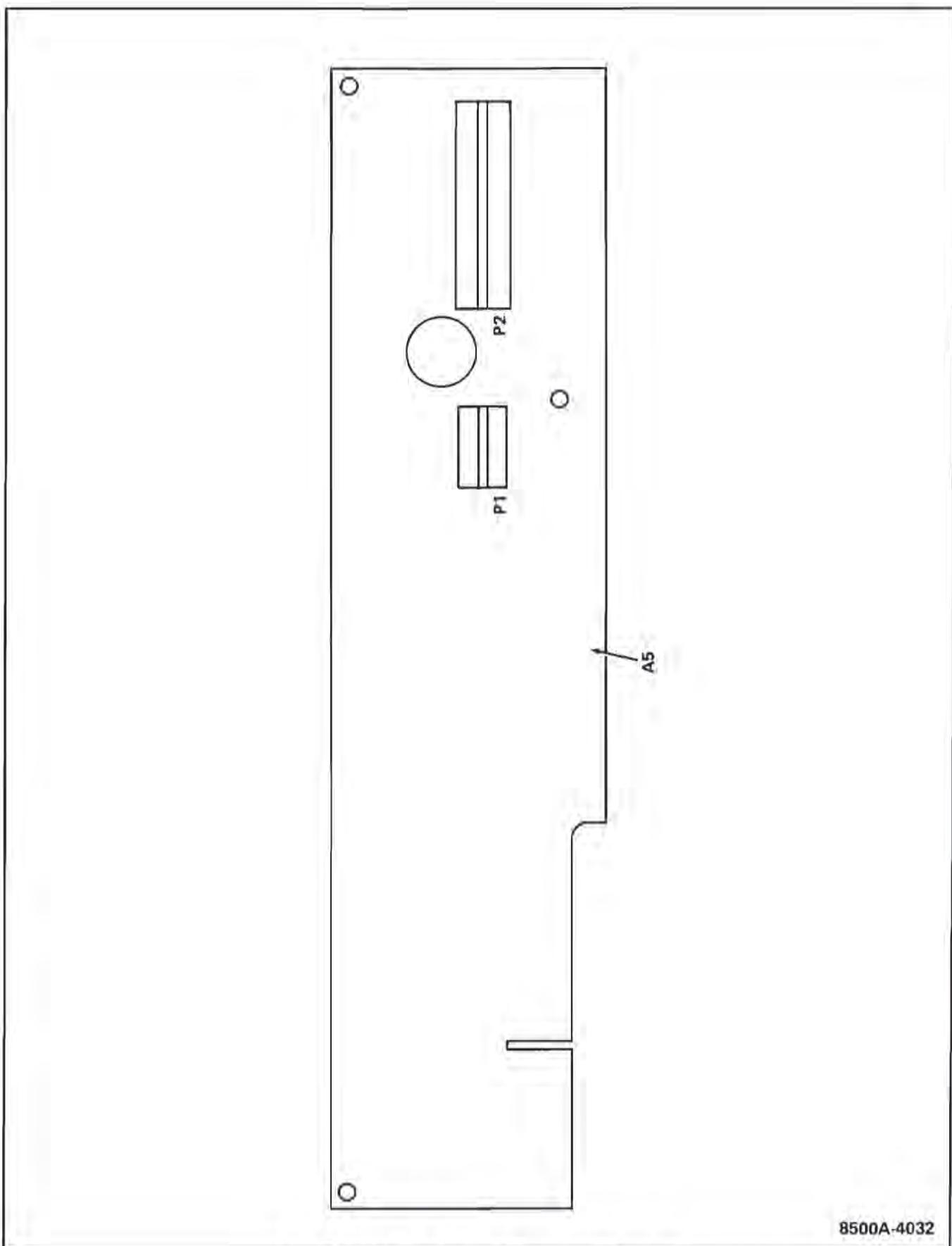


Figure 5-5. A4 Power Supply Assembly

Table 5-6. A5 Power Supply Interconnect Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A5	POWER SUPPLY 8502A INTERCONNECT ASSY FIGURE 5-6 (8500A-4032)	401760	89536	401760			REF
P1	CONNECTOR, BD EDGE, RECPT	291625	00779	583650-1		1	
P2	CONNECTOR, BD EDGE, RECPT	352682	00779	583694-2		1	



8500A-4032

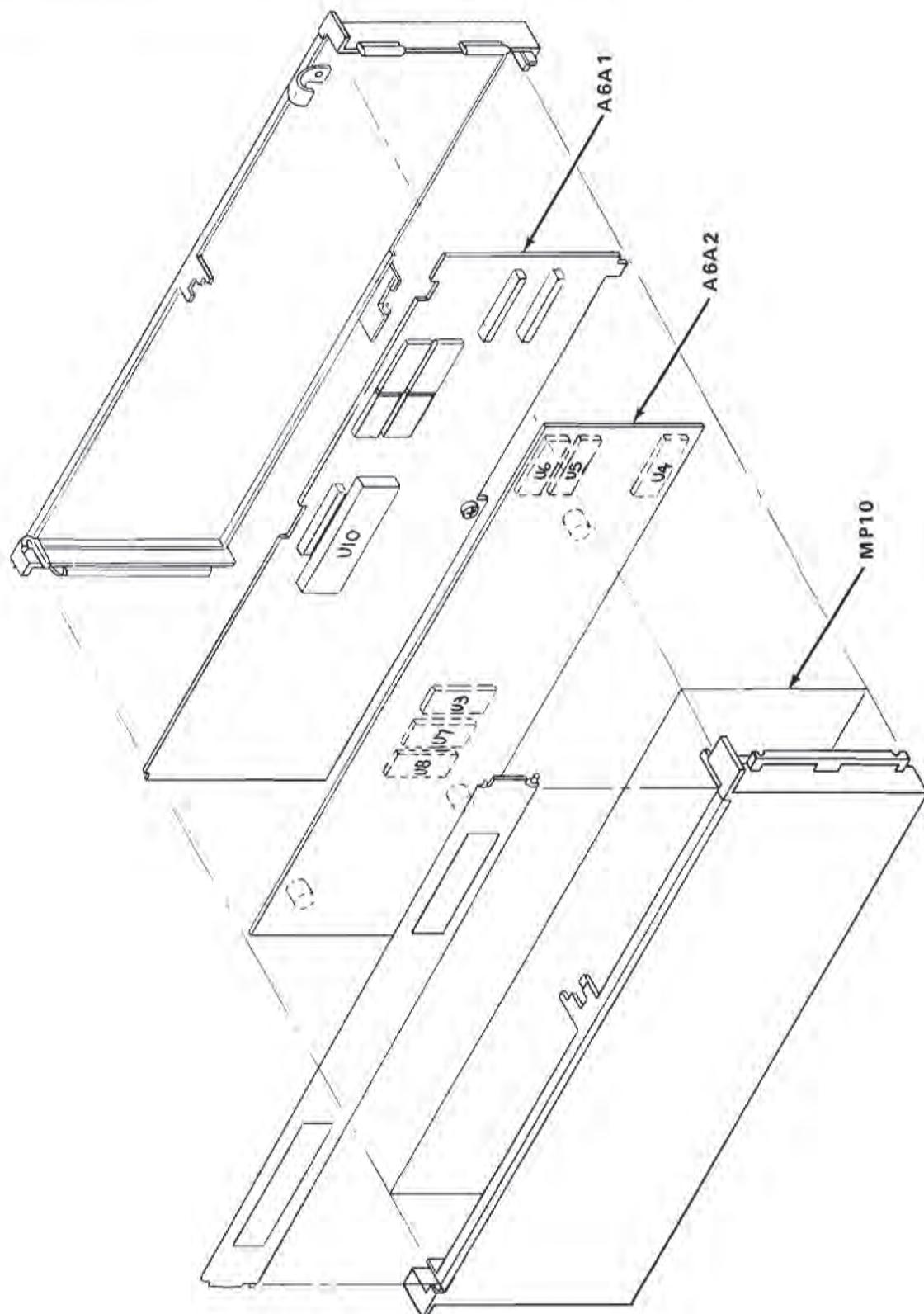
Figure 5-6. A5 Power Supply Interconnect Assembly

Table 5-7. A6 Controller Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A6	④ CONTROLLER ASSEMBLY FIGURE 5-7 (8502A-4185T)	384024	89536	384024	REF	1	
A6A1	CONTROLLER PCB ASSEMBLY (8502A-4185)	471318	89536	471318	1		
A6A2	PROM ROM PCB ASSEMBLY (8502A-4088T)	458141	89536	458141	1		
MP1	CASE, ASSY (INCLUDES MP2-MP9)	471326	89536	471326	1		2
MP2	CASE, HALF, MODULE	402990	89536	402990	REF		
MP3	CASE, HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE, CASE	486340	89536	486340	REF		
MP5	SHIELD, COVER	440008	89536	440008	REF		
MP6	DECAL, CONTROLLER	453696	89536	453696	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	MYLAR INSULATOR	463422	89536	463422	1		
U3	PROM 2716	490003	89536	490003	1		
U4	PROM 2716	489997	89536	489997	1		
U5	PROM 2716	489989	89536	489989	1		
U6	PROM 2716	489971	89536	489971	1		
U7	PROM 2716	489963	89536	489963	1		
U8	PROM 2716	489955	89536	489955	1		
U10	④ IIC, MOS, CPU	404541	01295	TMS8080	1		

1 EITHER OF THE A6 PCB ASSYS. MAY BE  
INSTALLED IN THIS UNIT.

2 SEE TABLE 5-17 AT THE END OF  
SECTION 5.



8500A-4185

Figure 5-7. A6 Controller Assembly

Table 5-8. A6A1 Controller PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
A6A1	② CONTROLLER PCB ASSEMBLY FIGURE 5-8 (8502A-4185)	471318	89536	471318		REF	
C1	CAP, MICA, 22 PF +/-5%, 500V	148551	72136	DM15E220J	1		
C2	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J	1		
C3	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	15		
C4	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C5	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C6	CAP, CER, 0.047 UF +/-20%, 50V	460733	71590	CW20C473M	1		
C7	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C8	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	1		
C9	CAP, MICA, 4 PF +/-0.5 PF, 500V	190397	72136	DM15C040E	1		
C10	CAP, CER, 1 UF +/-20%, 50V	436782	51642	300-050-601-105M	1		
C11	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C12	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C13	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C14	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C15	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C16	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C17	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C18	CAP, TA, 15 UF +/-20%, 6V	161935	56289	196D156X-0006-KA1	1		
C19	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
C20	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C21	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C22	CAP, ELECT, TA, 1 UF +/-5%, 15V	461152	56289	150D106X-5015A2	1		
C23	CAP, CER, 10,000PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C24	CAP, MICA, 33 PF +/-5%, 500V	160317	72136	DM15E330J	2		
C25	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X-0006	1		
C26	CAP, CER, 220 PF +/-10%, 500V	268425	72982	851-000-25R-222K	1		
C27	CAP, MICA, 33 PF +/-5%, 500V	160317	72136	DM15E330J		REF	
C28	CAP, CER, 0.022 UF -20/+100%, 40V	358325	72982	8121-A050-651-223Z	1		
C29	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X-0020HA1	3		
C30	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X-0020HA1		REF	
C31	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X-0020HA1		REF	
C32	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M		REF	
C33	CAP, TA, 150 UF +/-20%, V6	460204	56289	183DR157X0006F	1		
CR1	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	2		
CR2	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
H1	SCREW, PHP, 4-40X3/8	256164	73734	23024	1		
J1	SOCKET, IC, 9-PIN	436774	30035	33-109-1-09	1		
J2	SOCKET, IC, 12-PIN	417733	30035	SS-109-1-12	2		
MP1	CLAMP, NYLON STRAP, TIE (NOT SHOWN)	172080	06383	SST1M	1		
MP2	DECAL, CONTROLLER (NOT SHOWN)	454108	89536	454108	1		
MP3	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
R1	RES, VAR, CERMET, 10K +/-10%, 1/2W	285171	89536	285171	1		
R2	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	3		
R3	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	6		
R4	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	4		
R5	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	2		
R6	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		

Table 5-8. A6A1 Controller PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R7	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	REF		
R8	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R9	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R10	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R11	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R13	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R14	RES, MTL. FILM, 715 +/-1%, 1/8W	313080	91637	CMF557150F	1		
R15	RES, MTL. FILM, 523 +/-0.5%, 1/8W	294835	91637	CMF555230F	1		
R16	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R17	RES, MTL. FILM, 4.99K +/-1%, 1/8W	168252	91637	CMF554991F	1		
R18	RES, MTL. FILM, 23.2K +/-1%, 1/8W	291351	91637	CMF552322F	1		
R19	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	REF		
R20	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R21	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	REF		
R22	RES, DEP. CAR, 3K +/-5%, 1/4W	441527	80031	CR251-4-5P3K	1		
R23	RES, DEP. CAR, 680K +/-5%, 1/4W	442517	80031	CR251-4-5P680K	1		
R24	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	1		
R25	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R26	RES, DEP. CAR, 62K +/-5%, 1/4W	348904	80031	CR251-4-5P62K	1		
R27	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	REF		
R28	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
RN1	RESISTOR NETWORK, 4.7K	412916	89536	412916	2	1	
RN2	RESISTOR NETWORK, 4.7K	412916	89536	412916	REF		
RN3	RESISTOR NETWORK, 10K	412924	89536	412924	1	1	
U1	IC, TTL, LPS, DUAL J-K FF	412999	01295	SN74LS109N	1	1	
U2	②IC, C-MOS, HEX BUFFER/INVERTERS	381830	02735	CD4050AE	1	1	
U3	②IC, C-MOS, FAST QUAD 2-INPUT NAND GATE	413211	07263	34011PC4011PC	1	1	
U5	②IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	4	1	
U6	②IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U8	IC, TTL, AND-OR INVERT GATES	412981	01295	SN74LS51	1	1	
U9	②IC, C-MOS, HEX INVERTER	404699	12040	MM74C04N	1	1	
U12	②IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U13	②IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U14	②IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	2	1	
U15	IC, TTL, QUAD 2-INPUT POS AND GATES	393066	01295	SN74LS08	1	1	
U16	IC, TTL, HEX INVERTER POS NAND GATES	393058	01295	SN74LS04	2	1	
U17	②IC, C-MOS, QUAD 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U18	IC, TTL, HEX/QUAD TYPE D FLIP FLOP	393207	01295	SN74LS174N	1	1	
U19	②IC, C-MOS STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	2	1	
U20	IC, TTL, MULTIPLEXER	393165	01295	SN74LS139N	1	1	
U21	IC, TTL, HEX INVERTER POS NAND GATES	393058	01295	SN74LS04	REF		
U23	②IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	3	1	
U24	②IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	REF		
U26	IC, LIN, C-MOS, PLL	403584	02735	CD4046AE	1	1	
U27	②IC, C-MOS, QUAD 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	
U28	②IC, C-MOS, 8-BIT PRIORITY ENCODER	412973	02735	CD4523BE	1	1	
U29	②IC, C-MOS, STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	REF		
U30	②IC, C-MOS, TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	REF		
U31	IC, TTL, POS NAND GATES/INVERTERS	393074	01295	SN74LS10N	1	1	

Table 5-8. A6A1 Controller PCB Assembly (cont)

REF OES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U32	Φ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U34	Φ IC, C-MOS, DUAL UP COUNTER	355164	04713	MC14520CL/CP	1	1	
U35	Φ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	REF		
U36	Φ IC, C-MOS, NONOSTABLE MV	454017	04713	MC14538BCP	1	1	
U37	Φ IC, C-MOS, QUAD 2-INPUT NOR GATES	429944	02735	CD4001BE	1	1	
U38	Φ IC, C-MOS, QUAD 2-INPUT NAND	404632	02735	CD4039BE	1	1	
XU5	SOCKET, IC, 18-PIN	418228	91506	318-AG39D	4		
XU6	SOCKET, IC, 18-PIN	418228	91506	318-AG39D	REF		
XU10	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		
XU12	SOCKET, IC, 18-PIN	418228	91506	318-AG39D	REF		
XU13	SOCKET, IC, 18-PIN	418228	91506	318-AG39D	REF		
Y1	CRYSTAL, QUARTZ	412932	89536	412932	1		

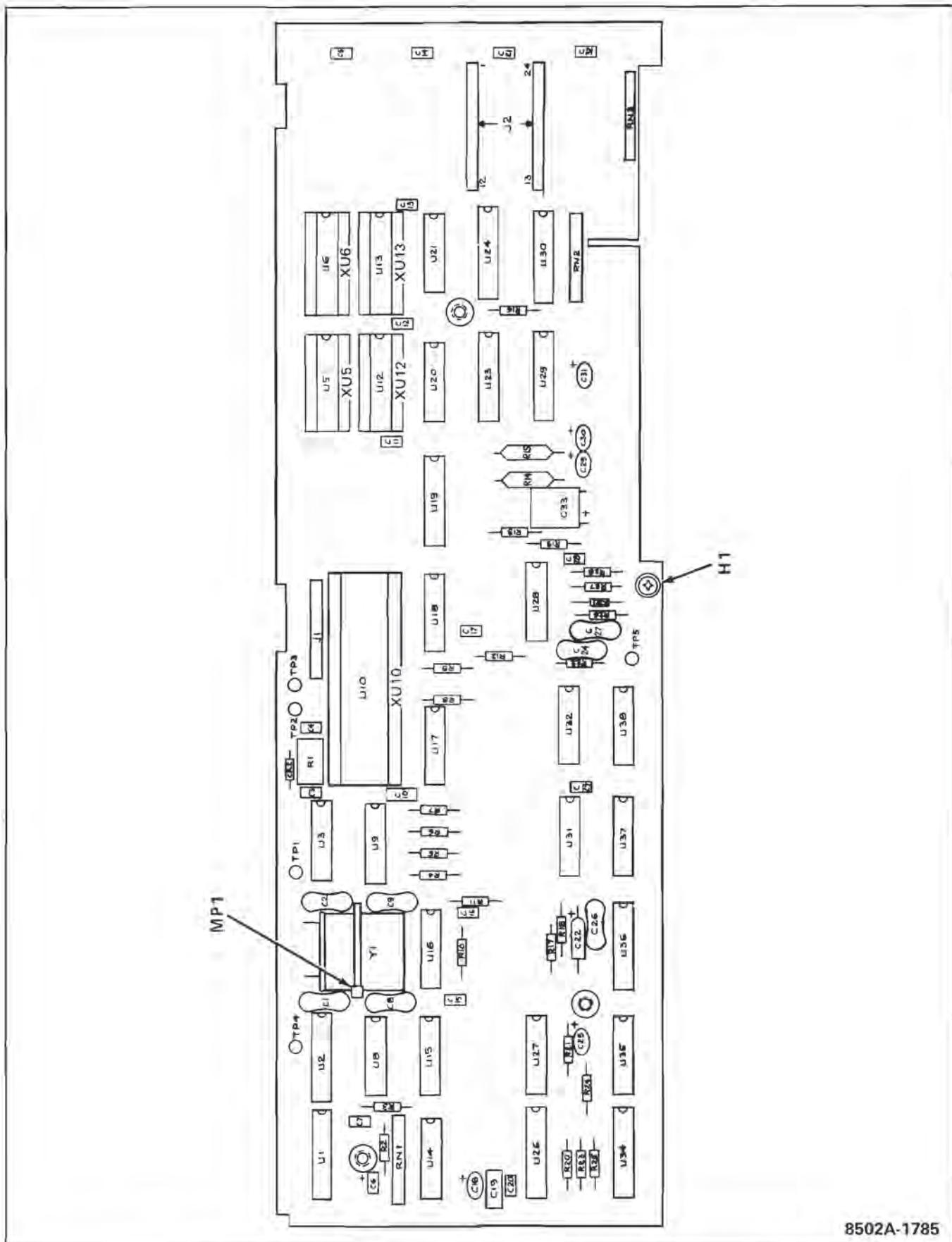


Figure 5-8. A6A1 Controller PCB Assembly

8502A-1785

Table 5-9. A6A2 Prom Rom PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
A6A2	Φ PROM ROM PCB ASSEMBLY FIGURE 5-9 (8502A-4088T)	458141	89536	458141		REF	
C1	CAP, CER, 0.01 UF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	6		
C4	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C5	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C7	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C8	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C17	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
H1	WASHER, FLAT, TEFLON (NOT SHOWN)	187989	89536	187989	6		
MP1	INSERTS, BOARD (NOT SHOWN)	376418	89536	376418	72		
P1	POST, CONTACT	447813	22526	65501-136	1		
P2	POST, CONTACT	447813	22526	65501-136	2		
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
U1	IC, TTL, SCHOTTKY 3-8 LINE DECODER	407585	01295	SN74LS138N	1		
U17	ΦIC, C-MOS TRISTATE HEX NON INV BUFFER	407759	04713	MC14503CP	3		
U18	ΦIC, C-MOS TRISTATE HEX NON INV BUFFER	407759	04713	MC14503CP		REF	
U19	ΦIC, C-MOS TRISTATE HEX NON INV BUFFER	407759	04713	MC14503CP		REF	
U20	IC, TTL, POS AND GATES	393066	01295	SN74LS08N	1		
U21	IC, TTL, QUAD, 2-INPUT POS OR GATE	393108	01295	SN74LS32N	1		
XU4	SOCKET, 24 PIN	376236	91506	324-AG39D	3		
XU5	SOCKET, 24 PIN	376236	91506	324-AG39D		REF	
XU6	SOCKET, 24 PIN	376236	91506	324-AG39D		REF	

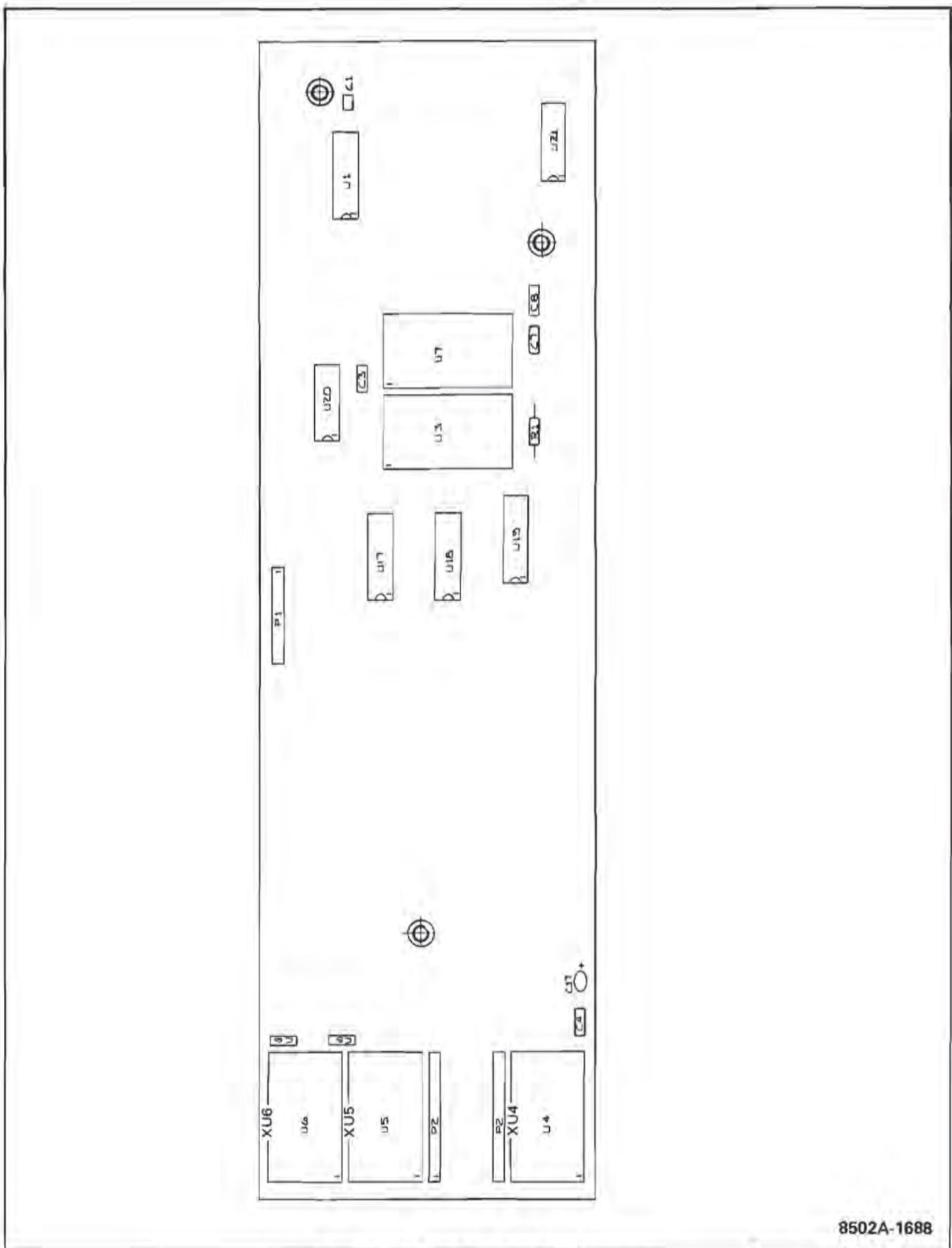


Figure 5-9. A6A2 Prom Rom PCB Assembly

8502A-1688

Table 5-10. A6 Controller PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A6	©CONTROLLER PCB ASSEMBLY FIGURE 5-10 (8502A-4186T)	577072	89536	577072	REF	1	
C1	CAP, MICA, 22 PF +/-5%, 500V	148551	02799	DM15C220J	1		
C2	CAP, MICA, 47 PF +/-5%, 500V	148536	02799	DM15E470J	1		
C3	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	15		
C4	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C5	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C6	CAP, CER, 0.047 UF +/-20%, 50V	460733	72982	8121-050-651-47NM	1		
C7	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C8	CAP, MICA, 15 PF +/-5%, 500V	148569	02799	DM15C150J	1		
C9	CAP, MICA, 4 PF +/-0.5%, 500V	190397	02799	DM15C040D	1		
C10	CAP, CER, 1 UF +/-20%, 50V	436782	72982	8131-050-601-105M	1		
C11	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C12	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C13	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C14	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C15	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C16	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C17	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C18	CAP, TA, 15 UF +/-20%, 6V	161935	56289	196D156X0006-KA1	1		
C19	CAP, CER, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-222M	1		
C20	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C21	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C22	CAP, ELECT, TA, 1 UF +/-5%, 15V	461152	56289	150D106X5015A2	1		
C23	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C24	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	2		
C25	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006	1		
C26	CAP, CER, 2200 PF +/-10%, 500V	268425	72982	851-000-Z5R-222K	1		
C27	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	REF		
C28	CAP, CER, 0.022 UF -20/+100%, 40V	358325	72982	8121-A050-651-223Z	1		
C29	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X0020HA1	3		
C30	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X0020HA1	REF		
C31	CAP, TA, 2.2 UF +/-20%, 20V	161927	56289	196D225X0020HA1	REF		
C32	CAP, CER, 10,000 PF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	REF		
C33	CAP, TA, 150 UF +/-20%, 6V	460204	56289	183DR157X0006F	1		
CR1	DIODE, SI, HI SPEED SWITCHING	203323	07910	1N4448	2	1	
CR2	DIODE, SI, HI SPEED SWITCHING	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
MP1	CASE ASSY (INCLUDES MP2-MP9)	611665	89536	611665	1	2	
MP2	CASE, HALF, MODULE	402990	89536	402990	REF		
MP3	CASE, HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE, CASE	402974	89536	402974	REF		
MP5	SHIELD COVER	440008	89536	440008	REF		
MP6	DECAL, CONTROLLER (NOT SHOWN)	536029	89536	536029	REF		
MP7	DECAL, CAUTION (NOT SHOWN)	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	CLAMP, NYLON STRAP	172080	06383	SSTM	1		
MP11	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380M	1		

Table 5-10. A6 Controller PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP12	MYLAR INSULATOR	463422	89536	463422	1		
R1	RES, VAR, CERMET, 10K +/-10%, 1/2W	285171	89536	285171	1		
R2	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	3		
R3	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	6		
R4	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	4		
R5	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	2		
R6	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
R7	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K		REF	
R8	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7		REF	
R9	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7		REF	
R10	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7		REF	
R11	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7		REF	
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R13	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K		REF	
R14	RES, MTL. FILM, 715 +/-1%, 1/8W	313080	91637	CMF557150F	1		
R15	RES, MTL. FILM, 523 +/-1%, 1/8W	294835	91637	CMF555230D	1		
R16	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7		REF	
R17	RES, MTL. FILM, 4.99K +/-1%, 1/8W	168252	91637	CMF554991F	1		
R18	RES, MTL. FILM, 23.2K +/-1%, 1/8W	291351	91637	CMF552322F	1		
R19	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K		REF	
R20	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K		REF	
R21	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8		REF	
R22	RES, DEP. CAR, 3K +/-5%, 1/4W	441527	80031	CR251-4-5P3K	1		
R23	RES, DEP. CAR, 680K +/-5%, 1/4W	442517	80031	CR251-4-5P680K	1		
R24	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	1		
R25	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R26	RES, DEP. CAR, 30K +/-5%, 1/4W	368753	80031	CR251-4-5P30K	1		
R27	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K		REF	
R28	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
RN1	RES NETWORK, SIP, 4.7K	412916	89536	412916	2	1	
RN2	RES NETWORK, SIP, 4.7K	412916	89536	412916		REF	
RN3	RES NETWORK, SIP, 10K	412924	89536	412924	1	1	
U1	IC, TTL LPS, DUAL J-K FF	412999	01295	SN74LS109N	1	1	
U2	④ IC, C-MOS, HEX BUFFER/INVERTERS	381830	02735	CD4040BCN	1	1	
U3	④ IC, C-MOS, FAST QUAD 2 INPUT NAND GATE	413211	07263	34011PC/4011PC	1	1	
U5	④ IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	4	1	
U6	④ IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4		REF	
U7	PROM	613505	89536	613505	1		
U8	IC, TTL-AND-OR-INVERT GATES	412981	01295	SN74LS51	1	1	
U9	④ IC, C-MOS, HEX INVERTER	404699	12040	MM74C04N	1	1	
U10	④ IC, MOS, CPU	404541	01295	TMS8080	1	1	
U12	④ IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4		REF	
U13	④ IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4		REF	
U14	④ IC, C-MOS, DUAL TYPE "D" FLIP FLOP	340117	04713	MC14013CP	2	1	
U15	IC, TTL QUAD 2 INPUT POS AND GATES	393066	01295	SN74LS08N	1	1	
U16	IC, TTL HEX INVERTER POS NAND GATES	393058	01295	SN74LS04N	2	1	
U17	④ IC, C-MOS TRI 3 INPUT NAND GATES	375147	02735	CD4023UBE	1	1	
U18	IC, TTL HEX/QUAD TYPE D FLIP FLOP	393207	01295	SN74LS174N	1	1	
U19	④ IC, C-MOS STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	2	1	
U20	IC, TTL MULTIPLEXER	393165	01295	SN74LS139N	1	1	

Table 5-10. A6 Controller PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U21	IC, TTL HEX INVERTER POS NAND GATES	393058	01295	SN74LS04			REF
U22	ROM	604132	89536	604132		1	
U23	①IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N		3	1
U24	①IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N			REF
U25	ROM	604116	89536	604116		1	
U26	IC, LIN C-MOS/MOS PLL	403584	02735	CD4046AE		1	1
U27	①IC, C-MOS, QUAD 2 INPUT OR GATE	408393	02735	CD4071BE		1	1
U28	①IC, C-MOS 8-BIT PRIORITY ENCODER	412973	02735	CD4523BE		1	1
U29	①IC, C-MOS STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP			REF
U30	①IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N			REF
U31	IC, TTL POS NAND GATES/INVERTERS	393074	01295	SN74LS10N		1	1
U32	①IC, C-MOS, HEX INVERTER	404681	02735	CD4069UBE		1	1
U33	ROM	604124	89536	604124		1	
U34	①IC, C-MOS DUAL UP COUNTER	355164	04713	MC14520BCP	4520B	1	1
U35	①IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	4013B		REF
U36	①IC, C-MOS, MONOSTABLE MV	454017	04713	MC14538BCP		1	1
U37	①IC, C-MOS QUAD 2 INPUT NOR GATES	429944	02735	CD4001BE	4001B	1	1
U38	①IC, C-MOS QUAD 2 INPUT NAND	404632	02735	CD4093BE	4093B	1	1
XU5	SOCKET, IC, 18-PINS	418228	91506	318-AG39D		4	
XU6	SOCKET, IC, 18-PINS	418228	91506	318-AG39D			REF
XU7	SOCKET, IC, 24-PINS	376236	91506	324-AG39D		4	
XU10	SOCKET, IC, 40-PINS	418988	91506	340-AG39D		1	
XU12	SOCKET, IC, 18-PINS	418228	91506	318-AG39D			REF
XU13	SOCKET, IC, 18-PINS	418228	91506	318-AG39D			REF
XU22	SOCKET, IC, 24-PINS	376236	91506	324-AG39D			REF
XU25	SOCKET, IC, 24-PINS	376236	91506	324-AG39D			REF
XU33	SOCKET, IC, 24-PINS	376236	91506	324-AG39D			REF
Y1	CRYSTAL, QUARTZ, 1.70 MHZ	412932	89536	412932		1	

1 EITHER OF THE A6 PCB ASSYS. MAY BE  
INSTALLED IN THIS UNIT.

2 SEE TABLE 5-17 AT THE END  
OF SECTION 5.

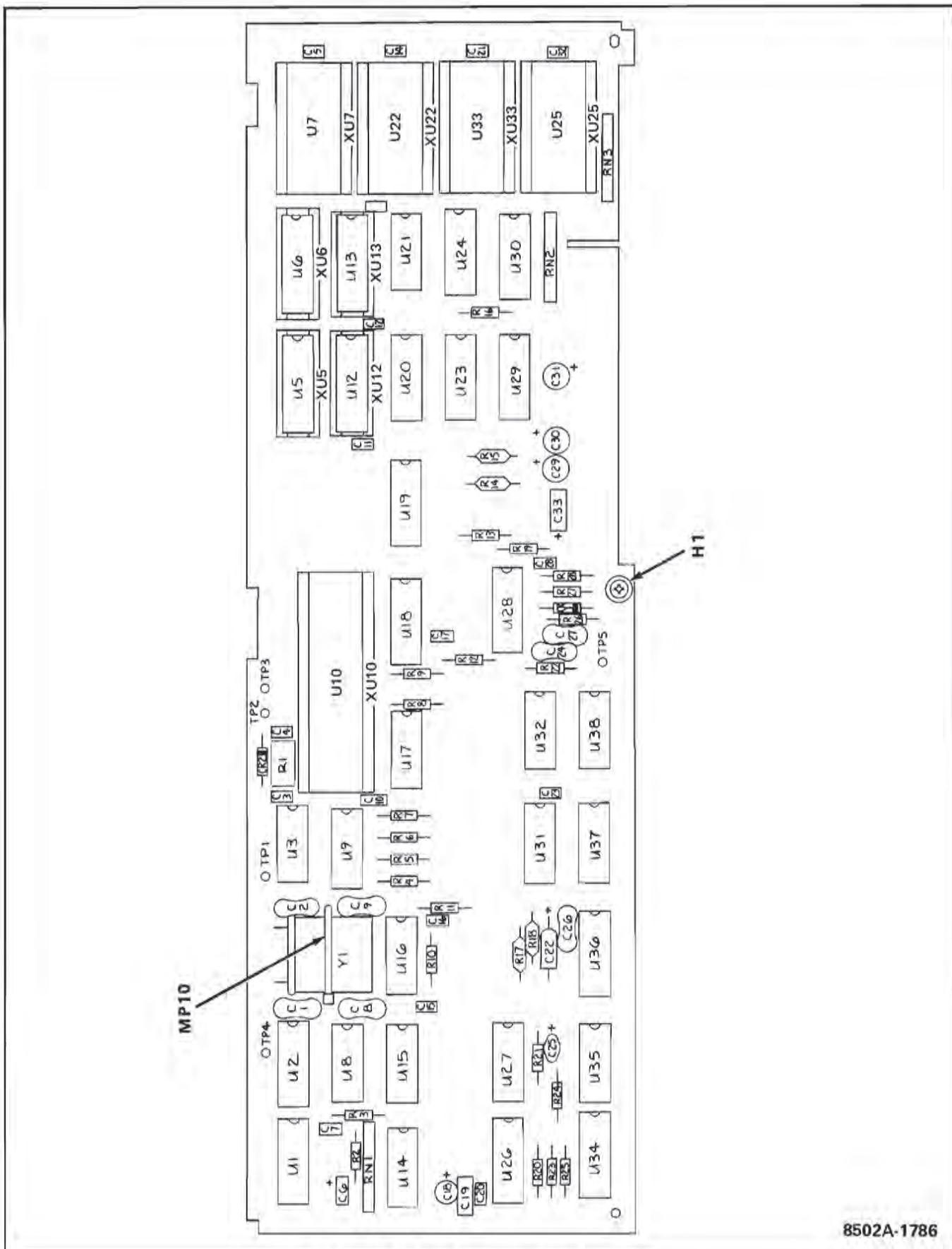


Figure 5-10. A6 Controller PCB Assembly

8502A-1786

Table 5-11. A7 Display PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A7	DISPLAY PCB ASSEMBLY FIGURE 5-11 (8502A-4023T)	481689	89536	481689		REF	
C1	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
C2	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
C3	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	1		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	6	2	
CR2	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448		REF	
CR3	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448		REF	
CR4	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448		REF	
CR5	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448		REF	
CR6	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448		REF	
CR7	DIODE, LED	413831	29083	MV5153	1	1	
E1	SPARK GAP (NOT SHOWN)	442731	25088	B1C145	1		
F1	FUSE, FAST-BLO	109330	71400	AGC11-2	1	5	
F2	FUSE, WIRE #36	160978	89536	160978	1		
J1	BINDING POST, RED	275552	32767	820-65	2		
J2	BINDING POST, RED	275552	32767	820-65		REF	
J3	BINDING POST, BLK	275560	32767	820-45	2		
J4	BINDING POST, BLK	275560	32767	820-45		REF	
J5	BINDING POST, BLUE	275578	32767	820-55	1		
L1	COIL ASSEMBLY	438325	89536	438325	1		
MP1	INSULATING BINDING POST (NOT SHOWN)	449363	89536	449363	1		
MP2	MASK, 0.40 LENS (NOT SHOWN)	418996	89536	418996	4		
MP3	SHIELD, FRONT PANEL (NOT SHOWN)	433524	89536	433524	1		
MP4	SPACER (NOT SHOWN)	448432	89536	448432	1		
P1	CONNECTOR PIN	233411	00779	60599-3	5		
Q1	TRANSISTOR, SI, NPN	330803	04713	MPS6560	1		
Q2	TRANSISTOR, SI, PNP	340026	04713	MPS6563	7	2	
Q3	TRANSISTOR, SI, PNP	340026	04713	MPS6563		REF	
Q4	TRANSISTOR, SI, PNP	340026	04713	MPS6563		REF	
Q5	TRANSISTOR, SI, PNP	340026	04713	MPS6563		REF	
Q6	TRANSISTOR, SI, PNP	340026	04713	MPS6563		REF	
Q7	TRANSISTOR, SI, PNP	340026	04713	MPS6563		REF	
Q8	TRANSISTOR, SI, PNP	340026	04713	MPS6563		REF	
Q10	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, DEP. CAR, 62 +/-5%, 1/4W	441634	80031	CR251-4-SP62ET	1		
R2	RES, DEP. CAR, 200 +/-5%, 1/4W	441451	80031	CR251-4-5P200ET	2		
R3	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100KT	1		
R4	RES, COMP, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150ET	1		
R5	RES, COMP, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7T	1		
R6	RES, COMP, 200 +/-5%, 1/4W	441451	80031	CR251-4-5P200ET		REF	
R7	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E			
R8	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
S1	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106	23		
	SWITCH TOP COVER	401299	89536	401299	23		
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3	23		
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4	23		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	14		

Table 5-11. A7 Display PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
S2	SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON	412106 401299 414516 416875	89536 89536 00779 00779	412106 401299 62353-3 62380-4			REF REF REF REF
S3	SWITCH, PUSHBUTTON, LT PUTTY GREY SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON	401307 412106 401299 414516 416875	89536 89536 89536 00779	401307 412106 401299 62353-3 62380-4			REF REF REF REF
S4	SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON SWITCH, PUSHBUTTON, LT PUTTY GREY	412106 401299 414516 416875 401307	89536 89536 00779 00779 89536	412106 401299 62353-3 62380-4 401307			REF REF REF REF
S5	SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON SWITCH, PUSHBUTTON, LT PUTTY GREY	412106 401299 414516 416875 401307	89536 89536 00779 00779 89536	412106 401299 62353-3 62380-4 401307			REF REF REF
S6	SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON SWITCH, PUSHBUTTON, LT PUTTY GREY	412106 401299 414516 416875 401307 406728	89536 89536 00779 00779 89536	412106 401299 62353-3 62380-4 401307 406728			REF REF REF REF REF 6
S7	SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON	412106 401299 414516 416875	89536 89536 00779 00779	412106 401299 62353-3 62380-4			REF REF REF REF
S8	SWITCH, PUSHBUTTON, DK PUTTY GREY SWITCH ASSEMBLY SWITCH ACTUATOR SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON	406728 412106 401299 414516	89536 89536 89536 00779	406728 412106 401299 62353-3			REF REF REF REF
S9	CONTACT, SWITCH, PUSHBUTTON SWITCH, PUSHBUTTON, DK PUTTY GREY	416875 406728	00779 89536	62380-4 406728			REF REF
S10	SWITCH, SLIDE, SPDT SWITCH ASSEMBLY SWITCH ACTUATOR	417287	95146	MSS-104D-1			1
S11	SWITCH TOP COVER SPRING, SWITCH, PUSHBUTTON CONTACT, SWITCH, PUSHBUTTON SWITCH, PUSHBUTTON, MED YELLOW	412106 414516 416875 419937	89536 00779 00779 89536	412106 62353-3 62380-4 419937			REF REF REF 2
	SWITCH ASSEMBLY						

Table 5-11. A7 Display PCB Assembly (cont)

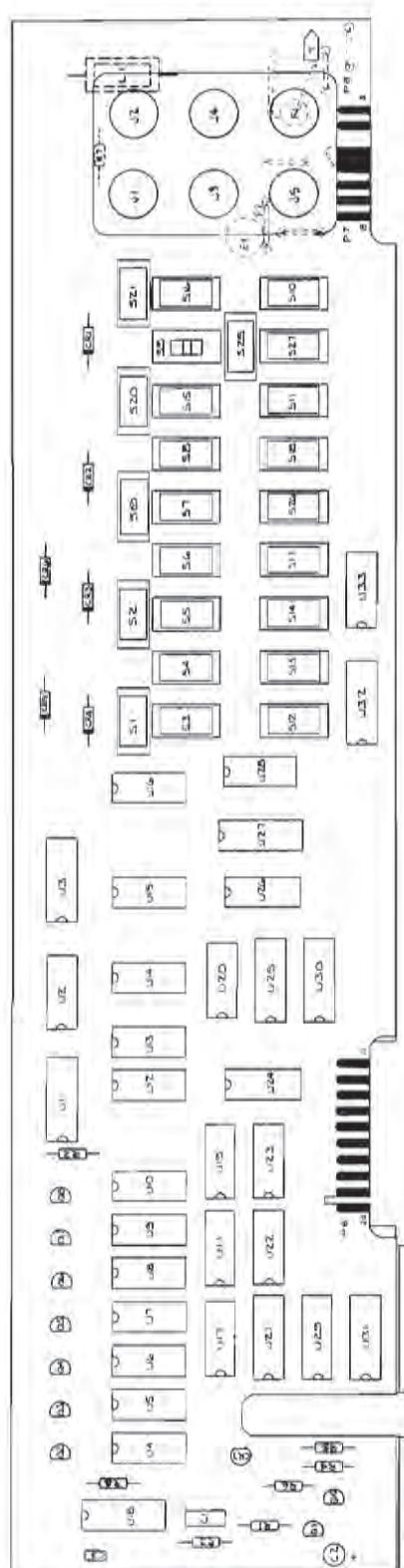
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH, PUSHBUTTON, MED YELLOW	419937	89536	419937			REF
S12	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S13	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728			REF
	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S14	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728			REF
	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S15	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728			REF
	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S16	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
S17	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S18	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S19	SWITCH, PUSHBUTTON, BLUE	406736	89536	406736		1	
	SWITCH ASSEMBLY						
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF

Table 5-11. A7 Display PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
S20	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
	SWITCH ASSEMBLY	412106	89536	412106			REF
S21	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
S21	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
	SWITCH ASSEMBLY	412106	89536	412106			REF
	SWITCH ACTUATOR	401299	89536	401299			REF
	SWITCH TOP COVER	414516	00779	62353-3			REF
S25	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH ASSEMBLY	412106	89536	412106			REF
	SWITCH ACTUATOR	401299	89536	401299			REF
	SWITCH TOP COVER	414516	00779	62353-3			REF
S26	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH ASSEMBLY	401307	89536	401307			REF
	SWITCH ACTUATOR	412106	89536	412106			REF
	SWITCH TOP COVER	401299	89536	401299			REF
S27	SPRING, SWITCH, PUSHBUTTON	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
	SWITCH ASSEMBLY	412106	89536	412106			REF
U1	SWITCH ACTUATOR	401299	89536	401299			REF
	SWITCH TOP COVER	414516	00779	62353-3			REF
	CONTACT, SWITCH, PUSHBUTTON	416875	00779	62380-4			REF
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307			REF
U2	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	3	1	
	QIC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U3	QIC, C-MOS, HEX D FLIP FLOP	404509	12040	MM74C174N	3	1	
U4	DISPLAY, LED	453282	29083	MAN4630A	2	1	
U5	DISPLAY SET	440016	89536	440016	1	1	
U6	DISPLAY SET	440016	89536	440016			REF
U7	DISPLAY SET	440016	89536	440016			REF
U8	DISPLAY SET	440016	89536	440016			REF
U9	DISPLAY SET	440016	89536	440016			REF
U10	DISPLAY SET	440016	89536	440016			REF
U11	QIC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U12	DISPLAY, LED	453282	29083	MAN4630A			REF
U13	DISPLAY SET	440016	89536	440016			REF
U14	DISPLAY, LED	453274	29083	MAN4610A	4	1	
U15	DISPLAY, LED	453274	29083	MAN4610A			REF
U16	QIC, C-MOS, DUAL, FLIP FLOP	340117	04713	MC14013CL	3	1	
U17	RES NETWORK 4.7K	344069	89536	344069	2	1	

Table 5-11. A7 Display PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
U18	©IC, C-MOS, RETRIGGERABLE/RESETTABLE	393512	04713	MC14528CP	1	1	
U19	©IC, C-MOS, DUAL 4-INPUT NAND GATE	355206	04713	MC14012CP	1	1	
U20	RES NETWORK 4.7K	344069	89536	344069	REF		
U21	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	REF		
U22	©IC, C-MOS, DUAL, FLIP FLOP	340117	04713	MC14013CL	REF		
U23	©IC, C-MOS, DUAL, FLIP FLOP	340117	04713	MC14013CL	REF		
U24	DISPLAY, LED	453274	29083	MAN4610A	REF		
U25	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	REF		
U26	DISPLAY, LED	453274	29083	MAN4610A	REF		
U27	©IC, C-MOS, HEX D FLIP FLOP	404509	12040	MM74C174N	REF		
U28	©IC, C-MOS, TRIPLE 3-INPUT NAND GATE	375147	04713	MC14023CP	1	1	
U29	RES, DUAL, IN LINE PACKAGE	358119	89536	358119	2	1	
U30	RES, DUAL, IN LINE PACKAGE	358119	89536	358119	REF		
U31	©IC, C-MOS, HEX D FLIP FLOP	404509	12040	MM74C174N	REF		
U32	©IC, C-MOS TRI STATE HEX NON INVRT BUFFER	407759	12040	MM80C97N	1	1	
U33	RESISTOR NETWORK, 4.7K	386961	89536	386961	1	1	
XF1	FUSEHOLDER ASSY (NOT SHOWN)				1		
	FUSEHOLDER	435628	89536	435628			
	CAP, WHITE	455857	89536	455857			
XU4	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	13		
XU5	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU6	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU7	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU8	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU9	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU10	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU12	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU13	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU14	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU15	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU24	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		
XU26	SOCKET, IC (NOT SHOWN)	453514	71785	133-59-90-0901/14E	REF		



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Figure 5-11. A7 Display PCB Assembly

Table 5-12. A8 DC Signal Conditioner PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A8	①DC SIGNAL CONDITIONER PCB ASSEMBLY FIGURE 5-12 (MIS-4100T)	383901	89536	383901		REF	
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	2		
C2	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-220NM	2		
C4	CAP, CER, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-220NM	REF		
C5	CAP, TA, 30 UF +/-20%, 6V	163915	56289	196D396X0006	1		
C10	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	80031	ET6P8X063A3	2		1
C11	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	80031	ET6P8X063A3	REF		
C12	CAP, MICA, 100 PF +/-5%, 500V	148494	02799	DM15F101J	2		
C13	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	1		
C14	CAP, MICA, 100 PF +/-5%, 500V	148494	02799	DM15F101J	REF		
C15	CAP, MICA, 47 PF +/-5%, 500V	148536	02799	DM15E470J	2		
C16	CAP, MICA, 47 PF +/-5%, 500V	148536	02799	DM15E470J	REF		
C18	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	2		
C19	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	REF		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	2		1
CR2	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, ZENER	181073	07910	1N969B	2		1
CR4	DIODE, ZENER	181073	07910	1N969B	REF		
CR5	DIODE, SI, LOW-CAP, LOW LEAKAGE	348177	07263	FD7223	1		1
H1	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY, ARMATURE	515437	89536	515437	2		
K2	RELAY, ARMATURE	515437	89536	515437	REF		
MP1	CASE ASSY (INCLUDES MP2-MP9)	458992	89536	458992	1		1
MP2	CASE HALF	402990	89536	402990	REF		
MP3	CASE HALF	402990	89536	402990	REF		
MP4	COVER, CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411918	89536	411918	REF		
MP6	DECAL, DC SIGNAL CONDITIONER ASSY	413377	89536	413377	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP11	TERMINAL, FEED-THROUGH (NOT SHOWN)	281865	12615	SL-841-777	1		
MP12	SOCKET, SPRING TYPE (NOT SHOWN)	343285	00779	2-331272-6	8		
MP13	SPACER (NOT SHOWN)	334797	32559	TO-35-15-E	1		
MP14	SPACER, TRANSIPAD (NOT SHOWN, USE W/Q37)	152207	07047	10123-DAP	1		
MP15	SPRING, COIL (NOT SHOWN)	424465	27745	C0120-014-0380M	1		
Q1	TRANSISTOR, NPN, SI	330803	07263	MPS6560	2		1
Q2	TRANSISTOR, PNP, SI	195974	04713	2N3906	6		2
Q3	TRANSISTOR, NPN, SI	330803	07263	MPS6560	REF		
Q4	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		
Q5	TRANSISTOR, PNP, SI	226290	04713	MPS3640	1		1
Q6	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		
Q7	TRANSISTOR, NPN, SI	218396	04713	2N3904	11		3
Q8	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	4		1
Q10	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q11	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q12	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		

Table 5-12. A8 DC Signal Conditioner PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
Q13	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
Q14	TRANSISTOR, FET, - N-CHANNEL	393314	89536	393314			REF
Q15	TRANSISTOR, FET, - N-CHANNEL	393314	89536	393314			REF
Q16	TRANSISTOR, FET, - N-CHANNEL	393314	89536	393314			REF
Q18	TRANSISTOR, NPN, SI	585109	89536	585109	1	1	
Q19	TRANSISTOR, NPN, SI	295717	24355	AD811-00/17	1	1	
Q22	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
Q23	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
Q31	TRANSISTOR, PNP, SI	195974	04713	2N3906			REF
Q32	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
Q33	TRANSISTOR, PNP, SI	195974	04713	2N3906			REF
Q34	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
Q35	TRANSISTOR, PNP, SI	195974	04713	2N3906			REF
Q36	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
Q37	TRANSISTOR, PNP, SI	218388	07263	PN3645	1	1	
Q38	TRANSISTOR, NPN, SI	218396	04713	2N3904			REF
R1	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	1		
R2	RES, MTL. FILM, 28.0K +/-1%, 1/8W	291385	91637	CMF552802F	2		
R3	RES, MTL. FILM, 28.0K +/-1%, 1/8W	291385	91637	CMF552802F			REF
R4	RES, MTL. FILM, 21K +/-1%, 1/8W	441212	91637	CMF552102F	2		
R5	RES, MTL. FILM, 17.8K +/-1%, 1/8W	349183	91637	CMF551782F	2		
R6	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
R7	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	5		
R8	RES, COMP, 150K +/-5%, 2W	110122	01121	HB1545	1		
R9	RES, COMP, 150K +/-10%, 1/2W	108167	01121	EB15415	1		
R10	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R11	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R12	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E	2		
R13	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E			REF
R15	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	4		
R16	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	8		
R17	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K			REF
R18	RES, MTL. FILM, 21K +/-1%, 1/8W	441212	91637	CMF552102F			REF
R19	RES, MTL. FILM, 17.8K +/-1%, 1/8W	349183	91637	CMF551782F			REF
R21	RES, DIVIDER SET	434605	89536	434605	1	1	
R22	(PART OF R21 SET)						REF
R23	(PART OF R21 SET)						REF
R24	RES, DC RANGE SET	409938	89536	409938	1	1	
R25	(PART OF R24 SET)						REF
R26	(PART OF R24 SET)						REF
R30	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R31	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K			REF
R32	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K			REF
R33	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K			REF
R34	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K			REF
R35	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	2		
R36	RES, CERMET, 100M +/-10%, 1W	441758	89536	441758	1		
R47	RES, VAR, CERMET, 200 +/-20%, 1/2W	284711	71450	190PC201B	1		
R48	RES, VAR, CERMET, 50 +/-20%. 1/2W	267815	71450	190PC500B	2		
R49	RES, VAR, CERMET, 50 +/-20%. 1/2W	267815	71450	190PC500B			REF

Table 5-12. A8 DC Signal Conditioner PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R50	RES, DEP. CAR, 2.2 +/-5%, 1/4W	354944	80031	CR251-4-5P2E2	1		
R51	RES, DEP. CAR, 20 +/-5%, 1/4W	442202	80031	CR251-4-5P20E	1		
R52	RES, VAR, CERMET, 100K +/-20%, 1/2W	268581	71450	190PC104B	1		
R53	RES, VAR, CERMET, 10K +/-20%, 1/2W	267880	71450	190PC103B	1		
R54	RES, SELECTED, DURING TEST				4		
R55	RES, SELECTED, DURING TEST					REF	
R56	RES, SELECTED, DURING TEST					REF	
R57	RES, SELECTED, DURING TEST					REF	
R58	RES, SET, MATCHED (PART OF R58 SET)	290320	89536	290320	1	1	
R59						REF	
R61	RES, MTL. FILM, 86.6K +/-1%, 1/8W	291468	91637	CMF558662F	1		
R62	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F		REF	
R63	RES, MTL. FILM, 1.87K +/-1%, 1/8W	267229	91637	CMF551871F	1		
R64	RES, MTL. FILM, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R70	RES, MTL. FILM, 52.3K +/-1%, 1/8W	237248	91637	CMF555232	1		
R71	RES, MTL. FILM, 3.01K +/-1%, 1/8W	312645	91637	CMF553011F	1		
R72	RES, MTL. FILM, 3.65K +/-1%, 1/8W	293779	91637	CMF553651F	2		
R73	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	2		
R74	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F		REF	
R75	RES, MTL. FILM, 80.6K +/-1%, 1/8W	281121	91637	CMF558062F	2		
R76	RES, MTL. FILM, 4.02 +/-1%, 1/8W	235325	91637	CMF554021F	1		
R77	RES, MTL. FILM, 200K +/-1%, 1/8W	261701	91637	CMF552003F	1		
R87	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R88	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R89	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R90	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R91	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R92	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		REF	
R93	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M		REF	
R94	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M		REF	
R95	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M		REF	
R97	RES, MTL. FILM, 3.65K +/-1%, 1/8W	293779	91637	CMF553651F		REF	
R98	RES, MTL. FILM, 2.15K +/-1%, 1/8W	293712	91637	CMF552151F	1		
R99	RES, MTL. FILM, 80.6K +/-1%, 1/8W	281121	91637	CMF558062F		REF	
U1	©IC, COS/MOS, QUAD CLOCKED D LATCH	355149	02735	CD4042BE	1	1	
U2	©IC, C-MOS, TRIPLE 3 INPUT NAND GATES	375147	02735	CD4023UBE	1	1	
U3	IC, OP AMP, J-FET	357830	12040	LH0042C	2	1	
U4	IC, OP AMP, J-FET	357830	12040	LH0042C		REF	
U5	IC, OP AMP	271502	12040	LM301A	2	1	
U6	IC, OP AMP	271502	12040	LM301A		REF	

1 SEE TABLE 5-17 AT THE END  
OF SECTION 5.

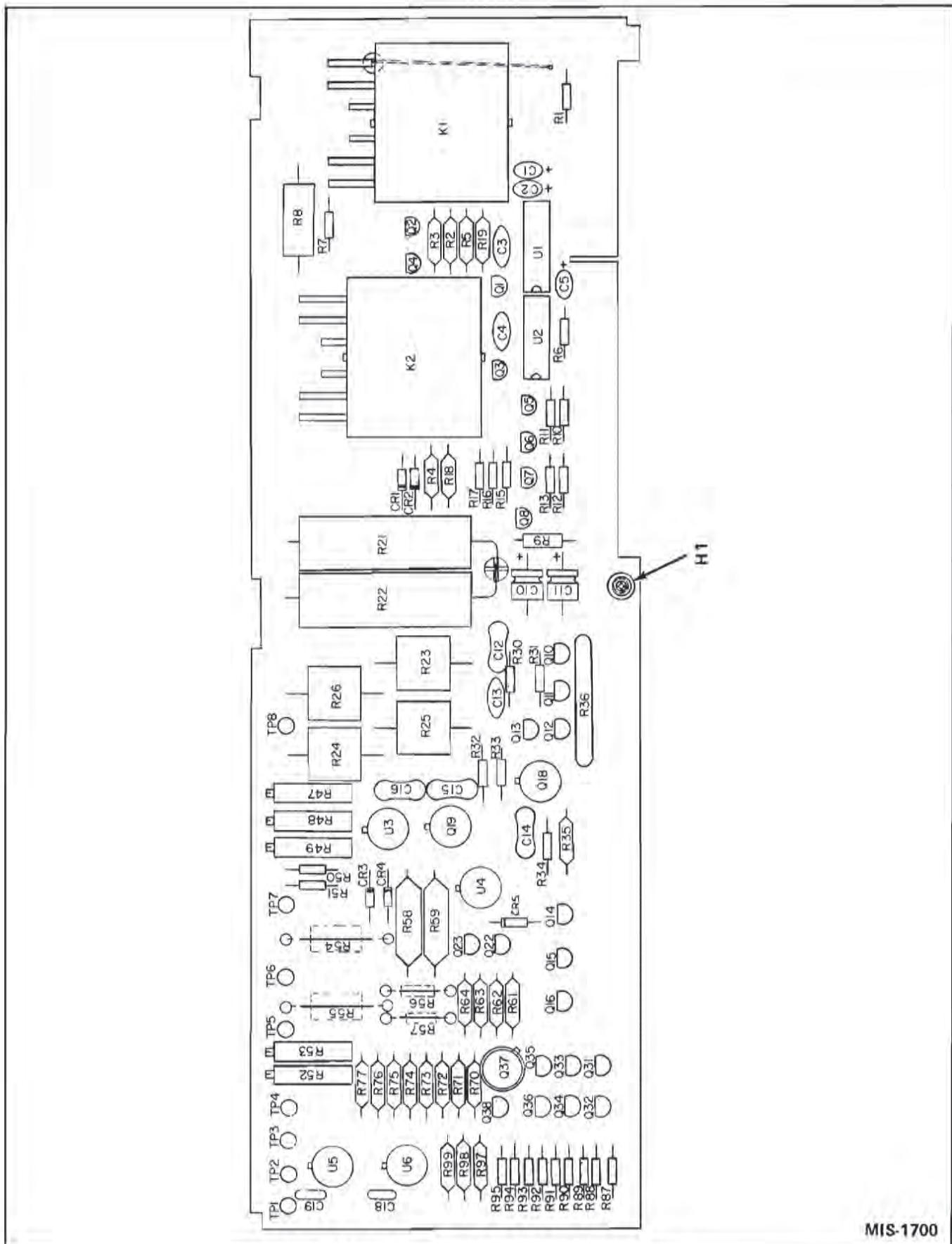


Figure 5-12. A8 DC Signal Conditioner PCB Assembly

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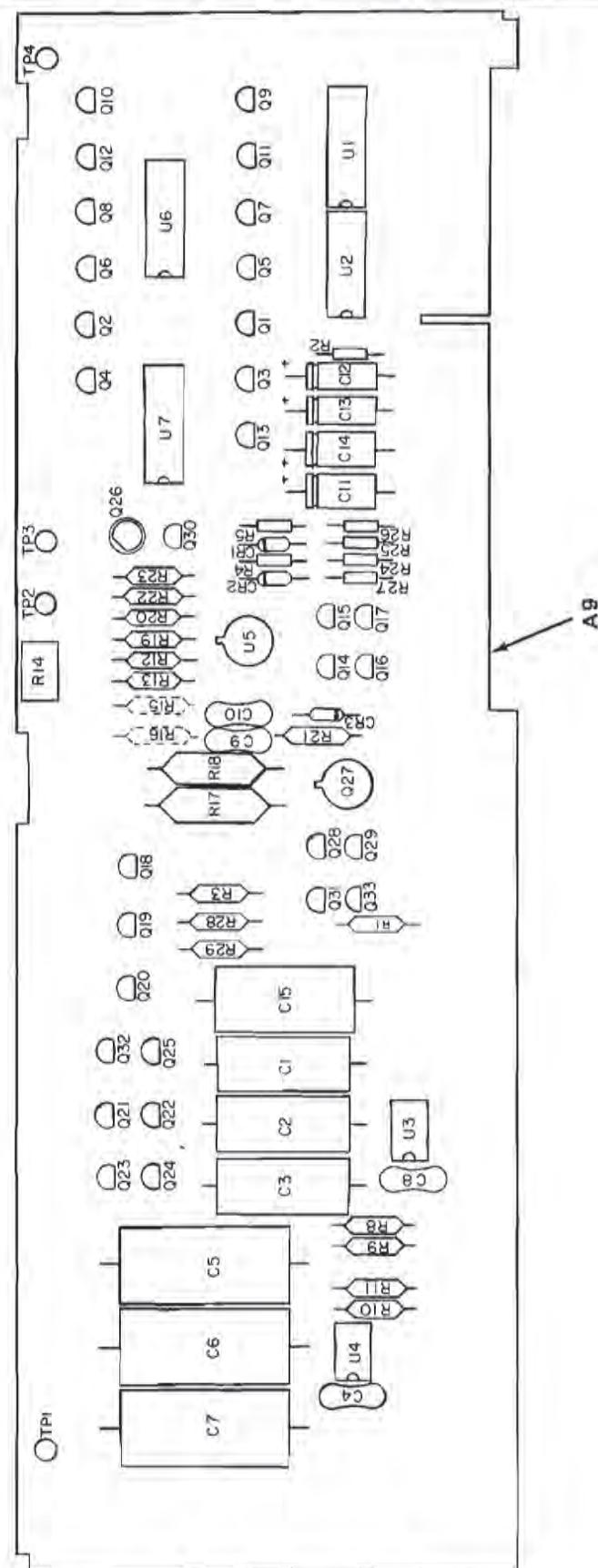
Table 5-13. A9 Active Filter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A9	⑧ ACTIVE FILTER PCB ASSEMBLY FIGURE 5-13 (MIS-4130T)	383976	89536	383976		REF	
C1	CAP, POLYPROP, 0.047 UF +/-10%, 50V	413328	89536	413328		3	
C2	CAP, POLYPROP, 0.047 UF +/-10%, 50V	413328	89536	413328		REF	
C3	CAP, POLYPROP, 0.047 UF +/-10%, 50V	413328	89536	413328		REF	
C4	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J		4	
C5	CAP, POLYPROP, 0.47 UF +/-10%, 50V	363085	89536	363085		3	
C6	CAP, POLYPROP, 0.47 UF +/-10%, 50V	363085	89536	363085		REF	
C7	CAP, POLYPROP, 0.47 UF +/-10%, 50V	363085	89536	363085		REF	
C8	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J		REF	
C9	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J		REF	
C10	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J		REF	
C11	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	73445	ET6P8X063A3		2	
C12	CAP, ELECT, 10 UF -10/+50%, 25V	170266	73445	ET100X025A2		2	
C13	CAP, ELECT, 10 UF -10/+50%, 25V	170266	73445	ET100X025A2		REF	
C14	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	73445	ET6P8X063A3		REF	
C15	CAP, POLYPROP, 0.0022 UF +/-10%, 200V	442632	89536	442632		1	
CR1	DIODE, ZENER	260695	07910	1N754A		1	1
CR2	DIODE, ZENER	386557	07910	1N960A		1	1
CR3	DIODE, SI, HI SPEED SWITCHING	203323	07910	1N4448		1	1
H1	SCREW, PHP, 4-40 X 3/8 (NOT SHOWN)	256164	89536	256164		1	
MP1	CASE, ASSY (INCLUDES MP2-MP9)	458976	89536	458976		1	
MP2	CASE HALF	402990	89536	402990		REF	
MP3	CASE HALF	402990	89536	402990		REF	
MP4	COVER, CASE	402974	89536	402974		REF	
MP5	SHIELD, COVER	411959	89536	411959		REF	
MP6	DECAL, ACTIVE FILTER ASSY	413443	89536	413443		REF	
MP7	DECAL, CAUTION	454504	89536	454504		REF	
MP8	GUARD, REAR	383364	89536	383364		REF	
MP9	GUARD, FRONT	383356	89536	383356		REF	
MP10	SPACER (USE W/Q26) (NOT SHOWN)	152207	07047	10123DAP		1	
MP11	SOCKET (USE W/R15, R16) (NOT SHOWN)	343285	00779	2-331272-6		4	
MP12	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380M		1	
Q1	TRANSISTOR, SI, PNP	195974	04713	2N3906		6	2
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904		9	2
Q3	TRANSISTOR, SI, PNP	195974	04713	2N3906		REF	
Q4	TRANSISTOR, SI, NPN	218396	04713	2N3904		REF	
Q5	TRANSISTOR, SI, PNP	195974	04713	2N3906		REF	
Q6	TRANSISTOR, SI, NPN	218396	04713	2N3904		REF	
Q7	TRANSISTOR, SI, PNP	195974	04713	2N3906		REF	
Q8	TRANSISTOR, SI, NPN	218396	04713	2N3904		REF	
Q9	TRANSISTOR, SI, PNP	195974	04713	2N3906		REF	
Q10	TRANSISTOR, SI, NPN	218396	04713	2N3904		REF	
Q11	TRANSISTOR, SI, PNP	195974	04713	2N3906		REF	
Q12	TRANSISTOR, SI, NPN	218396	04713	2N3904		REF	
Q13	TRANSISTOR, SI, PNP	226290	04713	MPS3640		1	1
Q14	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086		15	3
Q15	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086		REF	
Q16	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086		REF	
Q17	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086		REF	
Q18	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086		REF	
Q19	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086		REF	

Table 5-13. A9 Active Filter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
Q20	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q21	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q22	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q23	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q24	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q25	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q26	TRANSISTOR, SI, PNP	218388	07263	PN3645	1	1	
Q27	TRANSISTOR, SI, NPN	284075	32293	ITS1099	1	1	
Q28	TRANSISTOR, SI, NPN	218396	04713	2N3904			REF
Q29	TRANSISTOR, SI, NPN	218396	04713	2N3904			REF
Q30	TRANSISTOR, SI, NPN	218396	04713	2N3904			REF
Q31	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q32	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
Q33	TRANSISTOR, FET, N-CHANNEL	393314	17856	J086			REF
R1	RES, DEP. CAR, 6.2K +/-5%, 1/4W	442368	80031	CR251-4-5P6K2	1		
R2	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R3	RES, MTL. FILM, 51.1K +/-5%, 1/8W	289553	91637	CMF555112F	1		
R4	RES, DEP. CAR, 8.2K +/-5%, 1/4W	441675	80031	CR251-4-5P8K2	2		
R5	RES, DEP. CAR, 8.2K +/-5%, 1/4W	441675	80031	CR251-4-5P8K2			REF
R8	RES, MTL. FILM, 45.3K +/-1%, 1/8W	234971	91637	CMF554532F	4		
R9	RES, MTL. FILM, 45.3K +/-1%, 1/8W	234971	91637	CMF554532F			REF
R10	RES, MTL. FILM, 45.3K +/-1%, 1/8W	234971	91637	CMF554532F			REF
R11	RES, MTL. FILM, 45.3K +/-1%, 1/8W	234971	91637	CMF554532F			REF
R12	RES, MTL. FILM, 12.1K +/-1%, 1/8W	234997	91637	CMF551212F	3		
R13	RES, MTL. FILM, 4.87K +/-1%, 1/8W	294850	91637	CMF554871F	1		
R14	RES, VAR, CERMET, 20K +/-10%, 1/2W	291609	89536	291609	1		
R15	RES, SELECTED, DURING TEST						
R16	RES, SELECTED, DURING TEST						
R17	RES, MTL. FILM, 1M +/-1%, 1/2W	327510	91637	CMF651004F	2		
R18	RES, MTL. FILM, 1M +/-1%, 1/2W	327510	91637	CMF651004F			REF
R19	RES, MTL. FILM, 12.1K +/-1%, 1/8W	234997	91637	CMF551212F			REF
R20	RES, MTL. FILM 249K +/-1%, 1/8W	268805	91637	CMF552493F	2		
R21	RES, MTL. FILM, 57.6K +/-1%, 1/8W	289116	91637	CMF555762F	1		
R22	RES, MTL. FILM, 12.1K +/-1%, 1/8W	234997	91637	CMF551212F			REF
R23	RES, MTL. FILM, 249K +/-1%, 1/8W	268805	91637	CMF552493F			REF
R24	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E	2		
R25	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	2		
R26	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E			REF
R27	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E			REF
R28	RES, MTL. FILM, 26.7K +/-1%, 1/8W	245779	91637	CMF552672F	2		
R29	RES, MTL. FILM, 26.7K +/-1%, 1/8W	245779	91637	CMF552672F			REF
U1	©IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U2	©IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023UBE	1	1	
U3	IC, LINEAR, OP AMP	363515	12040	LM301AN	2	1	
U4	IC, LINEAR, OP AMP	363515	12040	LM301AN			REF
U5	IC, LINEAR, OP AMP	392902	12040	LM1436H	1	1	
U6	RESISTOR NETWORK, 100K +/-5%, 1/4W	404749	89536	404749	1	1	
U7	RESISTOR NETWORK, 100K +/-5%, 1/4W	380618	89536	380618	1	1	

1 SEE TABLE 5-17 AT THE END  
OF SECTION 5.



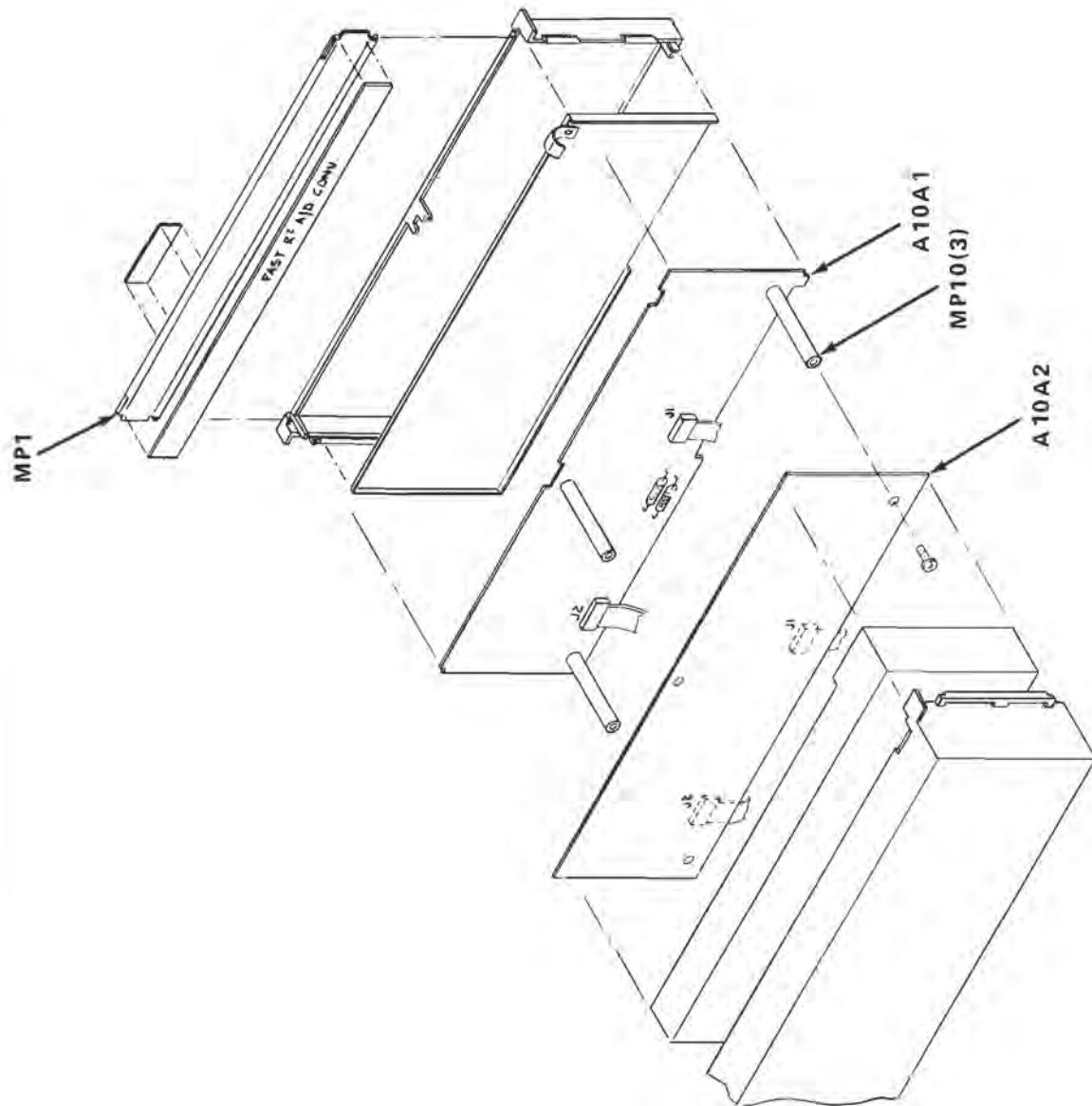
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Figure 5-13. A9 Active Filter PCB Assembly

Table 5-14. A10 Fast R<sup>2</sup> A/D Converter Assembly

REF OES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY COOE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A10	FAST R <sup>2</sup> A/D CONVERTER ASSEMBLY FIGURE 5-14 (MIS-4140T)	383984	89536	383984			REF
A10A1	A/D ANALOG PCB ASSEMBLY	ORDER	NEXT	HIGHER ASSEMBLY			
A10A2	A/D DIGITAL PCB ASSEMBLY	ORDER	NEXT	HIGHER ASSEMBLY			
MP1	CASE ASSY (INCLUDES MP2-MP9)	458968	89536	458968			1
MP2	CASE HALF	402990	89536	402990			REF
MP3	CASE HALF, MODIFIED	402982	89536	402982			REF
MP4	COVER, CASE	402974	89536	402974			REF
MP5	SHIELD, COVER	411967	89536	411967			REF
MP6	DECAL, FAST RR CONVERTER ASSY	413450	89536	413450			REF
MP7	DECAL, CAUTION	454504	89536	454504			REF
MP8	GUARD, REAR	383364	89536	383364			REF
MP9	GUARD, FRONT	383315	89536	383315			REF
MP10	SPACER	152207	07047	10123DAP			3

1 SEE TABLE 5-17 AT THE END  
OF SECTION 5.



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Figure 5-14. A10 Fast R<sup>2</sup> A/D Converter Assembly

Table 5-15. A10A1 A/D Analog PCB Assembly

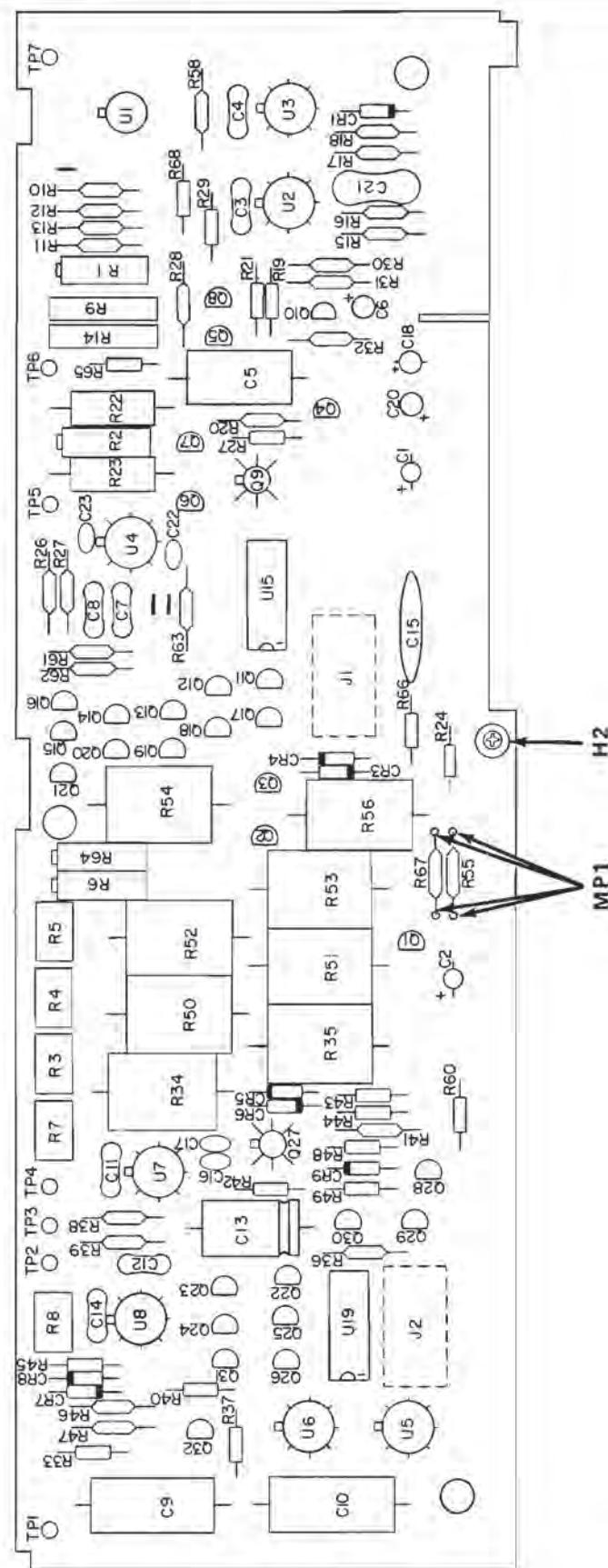
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A10A1	A/D ANALOG PCB ASSEMBLY FIGURE 5-15 (MIS-4140)	383752	89536	383752			REF
C1	CAP, TA, 10 UF +/-20%, 35V	4117683	56289	196D106X0035KA1	2		
C2	CAP, TA, 10 UF +/-20%, 35V	4117683	56289	196D106X0035KA1		REF	
C3	CAP, MICA, 33 PF +/-5%, 500V	160317	72136	DM15E330J	1		
C4	CAP, MICA, 30 PF +/-5%, 500V	340570	72136	DM15E300J	1		
C5	CAP, FILM, 0.22 UF +/-10%, 80V	159392	56289	192P2249R8	1		
C6	CAP, TA, 4.7 UF +/-20%, 25V	161943	56289	196D475X0025KA1	1		
C7	CAP, MICA, 150 PF +/-5%, 500V	148478	72136	DM15F151J	2		
C8	CAP, MICA, 150 PF +/-5%, 500V	148478	72136	DM15F151J		REF	
C9	CAP, POLYST, 0.047 UF +/-10%, 100V	260562	84411	863UW47391	2		
C10	CAP, POLYST, 0.047 UF +/-10%, 100V	260562	84411	863UW47391		REF	
C11	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J	3		
C12	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J		REF	
C13	CAP, ELECT, 470 UF -10/+50%, 6.3V	187773	80031	ET471X6P3A6	1		
C14	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J		REF	
C15	CAP, CER, 0.0047 UF +/-10%, 500V	106724	71590	CF-472	1		
C16	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C17	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C18	CAP, TA, 68 UF +/-20%, 25V	446450	56289	196D686X0025TE4	1		
C20	CAP, TA, 0.22 UF +/-20%, 35V	161331	56289	196D224X0035HA1	1		
C21	CAP, MICA, 1800 PF +/-5%, 500V	148353	72136	DM19F182J	1		
C22	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K		REF	
CR1	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	2	1	
CR3	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	4	1	
CR4	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223		REF	
CR5	DIODE, SI, CONTROLLER FWD VOL	234468	07910	TD9039	2	1	
CR6	DIODE, SI, CONTROLLER FWD VOL	234468	07910	TD9039		REF	
CR7	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223		REF	
CR8	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223		REF	
CR9	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
H1	SCREW, PHP, 4-40 X 1/4 (NOT SHOWN)	256156	89536	256156	3		
H2	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
J1	SOCKET	276535	91506	316-AG39D	2		
J2	SOCKET	276535	91506	316-AG39D		REF	
MP1	SOCKET, COMP. LEAD (TO R55, R67)	343285	00779	2-331272-6	4		
MP2	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
MP3	SPACER, XSTR, (NOT SHOWN)	152207	07047	10123-DAP	1		
Q1	TRANSISTOR, FET (SELECTED)	256487	89536	256487	1	1	
Q2	TRANSISTOR, FET (SELECTED)	256487	89536	256487		REF	
Q3	TRANSISTOR, FET (SELECTED)	256487	89536	256487		REF	
Q4	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	5	1	
Q5	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830		REF	
Q6	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830		REF	
Q7	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830		REF	
Q8	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830		REF	
Q9	TRANSISTOR, FET, DUAL, N-CHANNEL	376087	89536	376087	2	1	
Q10	TRANSISTOR, SI, NPN	218396	04713	2N3904	1	1	

Table 5-15. A10A1 A/D Analog PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
Q11	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q12	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q13	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q14	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q15	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q16	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q17	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578		12	3
Q18	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q19	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q20	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q21	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q22	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q23	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q24	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q25	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q26	TRANSISTOR, FET (SELECTED)	256487	89536	256487			REF
Q27	TRANSISTOR, FET, DUAL, N-CHANNEL	376087	89536	376087			REF
Q28	TRANSISTOR, SI, PNP	195974	04713	2N3906		1	
Q29	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q30	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q31	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
Q32	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578			REF
R1	RES, VAR, CERMET, 500 +/-20%, 1/2W	267849	75378	190PC501B		1	
R2	RES, VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B		2	
R3	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120		1	
R4	RES, VAR, CERMET, 200 +/-10%, 1/2W	285148	89536	285148		1	
R5	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122		2	
R6	RES, VAR, CERMET, 20 +/-20%, 1/2W	261180	75378	190PC200B		1	
R7	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122			REF
R8	RES, VAR, CERMET, 50K +/-10%, 1/2W	288290	89536	288290		1	
R9	REF. AMP SET (U1, R9, R14, R15, R16)	415034	89536	415034			REF
R10	RES, MTL. FILM, 3.4K +/-1%, 1/8W	260323	91637	MFF1-83401F		1	
R11	RES, MTL. FILM, 12.1 +/-1%, 1/8W	296608	91637	MFF1-812R1F		2	
R12	RES, MTL. FILM, 25.3 +/-1%, 1/8W	281816	91637	MFF1-824R3F		1	
R13	RES, MTL. FILM, 12.1 +/-1%, 1/8W	296608	91637	MFF1-812R1F			REF
R14	REF. AMP SET (U1, R9, R14, R15, R16)	415034	89536	415034			REF
R15	REF. AMP SET (U1, R9, R14, R15, R16)	415034	89536	415034			REF
R16	REF. AMP SET (U1, R9, R14, R15, R16)	415034	89536	415034			REF
R17	RES, MTL. FILM, 10K +/-1%, 1/8W	328120	91637	MFF1-81002F		2	
R18	RES, MTL. FILM, 10K +/-1%, 1/8W	328120	91637	MFF1-81002F			REF
R19	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K		3	
R20	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F		3	
R21	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K			REF
R22	RES SET (R22, R23)	409896	89536	409896		1	
R23	RES SET (R22, R23)	409896	89536	409896			REF
R24	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E		1	
R25	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	MFF1-84222F		2	
R26	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	MFF1-84222F			REF
R27	RES, DEP. CAR, 62 +/-5%, 1/4W	441634	80031	CR251-4-5P62E		1	
R28	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F		3	

Table 5-15. A10A1 A/D Analog PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R29	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	2		
R30	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F	REF		
R31	RES, MTL. FILM, 11.3K +/-1%, 1/8W	293639	91637	MFF1-81132F	1		
R32	RES, MTL. FILM, 24.9K +/-1%, 1/8W	291369	91637	MFF1-82492F	1		
R33	RES, DEP. CAR, 47 +/-5%, 1/4W	441592	80031	CR251-4-5P47E	2		
R34	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	1	1	
R35	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R36	RES, MTL. FILM, 26.7K +/-1%, 1/8W	245779	91637	MFF1-82672F	1		
R37	RES, DEP. CAR, 47 +/-5%, 1/4W	441592	80031	CR251-4-5P47E	REF		
R38	RES, MTL. FILM, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	3		
R39	RES, MTL. FILM, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	REF		
R40	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	2		
R41	RES, MTL. FILM, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	REF		
R42	RES, DEP. CAR, 3K +/-5%, 1/4W	441527	80031	CR251-4-5P3K	1		
R43	RES, DEP. CAR, 510 +/-5%, 1/4W	441600	80031	CR251-4-5P510E	1		
R44	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	1		
R45	RES, DEP. CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P470K	1		
R46	RES, MTL. FILM, 665 +/-1%, 1/8W	320028	91637	MFF1-86650F	1		
R47	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	1		
R48	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	REF		
R49	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R50	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R51	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R52	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R53	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R54	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R55	RES, MTL. FILM, 56.2 +/-1%, 1/8W	305938	91637	MFF1-856R2F	1		
R56	RES SET (R34, R35, R50-54, R56)	409946	89536	409946	REF		
R58	RES, MTL. FILM, 2573 +/-0.1%, 1/8W	321463	91637	MFF1-82573F	1		
R60	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	REF		
R61	RES, MTL. FILM, 57.6K +/-1%, 1/8W	289116	91637	MFF1-85762F	1		
R62	RES, MTL. FILM, 66.5K +/-1%, 1/8W	289082	91637	MFF1-86652F	1		
R63	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	1		
R64	RES, VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	REF		
R65	RES, DEP. CAR, 820 +/-5%, 1/4W	442327	80031	CR251-4-5P820E	1		
R66	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R67	RES, MTL. FILM, 18.7 +/-1%, 1/8W	441776	91637	MFF1-812R7F	1		
R68	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	1		
U1	REF. AMP SET (U1, R9, R14, R15, R16)	415034	89536	415034	1	1	
U2	IC, OP AMP	271502	12040	LM301A	2	1	
U3	IC, OP AMP	271502	12040	LM301A	REF		
U4	IC, OP AMP, J-FET, INPUT	310037	12040	LH0042CH	2	1	
U5	IC, LIN, VOL, FOLLOWER	288365	12040	LM310H	2	1	
U6	IC, LIN, VOL, FOLLOWER	288365	12040	LM310H	REF		
U7	IC, OP AMP, J-FET, INPUT	310037	12040	LH0042CH	REF		
U8	IC, OP AMP	225961	24355	AD3092	1	1	
U15	RES NETWORK, 33K	413146	89536	413146	1	1	
U19	RES NETWORK, 100K	380618	89536	380618	1	1	

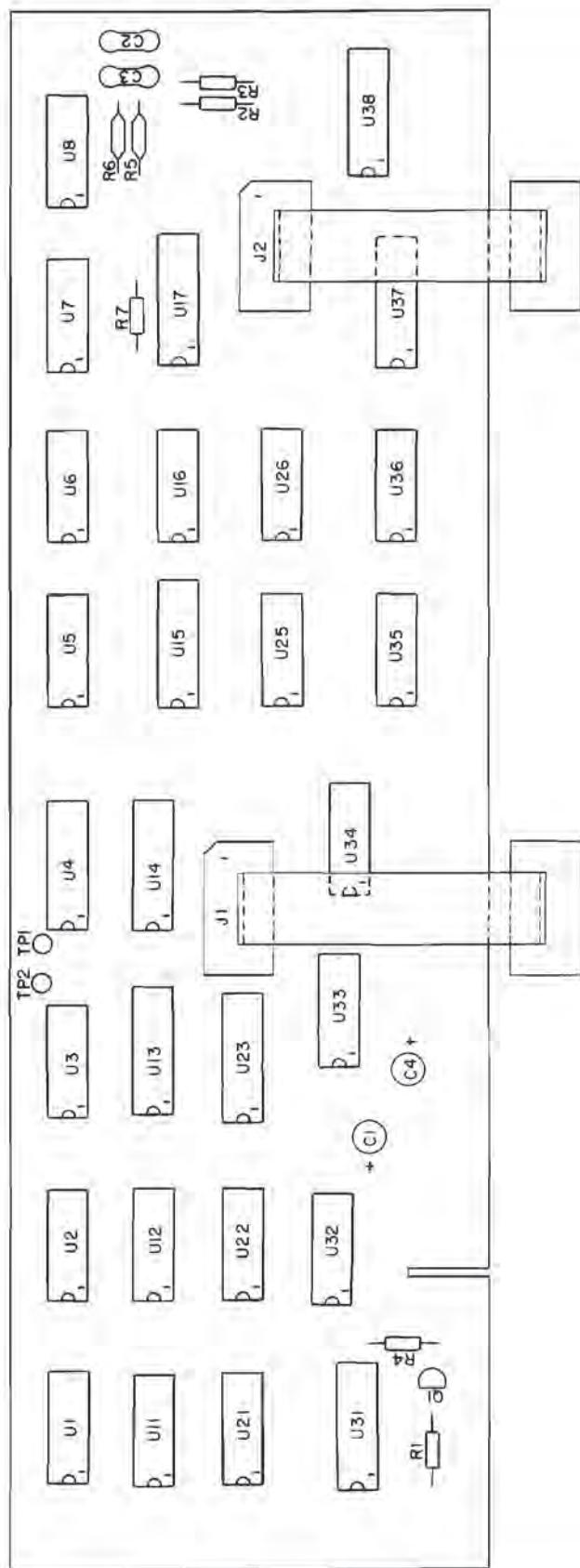


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Figure 5-15. A10A1 A/D Analog PCB Assembly

Table 5-16. A10A2 Fast R<sup>2</sup> A/D Converter Digital PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY COOE	MFG PART NO. DR TYPE	TOT QTY	REC QTY	NOTE
A10A2	⑧FAST R <sup>2</sup> A/D CONV DGTL PCB ASSEMBLY FIGURE 5-16 (MIS-4141)	383760	89536	383760			REF
C1	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	2		
C2	CAP, MICA, 82 PF +/-5%, 500V	148502	72136	DM15F820J	2		
C3	CAP, MICA, 82 PF +/-5%, 500V	148502	72136	DM15F820J			REF
C4	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4			REF
J1	CABLE ASSY, 16 PIN CONN	380576	08261	5122-003.5	2		
J2	CABLE ASSY, 16 PIN CONN	380576	08261	5122-003.5			REF
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1		
R1	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R2	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	2		
R3	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K			REF
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R5	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	2		
R6	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F			REF
R7	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
U1	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	9	2	
U2	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U3	⑨IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	3	1	
U4	RES NETWORK	380618	89536	380618	3	1	
U5	⑨IC, C-MOS, DUAL, COMPLEMENTARY	408013	02735	CD4007AE	1	1	
U6	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U7	⑨IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE			REF
U8	⑨IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	2	1	
U11	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U12	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U13	RES NETWORK	380618	89536	380618			REF
U14	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	3	1	
U15	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E			REF
U16	⑨IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	2	1	
U17	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E			REF
U21	⑨IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE			REF
U22	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U23	IC, LINEAR, 5 XSTR ARRAY	477778	89536	477778	2	1	
U25	⑨IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	1	1	
U26	IC, DGTL, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE			REF
U31	⑨IC, C-MOS, DIV BY -8, COUNTER/DIV	403360	02735	CD4022AE	1	1	
U32	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U33	⑨IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U34	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U35	⑨IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE			REF
U36	⑨IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE			REF
U37	RES NETWORK	380618	89536	380618			REF
U38	IC, LINEAR, 5 XSTR ARRAY	477778	89536	477778			REF

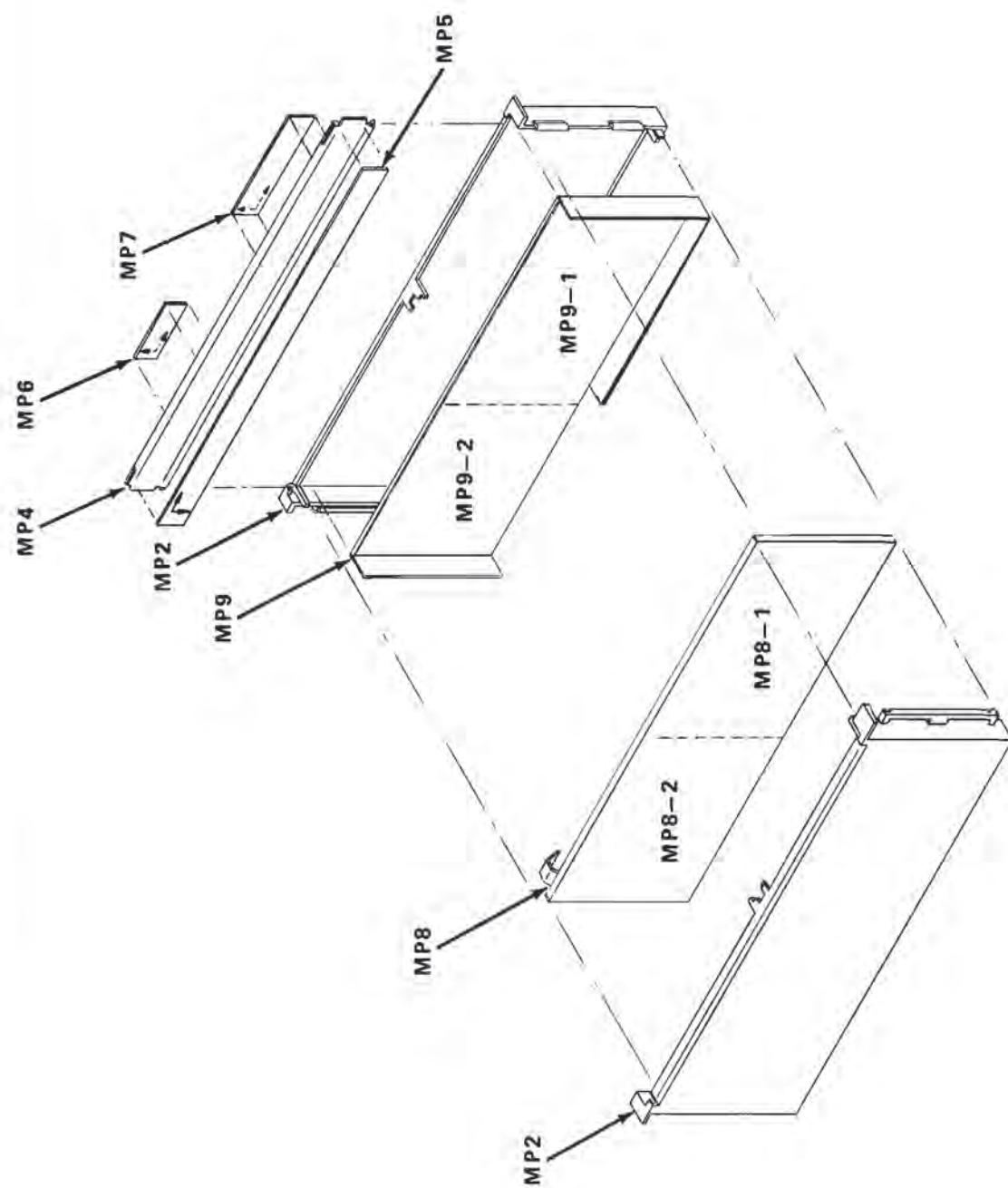


MIS-1741

Figure 5-16. A10A2 Fast R<sup>2</sup> A/D Converter Digital PCB Assembly

Table 5-17. Module Case Assembly

PCB ASSY	CASE ASSY	CASE	CASE	COVER				DECAL CAUTION	GUARD REAR	GUARD FRONT
		HALF MODULE	HALF MODF'D	MODULE	SHIELD, COVER	DECAL ASSY				
A6 OLD	471326	402990	402990	486340	440008	453696	454504	383364	383356	
A6 NEW	611665	402990	402990	402974	440008	536029	454504	383364	383356	
A8	458992	402990	402990	402974	411918	413377	454504	383364	383356	
A9	458976	402990	402990	402974	411959	413443	454504	383364	383356	
A10	458968	402990	402982	402974	411967	413450	454504	383364	383315	
OPT-01	459016	402990	402990	402974	411926	413385	454504	383364	383356	
OPT-02	458927	402990	402990	402974	411942	413435	454504	383364	383356	
OPT-03	459008	402990	402990	402974	412015	413419	454504	383364	383356	
OPT-04	458919	402990	402990	402974	411975	413484	454504	383364	383356	
OPT-05	458935	402990	456079	402974	441022	413518	454504	383364	NONE	
OPT-06	458943	402990	412031	402974	411983	413492	454504	383364	NONE	
OPT-07	458950	402990	427625	402974	411991	413500	454504	383364	NONE	
OPT-08A	459024	402990	402990	402974	437939	413534	454504			
LEFT								437947	487298	
RIGHT								383349	487280	
OPT-09A	425231	402990	402990	402974	468462	413401	454504	383364	383356	



8500A-4160

Figure 5-17. MP1 Module Case Assembly

## Section 6

# Option & Accessory Information

### TABLE OF CONTENTS

OPTION/ MODEL NO.	DESCRIPTION	DOCUMENTATION SUPPLIED:	PAGE NO.
ACCESSORIES			
M04-205-600	Rack Ear Mounting Assembly . . . . .	Herein	600-1
80F-5	High Voltage Probe . . . . .	Herein	600-1
80F-15	High Voltage Probe . . . . .	Herein	600-2
81RF	High Frequency Probe . . . . .	Herein	600-2
82RF	High Frequency Probe . . . . .	Herein	600-2
KDM1	Keyboard Display Module . . . . .	Herein	600-2
OPTIONS			
-01	AC/DC Converter (Averaging) . . . . .	With Option	601-1
-02	Ohms Converter . . . . .	With Option	602-1
-03	Current Shunts . . . . .	With Option	603-1
-04	Calibration Memory . . . . .	With Option	604-1
-05	IEEE Standard 488-1975 Interface . . . . .	With Option	605-1
-06	Bit Serial Asynchronous Interface . . . . .	With Option	606-1
-07	Parallel Interface . . . . .	With Option	607-1
-08A	Isolator . . . . .	With Option	608-1
-09A	AC/DC Converter (RMS) . . . . .	With Option	609-1
-16	Switchable Front-Rear Inputs . . . . .	With Option	616-1
-17	Rear Input . . . . .	With Option	617-1

## 6-1. INTRODUCTION

6-2. This section of the manual employs modular construction. 8502A accessory information is included first; page and paragraph numbering is described by a 600-X series where X is the page or paragraph number.

6-3. Should you order optional modules with your 8502A, appropriate subsections will be included in this

manual. Page and paragraph numbering for any option subsection will be a 6YY-X series where YY is the option number (01, 07, etc.) and X is the page or paragraph number.

6-4. Up-to-date manual subsections will be included with any further options you may order. These subsections can easily be added to this manual.

### WARNING

**POSSIBILITY OF ELECTRICAL SHOCK EXISTS WHEN OPTION -17 IS INSTALLED.  
FRONT AND REAR INPUTS ARE PARALLEL CONNECTED; INPUTS APPLIED AT  
EITHER SET OF TERMINALS WILL BE PRESENT AT THE OTHER. NEVER LEAVE  
TEST LEADS CONNECTED TO BOTH FRONT AND REAR TERMINALS. ALWAYS  
REMOVE FRONT PANEL TERMINAL STRAPS WHEN USING THE REAR INPUTS.**

## Accessories

### 600-1. RACK EAR MOUNTING ASSEMBLY

600-2. Figure 600-1 illustrates installation of the Rack Ear Mounting Assembly. Use the following procedure.

1. Remove the nameplate decals from handles.
2. Remove the screws from handles.
3. Attach rack ears with # 8 - 32 x 5/8 PHP screws (enclosed in kit).
4. Remove the front screws from top and bottom cover which match the hole pattern in trim items.
5. Attach trim angle on top cover and trim channel on bottom cover with # 6 - 32 x 3/8 PHP screws and lock washer (enclosed in kit).

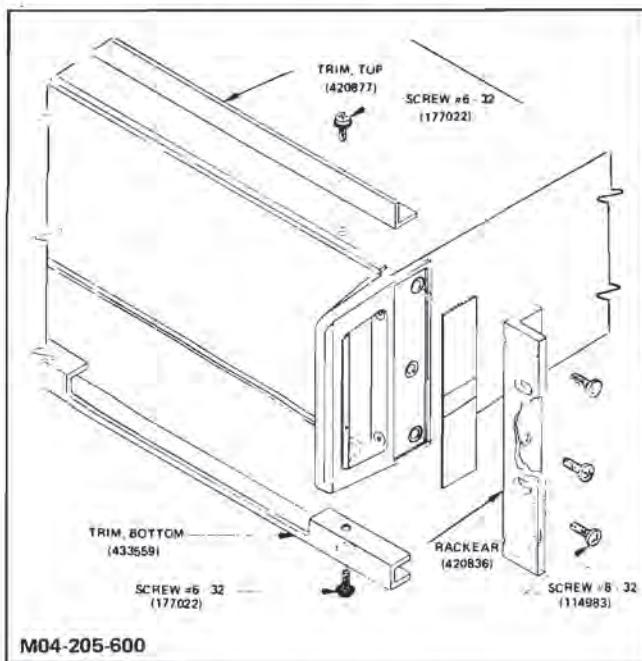


Figure 600-1. Rack Ear Mounting Installation

### 600-3. HIGH VOLTAGE PROBE (80F-5)

600-4. The Model 80F-5 Voltage Divider shown in Figure 600-2 allows measurement of up to 5k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

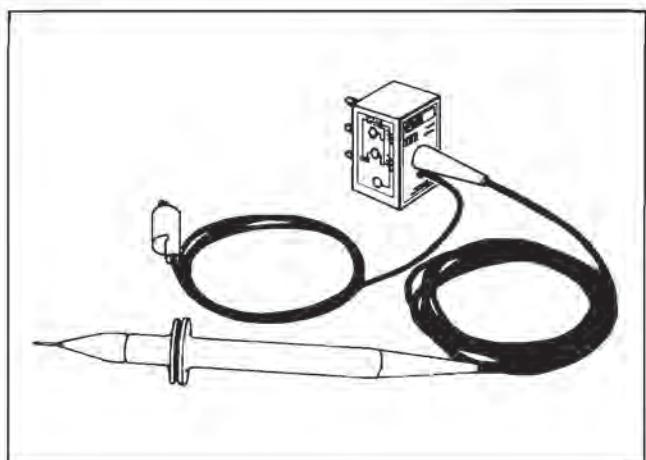


Figure 600-2. 80F5 Voltage Divider

600-5. Physical design of the Model 80F-5 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-6. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided

for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance ( $10^3$  megohms or greater) at null.

#### 600-7. HIGH VOLTAGE PROBE (80F-15)

600-8. The Accessory Model 80F-15 Voltage Divider, shown in Figure 6-7, allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

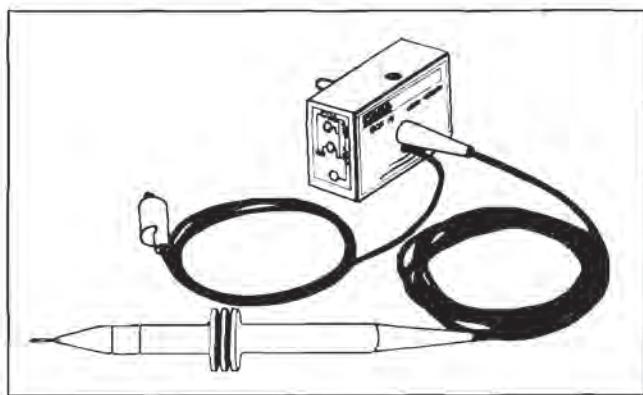


Figure 600-3. 80F15 Voltage Divider

600-9. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-10. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance ( $10^3$  megohm or greater) at null.

#### 600-11. HIGH FREQUENCY PROBE (81 RF)

600-12. The Model 81RF High Frequency Probe, Figure 600-4, extends the frequency range of the DVM/DMM to include 100 kHz to 100 MHz for ac voltage measurements from 0.25 to 30V rms. The 81RF operates in conjunction with the dc voltage ranges, and is connected to the DVM/DMM using a shielded dual-banana plug and, when necessary, a dual banana adaptor.

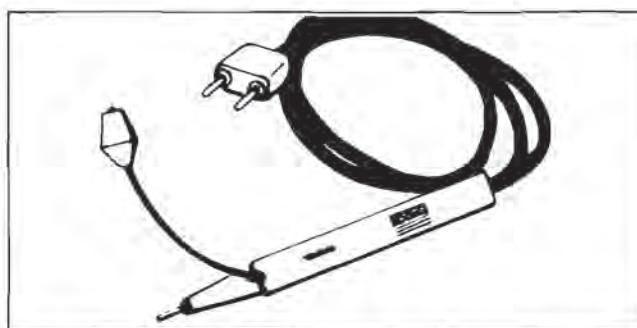


Figure 600-4. 81RF High Frequency Probe

#### 600-13. HIGH FREQUENCY PROBE (82RF)

600-14. The Model 82RF High Frequency Probe, Figure 600-5, allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30V rms. It is designed to be used with voltmeters having an input impedance of 10 megohms  $\pm$  10%. It may be used with a voltmeter having an input impedance higher than 10 megohms provided the input is externally shunted to make the equivalent input impedance equal to 10 megohms.

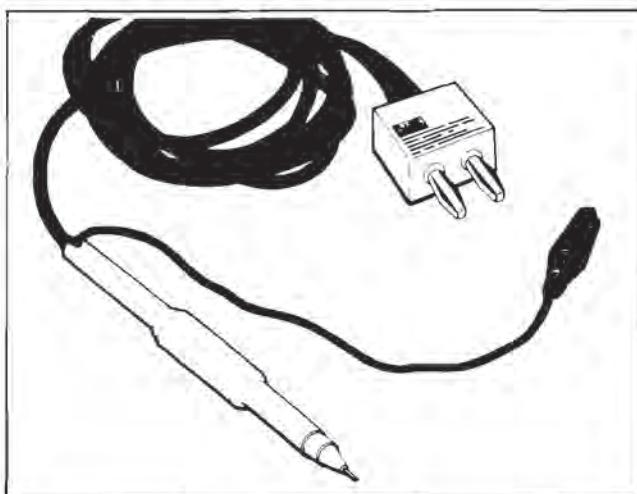


Figure 600-5. 82RF High Frequency Probe

600-15. Circuitry within the 82RF consists of a capacitor-coupled rectifier circuit which responds to the peak value of the input waveform. The output is positive polarity dc which is calibrated to be equivalent to the rms value of a sine wave.

#### 600-16. KEYBOARD DISPLAY MODULE (KDM1)

600-17. The Micon KDM1 Keyboard Display Module is a LED display terminal (with a connecting cable) for use with the Bit Serial Asynchronous Interface (Option -06). Standard ASCII characters are used on the keyboard to facilitate programming the 8500A/AE.

## Option —01 AC/DC Converter (Averaging)

### **601-1 INTRODUCTION**

601-2. The Average Responding AC Converter is used to convert ac signals to dc levels which can be measured by the A/D Converter. A maximum input of 1000V rms (or  $2 \times 10^7$  Volt-hertz product, whichever is less) may be applied with resolutions available to one microvolt. Input impedance is  $1 \text{ M}\Omega$  with less than 100 pf shunt capacity.

### **601-3. SPECIFICATIONS**

601-4. Table 601-1 lists the specifications for the -01 option.

### **601-5. INSTALLATION**

601-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing modules. The interconnect diagram in Section 8 contains a table listing the permissible and preferred slots for each module.

### **601-7. OPERATING NOTES**

601-8. The operating instructions given in Section 2 of this manual apply for operation of the instrument with the AC/DC Converter (Averaging) installed. The lowest range available through the average responding ac converter is the 1V range.

601-9. For rated accuracy below 400 Hz, the slow filter (FILTER LED on) must be selected. This selects additional filtering in the ac converter as well as in the Active Filter module. External reference measurements may be made as described in Section 2 but the external reference inputs must be dc only.

601-10. Once the instrument is zeroed for DC Volts, no additional zeroing is required for AC Volts measurements. Using the Offset function as an AC Volts zero could result

in greater error due to the nature of the floor digits specifications.

### **601-11. THEORY OF OPERATION**

601-12. The AC/DC Converter accepts signals either from the input terminals or from the optional current shunts module (RT1 and RT3). Refer to Figure 601-1. Input signals are applied to the input range amplifier, U1, through a dc blocking capacitor, C1, and a  $2 \text{ M}\Omega$  resistor, R2. R2 establishes the input resistance of the amplifier. U1 is a voltage amplifier controlling a current source, Q4 and Q6. Q4 and Q6 change the low impedance of U1 to a high impedance for driving CR10 and CR11. The high impedance at the collectors of Q4 and Q6 minimizes error introduced by the nonlinearity of CR10 and CR11, which have a relatively low impedance.

601-13. Distortion of the waveform occurs at the collectors of Q4 and Q6 due to the nonconducting regions of CR10 and CR11. During the portion of the waveform in which CR10 and CR11 are not conducting, the feedback path of the amplifier is effectively broken and the gain of the amplifier becomes very high. The time required for the waveform to cross the nonconducting region is determined by the slew rate of the amplifier. When CR10 and CR11 are conducting, the gain of the amplifier is controlled by R18 and associated parallel resistors as selected by K3, K4, and K5.

601-14. U6 is configured as a differential amplifier having a gain of approximately 8 times the average-to-rms scaling factor of 1.11. Signals from CR10 and CR11 are applied to U6 through a matched temperature coefficient resistor set which provides the gain setting for U6, and filtering with capacitors C18, C19, C21, and C22. When the slow filter is selected, additional filtering, C17 and C20, is switched in by Q12 and Q13.

Table 601-1, AC/DC Converter (Averaging) Specifications Accuracy

## ACCURACY

(Refer to the Specifications table in Section 1 for required environmental conditions)

Accuracy (0.1% of Range to Full Scale)  $\pm$  (% of Input + No. of Digits)

Frequency	24 Hours		90 Days		1 Year	
	0 to 500V	Above 500V	0 to 500V	Above 500V		
30 Hz to 50 Hz	0.3 + 5	0.4 + 5	0.5 + 5	0.55 + 5	1.0 + 5	1.0 + 5
50 Hz to 10 kHz	0.035 + 5	0.075 + 5	0.05 + 5	0.1 + 5	0.1 + 5	0.2 + 5
10 kHz to 40 kHz	—	0.1 + 5	—	0.15 + 5	—	0.3 + 5
10 kHz to 50 kHz (4)	0.075 + 5	—	0.1 + 5	—	0.2 + 5	—
50 kHz to 100 kHz(5)	0.3 + 5	—	0.5 + 5	—	1.0 + 5	—

NOTES: 1. Volt-Hertz product not to exceed  $2 \times 10^7$ .

2. Slow Filter must be used below 400 Hz for full accuracy.

3. For high resolution multiply No. of digits by 10.

4. On 1V range add 7 digits.

5. On 1V range add 35 digits.

## OPERATING CHARACTERISTICS

INPUT CHARACTERISTICS				COMMON MODE NOISE REJECTION (100Ω Unbalance)				
Range	Full Scale	Resolution		Impedance	> 120 dB, dc to 60 Hz			
		Normal	High		TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)			
1V	2.5V	10 uV	1 uV	1 MΩ, <100 pF	30 Hz to 50 kHz $\pm$ (30 ppm/reading $\pm$ 0.5 digit)/°C			
10V	20V	100 uV	10 uV		50 kHz to 100 kHz $\pm$ (100 ppm/reading $\pm$ 1 digit)/°C			
100V	160V	1 mV	100 uV		SETTLING TIME (To Within 0.05%)			
1000V	1000V	10 mV	1 mV		100 ms, Fast Filter 500 ms, Slow Filter			
Maximum Input—1000V rms or $2 \times 10^7$ volt-hertz product, whichever is less.				DIGITIZING TIME				
				Same as dc volts				

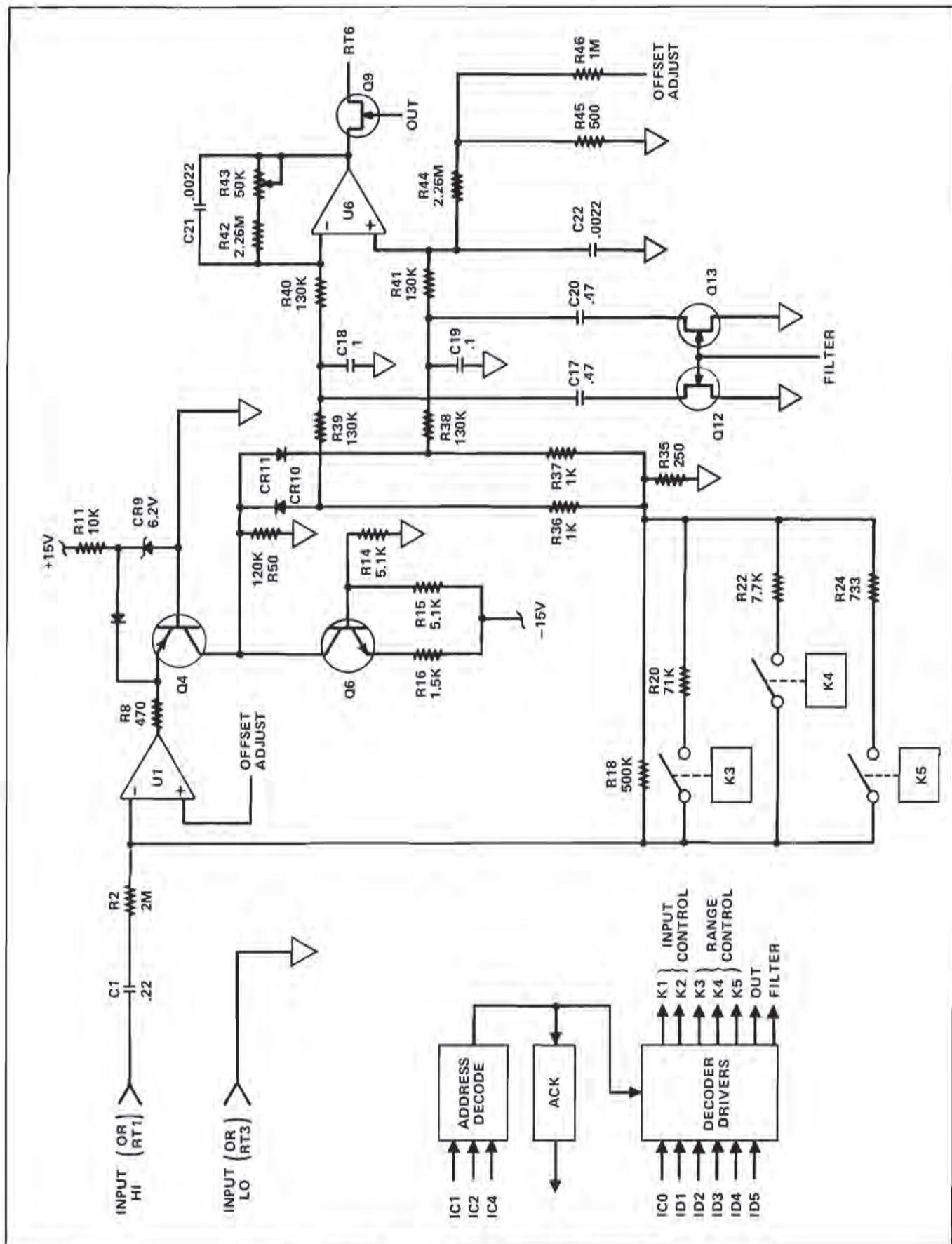


Figure 601-1. AC/DC Converter (Averaging)

**601-15. MAINTENANCE****601-16. Performance Test**

601-17. Sequentially apply the inputs listed in Table 601-2, ensuring that the reading is between the limits specified.

**Table 601-2. Performance Test**

Input Freq	Voltage	8500 Reading	
		Low	High
10 kHz	1 V	0.99945	1.00055
50 kHz	1 V	0.99895	1.00105
10 kHz	10 V	9.9945	10.0055
50 kHz	10 V	9.9895	10.0105
10 kHz	100 V	99.945	100.055
50 kHz	100 V	99.895	100.105
10 kHz	1000 V	998.95	1001.05

**601-18. Calibration**

601-19. Use the DC portion of the instrument to adjust the AC balance of the AC/DC Converter using the following procedure.

1. Select DC Volts, 100 mV range, and slow filtering (FILTER indicator illuminated).

2. Connect TP1 on the AC/DC Converter to the Input HI terminal.
3. Adjust R17 (AC Balance) for a reading of  $0 \pm 20 \mu\text{V}$ .
4. Remove the connection between TP1 and Input HI.

601-20. Select AC Volts and manually select the 1000V range. Connect the AC Calibrator to the instrument. Sequentially apply the inputs listed in Table 601-3, making adjustments as required to the nominal value. Repeat steps 1 through 6 until all six steps are within the stated tolerance without making any adjustments. Those inputs for which no adjustment is listed are to verify that the averaging Converter is within tolerance.

601-21. The adjustment in step 13 is performed using a computation derived from the readings in steps 13 and 14 if either step is out of tolerance. Use the following procedure to compute the value of the adjustment:

1. Subtract and record the absolute value of the reading in step 13 from the absolute value of the nominal reading, e.g. if the reading was 18.9322 you would subtract 189322 from 190000 for a result of +678.
2. Subtract and record the absolute value of the reading in step 14 from the absolute value of the nominal reading, e.g. if the reading was 1.90503 you would subtract 190503 from 190000 for a result of -503.

**Table 601-3. Calibration Chart**

Step	Input			Reading			Adjust
	Range	Voltage	Frequency	Minimum	Nominal	Maximum	
1	1000V	500	500 Hz	499.93	500.00	500.07	R43
2	1000V	500	60 kHz	499.92	500.00	500.08	C23
3	1000V	1	500 Hz	0.99	1.00	1.01	R47
4	1000V	1	100 kHz	0.97	0.98	0.98	C16
5	1V	1	500 Hz	0.99993	1.00000	1.00007	R19
6	1V	1	60 kHz	0.99975	1.00000	0.99990	C8
7	10V	10	500 Hz	9.9993	10.0000	10.0007	R21
8	10V	10	60 kHz	9.9991	10.0000	10.0009	C10
9	100V	100	500 Hz	99.993	100.000	100.007	R23
10	100V	100	60 kHz	99.991	100.000	100.009	C25
11	100V	100	10 kHz	99.975	100.000	100.025	
12	10V	19	30 Hz	18.9615	19.0000	19.0385	
13	10V	19	100 kHz	18.9520	19.0000	19.0480	
14	1V	1.9	100 kHz	1.89520	1.90000	1.90480	(R55)
15	1V	1.9	10 kHz	1.89520	1.90000	1.90050	
16	1V	.1	500 Hz	0.09995	0.10000	0.10005	
17	1000V	1000	20 kHz	999.50	1000.00	1000.50	
18	1V	5 0.025	50 kHz	0.02492	0.02500	0.2508	
19	1V	0.025	100 kHz	0.02465	0.02500	0.02535	

3. Algebraically add the two recorded results and double the result. With the example readings inserted the result is:  $2 * [+678 + (-503)] = +350$ .
4. With R55 adjust the reading in step 13. If the number is positive (+) increment the reading the computed number of digits, if it is negative (-) decrement the reading the computed number of digits.
5. Repeat the process until both readings are within the stated tolerances.

## 601-22. Troubleshooting

601-23. Table 601-4 contains a procedure to ensure the problem actually is in the AC Converter. Figure 601-2

contains symptom analysis of the AC Converter and address and data information.

## 601-24. PARTS LIST

601-25. Table 601-5 contains a parts breakdown for the AC/DC Converter (Averaging). Refer to Section 5 of this manual for ordering and use code information.

### CAUTION

Indicated devices are subject to damage by static discharge.

Table 601-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		Section
2	Is DC Volts within tolerance?	3	4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following:		
	1. Digital Logic Bad,      2. K1 or K2 shorted,      3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows:		
	VA1 = +14.25 to 15.75V VA2 = -14.25 to -15.75V VA3 = +29 to 32V	VA4 = -29 to -32V Vcc = -15V      Difference = 4.9 Vss = -20V      to 5.2	
14	Are the supply voltages OK?		Section
15	Go to Figure 601-2.	4	

SYMPTOM	POSSIBLE FAILURE	
Noisy Reading	U1, U6	
Single range bad	Digital logic, range relay	
All ranges bad	U1, U6	
Reading out of tolerance	Range relay, U1	
OVERRANGE	U6	
High frequency bad	U6	
No Output	Q9, Q10, Q11, U6, U1, K1, K2	
Interfering with DC or Ohms reading	K1 shorted, Q9 leaky	
<b>Address:</b> IC 4, 2, 1 high		
<b>Data:</b>		
ID0 = 1, ID1 = 0	AC Voltage Input Terminals	
ID0 = 0, ID1 = 1	AC Current, RT1 and RT3	
ID2 = 0	Filter on	
ID3 = 0	10V range	
ID4 = 0	100V range	
ID5 = 0	1000V range	
ID5, 4, 3 = 1	1V range	
If U1, Q4, Q6, R51, R52, CR10, or CR11 are replaced it may be necessary to change the value of R51 or R52 to correct offset error. Use the following procedure.		
1. Remove R51 or R52, whichever is installed.		
2. Connect test DMM Hi to TP1, Lo to TP2.		
3. With R17 fully CW, the reading should be more than +100 $\mu$ V.		
4. If not, center R17 and select a resistor value from the following table which has the closest corresponding offset voltage. For negative readings, install the resistor as R52. For positive readings, install the resistor as R51.		
OFFSET	RESISTOR	J.F. PART #
.25 mV	2.7 M $\Omega$	193490
.5	1.5M	182857
.75	910K	285338
1.0	680K	188433
1.25	560K	220533
1.5	470K	188441
1.75	390K	193383
2.0	360K	234690
2.25	300K	234682
2.5	270K	220061
2.75	240K	218016
3.0-3.25	220K	160937
3.5	200K	248781

Figure 601-2. Symptom Analysis

Table 601-5. AC/DC Converter (Averaging) PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	N OTE
-01	④AC/DC CONVERTER (AVG) PCB ASSEMBLY FIGURE 601-3 (MIS-4101T)	ORDER	BY	OPTION -01			
C1	CAP, FILM, 0.22 UF +/-20%, 1200V	268904	84411	JF-65	1		
C2	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	CM15E470J	1		
C5	CAP, MICA, 33 PF +/-5%, 500V	160317	72136	DM15E330J	1		
C6	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	8		
C7	CAP, CER, 1 PF +/-0.25%, 100V	436477	80031	2222-638-03108	1		
C8	CAP, VAR, 0.25-1.5 PF, 2000V	273151	74970	273-0001-002	2		
C9	CAP, MICA, 15 PF +/-2%, 500V	335612	72136	DM15C150G	2		
C10	CAP, VAR, 0.8-10 PF, 200V	229930	91293	JMC5201	1		
C11	CAP, MICA, 150 PF +/-1%, 500V	226134	72136	DM15F151F	1		
C12	CAP, MICA, 15 PF +/-2%, 500V	335612	72136	DM15C150G		REF	
C13	CAP, MICA, 1800 PF +/-2%, 500V	447441	72136	DM19F182G	1		
C14	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C15	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C16	CAP, VAR, CERMET, 1.7-10 PF, 250V	375238	52769	GKC10000	2		
C17	CAP, POLYESTER, 0.47 UF +/-10%, 100V	369124	89536	369124	2		
C18	CAP, POLYESTER, 0.10 UF +/-10%, 100V	393439	89536	393439	2		
C19	CAP, POLYESTER, 0.10 UF +/-10%, 100V	393439	89536	393439		REF	
C20	CAP, POLYESTER, 0.47 UF +/-10%, 100V	369124	89536	369124		REF	
C21	CAP, FILM, 0.0022 UF +/-10%, 50V	313239	06001	75F1R5A322	2		
C22	CAP, FILM, 0.0022 UF +/-10%, 50V	313239	06001	75F1R5A322		REF	
C23	CAP, VAR, 0.25-1.5 PF, 2000V	273151	74970	273-0001-002		REF	
C24	CAP, MICA, 68 PF +/-5%, 500V	148510	72136	DM15F680J	1		
C25	CAP, VAR, CERMET, 1.7-10 PF, 250V	375238	52769	GKC10000		REF	
C26	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C27	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C28	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C29	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C30	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1		REF	
C31	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	2		
C32	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1		REF	
C33	CAP, MICA, 10 PF +/-2%, 500V	335638	72136	DM15C100G	1		
CR1	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	6	2	
CR2	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
CR3	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	4	1	
CR4	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223		REF	
CR5	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
CR6	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
CR7	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
CR8	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448		REF	
CR9	DIODE, ZENER, UNCOMPENSATED	325811	07910	1N753A	2	1	
CR10	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223		REF	
CR11	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223		REF	
CR12	DIODE, ZENER, UNCOMPENSATED	325811	07910	1N753A		REF	
H1	SCREW, PHP, 4-40 X 3/16 (NOT SHOWN)	129882	89536	129882	3		
H2	SCREW, RH FILISTER, 6-32 X 1/2 (NOT SHOWN)	115006	89536	115006	3		
H3	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		

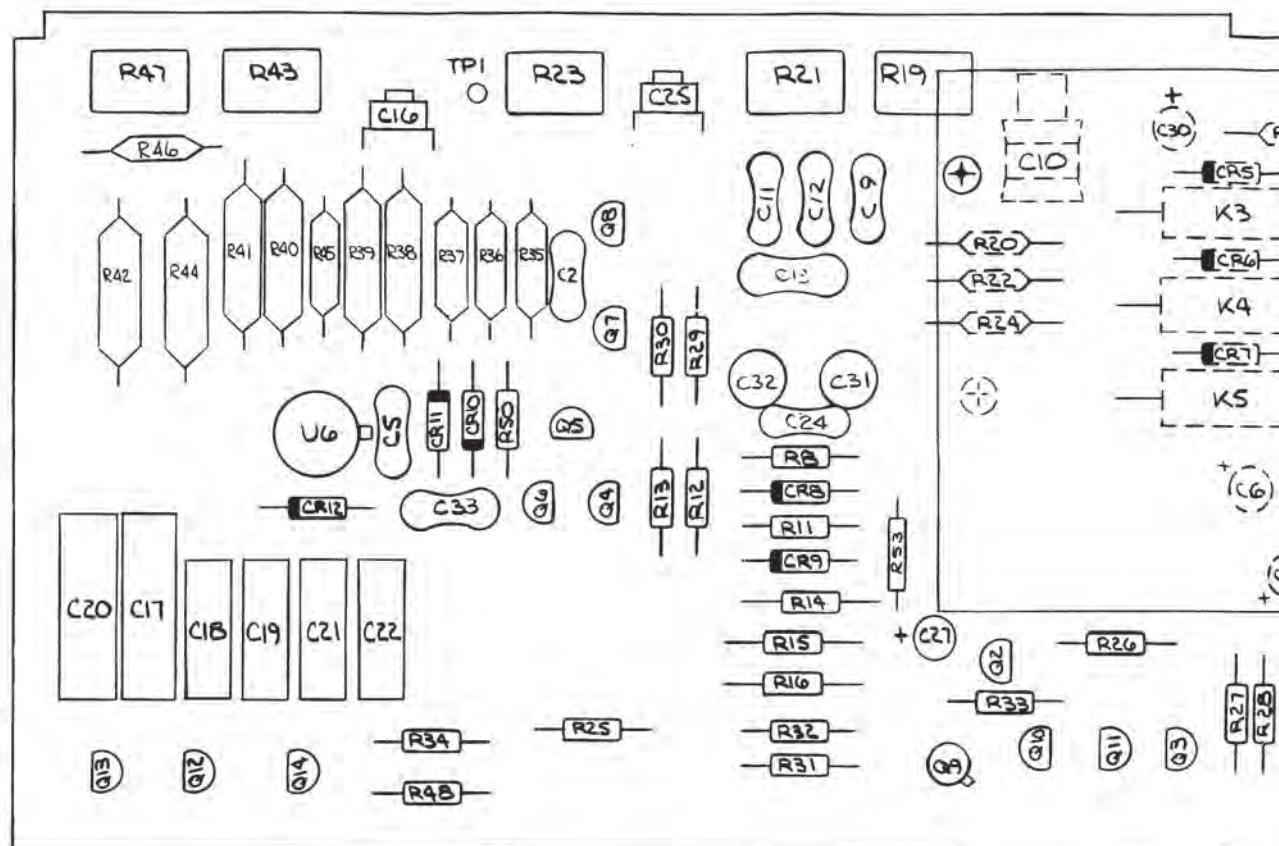
Table 601-5. AC/DC Converter (Averaging) PCB Assembly (cont)

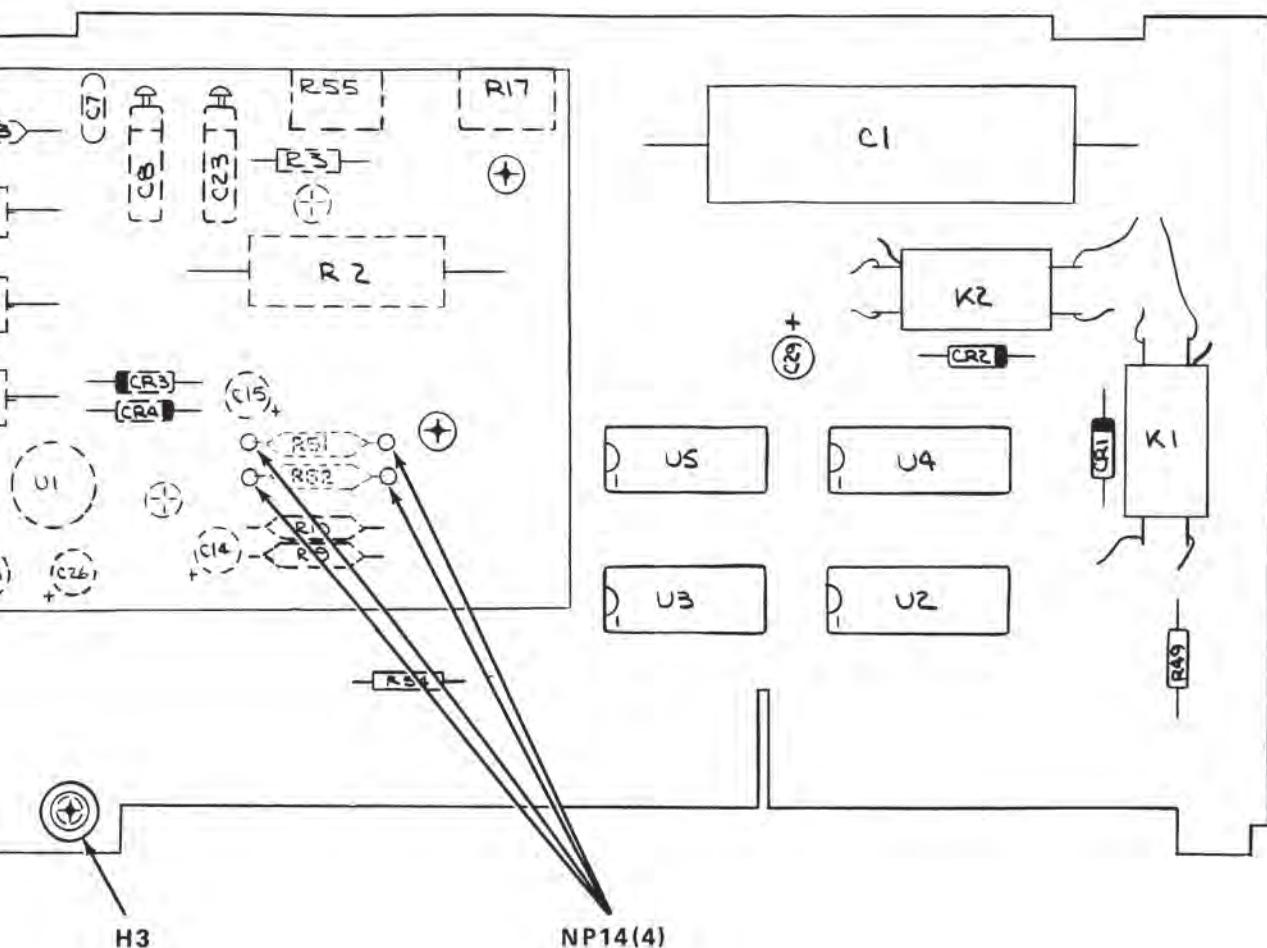
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
K1	RELAY ASSY RELAY, COIL, 6V FOIL SWITCH, DRY REED SWITCH, DRY REED	272070 313833 284091 414300	71707 89536 95348 95348	UD-6P 313833 MR138 MR5830-7	2 2 2 2		
K2	RELAY ASSY RELAY, COIL, 6V FOIL SWITCH, DRY REED SWITCH, DRY REED	272070 313833 284091 414300	71707 89536 95348 95348	UD-6P 313833 MR138 MR5830-7		REF REF REF REF	
K3	RELAY, DRY REED	357566	71707	UF40069	3		
K4	RELAY, DRY REED	357566	71707	UF40069		REF	
K5	RELAY, DRY REED	357566	71707	UF40069		REF	
MP1	MODULE CASE ASSY (MP2-MP9)	459016	89536	459016	1		1
MP2	CASE HALF, MODULE	402990	89536	402990		REF	
MP3	CASE HALF, MODULE	402990	89536	402990		REF	
MP4	COVER, MODULE CASE	402974	89536	402974		REF	
MP5	SHIELD, COVER	411926	89536	411926		REF	
MP6	DECAL, AC/DC CONVERTER (AVERAGING)	413385	89536	413385		REF	
MP7	DECAL, CAUTION	454504	89536	454504		REF	
MP8	GUARD, REAR	383364	89536	383364		REF	
MP9	GUARD, FRONT	383356	89536	383356		REF	
MP10	INSULATOR, AVG SHIELD (NOT SHOWN)	437913	89536	437913	1		
MP11	SHIELD, AVG CONVERTER (NOT SHOWN)	437905	89536	437905	1		
MP12	SHIELD, AVG CONVERTER, REAR (NOT SHOWN)	437897	89536	437897	1		
MP13	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
MP14	SOCKET, COMPONENT LEAD	343285	00779	2-331272-6	8		
Q2	XSTR, SI, NPN	218396	04713	2N3904	4		1
Q3	XSTR, SI, PNP	226290	04713	MPS3640	1		1
Q4	XSTR, SI, PNP	195974	04713	2N3906	2		1
Q5	XSTR, SI, NPN	218081	89536	218081	2		1
Q6	XSTR, SI, NPN	218396	04713	2N3904		REF	
Q7	XSTR, SI, NPN	218081	89536	218081		REF	
Q8	XSTR, FET, N-CHANNEL	352112	89536	352112	1		1
Q9	XSTR, FET, N-CHANNEL	393314	89536	393314	1		1
Q10	XSTR, SI, NPN	218396	04713	2N3904		REF	
Q11	XSTR, SI, PNP	195974	04713	2N3906		REF	
Q12	XSTR, FET, N-CHANNEL	343830	89536	343830	2		1
Q13	XSTR, FET, N-CHANNEL	343830	89536	343830		REF	
Q14	XSTR, SI, NPN	218396	04713	2N3904		REF	
R2	RES, MTL. FILM, 2M +/-0.5%, 1W	354894	89536	354894	1		
R3	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	2		
R8	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
R9	RES, MTL. FILM, 49.9 +/-1%, 1/8W	305896	91637	MFF1-849R9F	1		
R10	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	1		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K		REF	
R13	RES, DEP. CAR, 75K +/-5%, 1/4W	394130	80031	CR251-4-5P75K	1		
R14	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	2		
R15	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1		REF	

Table 601-5. AC/DC Converter (Averaging) PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R16	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	1		
R17	RES, VAR, CERMET, 100K +/-10%, 1/2W	288308	89536	288308	3		
R18	RES, MTL. FILM, 500.85K +/-0.1%, 1/8W	424614	91637	MFF1-8500851B	1		
R19	RES, VAR, CERMET, 5K +/-10%, 1/2W	288282	89536	288282	1		
R20	RES, MTL. FILM, 71.320K +/-0.1%, 1/8W	424515	91637	MFF1-871321B	1		
R21	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1		
R22	RES, MTL. FILM, 7.704K +/-0.1%, 1/8W	436121	91637	MFF1-87704B	1		
R23	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122	1		
R24	RES, MTL. FILM, 733.9 +/-0.1%, 1/8W	460212	91637	MFF1-8733R9B	1		
R25	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K		REF	
R26	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	3		
R27	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R28	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	1		
R29	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R30	RES, DEP. CAR, 8.2K +/-5%, 1/4W	441675	80031	CR251-4-5P8K2	1		
R31	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	3		
R32	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K		REF	
R33	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K		REF	
R34	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K		REF	
R35	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873	1		
R36	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R37	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R38	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R39	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R40	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R41	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R42	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R43	RES, VAR, CERMET, 50K +/-10%, 1/2W	288290	89536	288290	1		
R44	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R45	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R46	RES, MATCHED SET (R35-R42, R44-R46)	441873	89536	441873		REF	
R47	RES, VAR, CERMET, 100K +/-10%, 1/2W	288308	89536	288308		REF	
R48	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K		REF	
R49	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	1		
R50	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K		REF	
R51	RES, SELECTED						
R52	RES, SELECTED						
R53	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	2		
R54	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E		REF	
R55	RES, VAR, CERMET, 100K +/-10%, 1/2W	288308	89536	288308		REF	
U1	IC, LIN, OP AMP	429951	12040	LF357AH	1	1	
U2	©IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U3	©IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U4	©IC, C-MOS, HEX, INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U5	IC, TTL, HEX, INVERTER, BUFFER/DRIVER	288605	01295	SN7416N	1	1	
U6	IC, LIN, OP AMP	288928	12040	LM308AH	1	1	

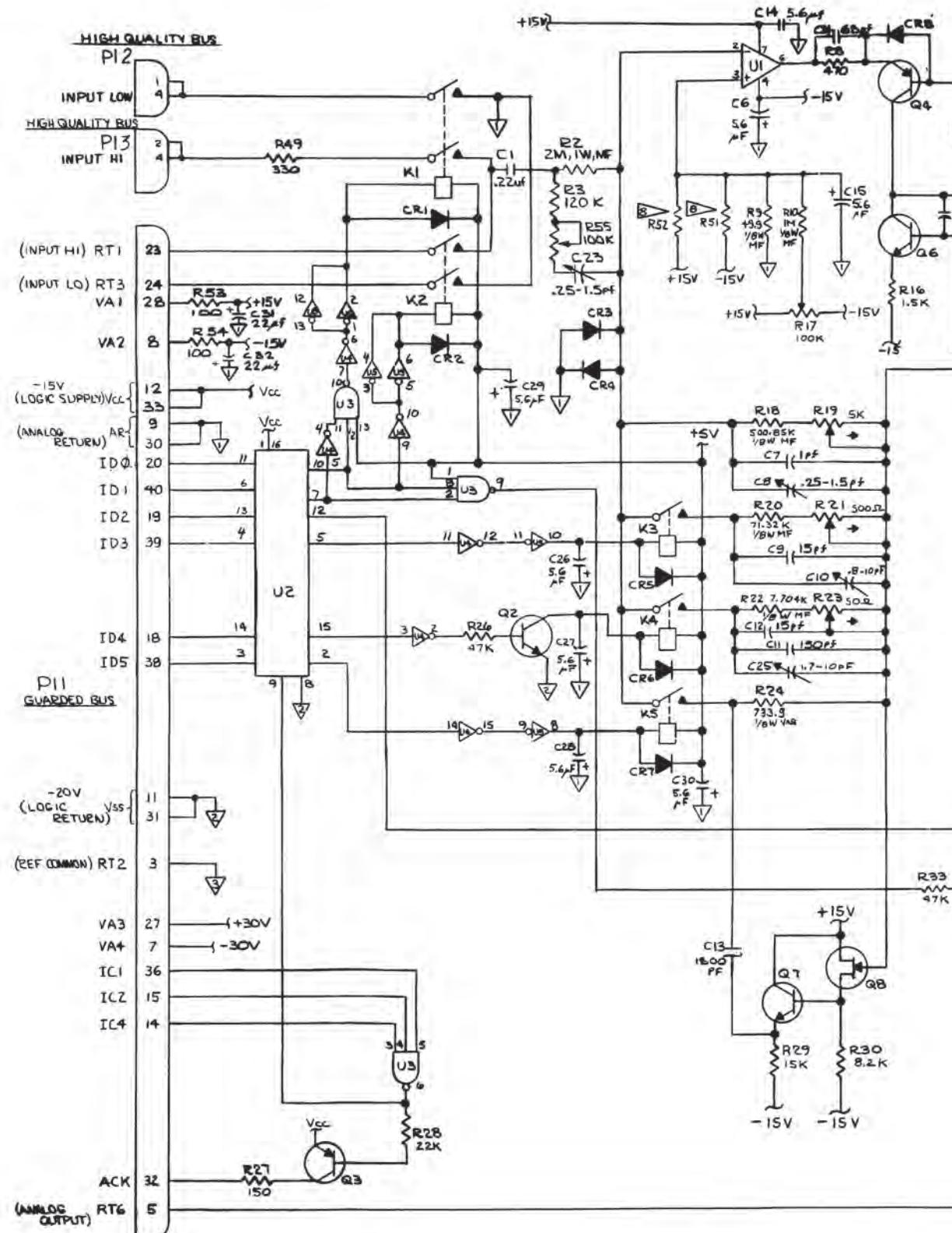
1 SEE TABLE 5-17 AT THE END  
OF SECTION 5.

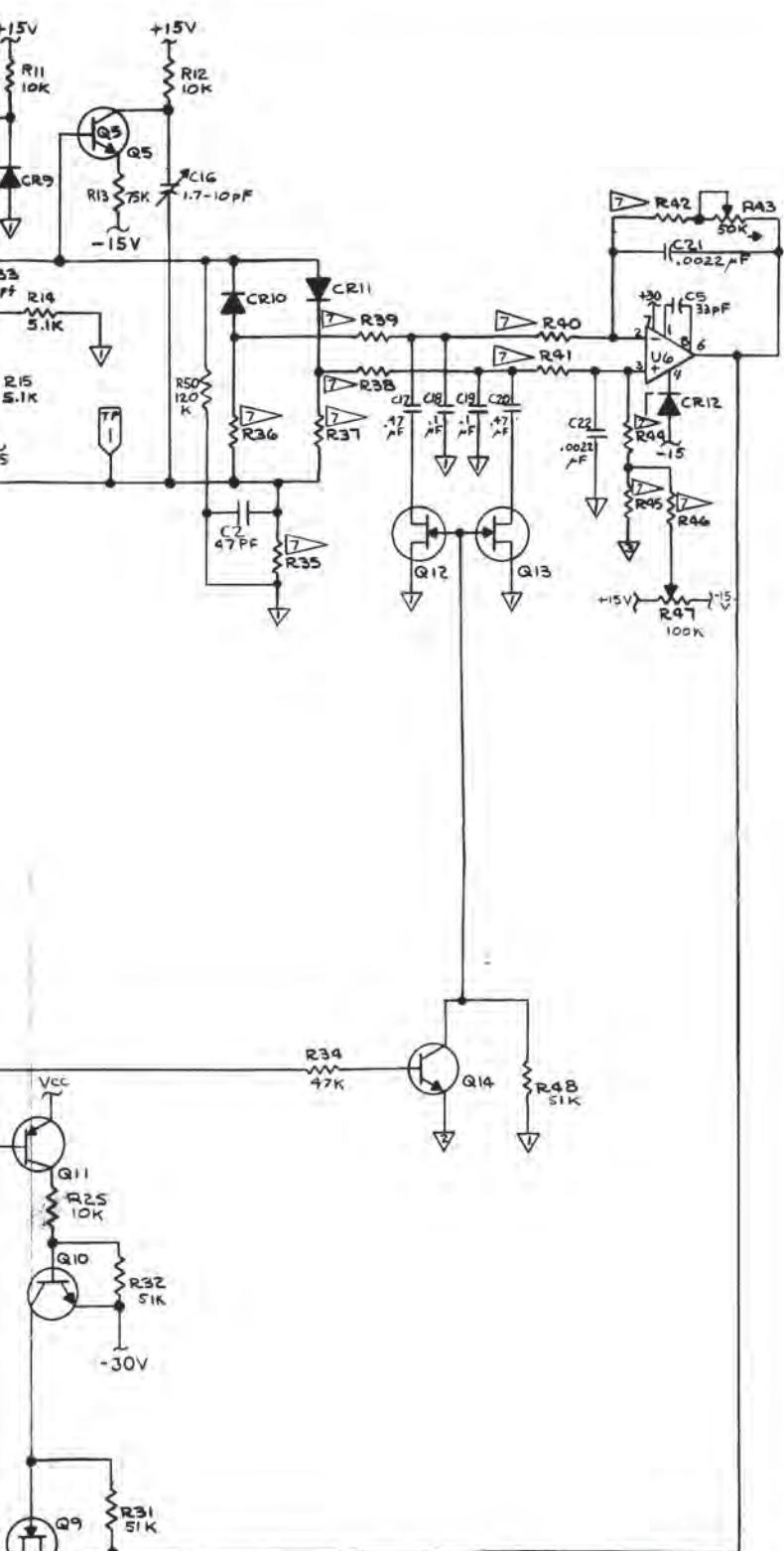




MIS-1701

**Figure 601-3.** AC/DC Converter (Averaging) PCB Assembly





I.C. NO'S	TYP	VSS	VCC
U2	74C174	8	16
U3	4023	7	14
U4	4050	8	1
U5	741G	7	14

## NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS 1/4W CC, ALL RESISTANCE IN OHMS.

2. FOR REF. DESIGNATION SEE MIS-1701

△ MATCHED RESISTOR SET.

□ FACTORY SELECTED PARTS.

Figure 601-3. AC/DC Converter  
(Averaging) PCB Assembly (cont)

## Option —02 Ohms Converter

### 602-1. INTRODUCTION

602-2. Installation of the Ohms Converter provides precision resistance measurement capability ranging from 100  $\mu\Omega$  to 262 M $\Omega$ . Both two-terminal and four-terminal measurements may be made.

### 602-3. SPECIFICATIONS

602-4. Table 602-1 lists the specifications of the Ohms Converter.

### 602-5. INSTALLATION

602-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing and removing modules. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

### 602-7. OPERATING NOTES

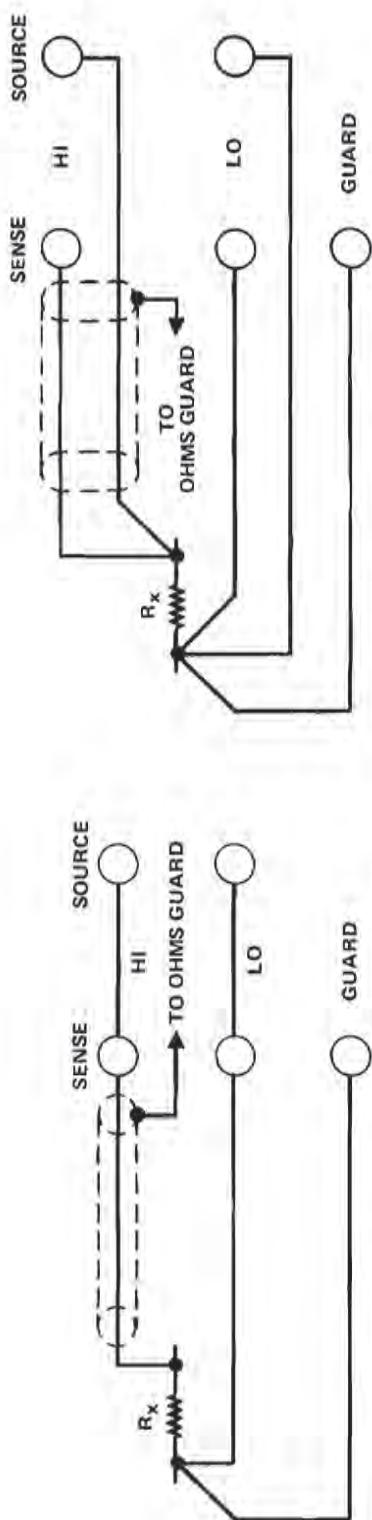
602-8. Operation of the front panel controls with the Ohms Converter Option installed is the same as described in Section 2 of this manual. Eight ranges are available for resistance measurements: 10, 100, 1K, 10K, 100K, 1M, 10M, and 100M. Ranges may be either manually or automatically selected. Four-wire measurements may be made up through the 100K range. In the 1M, 10M, and 100M ranges only two-wire measurements may be made, as lead resistance will not affect accuracy. However, the four-wire connections may still be used if desired. Sense HI to Source HI and Sense LO to Source LO connections must be made either with the shorting links provided (two-wire mode) or at the resistance to be measured (four-wire mode). Figure 602-1 shows possible connections for both the two-wire and four-wire modes.

Table 602-1. Ohms Converter Specifications

Range	NORMAL RESOLUTION			HIGH RESOLUTION		
	Accuracy $\pm$ (% of Input + No. of Digits)			Accuracy $\pm$ (% of Input + No. of Digits)		
	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
10 $\Omega$	0.003 + 20	0.005 + 20	0.01 + 20	—	—	—
100 $\Omega$	0.002 + 2	0.003 + 2	0.006 + 2	0.002 + 14	0.003 + 14	0.006 + 14
1 k $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10k $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
100 k $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
1 M $\Omega$	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10 M $\Omega$	0.01 + 1	0.02 + 1	0.04 + 1	0.01 + 8	0.02 + 8	0.004 + 8
100 M $\Omega$	0.03 + 1	0.05 + 1	0.1 + 1	0.03 + 8	0.05 + 8	0.1 + 8

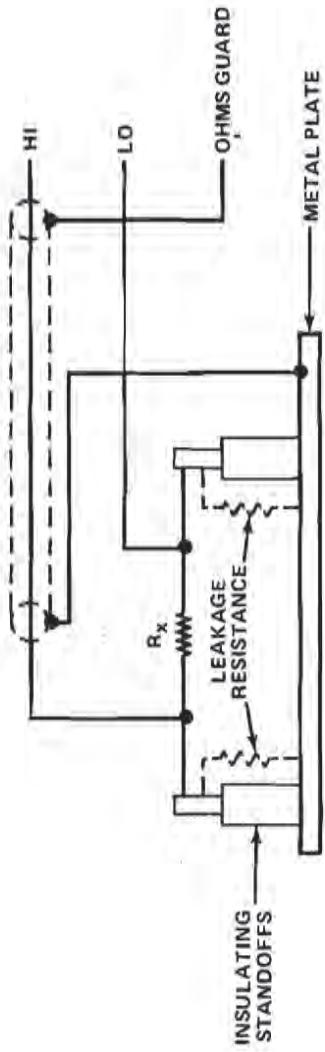
Table 602-1. Ohms Converter Specifications (Continued)

OPERATING CHARACTERISTICS									
Range	Full Scale	Current Through Unknown	Normal Resolution		High Resolution				
			Resolution	Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C	Resolution	Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C			
10Ω	31.25Ω	10 mA	100 uΩ	8 + 1.5	—	—			
100Ω	250Ω	10 mA	1 mΩ	7 + 0.2	100 uΩ	7 + 2			
1 kΩ	2 kΩ	1.25 mA	10 mΩ	7 + 0.2	1 mΩ	7 + 2			
10 kΩ	32 kΩ	78 uA	100 mΩ	7 + 0.2	10 mΩ	7 + 2			
100 kΩ	256 kΩ	9.8 uA	1Ω	7 + 0.2	100 mΩ	7 + 2			
1 MΩ	4.096 MΩ	4.9 uA	10Ω	7 + 0.2	1Ω	7 + 2			
10 MΩ	32.768 MΩ	0.61 uA	100Ω	30 + 0.2	10Ω	30 + 2			
100 MΩ	262,144 MΩ	76 nA	1 kΩ	50 + 0.2	100Ω	50 + 2			
*0°C to 18°C and 28°C to 50°C									
MAXIMUM LEAD RESISTANCE									
Mode	Leads	Range		Maximum Lead Resistance					
4-wire	Source	10 – 100Ω		10Ω					
4-wire	Source	1 kΩ		100Ω					
4-wire	Source	10 kΩ – 100 MΩ		1 kΩ					
4-wire	Source	All		1 kΩ					
2-wire	Source	All		Less than 0.001% of range unless offset					
OPEN CIRCUIT VOLTAGE			OVERLOAD						
Range	Voltage	Configuration	± 400V dc to 60 Hz, or 560 volts peak ac above 60 Hz maximum continuous on any range with no damage.						
10Ω to 100 kΩ 1 MΩ to 100 MΩ	7 volts max 25 volts max	4 Terminal 2 Terminal	SETTLING TIME – (To Rated Accuracy) 80 ms, Fast Filter 800 ms, Slow Filter						
DIGITIZING TIME									
Mode of Operation	Filter	60 Hz		50 Hz					
		Approx. Rdg. Rate	Digitizing Time	Approx. Rdg. Rate	Digitizing Time				
Bench	Fast	4 rdg/s	250 ms	3-1/3 rdg/s	300 ms				
	Fast	1-1/2 rdg/s	700 ms	1-1/4 rdg/s	800 ms				
	Slow	1-1/4 rdg/s	800 ms	1 rdg	1000 ms				
	Slow	5/6 rdg	1200 ms	3/4 rdg	1450 ms				
Remote	Fast	4 samples/rdg	145 ms	4 samples/rdg	175 ms				
	Slow	4 samples/rdg	700 ms	4 samples/rdg	840 ms				
(Subtract for fast Ohms)		Fast	—	110 ms	—				
		Slow	—	560 ms	—				



TWO TERMINAL OHMS MEASUREMENT CONNECTIONS TO  
MAXIMIZE THE EFFECTIVENESS OF THE GUARDS

FOUR TERMINAL OHMS MEASUREMENT CONNECTIONS TO  
MAXIMIZE THE EFFECTIVENESS OF THE GUARDS



OHMS GUARD IS AVAILABLE ONLY THROUGH THE  
OPTIONAL REAR INPUT (-17) CONNECTOR

Figure 602.1. Ohms Measurement Connections And Guarding

602-9. For the two-wire ohms mode, the instrument should be zeroed with a good quality short between Sense-Source HI and Sense-Source LO. Select either autoranging or the  $10\Omega$  range manually. Depress the V DC/ $\Omega$  ZERO switch. All ranges are now automatically zeroed. Ohms zero cannot be recalled. Depressing the RECALL switch while in Ohms results in a display of ERROR 0, then a return to the program. To compensate for lead resistance use the Offset mode. Short the ends of the leads together. Depress the STORE switch, then the OFFSET switch. This enters the lead resistance value into memory. Depress the OFFSET switch again (OFFSET LED illuminated) to enter the Offset mode in which the value of lead resistance will automatically be subtracted from further readings.

602-10. In the four-wire ohms mode, the instrument should be zeroed by placing a good quality short at the ends of the leads. Depress the V DC/ $\Omega$  ZERO switch to enter the zero value, which will automatically be subtracted from further readings.

#### 602-11. Guarding

602-12. The ohms guard connection is available only through the optional Rear Input Connection (-17). Figure 602-1 shows optimal use of the guard. Basically the ohms guard is used to minimize leakage resistance between the HI and LO leads which would appear as shunt resistance across high  $R_x$  values. In some high-resistance measurement set-ups, leakage resistance in or on the surface of insulating materials may provide enough shunt resistance to degrade the accuracy of the measurement. Figure 602-1 illustrates one such case. Connecting the ohms guard to the metal plate on which the standoffs are mounted reduces the effect of leakage resistance through or on the standoffs.

#### 602-13. THEORY OF OPERATION

602-14. The function of the Ohms Converter is to produce a current through an unknown resistance such that the voltage across the unknown is proportional to the value of resistance. This is accomplished by configuring the unknown resistance,  $R_x$ , as the feedback element of an operational amplifier. A reference voltage,  $V_{REF}$ , is applied through a reference resistor,  $R_{REF}$ , to the summing node of the amplifier. By definition of an ideal operational amplifier, the current through  $R_x$  is the same current flowing through  $R_{REF}$  (the summing node represents a virtual ground). Figure 602-2 is a simplified schematic of the Ohms Converter and contains an illustration of the derivation of the formula for  $R_x$ . The current flowing through  $R_{REF}$  equals

$(V_1 - V_2)/R_{REF}$ . Using the expression for current to obtain the value of  $R_x$ :

$$R_x = R_{REF} \left( \frac{V_o}{V_1 - V_2} \right).$$

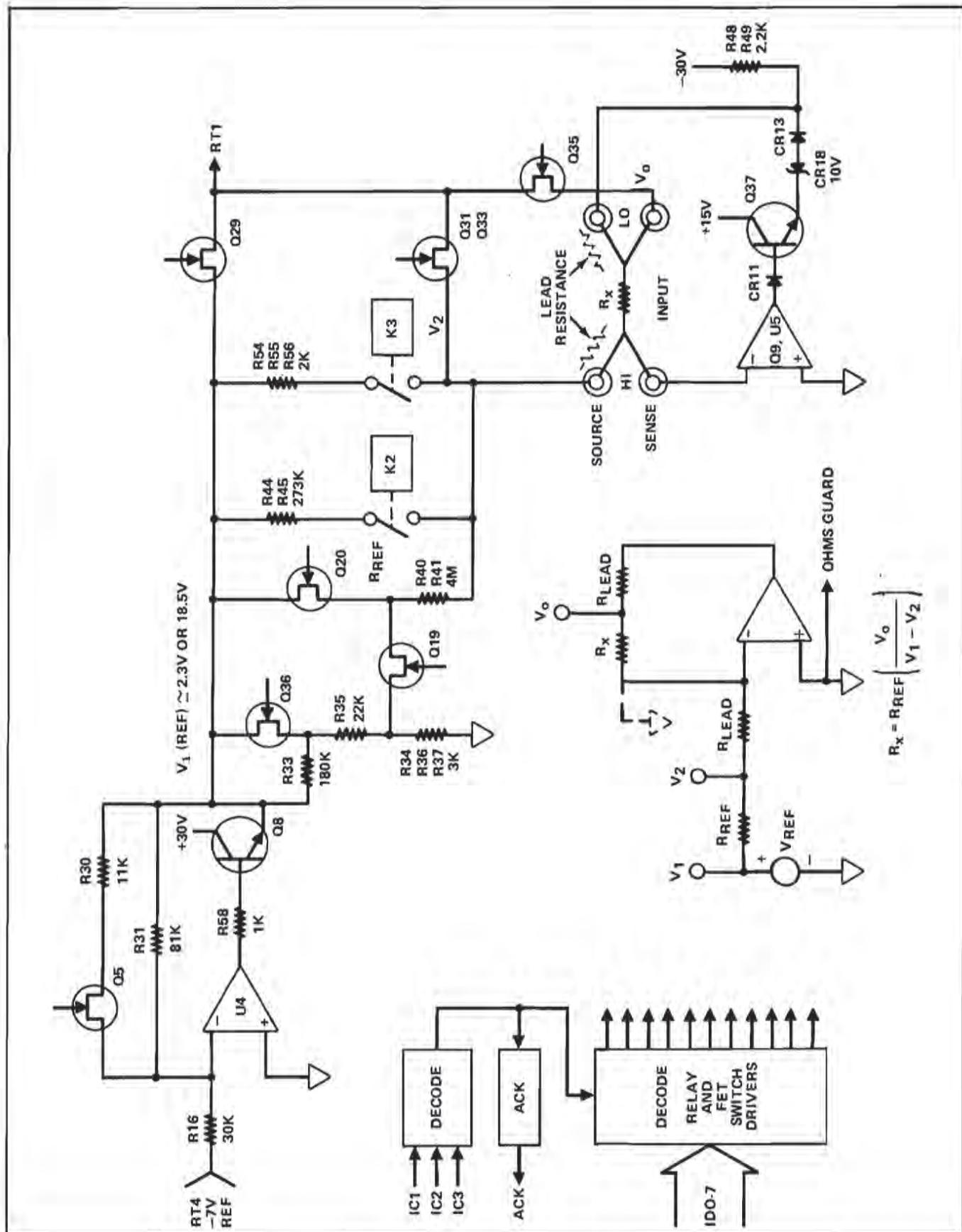
The Ohms Converter multiplexes the voltages which, after being routed through the DC Signal Conditioner and the Filter module, are measured by the A/D Converter.

602-15. The current reference for the Ohms Converter is derived from the  $-7V$  reference (RT4) from the A/D Converter. U4 is an inverting amplifier with two possible feedback paths to produce either approximately  $+2.3V$  or  $+18.5V$  as  $V_1$ . U4 drives Q8 with Q8 serving as a larger current source than is available from U4, R41, R45, and R56 are the reference resistors, each having an adjustment.

602-16.  $R_x$  is the feedback element for the operational amplifier composed of Q9 and U5. U5 drives Q37 which serves as a higher current source. This arrangement also allows a larger output voltage swing. Note that Q9 and U5 are configured as an inverter, yet the output of U5 is a positive voltage. Q37 draws its emitter current through R48 and R49 from the  $-30V$  supply with CR18 and CR13 ensuring that Q37 need not be in a state of saturation. SOURCE voltages out are negative voltages at SOURCE LO with respect to circuit common. In the 100M range, the voltage applied to R41 is divided by 8. However, the unattenuated  $V_{REF}$  is measured. The factor of 8 is preserved by assigning  $R_{REF}$  the value of  $8 \times R41$  ( $32.768 M\Omega$ ) in the equation. As the Ohms Converter downranges, R41 remains enabled so lower  $R_{REF}$  values are actually parallel combinations.  $V_2$  is not measured in the three highest ranges (1M, 10M, 100M) since lead resistance will not be large enough to affect accuracy.

602-17. Extensive overvoltage protection has been provided for the Ohms Converter. Refer to the full schematic. Voltages appearing on the SENSE or SOURCE HI terminals in excess of  $+28V$  or  $-3V$  (with respect to circuit common) are clamped to ground by Q14, CR7, Q10, and Q39. U5 is configured as a voltage comparator biased by CR19 and R14. The clamping action of Q14 or Q10 causes a voltage on the input Lo line which triggers comparator U5 through Q11 or Q15. In either case the output at U5 pin 7 toggles to its maximum positive level, clocking U3 while placing a high on the ID3 line. This opens relay K1 and removes the input voltages from the module. The high from U5 also inhibits the ACK logic so an Error 4 will be displayed. CR13 and CR14 at the output of Q9, U5 are high voltage blocking diodes. E1 is a spark gap preventing voltages in excess of 400V between the guard shield and circuit common.

602-18. The Ohms Converter is addressed by IC1, 2, 3 high, and must be addressed for each sample voltage. Samples are multiplexed out at the rate of one every four msec. This requires the fastest response time in the DC Signal Conditioner of any measurement mode.



**Figure 602-2. Ohms Converter**

**602-19. MAINTENANCE****602-20. Performance Test**

602-21. Test the Ohms function using the following procedure:

1. Connect test leads to the instrument in the four-wire configuration.
2. Select the Ohms function and Autoranging.
3. Short the HI and LO  $\Omega$  SOURCE leads, short the HI and LO SENSE leads; then connect the two pairs of shorted leads together.
4. Zero the instrument by depressing the STORE switch, then the V DC/ $\Omega$  ZERO switch.
5. Remove the shorts and sequentially connect the standard resistors in Table 602-2. The 8500A readings should fall within the limits specified.

**Table 602-2. Performance Test**

Standard Resistor	8500A Reading	
	Low (exponent)	High (exponent)
10	9.9975	10.0025
100	99.995	100.005
1K	.99996 (+3)	1.00004 (+3)
10K	9.9996 (+3)	10.0004 (+3)
100K	99.996 (+3)	100.004 (+3)
1M	.99996 (+6)	1.00004 (+6)
10M	9.9979 (+6)	10.0021 (+6)
100M	99.949 (+6)	100.051 (+6)

**602-22. Calibration**

602-23. Use the following procedure to calibrate the Ohms Converter:

1. Remove power and remove the Calibration Memory if installed.
2. Reapply power and allow a one hour warm-up.
3. Ensure that the dc Volts accuracy is within tolerance.
4. Connect test leads to the instrument in the four-wire configuration.
5. Use manual range selection to prevent range changes while testing at the range extremities.
6. Select the  $10\Omega$  range on the 8500A and short the four-terminal input leads for a zero input.
7. Adjust R24 for a reading between  $-0.0003$  and  $+0.0003$ .

8. Step through the other seven ranges, checking that the reading is  $0 \pm 1$  digit on all seven ranges.
9. Select the  $1 M\Omega$  range and connect the input leads to a  $4 M\Omega$  standard resistor.
10. Adjust R40 for a reading between  $3.99998 (+6)$  and  $4.00002 (+6)$ .
11. Select the  $100 M\Omega$  range and connect the input leads to a  $100 M\Omega$  standard resistor.
12. Adjust R37 for a reading between  $99.995 (+6)$  and  $100.005 (+6)$ .
13. Select the  $100 k\Omega$  range and connect the input leads to a  $250 k\Omega$  standard resistor.
14. Adjust R44 for a reading between  $249.998 (+3)$  and  $250.002 (+3)$ .
15. Select the  $1 k\Omega$  range and connect the input leads to a  $1.9 k\Omega$  standard resistor.
16. Adjust R54 for a reading between  $1.89998 (+3)$  and  $1.90002 (+3)$ .
17. Select the  $10\Omega$  range and short the four-terminal leads for a zero input.
18. Perform the Ohms Zero procedure found in the operating instructions, ensuring the result is  $0.0000 \pm 1$  digit.
19. Perform the tests in Table 602-3. There are no adjustments for the readings, if any reading exceeds the listed tolerance the module is not acceptable.

**Table 602-3. Calibration Tests**

Resistance Standard	Readings		
	Minimum	Nominal	Maximum
10	9.9989	10.0000	10.0011
100	99.997	100.000	100.003
1k	0.99997 (+3)	1.00000 (+3)	1.00003 (+3)
10k	9.9997 (+3)	10.0000 (+3)	10.0003 (+3)
100k	99.997 (+3)	100.000 (+3)	100.003 (+3)
1M	0.99997 (+6)	1.00000 (+6)	1.00003 (+6)
10M	9.9989 (+6)	10.0000 (+6)	10.0011 (+6)
100M	99.969 (+6)	100.000 (+6)	100.031 (+6)

**602-24. TROUBLESHOOTING**

602-25. Troubleshooting procedures for the Ohms Converter follow the format used for the mainframe instrument. Table 602-4, Failure Isolation, assures that the problem is in the Ohms Converter. Table 602-5 lists symptoms and possible failures in the order of probability. Figure 602-3 shows timing relationships, while Tables 602-6 through 602-8 give additional troubleshooting information.

602-26. Always remove power before removing or installing modules. RT1 is available only in the front four option slots and not in the Isolator or Interconnect slot.

**602-27. PARTS LIST**

602-28. Table 602-9 is a parts breakdown for the Ohms Converter. Refer to Section 5 of this manual for ordering and use code information.

Table 602-4. Failure Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC Volts within tolerance?	2	Section 4
2	Perform Ohms test. Is Ohms within tolerance?	4	3
3	Remove all optional modules except Isolator and Ohms converter.		
4	Is Ohms now within tolerance?	5	6
5	An optional module is affecting Ohms. Replace one at a time until Ohms goes bad. Last one in is faulty — go to appropriate portion of Section 6.		
6	Is Isolator installed?	7	9
7	Remove Isolator. Insert Jumper/Monitor pcb. Is Ohms within tolerance?	8	9
8	Bad Isolator. Go to Subsection 608.		
9	Check power supply voltages as follows. Test DMM LO on AR (analog return).		
	VA1 = +14.25 to 15.75V	VA4 = -29 to -32V	
	VA2 = -14.25 to -15.75V	Vcc = -15V } Difference = 4.9	
	VA3 = +29 to 32V	Vss = -20V } to 5.2	
	RT4 = -6.993 to -7.007		
10	Are the supply voltages within tolerance?	11	Section 4
11	The problem is probably in the Ohms board. However, the DC Signal Conditioner may contribute errors if the slew rates of the amplifiers are not fast enough. Go to Table 602-5.		

Table 602-5. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
No Ohms Readings ( $V_0$ ) ( $V_1$ )	U5, Q9, Q35, Digital Logic U4, Q8, Q29 Digital Logic & Drivers
Ohms Zero Drift	U5, Q9
10K – 100K Ranges Bad	Q32, Q33, Digital
10 – 100 – 1K Ranges Bad	Q30, Q31, Digital
10M Full Scale Low	Q20, Q22
No ACK	U5, Q14, Q11, Q38
All Ranges Out of Tolerance	Q37, U5
100M Noisy, 30M High	Q10, K3 Shorted
1K, 100K, 10M, 100M Ranges Bad	Q5, Q4
100M Range Bad	Q20, Q22, Q19 Leaky
Display Error 4 with no voltage at input	Q14
Noisy at 30M or Full Scale	CR15, CR17, CR4, CR8
Full Scale 1M, 10M, 100M Ranges Out of Tolerance	CR18
<b>DC SIGNAL CONDITIONER</b>	
Slew Rates Bad	Q37, Q38, Q19, U3, U5, U6
<i>Note: If Q9, Q19, U5, R19, R20, R21, R23, R25, or R26 are replaced it is necessary to return the module to the factory (Attn: Parts) for temperature compensation.</i>	

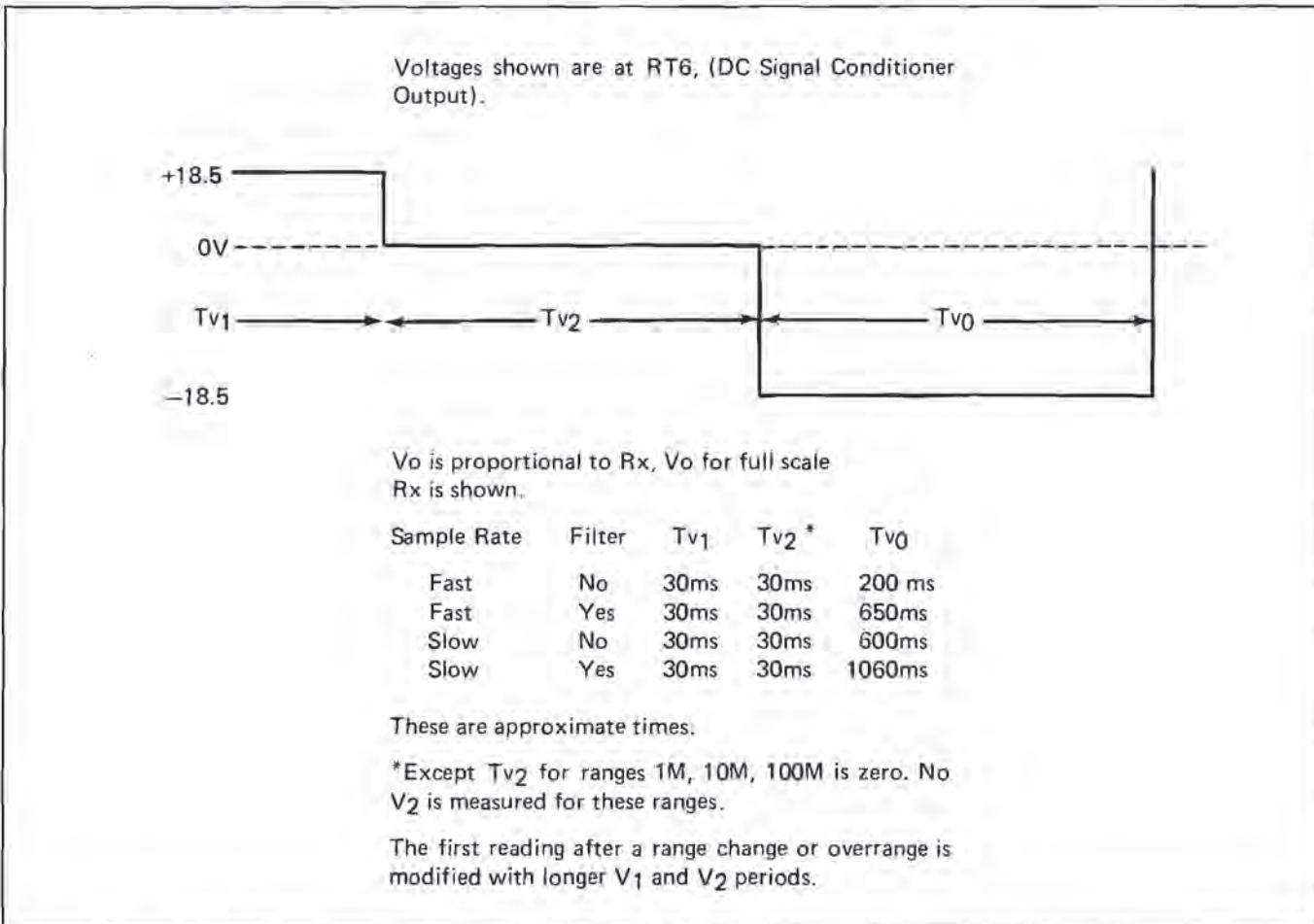


Figure 602-3. Timing

Table 602-6. Voltage Measurements

Range	Full Scale	V* TP2	R ref	Iref* (Source HI)	V <sub>0</sub> * (Range Value)	V <sub>1</sub> * (TP2)	V <sub>2</sub> (Offset)
10	31.25	+18.5V	2K	9.3ma	.093V	+18.5	< 100mv
100	250	+18.5V	2K	9.3ma	.93V	+18.5	< 100mv
1000	2000	+2.3V	2K	1.2ma	1.2V	+2.3	< 100mv
10K	32K	+18.5V	256K	.72μa	.72V	+18.5	< 100mv
100K	256K	+2.3V	256K	.9μa	.9V	+2.3	< 100mv
1M	4.091M	+18.5V	4.091M	4.5μa	4.5V	+18.5	NA
10M	32.728M	+2.3V	4.091M	.56μa	5.6V	+2.3	NA
100M	261.824M	+2.3V/8	4.091M	70na	7V	+2.3	NA

\* Approximate values ( $\pm 5\%$ )

TP1 is always -7.0V

TP3 Ref common (use for low side of measurements)

TP4 amplifier offset (<10μv properly adjusted)

V<sub>0</sub> is proportional to RX

V<sub>2</sub> will vary some with range change

SCANNER: Voltages will appear on RT1  
in order, V<sub>0</sub> – V<sub>1</sub> – V<sub>2</sub>

Table 602-7. Range Switch Closures

							Chart applies for time the particular voltage is SCANNED. All other times "0" applies.				
		K1	K2	K3	Q5	Q19	Q20	V <sub>0</sub> Q29	V <sub>2a</sub> Q31	V <sub>2b</sub> Q33	V <sub>1</sub> Q35
10Ω	1	0	1	0	0	1		1	1	0	1
100Ω	1	0	1	0	0	1		1	1	0	1
1KΩ	1	0	1	1	0	1		1	1	0	1
10KΩ	1	1	0	0	0	1		1	0	1	1
100KΩ	1	1	0	1	0	1		1	0	1	1
1MΩ	1	0	0	0	0	1		1	0	0	1
10MΩ	1	0	0	1	0	1		1	0	0	1
100MΩ	1	0	0	1	1	0		1	0	0	1
OHMS	0	0	0	1	0	1		0	0	0	0

Table 602-8. Address and Data Coding

ADDRESS IC1, 2, 3 HIGH									
Range	V	ID $\phi$	ID1	ID2	ID3	ID4	ID5	ID6	ID7
10	$V_\phi$	0	1	1	0	0	1	1	0
	$V_1$	1	0	1	0	0	1	1	0
	$V_2$	1	1	0	0	0	1	1	0
100	$V_\phi$	0	1	1	0	0	1	1	0
	$V_1$	1	0	1	0	0	1	1	0
	$V_2$	1	1	0	n	0	1	1	0
1K	$V_\phi$	0	1	1	0	1	1	1	0
	$V_1$	1	0	1	0	1	1	1	0
	$V_2$	1	1	0	0	1	1	1	0
10K	$V_\phi$	0	1	1	0	0	0	1	1
	$V_1$	1	0	1	0	0	0	1	1
	$V_2$	1	1	0	0	0	0	1	1
100K	$V_\phi$	0	1	1	0	1	0	1	1
	$V_1$	1	0	1	0	1	0	1	1
	$V_2$	1	1	0	0	1	0	1	1
1M	$V_\phi$	0	1	1	0	0	1	1	1
	$V_1$	1	0	1	0	0	1	1	1
10M	$V_\phi$	0	1	1	0	1	1	1	1
	$V_1$	1	0	1	0	1	1	1	1
100M	$V_\phi$	0	1	1	0	1	1	0	1
	$V_1$	1	0	1	0	1	1	0	1
OHMS		1	1	1	1	1	1	1	1

Table 602-9. MIS-4110 Ohms Converter Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	<b>OHMS CONVERTER ASSEMBLY</b> <b>Figure: 602-4</b>						
C1 thru C4	Cap, Ta, 6.8 uF $\pm 20\%$ , 35V	363713	56289	196D685X0035 KA1	4		
C5	Cap, cer, 33 pF $\pm 2\%$ , 100V	354852	80031	2222-638-10339	1		
C6, C7	Cap, cer, 1200 pF $\pm 20\%$ , 100V	358283	80031	2222-630-01-122			
C8	Cap, polystyren, 100 pF $\pm 10\%$ , 500V	446609	89536	446609	1		
C9, C10, C12 thru C15, C19	Cap, cer, 0.01 uF $\pm 20\%$ , 100V	149153	56289	C023B101F103M	7		
C11	Cap, Ta, 22 uF $\pm 20\%$ , 15V	423012	56289	196D226X0015 KA1	1		
C16	Cap, Ta, 5.6 uF $\pm 20\%$ , 25V	368869	56289	196D565X0025 KA1	1		
C17, C21 C23	Cap, cer, 0.22 uF $\pm 20\%$ , 50V	309849	71590	CW30C224K	3		
C18	Cap, Ta, 0.47 uF $\pm 20\%$ , 35V	161349	56289	196D474X0035 HA1	1		
C20	Cap, cer, 0.0022 uF $\pm 10\%$ , 500V	268425	32897	851000Z5R 222K	1		
C22	Cap, Ta, 0.33 uF $\pm 20\%$ , 35V	408690	56289	196D334X0035 HA1	1		
CR1, CR2, CR3, CR11, CR16, CR19, CR20	Diode, Si, Hi-speed switching	203323	07910	1N4448	7	2	
CR4, CR7, CR8, CR13, CR14, CR15, CR17	Diode, Si, rect	428144	01295	1N4006	7	2	

Table 602-9. MIS-4110 Ohms Converter Assembly (Continued)

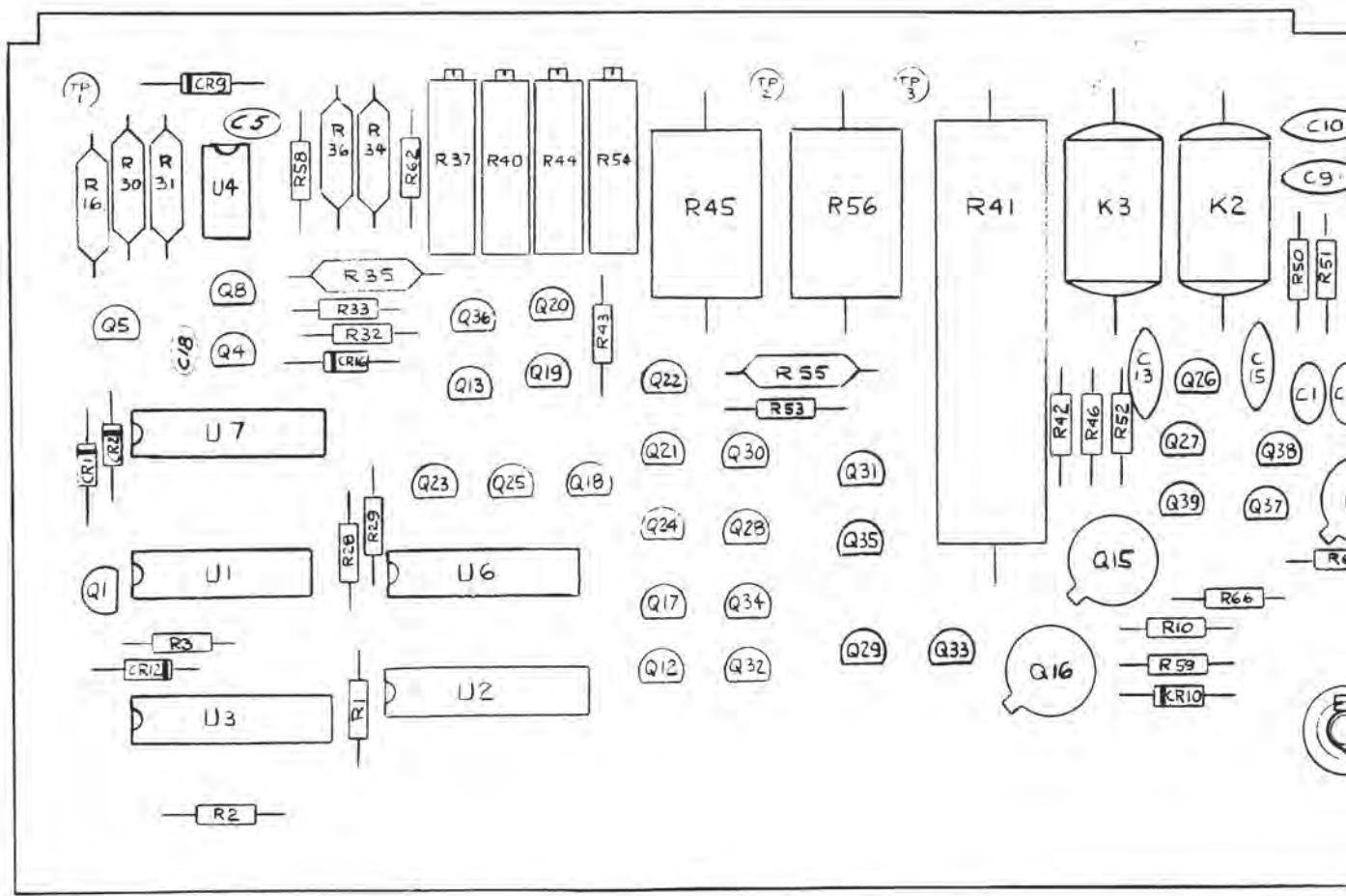
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR9, CR18	Diode, zener uncomp	113324	07910	IN961A	2	1	
CR10, CR12	Diode, Si, multipellet	375485	09214	MPD300	2	1	
E1	Surge protector, vol	442723	25088	B1-C145	1		
K1	Relay, armature	441261	77342	R40-E0186-1	1		
K2, K3	Relay, dry reed	357582	71707	UF40070	2		
L1	Choke, RF	111542	99800	1537-76	1		
Q1	Xstr, Si, NPN	226290	04713	MPS3640	1	1	
Q2, Q4, Q8, Q13, Q18, Q22, Q23, Q25, Q27, Q28, Q30, Q32, Q34, Q37	Xstr, Si, NPN	218396	04713	2N3904	14	3	
Q3, Q12, Q17, Q21, Q24, Q26, Q38	Xstr, Si, PNP	195974	04713	2N3906	7	2	
Q5, Q19, Q20, Q36	Xstr, FET N-channel	261578	89536	261578	4	1	
Q6, Q7, Q39	Xstr, Si, PNP	168716	07263	S19254	3	1	
Q9	Xstr, FET, dual, N-channel	287623	89536	287623	1	1	
Q10, Q11, Q14, Q15, Q16	Xstr, Si, NPN	203489	09214	11C2322	5	1	
Q29, Q31 Q33, Q35	Xstr, FET, N-channel	393314	89536	393314	2	1	
Q40	Xstr, FET junction, N-channel	288324	89536	288324	1	1	
R1, R3, R10, R11 R42, R59	Res, comp, 20k $\pm$ 5%, 1/4W	221614	01121	CB2035	6		

Table 602-9. MIS-4110 Ohms Converter Assembly (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R2, R4 thru R7, R52	Res, comp, $150 \pm 5\%$ , 1/4W	147934	01121	CB1515	6		
R8	Res, comp, $220k \pm 5\%$ , 1/2W	109025	01121	EB2245	1		
R9, R49	Res, comp, $1.8k \pm 5\%$ , 1W	180331	01121	GB1825	2		
R12	Res, comp, $100k \pm 10\%$ , 1W	109397	01121	GB1041	1		
R14, R47, R61, R62, R66	Res, comp, $120k \pm 5\%$ , 1/4W	193458	01121	CB1245	5		
R16	Res, mf, $30.1k \pm 1\%$ , 1/8W	293431	91637	MFF1-83012F	1		
R17, R18, R32, R43, R53, R57	Res, comp, $1M \pm 5\%$ , 1/4W	182204	01121	CB1055	6		
R19, R25	Res, ww, $40k \pm 0.1\%$	271403	89536	271403	2	1	
R20, R23	Res, selected				2		
R21, R26	Res, mf, $10 \pm 1\%$ , 1/8W	268789	91637	MFF1-8A100F	2		
R24	Res, var, cermet $100 \pm 20\%$ , 1/2W	267823	11236	190PC101B	1	1	
R27	Res, mf, $20k \pm 1\%$ , 1/8W	291872	91637	MFF1-82002F	1		
R28, R29	Res, comp, $39k \pm 5\%$ , 1/4W	188466	01121	CB3935	2		
R30	Res, mf, $11.3k \pm 1\%$ , 1/8W	335414	91637	MFF1-81132F	1		
R31	Res, mf, $80.6k \pm 1\%$ , 1/8W	312710	91637	MFF1-88062F	1		
R33	Res, comp, $180k \pm 5\%$ , 1/4W	193441	01121	CB1845	1		
R34	Res, mf, $3.16k \pm 0.1\%$ , 1/8W	340588	91637	MFF1-83161B	1		
R35	Res, mf, $21.5k \pm 0.1\%$ , 1/8W	344440	91637	MFF1-82152B	1		
R36	Res, mf, $100k \pm 1\%$ , 1/8W	248807	91637	MFF1-81003F	1		
R37	Res, var, cermet, $50k \pm 10\%$ , 1/2W	330688	11236	190PC503B	1	1	
R39	Res, comp, $1.6k \pm 5\%$ , 1/4W	266197	01121	CB1625	1		
R40	Res, var, cermet, $10k \pm 20\%$ , 1/2W	267880	11236	190PC103B	1	1	
R41	Res, ww, $4.091M \pm 0.1\%$ , 2W	412205	89536	412205	1	1	
R44	Res, var, cermet, $500 \pm 20\%$ , 1/2W	267849	11236	190PC501B	1	1	

Table 602-9. MIS-4110 Ohms Converter Assembly (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R45	Res, ww, 272.84k $\pm 0.08\%$ , 1/2W	412197	89536	412197	1	1	
R46	Res, comp, 3.3k $\pm 5\%$ , 1/4W	148056	01121	CB3325	1		
R48, R71	Res, comp, 470 $\pm 5\%$ , 1/4W	147983	01121	CB4715	2		
R50, R51	Res, comp, 2.7k $\pm 5\%$ , 1/4W	170720	01121	CB2725	2		
R54	Res, var, cermet, 200k $\pm 20\%$ , 1/2W	381509	11236	190PC204B	1	1	
R55	Res, mf, 332k $\pm 1\%$ , 1/8W	289504	91637	MFF1-83323F	1		
R56	Res, ww 2.01k $\pm 0.1\%$ , 1/2W	412189	89536	412189	1	1	
R58, R67	Res, comp, 1k $\pm 5\%$ , 1/4W	148023	01121	CB1025	2		
R60	Res, mf, 1M $\pm 1\%$ , 1/8W	268797	91637	MFF1-81004F	1		
R63	Res, mf, 28k $\pm 1\%$ , 1/8W	291835	91637	MFF1-82802F	1		
R64	Res, mf, 21k $\pm 0.5\%$ , 1/8W	229484	91637	MFF1-82102D	1		
R65	Res, mf, 17.8k $\pm 1\%$ , 1/8W	349183	91637	MFF1-81782F	1		
R68	Res, comp, 560k $\pm 5\%$ , 1/4W	220533	01121	CB5645	1		
R69	Res, car, 300 $\pm 5\%$ , 1/4W	441519	80031	CR251-4-5P200 KT	1		
R70	Res, car, 200k $\pm 5\%$ , 1/4W	441485	80031	CR251-4-5P200KT	1		
U1	IC, Dgtl, C-MOS, NAND gates	375147	02735	CD4011AE	1	1	
U2, U3	IC, Dgtl, C-MOS, quad, clocked D latch	355149	02735	CD4042AE	2	1	
U4	IC, lin, opnl ampl	363515	34333	SG301A	1	1	
U5	IC, lin, opnl ampl	418566	12040	LM358N	1	1	
U6, U7	IC Res Network	380618	89536	380618	2	1	
	Case half, module	402990	89536	402990	2		
	Cover Module Case	402974	89536	402974	1		
	Decal, Ohms, Converter	413435	89536	413435	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Socket, component lead	343285	00779	2-331272-6	8		



**NOTES:**

1. FOR SCHEMATIC DIAGRAM SEE MIS - 1110.
  2. FOR PCB DETAIL DWG. SEE MIS - 3110.
  3. FOR ASSEMBLY DWG. SEE MIS - 4110.

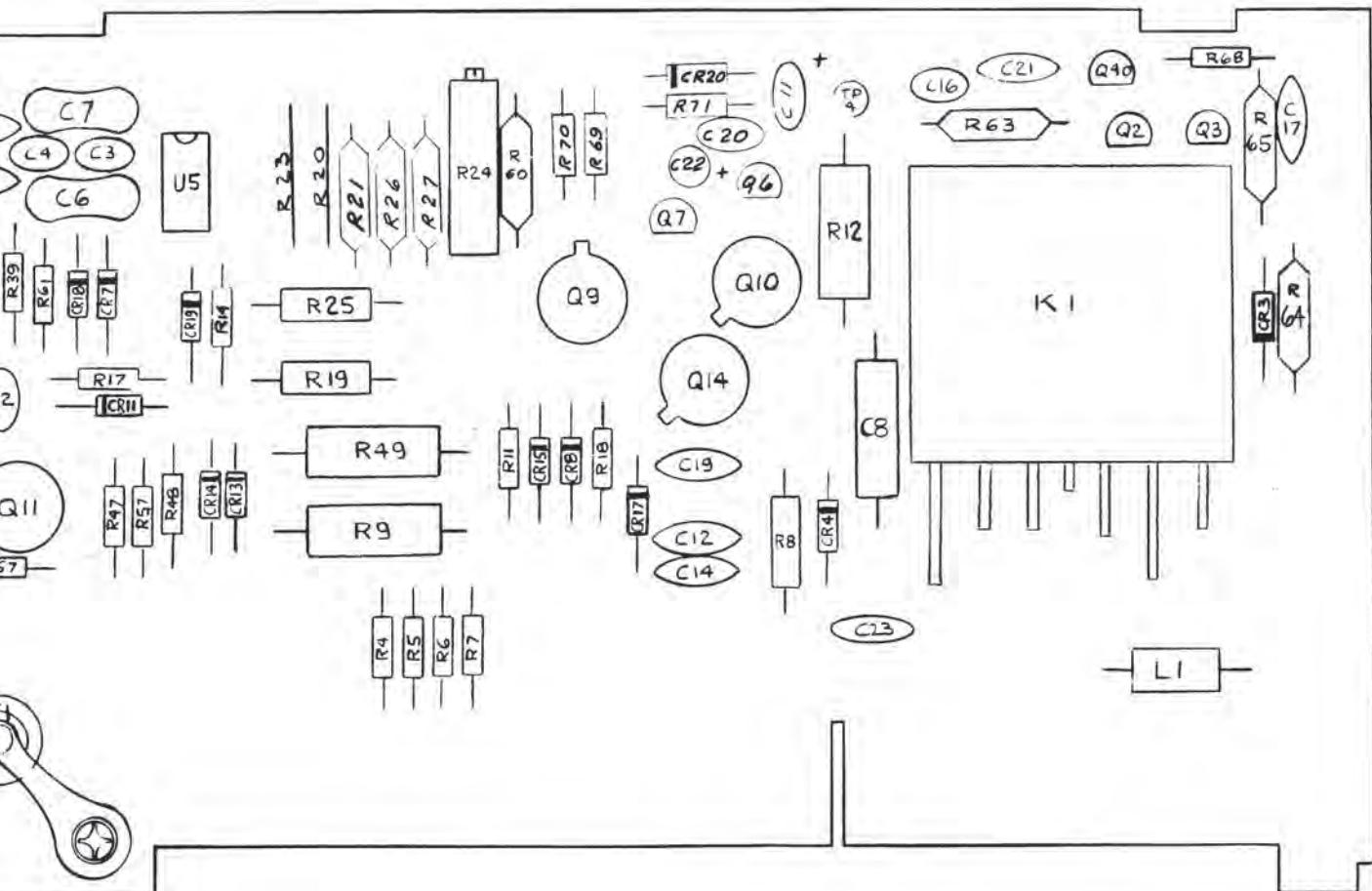
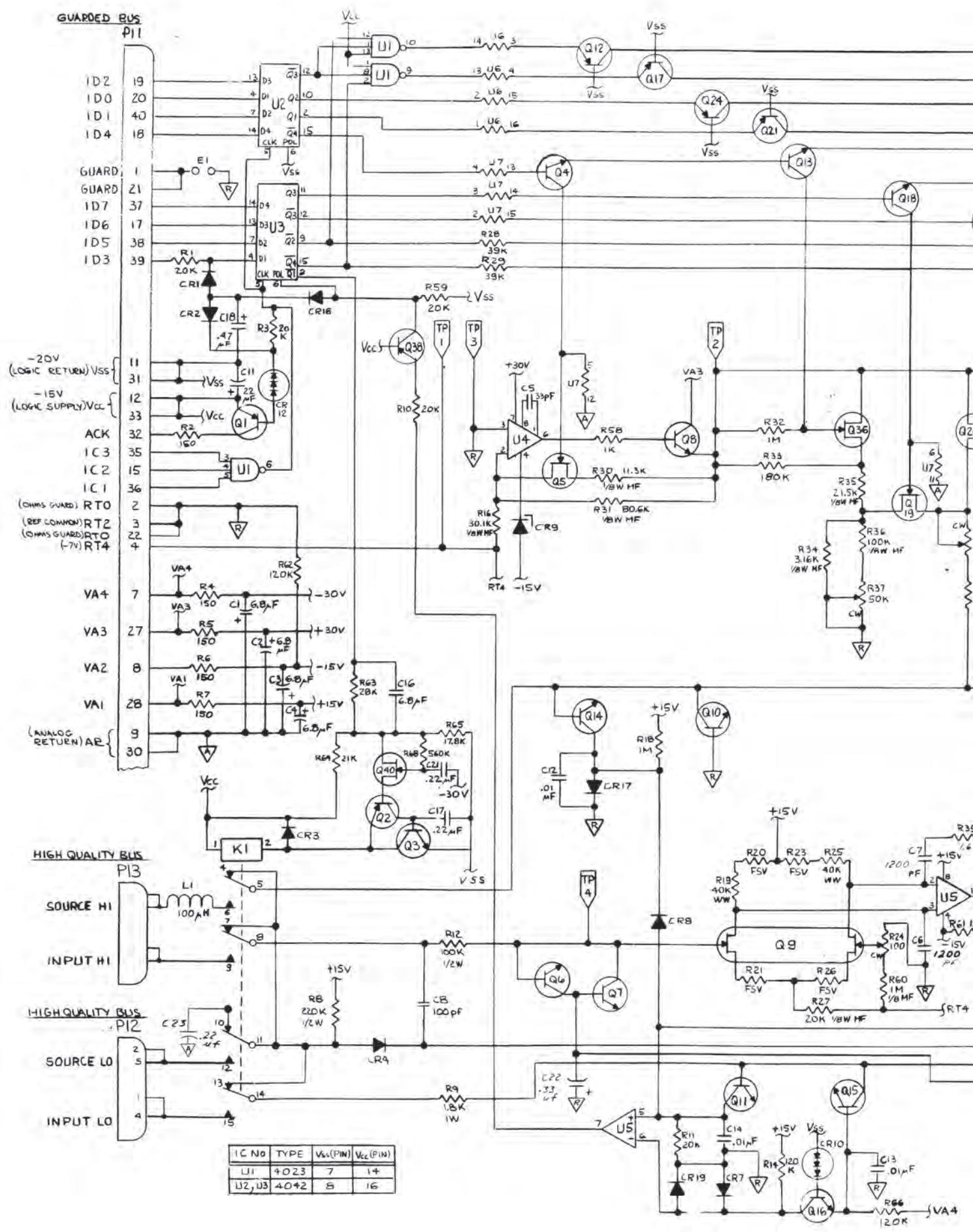
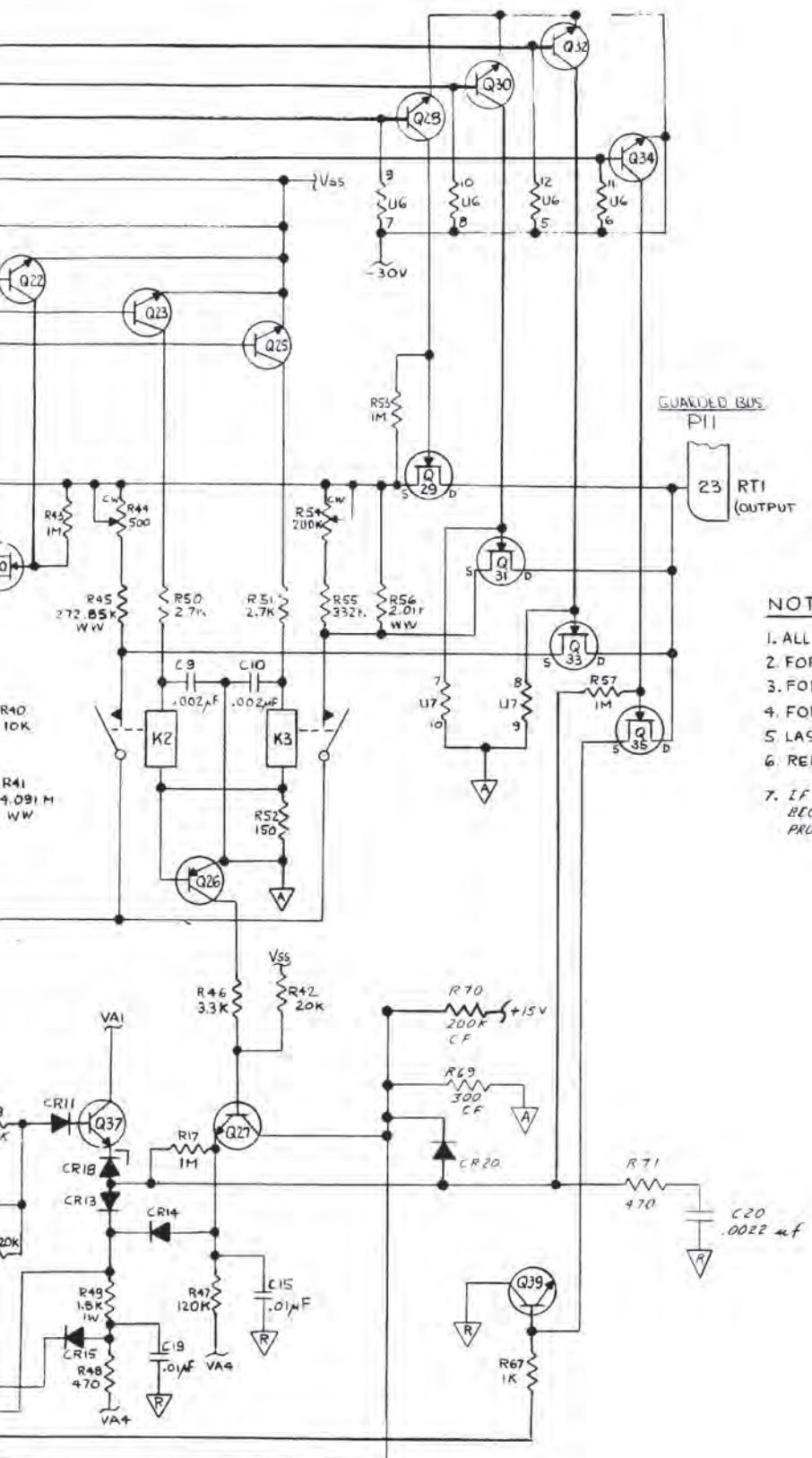


Figure 602-4 Ohms Converter Assembly (MLS-1710)





**NOTES: (UNLESS OTHERWISE SPECIFIED)**

1. ALL RESISTORS 1/4W, CC, AND ALL RESISTANCE IN OHMS.
  2. FOR REF. DESIGNATION DWG SEE MIS - 1710.
  3. FOR PCB DETAIL DWG SEE MIS - 3110.
  4. FOR ASSY. DWG SEE MIS - 4110.
  5. LAST REF. DES NO'S USED: U7, Q40, CR20, K3, E1, R70, C22.
  6. REF. DES. NO'S NOT USED: CRS, CRG, R13, R15, R22, R38.
  7. IF Q19, U5, R19, R20, R21, R23, R25 OR K26 ARE REFERENCED, IT BECOMES NECESSARY TO TEST THE MODULE PER MIS-4110-151 TEST PROCEDURE.

## **Change/Errata Information**

**Issue No:** 1      **8/78**

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual in the order given.

### **MANUAL**

**Title:** OPTION -02 OHMS CONVERTER  
**Print Date:** (8500 Series) (Part Number 469700)  
**Rev and Date:**

### **C/E PAGE EFFECTIVITY**

<b>Page No.</b>	<b>Print Date</b>
1	8/78

## ERRATA #1

In the explanation of two-wire ohms zeroing (paragraph 602-9), add the following sentence immediately prior to "Depress the V DC/OHMS ZERO switch." : "Depress the STORE switch."

Under the CALIBRATION procedure, 602-22, change steps 4, 6 and 9 to read:

- "4. Short the INPUT terminals as illustrated in Figure 602-6. Use the terminal shorting straps (provided with the instrument) or equivalent."
- "6. Select the 10 ohm range on the DMM."
- "9. Remove the shorting straps and make four-wire ohms measurement connections to the INPUT terminals. Select the 1 Mohm range and connect the input leads to a 4 Mohm standard resistor. (Standard resistors are listed in Table 4-1 of the Instruction Manual.)"

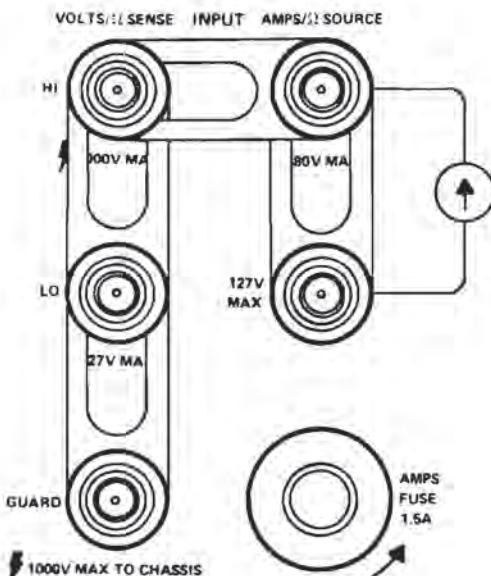


Figure 602-6. Input Terminal Shorting

## ERRATA #2

Under reference designator U1, change Mfg. Part No. from: CD4011AE to: CD4023AE

## CHANGE #1-11322

In Table 602-9 (Parts List), make the following changes:

Under reference designator Q9, change the Fluke Stock No. and the Mfg. Part No. from: 287623 to: 476309.

## Option —03 Current Shunts

### **603-1. INTRODUCTION**

603-2. Installation of the Current Shunts module allows current measurement in five ranges: 100  $\mu$ A, 1mA, 10 mA, 100 mA, and 1 A. Either dc or ac current measurements may be made, but ac measurements require installation of one of the optional ac converters.

### **603-3. SPECIFICATIONS**

603-4. Table 603-1 lists the specifications for the Current Shunts module. Accuracy specifications for the lower current ranges (100  $\mu$ A, 1 mA, and 10 mA) depend on the source resistance of the current to be measured, due to the configuration of the measurement circuit. Source resistances only affect the number of floor digits, which can be determined from the formula given. For source resistances greater than specified, the number of uncertain digits will decrease. For ac currents, source resistance has a similar effect but the formula is much too complex for ordinary use.

### **603-5. INSTALLATION**

603-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the Current Shunts module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

### **603-7. OPERATING NOTES**

603-8. Operation of the front panel switches is the same as described in Section 2 of this manual. Inputs to the Current Shunts module are between Source HI and Source LO. Sense HI and Sense LO may be left connected with the shorting links provided.

### **603-9. THEORY OF OPERATION**

603-10. The function of the Current Shunt module is to generate a voltage proportional to the current to be mea-

sured. Outputs from the Current Shunt module are applied either to the DC Signal Conditioner for dc currents or to an optional ac converter for ac currents.

603-11. Two modes of operation are used in the Current Shunt module, depending on the range selected. Figure 603-1 illustrates the two configurations and contains tables relating resistors, switches, and relays to each range. Mode A is used for the 100  $\mu$ A, 1 mA, and 10 mA ranges. Input currents are applied to the summing node (virtual ground) of an operational amplifier through R4. R4 ensures stability when the current source is highly capacitive, while presenting a very low voltage burden. The formula given for determining floor digits (uncertainty) in the accuracy specifications is based on the feedback resistors used in the three lowest ranges. For source resistances less than approximately  $10 \times R_{FEEDBACK}$ , the gain of the circuit becomes greater than one for error sources such as offset voltages and current noise. Thus the basic uncertainty (digits) of a measurement increases as the source resistance decreases. The output voltage is equal to the input current multiplied by  $R_{FEEDBACK}$ .

603-12. Mode B configures the amplifier as a difference amplifier measuring the voltage across a shunt. The ratio of the feedback resistor, R66, to  $R_I$  sets the gain of the amplifier at approximately 20 [ $R_{66}/R_I = (R_8 + R_{73})/R_6$ ].

603-13. The amplifier consists of a dual FET (Q19), U1, Q1, and Q2. Refer to the schematic. R18 biases Q19 from the -7V reference (from the A/D Converter). R57 and R58 are selected to compensate for offset error (one of them will always be  $10\Omega$ ). R55 and R56 are selected for temperature coefficient compensation. Q1 and Q2 are a complementary pair (for either polarity output) to increase the current output capability of the amplifier.

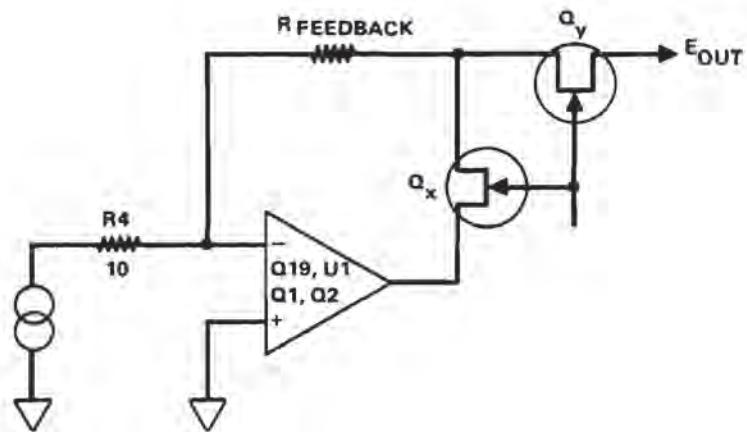
Table 603-1. Current Shunts Specifications

ACCURACY						
(Refer to the specifications table in Section 1 for required environmental conditions)						
DIRECT CURRENT						
RANGE	FULL SCALE	AT SOURCE <sup>1</sup> RES. ( $R_s$ )	ACCURACY $\pm$ (% OF INPUT + NO. OF DIGITS <sup>2</sup> )			
			24 HOURS	90 DAYS	1 YEAR	
100 uA	312 uA	80 k $\Omega$	0.02 + 10	0.03 + 10	0.05 + 10	
1 mA	2.5 mA	10 k $\Omega$	0.02 + 10	0.03 + 10	0.05 + 10	
10 mA	20 mA	1.25 k $\Omega$	0.02 + 10	0.03 + 10	0.05 + 10	
100 mA	160 mA	—	0.03 + 20	0.05 + 20	0.1 + 20	
1 A	1.28A	—	0.03 + 20	0.05 + 20	0.1 + 20	
<sup>1</sup> For Source Resistance less than specified, replace floor digit specification with following: Accuracy: Range + No. of Digits						
100 uA $9(1 + 8k/R_s)$ 1 mA $9(1 + 1k/R_s)$ 10 mA $9(1 + 125/R_s)$						
<sup>2</sup> For high resolution multiply the number of digits by 10.						
ALTERNATING CURRENT						
Range	Full Scale	Frequency	Accuracy $\pm$ (% of Input + No. of Digits) from 0.1% of full scale to full scale:			
			24 Hours		90 Days	
			Average Current	True RMS Current	Average Current	True RMS Current
100 uA*	312.5 uA	10 Hz–20 Hz	—	0.7 + 110	—	1.0 + 110
		20 Hz–50 Hz	0.55 + 9	0.55 + 35	0.8 + 9	0.8 + 35
		50 Hz–10 kHz	0.3 + 9	0.28 + 35	0.4 + 9	0.4 + 35
		10 kHz–20 kHz	0.5 + 9	0.7 + 110	0.7 + 9	1.0 + 110
		20 kHz–50 kHz	1.0 + 9	1.0 + 260	1.5 + 9	1.5 + 260
		50 kHz–100 kHz	2.0 + 9	2.8 + 760	3.0 + 9	4.0 + 760
1 mA* and 10 mA*	2.5 mA 20 mA	10 Hz–20 Hz	—	0.7 + 110	—	1.0 + 110
		20 Hz–50 Hz	0.35 + 9	0.35 + 35	0.5 + 9	0.5 + 35
		50 Hz–10 kHz	0.05 + 9	0.08 + 35	0.06 + 9	0.11 + 35
		10 kHz–20 kHz	0.08 + 9	0.14 + 110	0.11 + 9	0.2 + 110
		20 kHz–50 kHz	0.08 + 9	0.2 + 260	0.12 + 9	0.3 + 260
		50 kHz–100 kHz	0.35 + 9	0.7 + 760	0.51 + 9	1.0 + 760
100 mA	160 mA	10 Hz–20 Hz	—	0.7 + 150	—	1.0 + 150
		20 Hz–50 Hz	0.34 + 55	0.35 + 80	0.5 + 55	0.5 + 80
		50 Hz–10 kHz	—	0.18 + 80	—	0.26 + 80
		50 Hz–100 kHz	0.16 + 55	—	0.24 + 55	—
1A	1.28A	10 Hz–20 Hz	—	0.7 + 150	—	1.0 + 160
		20 Hz–50 Hz	0.34 + 65	0.35 + 90	0.5 + 65	0.5 + 90
		50 Hz–10 kHz	0.16 + 65	0.18 + 90	0.24 + 65	0.26 + 90

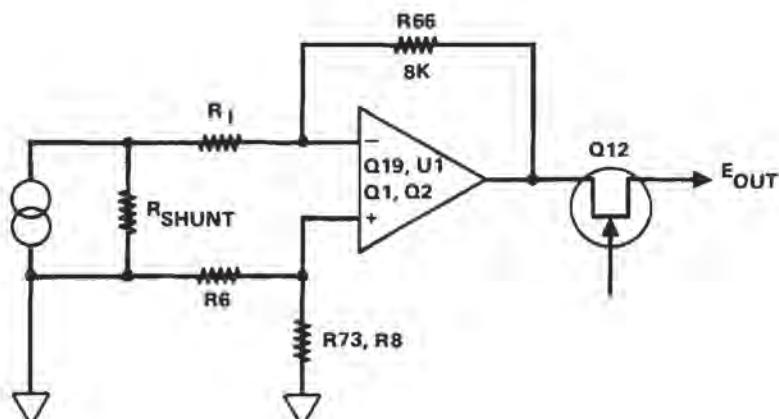
\*Minimum Source Resistance, same as for Direct Current.

Table 603-1. Current Shunts Specifications (Continued)

OPERATING CHARACTERISTICS						
DIRECT CURRENT						
Range	Full Scale	At Source 1 Res. ( $R_s$ )	Temperature 2 Coefficient			
			Voltage Burden	$\pm (\text{ppm}/\text{rdg} + \text{No. of Digits})/\text{C}^3$		
100 $\mu\text{A}$	312 $\mu\text{A}$	80 $\text{k}\Omega$	$\leq 100 \text{ mV}$	25 + 0.6		
1 mA	2.5 mA	10 $\text{k}\Omega$	$\leq 100 \text{ mV}$	25 + 0.6		
10 mA	20 mA	1.25 $\text{k}\Omega$	$\leq 200 \text{ mV}$	25 + 0.6		
100 mA	160 mA	—	$\leq 200 \text{ mV}$	35 + 0.6		
1A	1.28A	—	$\leq 500 \text{ mV}$	35 + 0.6		
<sup>1</sup> For Source Resistance less than specified, replace Temperature Coefficient with the following:			<sup>2</sup> 0°C to 18°C and 28°C to 50°C.			
			<sup>3</sup> For high resolution multiply No. of digits by 10.			
Temperature Coefficient:		Range	+ No. of Digits/ $^\circ\text{C}$			
		100 $\mu\text{A}$	0.5 (1 + 8k/ $R_s$ )			
		1 mA	0.5 (1 + 1k/ $R_s$ )			
		10 mA	0.5 (1 + 125/ $R_s$ )			
OVERLOAD			PROTECTION			
1.5A maximum, $\pm 140\text{V}$ dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.			1-1/2A fuse			
SETTLING & DIGITIZING TIME						
Same as dc volts						
ALTERNATING CURRENT						
TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)			VOLTAGE BURDEN			
			Same as dc current			
RANGE	TEMPERATURE COEFFICIENT		OVERLOAD			
	RMS AC	Avg. AC	1.5A maximum current (1-1/2A fuse protected) $\pm 140\text{V}$ dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.			
100 $\mu\text{A}^*$	(50 ppm + 3.5 digits/ $^\circ\text{C}$ )	(40 ppm + 1.5 digits/ $^\circ\text{C}$ )	<b>CREST FACTOR (RMS only)</b> $\leq 4.5$ full scale, increasing down scale by: $4.5 \sqrt{\frac{I_{\text{Range}}}{I_{\text{Input}}}}$			
1 mA*	(50 ppm + 3.5 digits/ $^\circ\text{C}$ )	(40 ppm + 1.5 digits/ $^\circ\text{C}$ )				
10 mA*	(50 ppm + 3 digits/ $^\circ\text{C}$ )	(40 ppm + 1 digit/ $^\circ\text{C}$ )				
100 mA	(50 ppm + 9 digits/ $^\circ\text{C}$ )	(40 ppm + 7 digits/ $^\circ\text{C}$ )				
1A	(50 ppm + 9 digits/ $^\circ\text{C}$ )	(40 ppm + 7 digits/ $^\circ\text{C}$ )				

MODE A – 100  $\mu$ A, 1 mA, 10 mA

RANGE	R <sub>FEEDBACK</sub>	Q <sub>X</sub>	Q <sub>Y</sub>	RELAYS	FULL SCALE E <sub>OUT</sub>
100 $\mu$ A	R <sub>30</sub> , R <sub>31</sub>	Q <sub>30</sub>	Q <sub>31</sub>	K <sub>3</sub> , K <sub>4</sub>	.8 V
1 mA	R <sub>33</sub> , R <sub>34</sub>	Q <sub>7</sub>	Q <sub>10</sub>	K <sub>3</sub> , K <sub>4</sub>	1.0 V
10 mA	R <sub>36</sub> , R <sub>37</sub>	Q <sub>9</sub>	Q <sub>8</sub>	K <sub>3</sub> , K <sub>4</sub>	1.25 V



MODE B 100 mA, 1A

RANGE	R <sub>SHUNT</sub>	R <sub>1</sub>	RELAYS	FET SWITCHES	FULL SCALE E <sub>OUT</sub>
100 mA	R <sub>2</sub> , R <sub>1</sub>	R <sub>7</sub> , R <sub>70</sub> , R <sub>71</sub>	K <sub>1</sub> , K <sub>3</sub>	Q <sub>20</sub> , Q <sub>32</sub> , Q <sub>29</sub> , Q <sub>12</sub>	1.6V
1 A	R <sub>1</sub>	R <sub>7</sub> , R <sub>68</sub> , R <sub>69</sub>	K <sub>2</sub> , K <sub>3</sub>	Q <sub>20</sub> , Q <sub>29</sub> , Q <sub>28</sub> , Q <sub>12</sub>	2.0V

Q<sub>11</sub> and either Q<sub>3</sub> or Q<sub>4</sub> will be conducting in all ranges

Figure 603-1. Current Shunt Configurations And Range Information

603-14. Q11 and relay K3 are always closed for current measurements. Q3 and Q4 control the ground reference selection for the amplifier. In the dc mode, Q3 connects the noninverting input of the amplifier to reference common. In the ac mode the amplifier is referenced to the ac module ground (RT3) through Q4.

603-15. The Current Shunts module is addressed by IC0, 1, 3 high. At the first address, an ACK is returned and K5 is energized to sample the input voltage. If the voltage exceeds  $\pm 45V$ , one section of U6 will have a high output, depending on the input polarity. The output from U6 is stored on C10. At the next address the voltage on C10 will prevent the return of the ACK response and will prevent control data from being latched into U2. An Error 4 will be displayed. In addition to overvoltage protection provided by U6, overcurrent protection is provided by CR9 and CR10 in the  $100 \mu A$ ,  $1 mA$ , and  $10 mA$  ranges, and by CR5 and CR6 in the  $100 mA$  and  $1 A$  ranges. A fuse in series with the Source HI terminal is located on the front panel for additional overcurrent protection.

603-16. At the second address, if the input voltage did not exceed  $\pm 45V$ , termination of the address clocks range and reference control data into U2. Since relay common is Vcc, relay drivers must go low to energize a relay. FET switch drivers are configured to use a low from U2 to turn on the FET (close the switch) by turning off the gate control transistor.

## 603-17. MAINTENANCE

### 603-18. Performance Test

603-19. Test the direct current function by using the following procedure.

1. Select ADC and AUTO.
2. Connect the direct current source output HI to the instrument SOURCE HI and output LO to SOURCE LO.
3. Using Table 603-2, sequentially apply the inputs shown, manually selecting the range after the first reading. The instrument must read within the limits specified.

Table 603-2. Performance Test

Range	DC Input	Reading	
		Low (exp.)	High (exp.)
100 $\mu A$	10 $\mu A$	9.987 (-6)	10.013 (-6)
100 $\mu A$	100 $\mu A$	99.960 (-6)	100.040 (-6)
100 $\mu A$	250 $\mu A$	249.915 (-6)	250.085 (-6)
1 mA	0.1 mA	0.09987 (-3)	0.10013 (-3)
1 mA	1.0 mA	0.99960 (-3)	1.00040 (-3)
1 mA	2.0 mA	1.99930 (-3)	2.00070 (-3)
10 mA	1.0 mA	0.9996 (-3)	1.0004 (-3)
10 mA	10 mA	9.9960 (-3)	10.0040 (-3)
10 mA	15 mA	14.9945 (-3)	15.0055 (-3)
100 mA	10 mA	9.930 (-3)	10.070 (-3)
100 mA	100 mA	99.930 (-3)	100.070 (-3)
100 mA	150 mA	149.905 (-3)	150.095 (-3)
1A	0.1A	0.09975	0.10025
1A	1A	0.99930	1.00070

### 603-20. Calibration

603-21. Before calibrating any part of the instrument, the Calibration Memory module should be removed if installed. Apply power and allow a one hour warm-up period. All adjustments are on the Current Shunts module. DC calibration should be performed before calibrating current. Use the following procedure to calibrate the Current Shunts module.

1. Verify that the instrument is in the 1A range and the Cal mode (CAL indicator illuminated).
2. Connect the test DVM HI input lead to TP3 and the LO input to TP1.
3. The test DVM must read less than 200 mV.
4. Remove the test DVM.
5. Select the 100 mA range on the instrument.
6. Adjust R17 for a reading between -0.000-1 and +0.000-1 ( $0.000 \pm 1$  cal digit).
7. Set the current source controls for an output of 20.0000V dc.
8. Connect the instrument HI input to the current source HI output inserting a  $200 k\Omega \pm 0.01\%$  resistor in series with the instrument HI input lead. Connect the LO input terminal to the current source LO output.
9. Select the 100  $\mu A$  range on the instrument and adjust R31 for a reading between +99.999 and +100.001.
10. Disconnect the instrument HI input lead from the current source, remove the inserted resistor and reconnect the HI input lead.
11. Select a current source output of +1.00000 mA.
12. Adjust R34 for a reading between +0.99999-0 and +1.00001-0.
13. Select a current source output of 10.0000 mA.
14. Adjust R37 for a reading between +9.9999-0 and +10.0001-0.
15. Select a current source output of 100.000 mA.
16. Adjust R4 for a reading between +99.999-0 and +100.001-0.
17. Select a current source output of 1.00000A.
18. Adjust R7 for a reading between +0.99999-0 and +1.00001-0.
19. Select the VDC function and Autorange on the instrument.

20. Select a 50V dc output from the current source.
21. Select the ADC function on the instrument.
22. ERROR 4 is displayed to show excessive voltage in the current function.

### 603-22. Troubleshooting.

603-23. Troubleshooting procedures for the Current Shunts module follow the format used for the mainframe instrument. Table 603-3 assures that the problem is in the

Current Shunts module. Figure 603-2, Symptom Analysis, lists symptoms and possible failures in the order of probability. Table 603-4 contains address and data information used to set up the module.

603-24. Always remove power before removing or installing modules.

### 603-25. PARTS LIST

603-26. Table 603-5 is a parts breakdown for the Current Shunts module. Refer to Section 5 of this manual for ordering and use code information.

Table 603-3. Current Shunts Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC within tolerance?	2	Section 4
2	Perform Current test. Is Current within tolerance?		3
3	Remove all optional modules except Isolator and Current Shunts. Is Current now within tolerance?	4	5
4	Replace modules one at a time, testing Current between modules. Last one in when Current goes bad is faulty. Go to appropriate subsection of Section 6.		
5	Remove Isolator. Install Interconnect/Monitor pcb. Is Current within tolerance?	6	7
6	Bad Isolator. Go to subsection 608.		
7	Bad Current Shunts module. Go to figure 603-2.		

Figure 603-2. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
Zero noisy or out of tolerance	Q21, Q20, Q29, U1, Q3, Q4, leaky output FETS
No zero reading	K3, K4, Q19, U1, Q1, Q2
Always zero	K3 or Q11 open
100 $\mu$ A, 1 mA, 10 mA ranges bad, others OK	K4 open, Q29, Q20, leaky protection diodes
100 mA, 1 A ranges bad, others OK	Q20, Q29, leaky protection diodes, Q12
High random – full-scale readings	Q19, U1, Q1, Q2
No display	U5, U2
No ACK – Error 9 or Error 4	Voltage limit circuit, U6 or leaky diode (CR14, CR15), U5, Q18
Only 100 $\mu$ A range bad	Q30, Q31, Digital Control
Only 1 mA range bad	Q7, Q10, Digital Control
Only 10 mA range bad	Q8, Q9, Digital Control
Only 100 mA range bad	K2, Q32, Digital Control
Only 1 A range bad	K2, Q28, Digital Control
<b>Q19 DC Readings with Zero Input</b>	
Drains ( $10\Omega$ resistors) $\approx$ -0.6 V dc	
Sources ( $40\text{ k}\Omega$ resistors) $\approx$ 8.0 V dc	
U1 pin 6 $\approx$ 0 V dc	
<b>Differences between ADC and AAC</b>	
1. AC/DC Reference (ground)	
2. Frequency response in AAC	
3. RT1 outputs are applied to DC Signal Conditioner for DC and to optional AC module for AC (DC Signal Conditioner bypassed)	
If Q19, R15, R16, R55, or R56 are replaced, it is necessary to return the module to the factory (attn: PARTS) for temperature compensation.	

Table 603-4. Address and Data Field

Address – 1C0, 1, 3 High						
	ID0	ID1	ID2	ID3	ID4	ID5
Current LO Input (K3) and Output FET (Q11)	X	X	X	0	X	X
DC Reference (Q3)	0	X	X	0	X	X
AC Reference (Q4)	1	X	X	0	X	X
100 $\mu$ A Range	X	1	1	0	1	1
1 mA Range	X	1	1	0	0	
10 mA Range	X	1	1	0	1	0
100 mA Range	X	1	0	0	1	1
1A Range	X	0	1	0	1	1
Voltage Check	0	0	0	0	0	0
Reset	1	1	1	1	1	1

Table 603-5 Current Shunts Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
(X)	CURRENT SHUNTS ASSEMBLY Figure: 603-3						
C1, C2	Cap, Ta, 0.47 uF ±20%, 35V	161349	56289	196D474X0035 HA1	2		
C3	Cap, mica, 47 pF ±1%, 500V	284802	72136	DM15E470F	1		
C4	Cap, mica, 150 pF ±5%, 500V	148478	72136	DM15F151J	1		
C5, C6	Cap, mica, 100 pF ±5%, 500V	148494	72136	DM15F101J	2		
C7	Cap, cer, 1200 pF ±20%, 100V	358283	80031	2222-630-01-122	1		
C8, C9	Cap, mica, 39 pF ±5%, 500V	148544	72136	DM15E390J	2		
C10	Cap, Ta, 4.7 uF ±20%, 25V	161943	56289	196D475X0025 KA1	1		
C11	Cap, Ta, 220 uF ±20%, 6V	408682	56289	196D227X0006 TE4	1		
CR1, CR2, CR3, CR4, CR11, CR12, CR14 thru CR21	Diode, Hi-speed Switching	203323	07910	1N4448	14	4	
CR5 thru CR10	Diode, Si, Rect	347559	05277	1N5400	6	2	
CR22	Diode, zener	325803	07910	TD333408	1	1	
K1 thru K5	Coil, reed relay	269019	71707	U-6-P	5		
	Switch, wet mercury reed (use with K1-K4)	335737	95348	WR-126-26	4		
	Switch, dry reed	284091	95348	MR-138 MOD	1		
Q1, Q5, Q6, Q13 thru Q16, Q21, Q22, Q23, Q25, Q26, Q27	Xstr, Si, NPN	218396	04713	2N3904	13	3	
Q2, Q17, Q33	Xstr, Si, PNP	195974	04713	2N3906	3	1	

Table 603-5. Current Shunts Assembly (Continued)

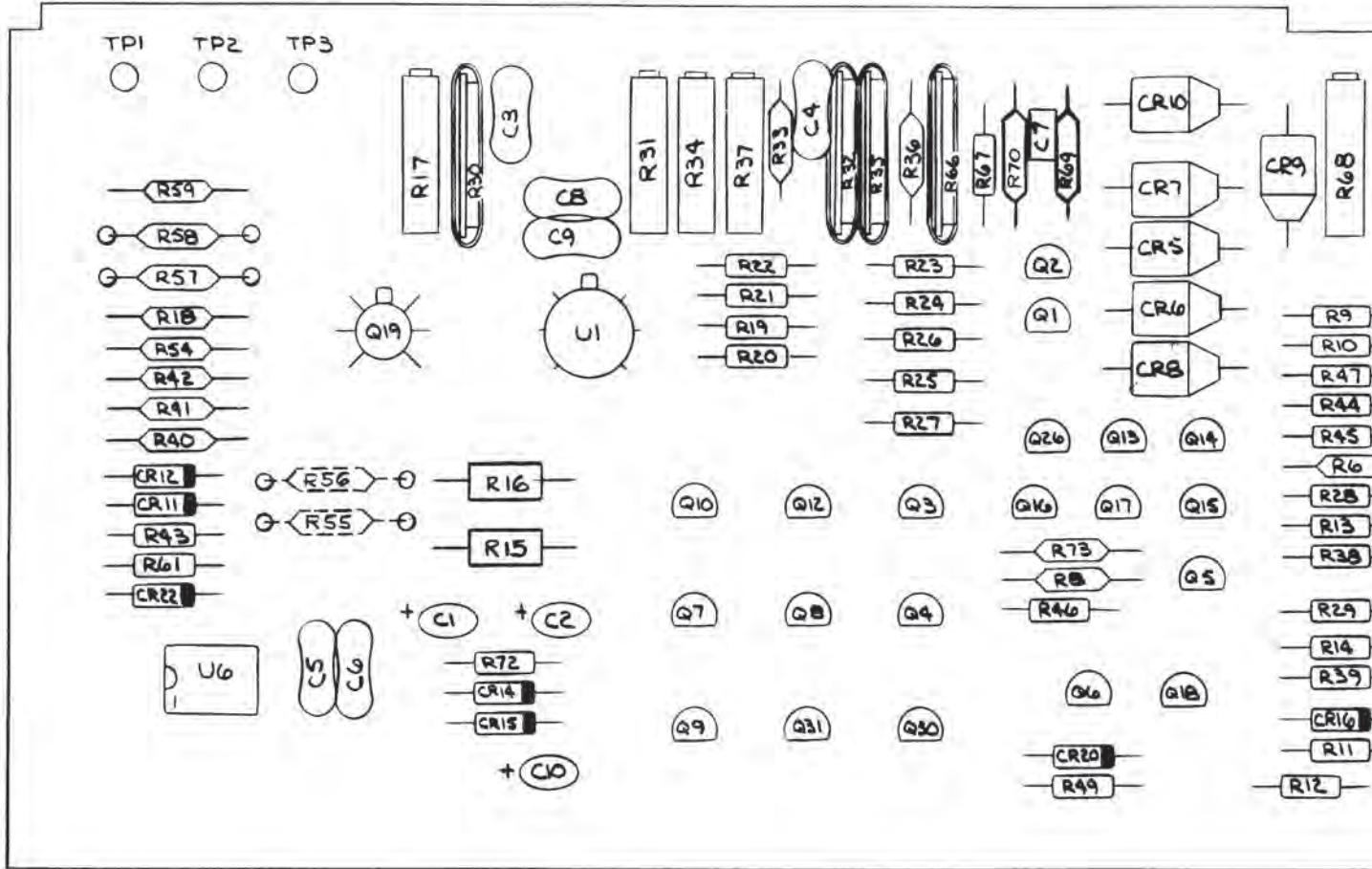
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q3, Q4, Q7 thru Q10, Q12, Q20, Q28 thru Q32	Xstr, FET, N-channel	261578	89536	261578	13	3	
Q11	Xstr, FET N-channel	393314	89536	393314	1	1	
Q18	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
Q19	Xstr, FET, dual, N-channel (selected)	267963	89536	267963	1	1	
R1	Res, ww, 0.1 $\pm$ 0.05%, 1/2W	374611	89536	374611	1	1	
R2	Res, ww, 0.7 $\pm$ 0.1%, 1/4W	440404	89536	440404	1	1	
R3, R5, R9 thru R13, R25 thru R29, R44, R46, R47, R53, R62 thru R65, R67, R72	Res, comp, 100k $\pm$ 5%, 1/4W	148189	01121	CB1045	23		
R4, R57, R58, R59	Res, mf, 10 $\pm$ 1%, 1/8W	268789	91637	MFF1-8A100F	4		
R6	Res, mf, 383 $\pm$ 1%, 1/8W	375899	91637	MFF1-83830F	1		
R7	Res, ww, 419 $\pm$ 0.1%, 2W	440883	89536	440883	1	1	
R8	Res, mf, 7.87k $\pm$ 1%, 1/8W	294934	91637	MFF1-87871F	1		
R15, R16	Res, ww, 40k $\pm$ 0.1%	271403	89536	271403	2	1	
R17	Res, var, cermet, 10 $\pm$ 20%, 1/2W	344135	75378	190PC100B	1	1	
R18	Res, mf, 19.1k $\pm$ 1%, 1/8W	234963	91637	MFF1-81912F	1		
R19, R21	Res, comp, 1k $\pm$ 5%, 1/4W	148023	01121	CB1025	2		
R20, R22	Res, comp, 18k $\pm$ 5%, 1/4W	148122	01121	CB1835	2		
R23, R24	Res, comp, 39 $\pm$ 5%, 1/4W	193391	01121	CB3905	2		
R30, R66	Res, ww, 7975	440909	89536	440909	2	1	
R31	Res, var, cermet, 50 $\pm$ 20%, 1/2W	267815	75378	190PC500B	1	1	
R32	Res, ww, 1020 $\pm$ 0.05%, 0.2W	440891	89536	440891	1	1	

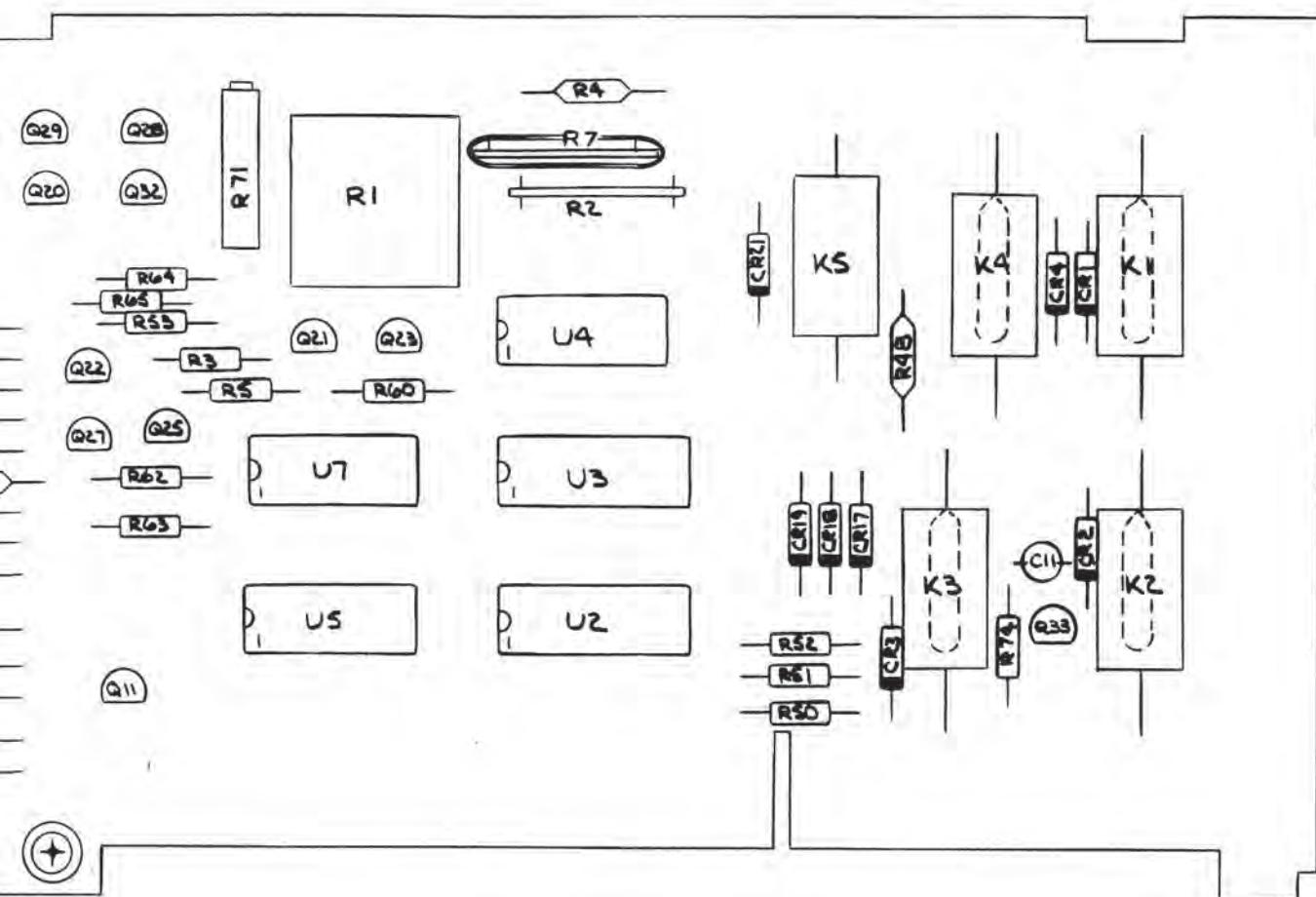
Table 603-5. Current Shunts Assembly (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R33	Res, mf, 47.5k $\pm$ 1%, 1/8W	289546	91637	MFF1-84752F	1		
R34	Res, var, cermet, 10k $\pm$ 20%, 1/2W	267880	75378	190PC103B	1	1	
R35	Res, ww, 128 $\pm$ 0.05%, 0.2W	440875	89536	440875	1	1	
R36	Res, mf, 4.99k $\pm$ 1%, 1/8W	168252	91637	MFF1-84991F	1		
R37	Res, var, cermet, 1k $\pm$ 20%, 1/2W	267856	75378	190PC102B	1	1	
R38	Res, comp, 150 $\pm$ 55, 1/4W	147934	01121	CB1515	1		
R39, R49 thru R52	Res, comp, 20k $\pm$ 5%, 1/4W	221614	01121	CB2035	5		
R40	Res, mf, 49.9k $\pm$ 1%, 1/8W	268821	91637	MFF1-84992F	1		
R41, R42	Res, mf, 100k $\pm$ 0.5%, 1/8W	291054	91637	MFF1-81003D	2		
R43, R61	Res, comp, 10M $\pm$ 10%, 1/2W	108142	01121	EB1061	2		
R45	Res, comp, 47k $\pm$ 5%, 1/4W	148163	01121	CB4735	2		
R48	Res, mf, 150k $\pm$ 1%, 1/8W	241083	91637	MFF1-81503F	1		
R54	Res, mf, 13k $\pm$ 1%, 1/8W	335539	91637	MFF1-81302F	1		
R55, R56	Res, selected				2		
R60	Res, comp, 5.6k $\pm$ 5%, 1/4W	148080	01121	CB5625	1		
R68, R71	Res, var, cermet, 5k $\pm$ 20%, 1/2W	267872	75378	190PC502B	2	1	
R69	Res, mf, 12.4k $\pm$ 1%, 1/8W	261644	91637	MFF1-81242F	1		
R70	Res, mf, 13.3k $\pm$ 1%, 1/8W	296566	91637	MFF1-81332F	1		
R73	Res, mf, 100 $\pm$ 1%, 1/8W	168195	91637	MFF1-81000F	1		
R74	Res, comp, 6.8k 5%, 1/4W	148098	01121	CB6825	1		
U1	IC, Lin, Op-Amp	329912	12040	LM318H	1	1	
U2	IC, Dgtl, C-MOS, hex, "D", flip-flop	404509	12040	MM74C174N	1	1	
U3	IC, Dgtl, C-MOS, hex, inverter/buffer	381848	02735	CD4049AE	1	1	
U4	IC, TTL, hex inverter, buffer/driver	327775	01295	SN7416J	1	1	
U5	IC, Dgtl, C-MOS, triple, 3-input NAND gates	375147	02735	CD4023Ae	1	1	
U6	IC, Lin, Op-Amp, dual	418566	12040	LM358N	1	1	
U7	IC, Dgtl, COS/MOS, quad, 2-input NOR gates	355172	02735	CD4001AE	1	1	

Table 603-5. Current Shunts Assembly (Concluded)

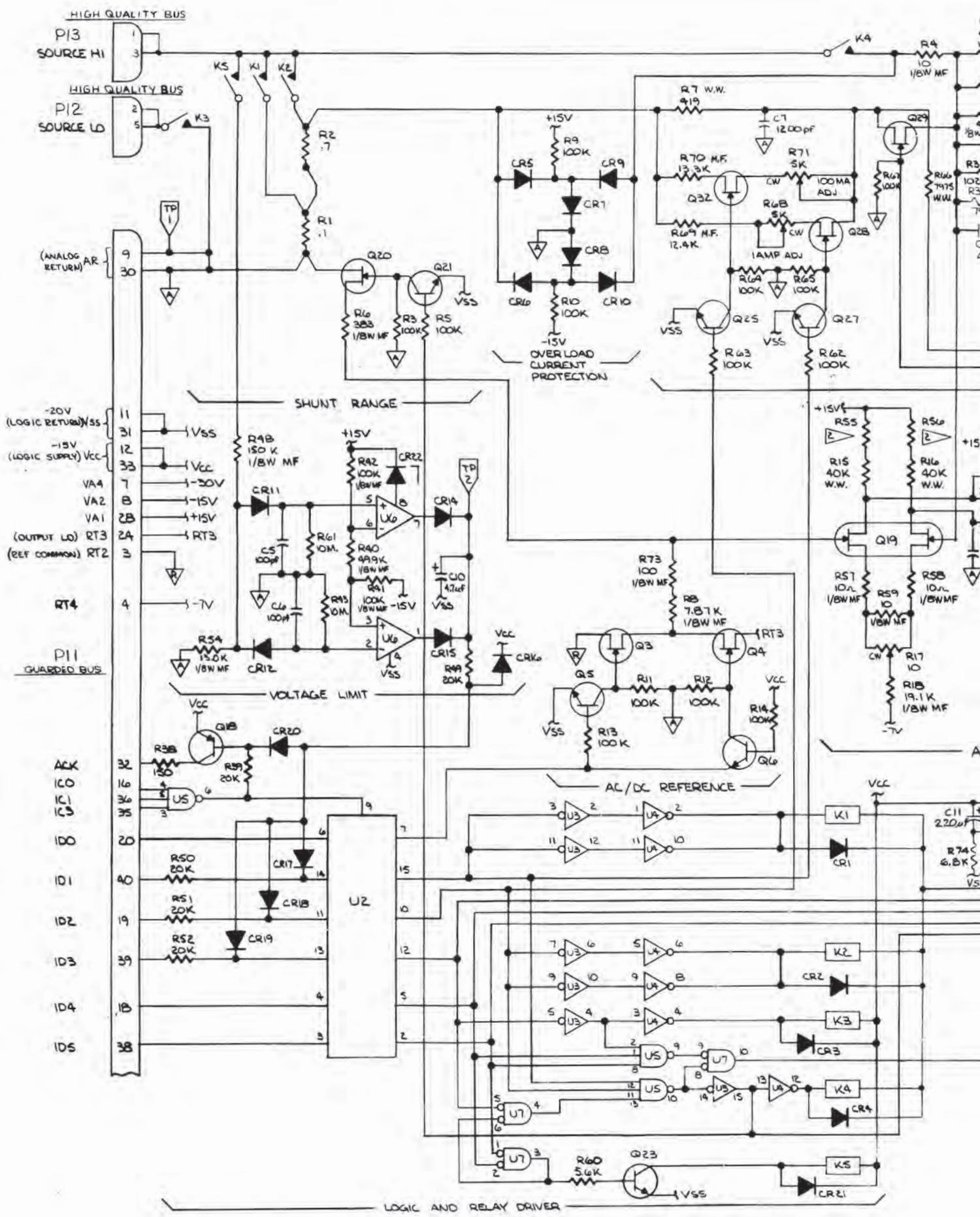
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Casehalf, Module	402990	89536	402990	2		
	Cover, Module half	402974	89536	402974	1		
	Decal, Current Shunt	413419	89536	413419	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Shield, cover	412015	89536	412015	1		
	Socket, spring type	343285	00779	2-331272-6	8		
	Spacer PCB component (use with R7, R30, R32; R35, R66)	296319	32559	T0-8-06	10		

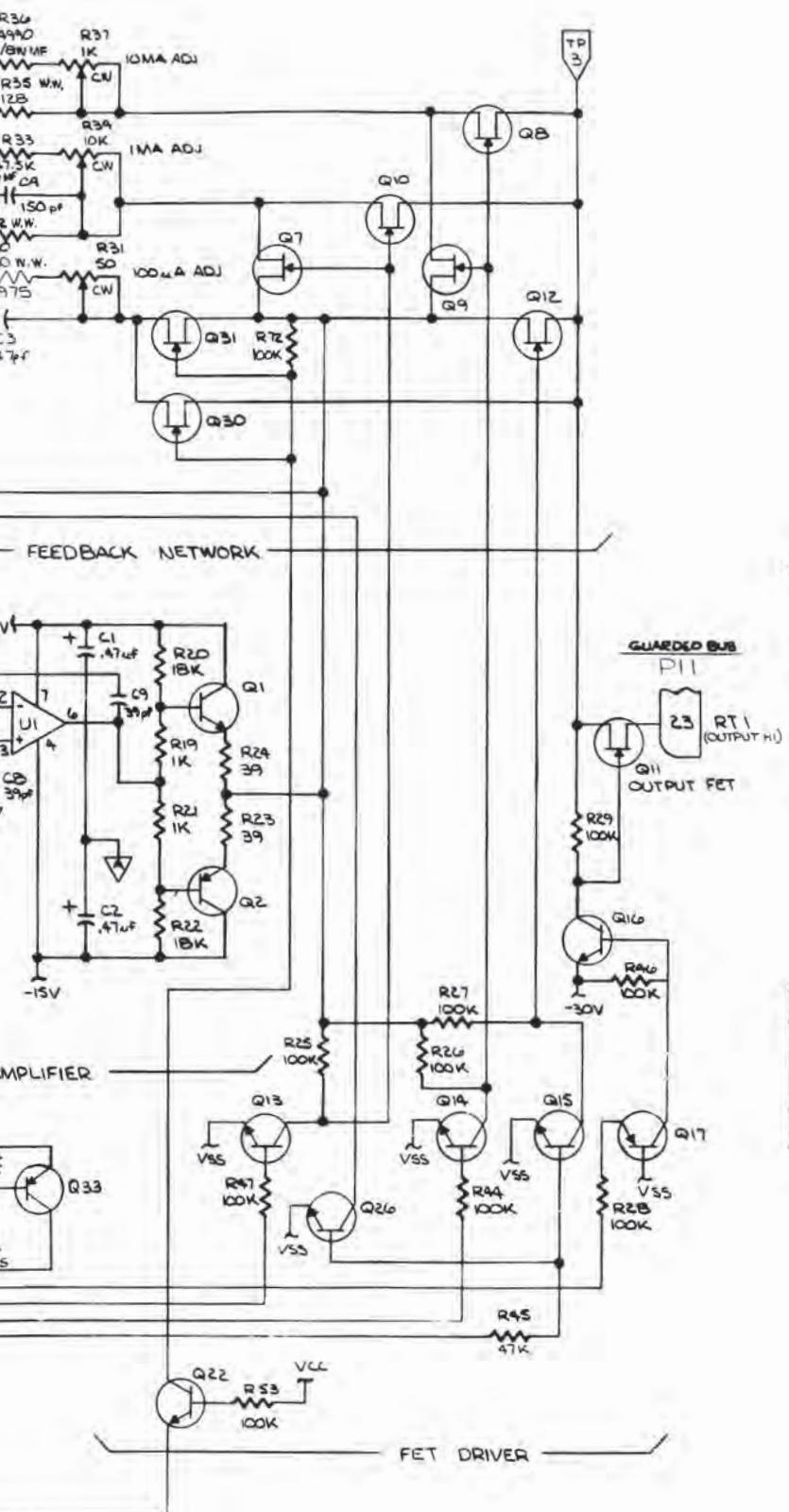


NOTES:

1. FOR SCHEMATIC DIAGRAM SEE MIS-1104.
2. FOR PCB DRAWING SEE MIS-3104.
3. FOR ASSY DRAWING SEE MIS-4104.
4. R55 & R56 WILL BE DETERMINED DURING TEST.  
RESISTORS MAY BE INSTALLED.
5. R7, R30, R33, R35 & R66 ARE SLEEVED

Figure 603-3. Current Shunt Assembly (M.I.S.1704)





NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCE IS IN OHMS AND  
ALL RESISTORS 1/4W C.C.

2. SELECT AT TEST

3. LAST REF. DES. NO.'S USED  
R74, C11, CR22, Q33, U7, KS

4. REF. DES. NO.'S NOT USED  
Q24, CR13, R49

5. FOR REF. DES. DRAWING SEE M.I.S.-170A

6. FOR PCB DETAIL DRAWING SEE M.I.S.-310A.

7. FOR PCB ASSY DRAWING SEE M.I.S.-410A.

8. IF B19, R15, R16, R55 OR R56 ARE REPLACED,  
IT BECOMES NECESSARY TO TUNE THE MOONIE  
PER M.I.S.-104-151 TES PROCEDURE.

I.C. NO.	TYPE	VSS	VCC
U1	UM31B		
U2	74C174	B	16, 1
U3	4049	B	1
U4	74160	T	14
U5	4023	T	14
U6	UM35B		
U7	4001	T	14, 13, 12

## Option -05 IEEE-488 Interface

### **605-1. INTRODUCTION**

605-2. This manual will specifically describe the IEEE Interface (Option -05); refer to the IEEE standard for general IEEE-488 bus interface information. Descriptions unique to the IEEE Interface will be presented separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Refer also to Fluke Application Bulletins 25 and 36, and the IEEE Standard 488-1975 Digital Interface for Programmable Instrumentation.

### **605-3. SPECIFICATIONS**

605-4. Specifications for the IEEE 488-1975 Standard Interface, Option -05, conform to those established in the IEEE Standard Digital Interface for Programmable Instrumentation as published by the Institute of Electrical and Electronics Engineers; 345 E. 47th Street, New York, N.Y. 10017. For an explanation of the IEEE 488-1975 Standard, refer to the Standard Document.

### **605-5. INSTALLATION**

605-6. The IEEE-488 Interface is easily installed as a module in the 8500 Series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.
2. Remove the DMM's top cover.
3. The Interface module fits in the rear slot, bus connector and addresss switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

#### *NOTE*

*Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.*

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.

5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

#### *NOTE*

*Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.*

6. Connect the Interface to the IEEE-488 Bus. Attach a standard 24-pin cable to the bus connector accessed through the DMM's rear panel. Standard cables, listed in Table 605-1, are available from John Fluke Mfg. Co., Inc.

7. Optionally, connect the cable shield to chassis ground. The shield, pin 12 in the connector, is accessed from the rear panel via a banana jack. Chassis ground is available at a binding post on the DMM's rear panel.

8. Set the Interface address switches (A1-A5) as required. Controls and connections accessed through the rear panel are illustrated in Figure 605-1. Refer to Table 605-2 for permissible address settings. Depressing a switch to the bottom sets the associated address bit true (true = 1). TALK address bits T1 through T5 are equal to LISTEN address bits L1 through L5.

**NOTE**

*If the other devices in the system are listeners only, the DMM may be placed in TALK ONLY mode by toggling the TALK/ADDRESSABLE switch; access to this switch is through the rear panel.*

9. Replace the DMM's top cover.

10. Energize the DMM.

11. Remote operation can be entered by transmitting any character that the DMM will recognize from the remote controlling terminal. When remote operation is entered, use of DMM front panel switches (other than RESET or POWER) will be ignored.

Table 605-1. IEEE-488 Standard Cables

ORDER NUMBER	DESCRIPTION
Y8001	IEEE-488 Cable, 1 meter
Y8002	IEEE-488 Cable, 2 meters
Y8003	IEEE-488 Cable, 4 meters

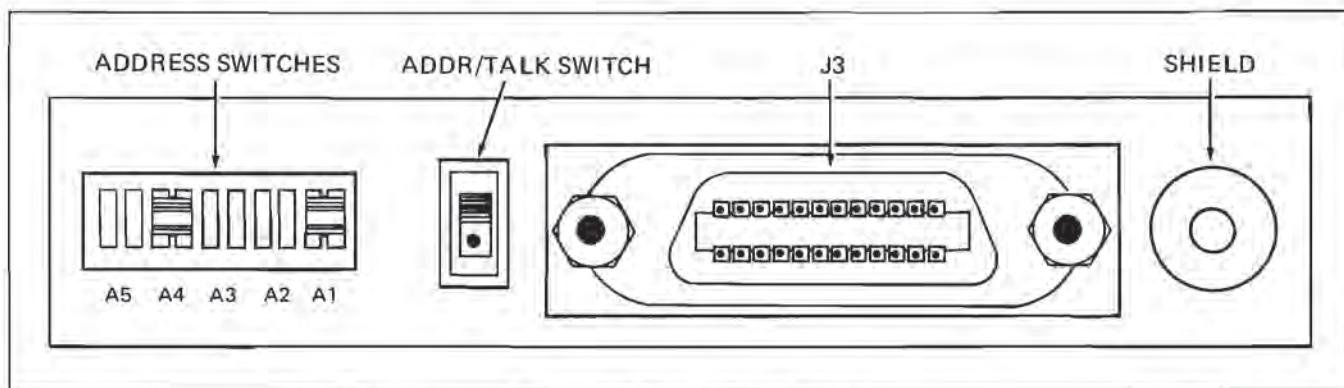


Figure 605-1. Rear Panel Access

Table 605-2. Allowable Listen and Talk Addresses

DECIMAL	5 4 3 2 1 BINARY		ASCII CHARACTER		DECIMAL	5 4 3 2 1 BINARY		ASCII CHARACTER	
	LISTEN	TALK	LISTEN	TALK		LISTEN	TALK	LISTEN	TALK
0	0 0 0 0 0		SP	@	16	1 0 0 0 0		0	P
1	0 0 0 0 1		!	A	17	1 0 0 0 1		1	Q
2	0 0 0 1 0		"	B	18	1 0 0 1 0		2	R
3	0 0 0 1 1		=	C	19	1 0 0 1 1		3	S
4	0 0 1 0 0		\$	D	20	1 0 1 0 0		4	T
5	0 0 1 0 1		%	E	21	1 0 1 0 1		5	U
6	0 0 1 1 0		&	F	22	1 0 1 1 0		6	V
7	0 0 1 1 1		'	G	23	1 0 1 1 1		7	W
8	0 1 0 0 0		(	H	24	1 1 0 0 0		8	X
9	0 1 0 0 1		)	I	25	1 1 0 0 1		9	Y
10	0 1 0 1 0		*	J	26	1 1 0 1 0			Z
11	0 1 0 1 1		+	K	27	1 1 0 1 1			l
12	0 1 1 0 0		,	L	28	1 1 1 0 0		<	
13	0 1 1 0 1		-	M	29	1 1 1 0 1		=	
14	0 1 1 1 0		:	N	30	1 1 1 1 0		>	A
15	0 1 1 1 1		/	O					

## 605-7. OPERATING FEATURES

605-8. Attached to the assembly and accessible through a port on the rear panel (Figure 605-1) are a standard specified connector, five address switches and a Talk Only Mode switch. The connector is standard for the IEEE bus and is specified by the standard document. The address of the instrument is set using the five address switches. The characters used to address the instrument in the talk and listen mode are given in Table 605-1. The five low order bits of the message determine the address, the next two higher bits differentiate between the Talk and Listen modes. Normal operation allows the instrument to both talk and listen to the bus. The Listen mode can be disabled with the Talk Only switch, if desired.

## 605-9. OPERATING NOTES

### 605-10. Interface Control

605-11. Information is input to the interface from the controller on the system bus, which contains eight data lines, three handshake lines and five bus management lines. Control of the handshake and management lines is from the controller and will vary with the controller used. Refer to the instructions with the system controller for the information on how to obtain the correct level on these lines. The lines and a brief explanation of their function are given in Table 605-3. Refer to the IEEE 488-1975 Standard Manual for a further explanation of their function.

### 605-12. Interface Messages

605-13. Multiple line messages are input to the interface from the controller using the data lines. The messages used within the instrument are listed with their codes in Table 605-4. Further information on the messages can be obtained from the IEEE 488-1975 Standard Manual.

### 605-14. Status Request Responses

605-15. If enabled by the applicable Interface Interrupt Enable Code, a service request (SRQ) can be generated within the interface by either an error or ready condition. When the instrument is addressed during a serial poll operation by the IEEE 488 Controller, and an interrupt is generated, the response byte will be a zero for ready or the numeric of the applicable Error Code. If the SRQ was not generated, the response is a null character (binary 00000000) to the controller.

## 605-16. THEORY OF OPERATION

605-17. The IEEE Interface provides for communication between the IEEE system bus and the DMM internal bus structure. The IEEE system bus is defined by the IEEE standard; the DMM internal bus structure is discussed in the instrument Instruction Manual. System bus signal lines will be referred to by their mnemonic designators (refer to Table 605-3 for definitions).

605-18. The IEEE Interface consists of two interconnected PCB's in one module. Each PCB will have its own reference designator system. To distinguish between the two, reference designators mounted on the Piggyback board will be followed by a (PB).

### 605-19. Data Lines

605-20. System bus data lines (DI01-08) are applied to the interface through receiver/drivers, U21 and U24. The receivers consist of noninverting buffers, while the drivers are gates with a common enable line from U32-8.

#### NOTE

*True conditions on the system data bus are defined as a low; true conditions on the instrument bus are defined as a high.*

Outputs from the data line receiver drivers are applied directly to address decoders, U19 and U12, through address switch S1 to address decoders U6 and U3, and through inverters to a data register consisting of U30 and part of U31.

605-21. The internal DMM data bus is applied to a response register consisting of U26 and U29. This register latches data up for application to the system bus lines (the system bus requires that data be held longer than is desirable to tie up the instrument controller). Instrument data is also applied to the control register on the Piggyback board (U11-PB, U16-PB, U14-PB).

### 605-22. Addresses

605-23. Instrument address lines (IC0-IC6) are applied to address decoders located on the Piggyback board. All of the following listed addresses cause an ACK to be returned to the instrument controller through U6 (PB)-1.

1. IC 1, 5 and 4 High: Decoded U12 (PB)-6 to enable the response register.
2. IC 6, 4 and 3 High: U12(PB)-10 to clock data into the control register; if ID0 is high, this address also causes a Return to Local signal from U8(PB)-3.
3. IC 5, 3 and 0 High: Decoded by U13(PB)-6 to cause a software reset through U8(PB)-10.
4. IC 6, 0 and 4 High: Decoded by U13(PB)-9 to enable the status register (U28 and part of U31).
5. IC, 6, 1 and 4 High: Decoded by U13(PB)-10 to enable the data register (U30 and part of U31).

605-24. Addresses to the IEEE Interface from the system are received on the data lines when ATN is true. Address switch S1 routes My Listen Address (MLA) and My Talk Address (MTA). Decoding for MLA is done by U6-13; the DAV signal clocks this address into U11-1. The MTA flip-flop U11-1 is cleared by the UNL (Unlisten) signal (decoded by U19-13). The Message Decoder (U9, U5 and U8) is enabled by the ATN and U12-10 (decoded by DI02, DI06, DI07).

Table 605-3. Mnemonics

PIN	MNEMONICS	FUNCTION	COMMENTS
1	DIO 1	Data	
2	DIO 2	Data	
3	DIO 3	Data	
4	DIO 4	Data	
13	DIO 5	Data	Data input/output lines. Message bytes are carried on the DIO lines in a bit-parallel byte-serial form, asynchronously, and generally in a bidirectional manner.
14	DIO 6	Data	
15	DIO 7	Data	
16	DIO 8	Data	
5	EOI	End Or Identify	Used to indicate the end of a multiple byte message.
6	DAV	Data Available	Is asserted TRUE by the sender of data when NRFD goes TRUE, remains TRUE until NDAC is sent TRUE by the data receiver.
7	NRFD	Not Ready For Data	When all devices are ready to receive data this line goes high. Remains high until DAV is sent TRUE.
8	NDAC	Not Data Accepted	When all receiving devices are through with the data on the bus, this line goes high, indicating that the sender may remove the data and set DAV low. When DAV goes to the receiving devices then pull NDAC low again.
9	IFC	Interface Clear	Sent high by the controller. It places all device interfaces in a known quiescent state.
10	SRQ	Service Request	This line is used by any device to get the attention of the controller.
11	ATN	Attention	Used by the controller to notify all other devices what type of message (interface versus device dependent) is on the data bus. When ATN is TRUE, messages sent are interface messages and all devices capable of receiving messages must handshake the transfer. When false, device dependent messages are sent and only devices that have been addressed remain active.
12		Shield*	Surrounds all conductors.
17	REN	Remote Enable	Must be TRUE to place instruments into remote. Once in Remote, if REN goes false all instruments must go to local.
18	GND	Return for DAV	
19	GND	Return for NRFD	
20	GND	Return for NDAC	
21	GND	Return for IFC	
22	GND	Return for SRQ	
23	GND	Return for ATN	
24	GND	Logic common for DIO 1-DIO 8, EOI, and REN	

\*The cable shield is routed to a banana jack on the rear of the Option -05 interface adjacent to the programming conductor. This banana jack may be tied to the DMM chassis ground post located on the rear panel. However, caution must be exercised to prevent ground loops in the system.

Table 605-4. Interface Messages

MNEMONIC	MESSAGE	CODING			ALL DEVICES RESPOND (Universal)	ADDRESSED DEVICES ONLY RESPOND	DEVICE IN LOCAL RESPONDS AND GOES TO REMOTE	NOTE
		BINARY	OCTAL	HEX				
MLA	My Listen Address	X F T A5 A4 A3 A2 A1				X	X	1
MTA	My Talk Address	X T F A5 A4 A3 A2 A1				X	X	1
UNL	Unlisten	X F T T T T T	077	3F	X			
UNT	Untalk	X T F T T T T	137	5F	X		X	
OTA	Other Talk Address	X X X X X X X					X	2
SPE	Serial Poll Enable	X F F T T F F F	030	18	X		X	
SPD	Serial Poll Disable	X F F T T F F T	031	19	X		X	
LLO	Local Lockout	X F F T F F F T	021	11	X		X	
GTL	Go To Local	X F F F F F F T	001	01		X		
DCL	Device Clear	X F F T F T F F	024	14	X			
SDO	Selected Clear	X F F F F T F F	004	04		X		

## 605-25. Resets

605-26. Power-on or software resets may occur. At power-on, U8(PB)-10 causes an interface reset to prevent unwanted states in the interface logic. Software resets, decoded by U13(PB)-6, may occur as a result of a momentary power interruption, a front panel request, or a system request.

## 605-27. Control Register

605-28. The following six "D" flip-flops compose the control register:

1. Interrupt enable U14(PB)-2 remains true, except during the power-on routine.
2. A service request (SRQ) to the system controller is initiated by U14(PB)-13.
3. The instrument controller being ready for data (RFD) is indicated by U16(PB)-1.
4. At the last data byte of a message to the system from the instrument controller, U11(PB)-13 goes true.
5. Data accepted (DAC) is sent and RFD is reset by U16(PB)-13.
6. When the instrument is a talker, U11(PB)-2 is used to generate the data available (DAV) signal.

## 605-29. Status Register

605-30. The status register consists of U28 and part of U31. The instrument address decoded by U13(PB)-9 enables a status byte to be placed on the data bus (ID0-ID7). This status byte is defined as follows:

1. ID0: true from U28-7 when in the talk only mode.
2. ID1: true from U28-9 when remote enable (REN) from the system controller is false.
3. ID2: true from U28-9 when go to local (GTL) is true from the message decoder U5-4.
4. ID3: true from U28-3 for an interface message.
5. ID4: true from U31-3 for an interface message.
6. ID5: true from U31-5 to indicate a device dependent message.
7. ID6: true from U31-7 during the serial poll mode when the system controller is requesting status.
8. ID7: true from U31-9 when the system controller is requesting data from the instrument.

**605-31. Message Decoder**

605-32. Interface messages sent by the system controller on the data bus are decoded by U9, U5 and U8. The device dependent messages GET, SCD and GTL require the interface to be a listener before the instrument controller is interrupted. For group execute trigger (GET), U8-11 is true. For selected device clear (SDC), U8-10 is true. For go to local (GTL), U5-4 is true. The universal messages DCL and LLO are unique in that they cause the instrument controller to be interrupted when in local. For local lockout (LLO), U5-3 is true. For device clear (DCL), U5-10 is true. In addition, U8-4 goes true for the serial poll mode (SPE), and U8-3 is true for serial poll disable (SPD).

**605-33. Mode Register**

605-34. The mode register consists of the following four J-K flip-flops: U11-1 (clocks in MLA), U11-15 (clocks in MTA), U15-1 (true in remote mode) and U15-15 (true in serial poll mode).

**605-35. Instrument Interrupts**

605-36. Except during the power-on routine, interrupts are enabled by U14(PB)-2. The interrupt flip-flop may be clocked by the DAV signal through U4(PB)-4 and U4(PB)-3 or by U6(PB)-13 when the instrument is to be an active talker.

**605-37. MAINTENANCE**

605-38. Refer to Section 4 of the Instruction Manual for information on cleaning the module. The two PCB's are disassembled by removing the screws and standoffs

fastening them together. To prevent damage to the electrical connectors, pull the boards straight apart.

**605-39. PERFORMANCE TEST**

605-40. Operation of the IEEE Interface can be verified by programming changes in range, output and mode, and by observing response data.

**605-41. CALIBRATION**

605-42. The IEEE Interface does not require calibration.

**605-43. TROUBLESHOOTING**

605-44. Troubleshooting the -05 IEEE Remote Interface Option consists of the tabular flow chart in Table 605-5. When a step in the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

**605-45. Programming Instructions**

605-46. Programming commands and instrument responses are explained in Table 605-6.

**605-47. PARTS LIST**

605-48. Table 605-7 provides a detailed parts list for the Interface PCB; Table 605-8 lists parts for the Piggyback PCB. Refer to Section 5 of this manual for ordering information.

Table 605-5. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	<p style="text-align: center;"><b>NOTE</b></p> <p><i>Due to the speed and complexity of the data on the bus system, it is recommended that the pcb be sent to the nearest Fluke Service Center for repair when a problem is isolated to the interface. The following table will be of some assistance when troubleshooting simpler problems; however, many problems will require the use of a Fluke Trendar, or similar logic board tester. The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.</i></p>		
1	This test is based on the assumption that the DMM was checked and found operational in local operation prior to installation of the IEEE Interface.		
2	Install the IEEE Interface Assembly in the instrument and apply power from the front panel switch.		
3	Is the front panel display correct?	6	4
4	If the display is blank, check the ACK circuit on the PB PCB.		
5	If the display is incorrect, check the input latches and output buffers on the Main PCB. Repair as required and return to step 2.		
6	Address the instrument on the IEEE bus with the applicable address. Does the instrument go into remote?	8	7
7	On the Main Board check the address lines through the Receiver/Driver, the address switches, the MLA circuitry, and the REN and DAV signals. On the Piggyback Board check the INT circuit. Repair as required then resume at step 2.		
8	Program an instruction from the remote controller. Is the output display as programmed?	10	9
9	Check the output latches and buffers, the UNL circuitry and the Receiver/Driver on the Main Board. Repair as required and return to step 8.		
10	Does the instrument respond to an "SRQ" from an Interrupt Ready or Error?	12	11
11	Check the SRQ line and the Receiver/Driver on the Main Board and the status latches on the Piggyback Board. Repair as required then resume at step 10.		
12	Does the interface clear from the system controller?	14	13
13	Check the IFC input and the IFC circuit. Repair as required, then resume at step 12.		
14	Can the Front Panel be locked out from the system controller?	16	15
15	Check the LLO line and the decoder circuit. Repair as required then resume at step 14.		
16	Troubleshooting of the IEEE Interface, as applicable at this level, is complete.		

Table 605-6. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ♦ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.
2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

#### INITIALIZATION

When power is applied, or the Reset character (\*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

REMOTE CODE	COMMAND
V	Volts DC
R4	1000V range
♦ S5 (8500A)	2 <sup>5</sup> Samples per Reading
♦ S7 (8502A)	2 <sup>7</sup> Samples per Reading
F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
X0	External Reference/Scaling Disabled
P0	Offset Feature Disabled
U0	Limits-Peak Value Storage Disabled
T0	Single Reading Line Synchronous
B0	Single Character ASCII Format
D0	Front Panel Display Active
L0	Deactivate Local Lockout
J0	Deactivate Line Feed Suppression
M0	Enable Cal Memory Factors
♦ Q0 (8502A)	Disable External Trigger
♦ W (8502A)	No Delay
● Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

Remote/Local	Local
Offset	Zeroed
V dc Zero	Zeroed or *
Ohms Zero	Zeroed or *
Cal Memory Factors	*
Peak Values	Cleared
Limits Values	Zeroed
Ext. Ref/Scaling Values	1
● 8/16 Bit Mode (-07 Option only)	8 Bit

\*Retained if Cal Memory Option -04 installed

Table 605-6. Programming Instructions (cont)

**PROGRAM SEQUENCE**

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

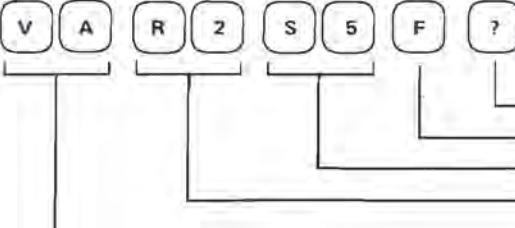
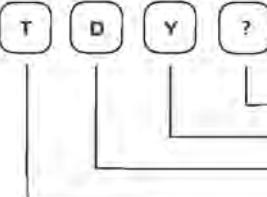
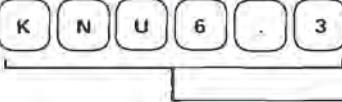
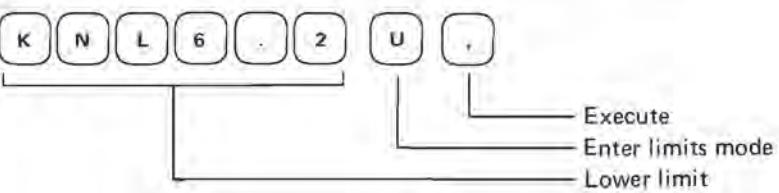
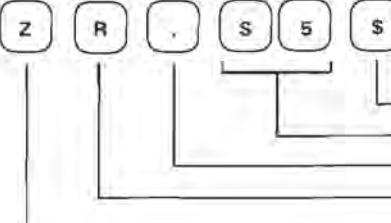
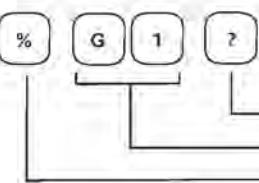
1.  Execute, trigger and transmit  
Slow filter, no time out  
 $2^5$  samples/reading  
10 volt range  
AC voltage
2.  Execute, trigger and transmit  
Echo characters  
Turn display off  
Continuous line synchronized readings
3.   
Upper limit  
 Execute  
Enter limits mode  
Lower limit
4.  Clears command string to preceding " ", "?" or "@"  
 $2^5$  samples/reading  
Execute  
Auto range  
Ohms
5.  Execute, trigger and transmit  
Get status and transmit on trigger  
Halt reading

Table 605-6. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

- With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

#### IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.

**Reset**

This immediate character will reset the instrument to the conditions described under INITIALIZATION.

- When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.

**Halt**

The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used:

From: Continuous Line Synchronous  
To: Signal Reading Line Synchronous

From: Continuous Asynchronous  
To: Single Reading Asynchronous

**Go To Local - Lock Out Remote**

- This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface.
- The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

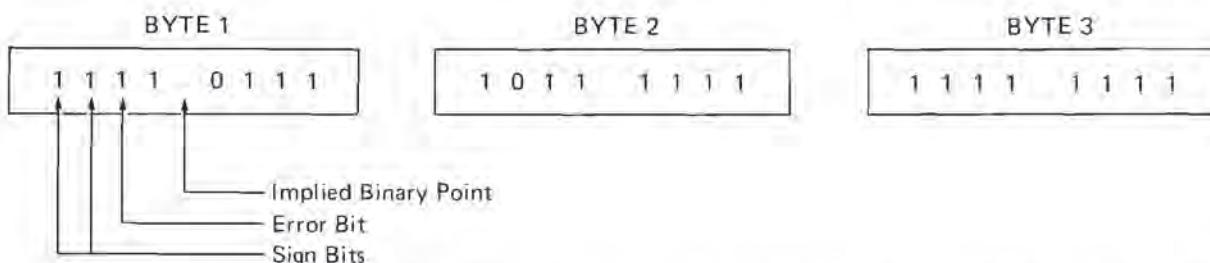
Table 605-6. Programming Instructions (cont)

#	<b>Go To Local-Lock Out Remote (cont)</b>	<p>The state of the instrument, when changing from remote to local operation will be modified as follows:</p> <ul style="list-style-type: none"> <li>1. Ohms fast mode will be ignored.</li> <li>◆ 2. Scaling mode will not be in effect (8500A only).</li> <li>◆ 3. If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2<sup>7</sup> (8500A only).</li> </ul> <p>The state of the instrument when changing from local to remote operation will be modified as follows:</p> <ul style="list-style-type: none"> <li>1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when place into local.</li> <li>2. Any error that occurred during local operation will be stored and available for recall.</li> </ul>
!	<b>High Speed Reading Mode</b>	<ul style="list-style-type: none"> <li>● The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation.</li> </ul> <p>True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25).</p> <p>The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value).</p> <ul style="list-style-type: none"> <li>◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.</li> </ul>

Table 605-6. Programming Instructions (cont)

**Voltage and Current Reading In "!"**

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.

$$\begin{array}{r}
 \boxed{0\ 0\ 0\ 0} \quad \boxed{1\ 0\ 0\ 0} \quad + \quad \boxed{0\ 1\ 0\ 0} \quad \boxed{0\ 0\ 0\ 0} \quad + \quad \boxed{0\ 0\ 0\ 0} \quad \boxed{0\ 0\ 0\ 1} \\
 \underbrace{\hspace{1cm}}_{-(0)} \quad \underbrace{\hspace{1cm}}_{.5} \quad + \quad \underbrace{\hspace{1cm}}_{.015625} \quad 0 \quad + \quad 0 \quad .000001
 \end{array}$$

$$= 0.515626 \times 10 \text{ (the implied scale factor)}$$

Further conversion to calculate the true reading  $R_t$  necessitates multiplication of the A/D Converter reading ( $R_{AD}$ ) by the scale factor for the instrument's range and function.

$$[R_t = R_{AD} \times \text{Scale Factor}]$$

**Ohms Readings in "!"**

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "!" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.

**8/16 Bit Toggle**

The "/" character is used to toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 605-6. Programming Instructions (cont)

### TERMINATION CHARACTERS

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.


**Clear the Command String**

- (Normally used only with the Bit-Serial Interface -06 Option.)

This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.


**Execute the Command String**

This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.


**Execute the Command String and Trigger**

This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state.

An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered).

When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.


**Execute, Trigger, and Interrupt when Ready**

This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 605-6. Programming Instructions (cont)

@

**Execute, Trigger, and Interrupt when Ready (cont)**

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

*The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.*

**COMMAND CHARACTERS**

Command characters are classified within the following five groups:

- |             |              |
|-------------|--------------|
| 1. FUNCTION | 3. MODIFIERS |
| 2. RANGE    | 4. CONTROL   |
| 5. MEMORY   |              |

**FUNCTION COMMAND CHARACTERS**

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.

 DC Volts

  AC Volts

 DC Coupled AC Volts

 DC Current

  AC Current

Table 605-6. Programming Instructions (cont)

**Z** Ohms

**Z** **1** Fast Ohms

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value Rx is computed from the following measurements:

V1-V2: the voltage across an internal precision resistor (Rr)

V0: the voltage across the unknown resistor (Rx).

The value of Rx is then computed with Ohm's Law:

$$Rx = Rr \frac{V_0}{V_1 - V_2}$$

Fast Ohms mode differs in that the value of  $\frac{Rr}{(V_1 - V_2)}$  is stored as a constant. The instrument will then find Rx by measuring V0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

#### NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, Rx is not computed by the DMM.

#### RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
<b>R</b>	Auto	Auto	Auto	Auto
<b>R</b> <b>0</b>	312 mV	Auto	312 $\mu$ A	31.25Ω
<b>R</b> <b>1</b>	2.5V	2.5V	2.5 mA	250Ω
<b>R</b> <b>2</b>	20V	20V	20 mA	2 kΩ
<b>R</b> <b>3</b>	160V	160V	160 mA	32 kΩ
<b>R</b> <b>4</b>	1200V	1000V	1.28A	256 kΩ
<b>R</b> <b>5</b>	Auto	Auto	Auto	4.096 MΩ
<b>R</b> <b>6</b>	Auto	Auto	Auto	32.768 MΩ
<b>R</b> <b>7</b>	Auto	Auto	Auto	262.144 MΩ

Table 605-6. Programming Instructions (cont)

**MODIFIER COMMAND CHARACTERS****SAMPLES PER READING COMMAND CHARACTERS**

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

<b>S</b>	<b>0</b>	$2^0 = 1$ Sample/Reading (4 ms)
<b>S</b>	<b>1</b>	$2^1 = 2$ Samples/Reading (8 ms)
<b>S</b>	<b>2</b>	$2^2 = 4$ Samples/Reading (17 ms)
<b>S</b>	<b>3</b>	$2^3 = 8$ Samples/Reading (33 ms)
<b>S</b>	<b>4</b>	$2^4 = 16$ Samples/Reading (67 ms)
<b>S</b>	<b>5</b>	$2^5 = 32$ Samples/Reading (134 ms)
<b>S</b>	<b>6</b>	$2^6 = 64$ Samples/Reading (267 ms)
<b>S</b>	<b>7</b>	$2^7 = 128$ Samples/Reading (534 ms)
<b>H</b>	<b>0</b>	$2^8 = 256$ Samples/Reading (1.1s)
<b>H</b>	<b>1</b>	$2^9 = 512$ Samples/Reading (2.1s)
<b>H</b>	<b>2</b>	$2^{10} = 1,024$ Samples/Reading (4.3s)
<b>H</b>	<b>3</b>	$2^{11} = 2,048$ Samples/Reading (8.5s)
<b>H</b>	<b>4</b>	$2^{12} = 4,096$ Samples/Reading (17.1s)
<b>H</b>	<b>5</b>	$2^{13} = 8,192$ Samples/Reading (34.1s)
<b>H</b>	<b>6</b>	$2^{14} = 16,384$ Samples/Reading (68.3s)
<b>H</b>	<b>7</b>	$2^{15} = 32,768$ Samples/Reading (137s)
<b>H</b>	<b>8</b>	$2^{16} = 65,536$ Samples/Reading (273s)
<b>H</b>	<b>9</b>	$2^{17} = 131,072$ Samples/Reading (546s)

Table 605-6. Programming Instructions (cont)

**FILTER COMMAND CHARACTERS**

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

- |          |                                 |   |
|----------|---------------------------------|---|
| <b>F</b> | Slow filter, time-out disabled. |   |
| <b>F</b> | <b>O</b>                        | Fast filter, time-out disabled.                       |
| <b>F</b> | <b>1</b>                        | Bypass filter.  |
| <b>F</b> | <b>2</b>                        | Slow filter, time-out enabled (approximately 500 ms). |
| <b>F</b> | <b>3</b>                        | Fast filter, time-out enabled (approximately 50 ms).  |

**TRIGGER COMMAND CHARACTERS**

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

- |          |  |  |
|----------|--|--|
| <b>T</b> | Continuous reading mode/line synchronized. |  |
| <b>T</b> | <b>O</b>                                   | Single reading mode/line synchronized.     |
| <b>T</b> | <b>1</b>                                   | Continuous reading mode/line asynchronous. |
| <b>T</b> | <b>2</b>                                   | Single reading mode/line asynchronous.     |

**NOTE**

*When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.*

- ◆ When in the continuous mode, any character (except "%" HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"), and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 605-6. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

#### *NOTE*

*The front panel display does not update in this mode unless the controller asks for a reading.*

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

#### OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

- ◆ When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from  $\pm 1 \times 10^9$  to  $\pm 1 \times 10^{-9}$  (including 0.0).



Offset subtracted (ON).



Offset not subtracted (OFF).

#### EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.



External Reference On, Scaling Off

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle.

- ◆ Minimum Vxref =  $\pm 0.0001V$  or the input divided by the maximum display with the Volts range, whichever is greater (8500A only).
- ◆ For the 8502A, the minimum Vxref is the input divided by  $10^9$ .

Maximum Vxref =  $\pm 40V$  between Ext Ref Hi and Lo terminals, providing neither terminal is greater than  $\pm 20V$  relative to the Sense Lo or Ohms Guard Terminals.

Table 605-6. Programming Instructions (cont)

<b>X</b>	<b>O</b>	<b>External Reference Off, Scaling Off</b>	
<b>X</b>	<b>1</b>	<b>External Reference Off, Scaling On</b>	<p>The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read value may not be used as a scaling factor.</p> <ul style="list-style-type: none"> <li>◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A.</li> <li>◆ For the 8502A minimum = <math>10^{-9}</math>. Factors less than this will be set to 0, which is not a valid scale factor.</li> </ul> <p>Maximum scaling factor = <math>\pm 100</math> (8500A), or Input/Max Scale factor <math>&lt; 10^{-9}</math> (8502A).</p>
<b>NOTE</b>			
<i>The "X" and "X1" modes are mutually exclusive.</i>			
<b>LIMITS AND PEAKS COMMAND CHARACTERS</b>			
The "U" command characters specify selection of Limits or Peaks modes.			
<b>U</b>	<b>Limits Testing On</b>	<b>When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows:</b>	
		"0" is transmitted for a reading within limits.	
		"1" is transmitted for a reading greater than the upper limit.	
		"-1" is transmitted for a reading less than the lower limit.	
		"2" is transmitted if an error occurs (e.g., overranging).	
<b>U</b>	<b>O</b>	<b>Disable Limits and Peak Mode(s)</b>	
<b>U</b>	<b>1</b>	<b>Save Highest and Lowest Values (Peaks On)</b>	Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 605-6. Programming Instructions (cont)

**U****1****Save Highest and Lowest Values (Peaks On) (cont)**

- ◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

**NOTE**

*Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.*

**CONTROL COMMAND CHARACTERS****Output Format**

The "B" characters activate binary or ASCII output format.

**B****Single Byte Binary Format****B****O****Single Byte ASCII Format****B****1****Binary 16-Bit Parallel****B****2****16-Bit Parallel**

"B1", "B2" used with Parallel ASCII Interface (Option -07) only.

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

**The Binary Output Format**

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

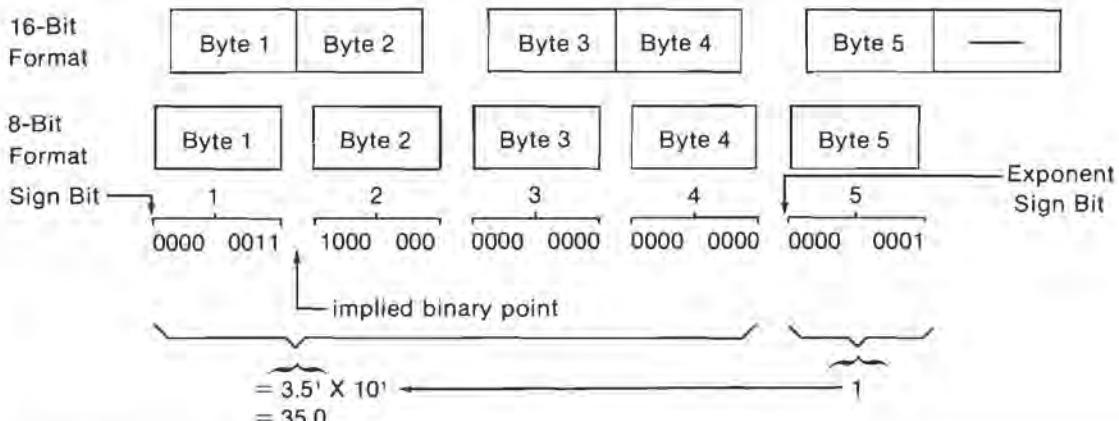
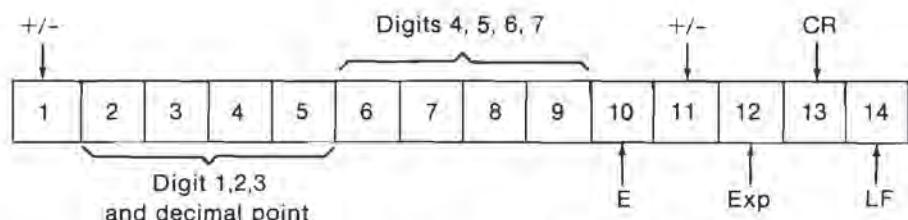


Table 605-6. Programming Instructions (cont)

**NOTE**

*In dc volts and ac volts, the exponent is always 1.  
In dc and ac current, the exponent is always -2.  
The exponent is range dependent in ohms function (1 for ohm ranges, 4 for kohm ranges,  
and 7 for Mohm ranges).*

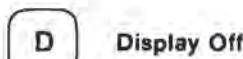
Errors will be indicated by 5 bytes of 0.

**ASCII Data Output Format**

The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument. (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

**DISPLAY CONTROL**

The "D" command characters turn the DMM front panel display on or off.



Display Off

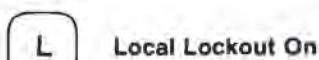


Display On

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

**LOCAL LOCKOUT CONTROL**

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.



Local Lockout On

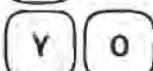


Local Lockout Off

**ECHO COMMAND CHARACTERS**  
● (used with Bit Serial Option -06 only)



ECHO ON (Full-Duplex)



ECHO OFF (Half-Duplex)

Table 605-6. Programming Instructions (cont)

**LINE FEED CONTROL COMMAND CHARACTERS**

<b>J</b>	<b>Suppress Line Feed Character</b>	This character suppresses the LF character normally sent at the end of a response line.
<b>J</b> <b>O</b>	<b>Transmit Line Feed Character</b>	This character disables the "J" character; the "LF" character will be sent.
<b>J</b> <b>1</b>	<b>Suppress Output of Readings</b>	◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode.

**CALIBRATION CONSTANT**

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

<b>M</b>	<b>Inhibit Calibration Memory Factors</b>
<b>M</b> <b>O</b>	<b>Enable Calibration Memory Factors</b>

**TRIGGER COMMAND CHARACTERS**

◆ This set of command characters is available for the 8502A with the Isolator Option ~08A

<b>Q</b>	<b>Activate External Triggering Mode, Interrupt when Ready</b>	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
<b>Q</b> <b>O</b>	<b>Deactivate External Triggering Mode</b>	
<b>Q</b> <b>1</b>	<b>Activate External Triggering Mode, Transmit when Ready</b>	The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.

**NOTE**

*The "?" and "@" characters remain operative during External Triggering.*

Table 605-6. Programming Instructions (cont)

**◆ EXTERNAL TRIGGER DELAY COMMAND CHARACTERS  
(-08A with 8502A only)**

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

<b>W</b>	<b>No Delay</b>
<b>W</b>	<b>0</b> <b>2.083 ms</b>
<b>W</b>	<b>1</b> <b>4.166 ms</b>
<b>W</b>	<b>2</b> <b>8.332 ms</b>
<b>W</b>	<b>3</b> <b>16.66 ms</b>
<b>W</b>	<b>4</b> <b>33.33 ms</b>
<b>W</b>	<b>5</b> <b>66.66 ms</b>
<b>W</b>	<b>6</b> <b>133.3 ms</b>
<b>W</b>	<b>7</b> <b>266.6 ms</b>
<b>W</b>	<b>8</b> <b>533.2 ms</b>
<b>W</b>	<b>9</b> <b>1.066s</b>
<b>W</b>	<b>1</b> <b>0</b> <b>2.133s</b>
<b>W</b>	<b>1</b> <b>1</b> <b>4.266s</b>
<b>W</b>	<b>1</b> <b>2</b> <b>8.532s</b>
<b>W</b>	<b>1</b> <b>3</b> <b>17.06s</b>
<b>W</b>	<b>1</b> <b>4</b> <b>34.13s</b>
<b>W</b>	<b>1</b> <b>5</b> <b>68.26s</b>

Table 605-6. Programming Instructions (cont)

**MEMORY COMMAND CHARACTERS****STORE**

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

- K** Store Last Reading as Offset      ♦ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.
- K O** Store Last Voltage Taken as VDC Zero (on R0 Only)
- K 1** Store Last Reading as Ohms Zero (on R0 Only)
- K N P** Store Numeric Value Following as Offset
- K N X** Store Numeric Value Following as Scaling Factor  
*(Note: The read value may not be stored as a Scaling Factor.)*
- K N U** Store Numeric Value Following as Upper Limit
- K N L** Store Numeric Value Following as Lower Limit

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

**K N P 1 0**

Keep Numeric offset of 10.0

**K N X 1 0 - 3 E - 1**

Keep numeric scaling factor of  $10.3 \times 10^{-1}$  or 1.03

**K N U 7 . 6 E 4**

Keep numeric upper limit of  $7.6 \times 10^4$

**K N L - 1 2 3 - 4 5 6 E + 0**

Keep numeric lower limit of -123.456

Table 605-6. Programming Instructions (cont)

An example of an illegal numeric string is:



Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

#### *NOTE*

*Numeric entries are limited to the maximum display value. These values are:*

*+1.00000 E +9 to +1.00000 E -9, and -1.00000 E -9 to -1.00000 E +9*

*Numbers less than the ±1.00000 E -9 are treated as zero.*

#### **RECALL**

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

**G      Recall Previous Reading and Send on Next Trigger**

**G      0      Recall DC Zero and Send on Next Trigger**

**G      1      Recall Status and Send on Next Trigger**

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

#### **Error Codes**

1	2					
---	---	--	--	--	--	--

Characters 1 and 2 define error code status. Each error code contains two digits: those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

- 00 No Error
- 06 System Error
- 07 Illegal Numeric Entry
- 08 Remote Command String Error
- 09 Remote Overrange
- 10 V DC Zero/Ohms Zero Error
- ◆ 11 Offset Error (8500A) Store during Overrange (8502A)

Table 605-6. Programming Instructions (cont)

**Error Codes (cont)**

- 12 Filter Module Faulty or not installed
- 13 DC Signal Conditioner Module Faulty or not installed
- 14 Excessive voltage present at terminals for Ohms/Current Measurement
- 15 Fast A/D Converter Faulty or not installed
- 16 Numeric Display Overflow
- 17 Magnitude of External Reference Input >20V
- 18 Controller Module Faulty
- 19 Function Module selected not installed

**Range Codes**

		3				
--	--	---	--	--	--	--

The third character of the status response contains the following range information:

- 0 100 mV dc, 100  $\mu$ A, 10 $\Omega$
- 1 1V dc, 1V ac, 1 mA, 100 $\Omega$
- 2 10V dc, 10V ac, 10 mA, 1k $\Omega$
- 3 100V dc, 100V ac, 100 mA, 10 k $\Omega$
- 4 1000V dc, 1000V ac, 1A, 100 k $\Omega$
- 5 1 M $\Omega$
- 6 10 M $\Omega$
- 7 100 M $\Omega$

**Sample Codes**

			4			
--	--	--	---	--	--	--

The fourth status response character contains sample information identified by the following codes:

- 0 1 Sample per Reading
- 1 2 Samples per Reading
- 2 4 Samples per Reading
- 3 8 Samples per Reading
- 4 16 Samples per Reading
- 5 32 Samples per Reading
- 6 64 Samples per Reading
- 7 128 Samples per Reading or Greater

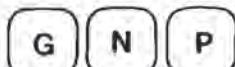
**Function Codes**

					5	<CR>	<LF>
--	--	--	--	--	---	------	------

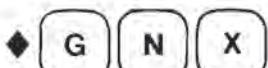
The fifth response character identifies function:

- 0 DC Volts
- 1 AC Volts
- 2 DC Amps
- 3 AC Amps
- 4 Ohms
- 5 DC Coupled AC Volts
- 7 Function Not Defined

Table 605-6. Programming Instructions (cont)

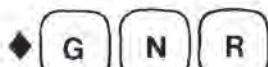
G N P

Recall Offset and Send on Next Trigger

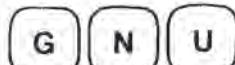
◆ G N X

Recall External Ref or Scaling Factor and Send on Next Trigger (8500A)

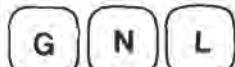
Recall Scaling Factor (8502A)

◆ G N R

Recall External Reference Factor and Send on Next Trigger (8502A)

G N U

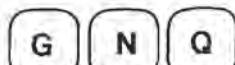
Recall Upper and Send on Next Trigger

G N L

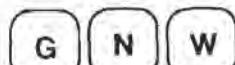
Recall Lower Limit and Send on Next Trigger

*NOTE*

The instrument will replay to "GNU" or  
"GNL" by transmitting the stored limit  
value.

G N Q

Recall Lowest (Peak) Value Found and Send on Next Trigger

G N W

Recall Highest (Peak) Value Found and Send on Next Trigger

Table 605-7. IEEE-488 Interface Assembly

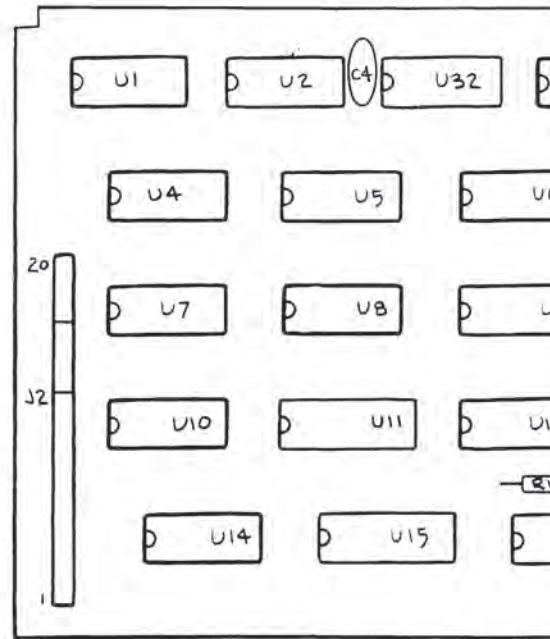
ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	① IEEE, 488-1975 INTERFACE ASSY --FIGURE 605-2 (MIS-4172T)		ORDER BY	OPTION MIS-05	1		
	IEEE, 488-1975 PIGGY BACK PCB ASSY --FIGURE 605-4 (MIS-4072)		PART OF	OPTION MIS-05			
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J		REF	
C3	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015KA1	1		
C4	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	5		
C5	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K		REF	
C6	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K		REF	
C7	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K		REF	
C8	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K		REF	
C9	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
CR1	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	1		
H1	COIL, SPRING	424465	83553	C0120-014-0380	1		
H2	LOCKWASHER, SPLIT, 8-32	111070	89536	111070	2		
H3	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H4	SCREW, CONN MTG, (USE ON J3)	429472	89536	429472	2		
J2	POST, CONTACT	447813	22526	65501-136	3		
J3	CONN, CABLE, 24-PIN, MODIFIED	441337	02660	57-20240-14	1		
MP1	BAG, ANTI-STATIC (NOT SHOWN)	453530	89536	453530	1		
MP2	CASE HALF (NOT SHOWN)	402990	89536	402990	1		
MP3	CASE MODULE, MODIFIED (NOT SHOWN)	456079	89536	456079	1		
MP4	COVER, MODULE CASE (NOT SHOWN)	402974	89536	402974	1		
MP5	DECAL, CAUTION (NOT SHOWN)	454504	89536	454504	1		
MP6	DECAL, IEEE (NOT SHOWN)	413518	89536	413518	1		
MP7	GUARD, REAR (NOT SHOWN)	383364	89536	383364	1		
MP8	SHIELD, COVER (NOT SHOWN)	441022	89536	441022	1		
MP9	IEEE INTERFACE (NOT SHOWN)	383596	89536	383596	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1		
R1	RES, COMP, 18K +/-5%, 1/4W	148122	01121	CB1835	1		
R2	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	1		
R3	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	1		
R4	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	1		
R5	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	1		
S1	SWITCH, MODULE SPDT, 5-POS.	417766	00779	435470-4	1	1	
S2	SWITCH, SLIDE, SPDT	417287	95146	MSS-1040-1	1	1	
U1	② IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U2	② IC, COS/MOS, DUAL, 4-INPUT, NOR GATES	363820	02735	CD4002AE	1	1	
U3	IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	3	1	
U4	② IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	2	1	
U5	② IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	3	1	
U6	② IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE		REF	
U7	② IC, COS/MOS, TRIPLE, 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U8	② IC, COS/MOS, QUAD, 2-INPUT, NOR GATES	355172	02735	CD4001AE		REF	
U9	② IC, C-MOS, DCDR/MULTIPLEXER	408369	04713	MC14556CP	1	1	
U10	② IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	
U11	② IC, COS/MOS, DUAL JK MASTER FLIP-FLOP	355230	02735	CD4027AE	2	1	
U12	② IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U13	② IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	

Table 605-7. IEEE-488 Interface Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE COE
U14	② IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE			REF
U15	② IC, COS/MOS, DUAL, JK MASTER FLIP-FLOP	355230	02735	CD4027AE			REF
U16	② IC, C-MOS, QUAD, 2-INPUT, NAND	404632	02735	CD4093BE		1	1
U17	② IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE			REF
U18	② IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE			REF
U19	② IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE			REF
U20	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P		4	1
U21	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P			REF
U22	② IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE		2	1
U24	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P			REF
U25	② IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE			REF
U26	IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE		2	1
U27	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P			REF
U28	② IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N		3	1
U29	② IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE			REF
U30	② IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N			REF
U31	② IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N			REF
U32	IC, TTL, QUAD, 2-INPUT NAND GATES	393033	01295	SN74LS00N		1	1
U33	RES. NETWORK, 4.7K	412916	89536	412916		2	1
U34	RES. NETWORK, 4.7K	412916	89536	412916			REF

Table 605-8. IEEE-488 Piggy Back Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE COE
	② IEEE-488-1975 PIGGY BACK PCB ASSEMBLY --FIGURE 605-4 (MIS-4072)		PART OF	OPTION MIS-05	1		
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
C3	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	1		
C4	CAP, MICA 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	WASHER, FLAT, S/S 1/4 INCH	200980	86928	5710-65-16	1		
H2	WASHER, INT LOCK, 1/4 INCH	110817	73734	1308	1		
P2	CONNECTOR, SOCKET, 4-PIN	417311	20447	SS-109-1-04	5		
P2-1	--CONNECTOR, SOCKET, 12-PIN	417733	20447	SS-109-1-12	3		
P4	BINDING POST	441741	89536	441741	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
Q2	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	3		
R2	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	2		
R3	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	2		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	REF		
R5	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R6	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	REF		
R7	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R8	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	1		
R9	RES, SELECTED						
U1	② IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	4	1	
U2	② IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	2	1	
U3	② IC, C-MOS, QUAD, 2-INPUT NAND GATE	404632	02735	CD4093BE	1	1	
U4	② IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U5	② IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U6	② IC, COS/MOS, DUAL, 4-INPUT NOR GATES	363820	02735	CD4002AE	1	1	
U7	② IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	② IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	2	1	
U9	② IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	REF		
U10	② IC, C-MOS, HEX INVERTER BUFFERS	381848	02735	CD4049AE	1	1	
U11	② IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U12	② IC, C-MOS, TRIPLE 3-INPUT AND GATES	408807	02735	CD4073BE	1	1	
U13	② IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U14	② IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U16	② IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		



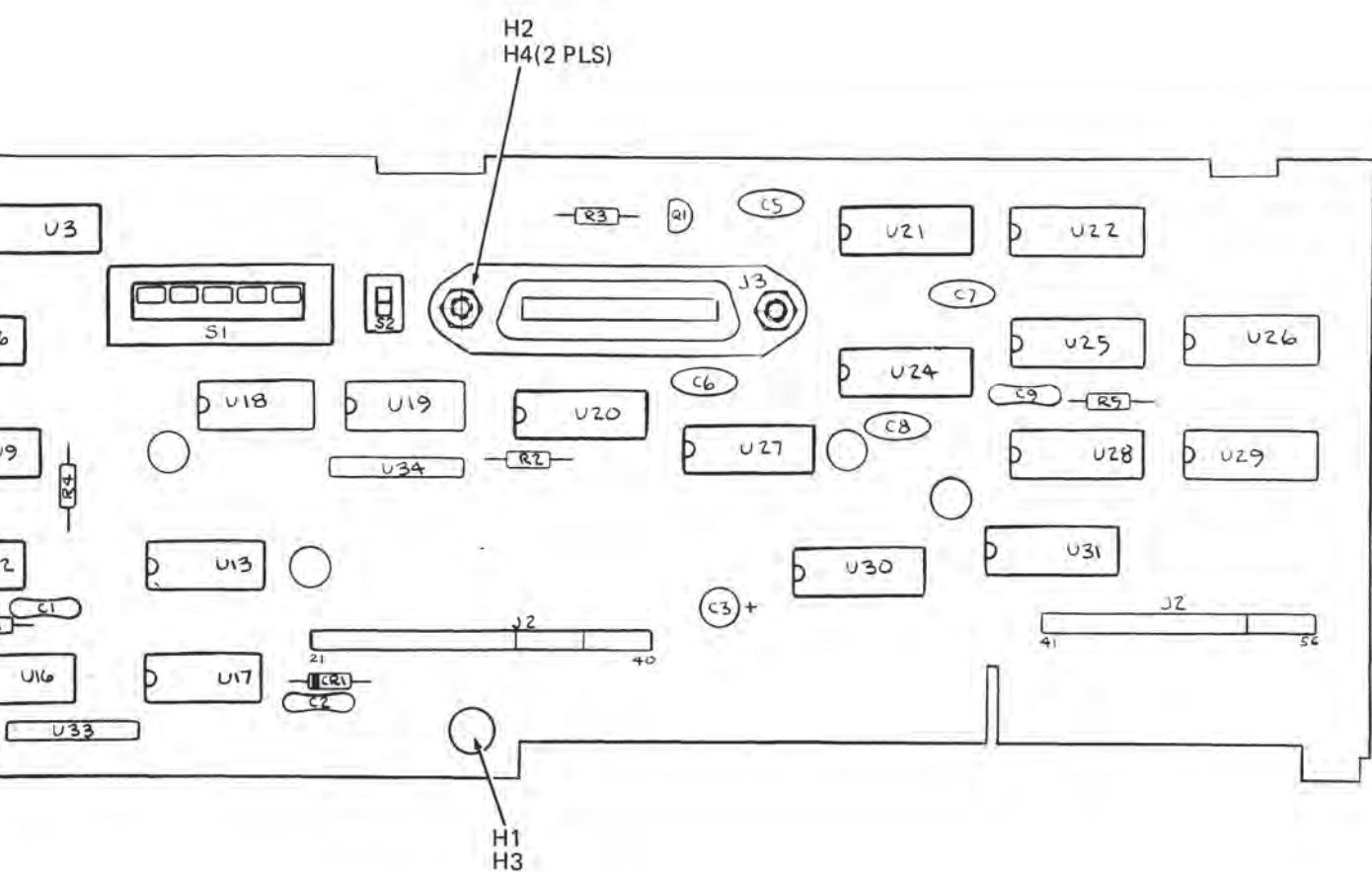
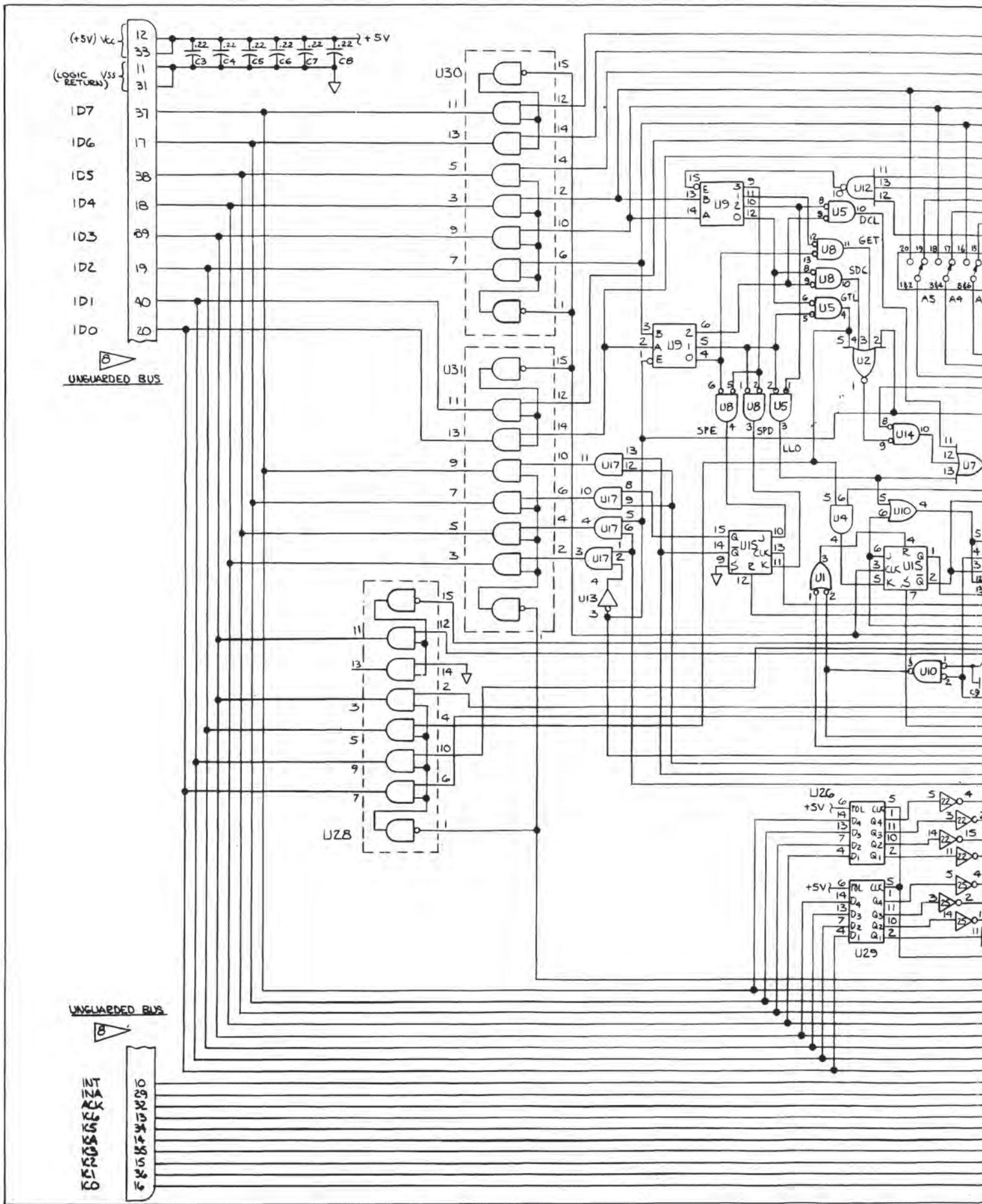


Figure 605-2 IEEE-488 Interface Assembly



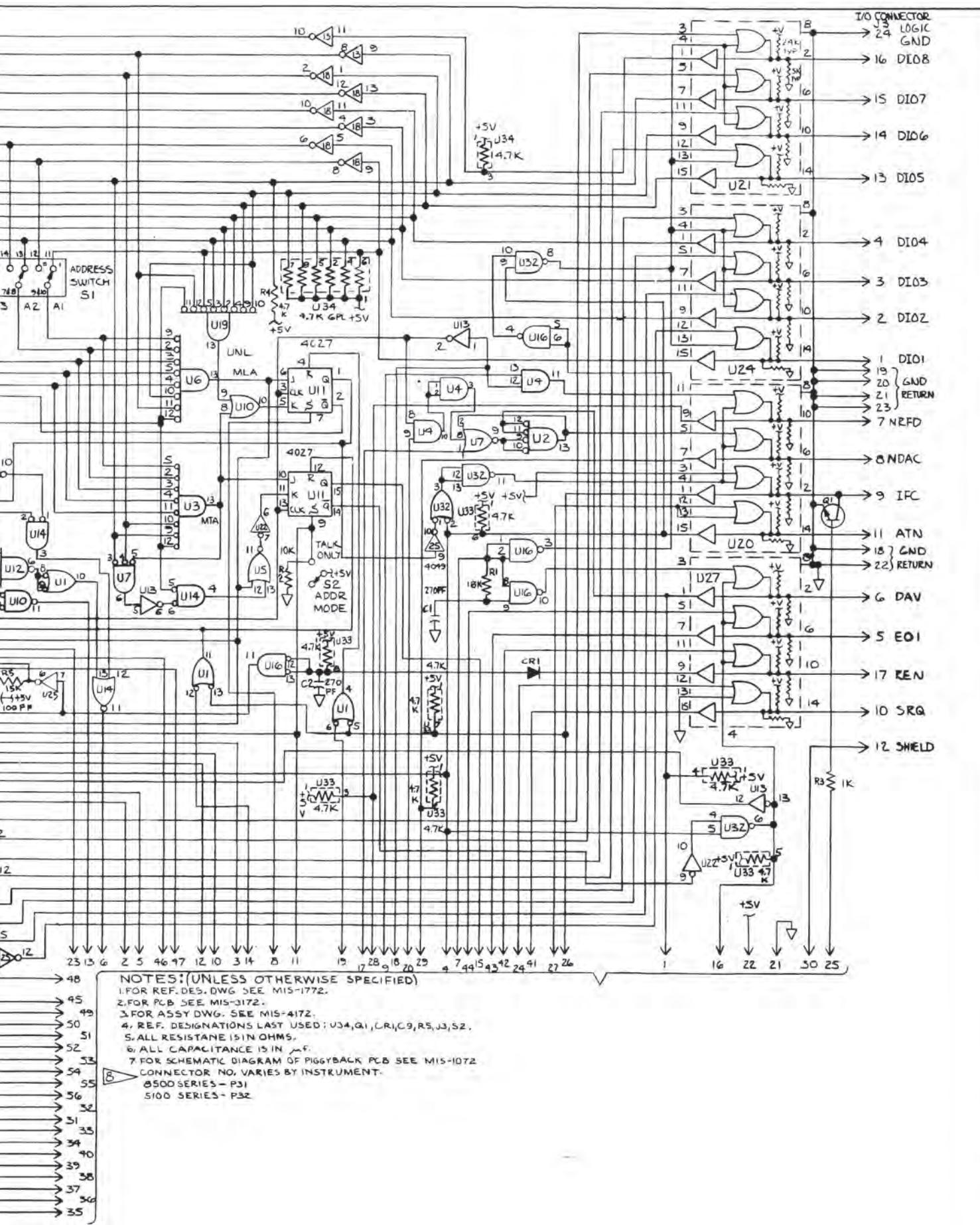
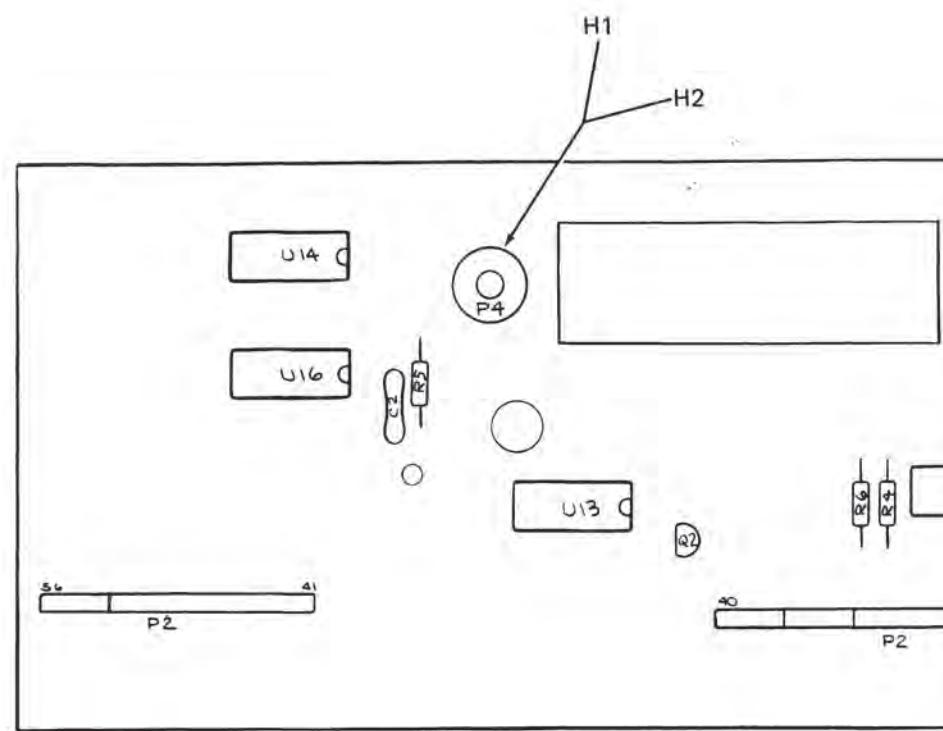


Figure 605-2 IEEE-488 Interface Assembly (cont)



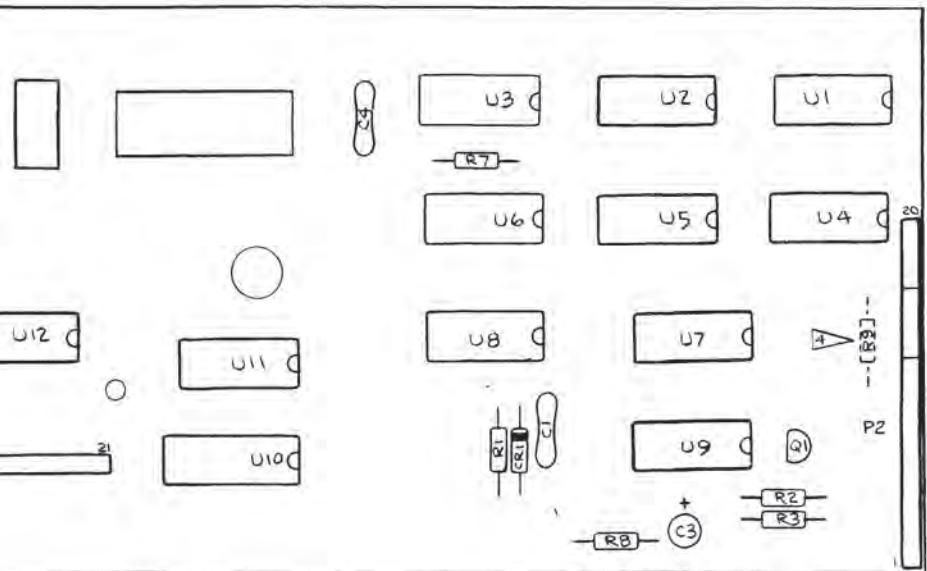
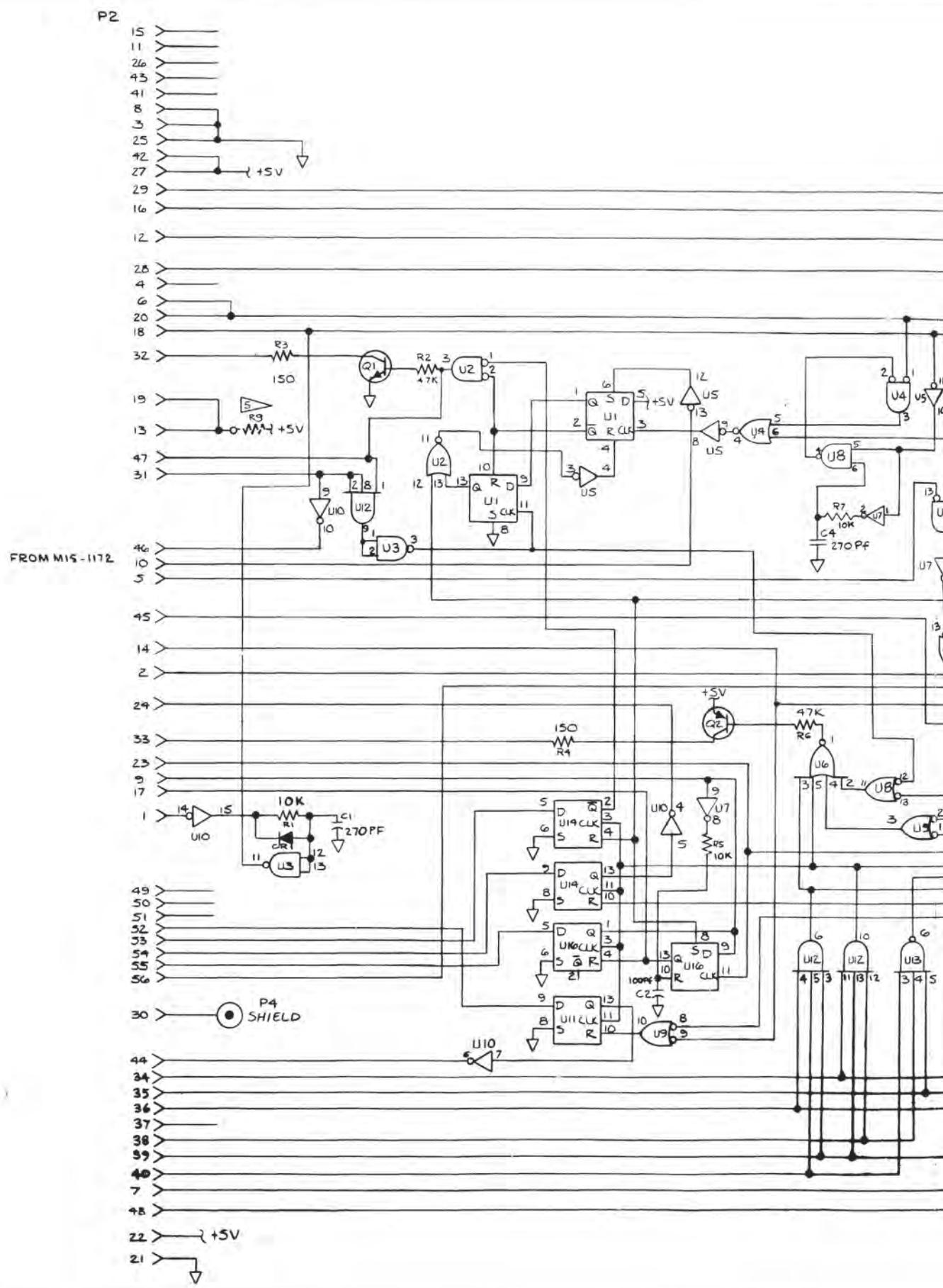
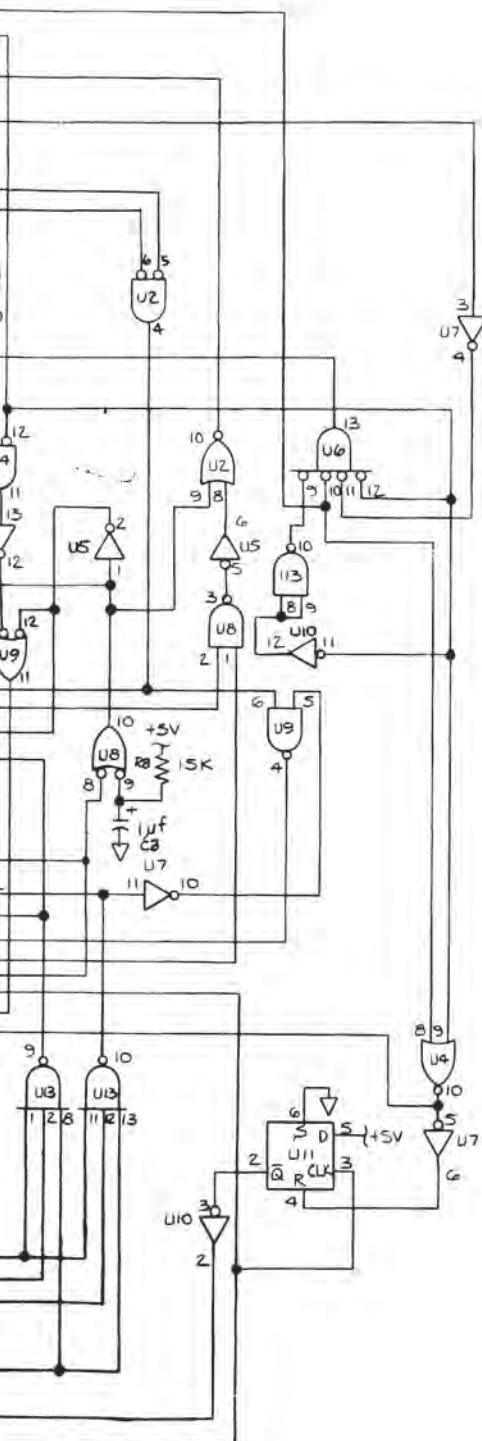


Figure 605-3 IEEE-488 Piggy Back Assembly



NOTES: (UNLESS OTHERWISE SPECIFIED).

1. FOR REF. DES. DWG SEE MIS-1672.
2. FOR PCB SEE MIS-3072.
3. FOR ASSY. DWG. SEE MIS-4072.
4. ALL RESISTORS ARE C.C. 1/4W AND RESISTANCE IS IN OHMS.
5. R9 IS TO BE SELECTED AT TEST IF REQUIRED
6. LAST REF. DES. USED: U1G, Q2, C1, R9, C4, P4.
7. REF. DES. NOT USED: U15, P1, P3.
- B. FOR SCHEMATIC DIAGRAM OF MAIN PCB SEE MIS-1172.

## Option -06 Bit Serial Interface

### **606-1. INTRODUCTION**

606-2. The Bit Serial Asynchronous Interface provides remote programming capability in applications where speed is not a critical factor. Switch selectable baud rates, stop bits, and current requirements permit maximum flexibility.

### **606-3. SPECIFICATIONS**

606-4. The Bit Serial Asynchronous Interface meets or exceeds the requirements for data transmission and reception of EIA Standard RS-232B or C, MIL-STD-188B, CCITT V24 and 20 mA current loop. Specifications are as follows:

Input Format	Byte Serial, 8-bit parallel.
Timing Format	Asynchronous.
Output Format	Bit Serial.
Baud Rates	50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800 and 9600.
Operating Power	Derived from the DMM.
Operating Temperature	0° to 50°C.

### **606-5. INSTALLATION**

606-6. The Bit Serial Interface is easily installed as a module in the 8500 series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.
2. Remove the DMM's top cover.
3. The Interface module fits in the rear slot, bus connector and address switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

#### *NOTE*

*Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.*

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends, and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.

5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

#### *NOTE*

*Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.*

6. Replace the DMM's top cover.

### **606-7. GENERAL**

606-8. EIA Standard RS-232-C provides the electronics industry with the ground rules necessary for independent manufacturers to design and produce both data terminal and data communication equipment that conforms to a common interface requirement. As a result, a data communications system can be formed by connecting an RS-232-C data terminal (such as the 8502A) to an RS-232-C data communications peripheral (such as a TTY, MODEM, computer, etc.). This works fine on paper. However, in practice the user must be aware of the subtleties of serial binary data interchange to ensure that any two pieces of RS-232-C equipment will be compatible. For example, the two instruments must share

at least one of the features from each of the following characteristics.

1. Timing Format - Synchronous or Asynchronous.
2. Transmission Mode - Simplex, half-duplex, or full duplex.
3. Baud Rate (bits per second) - 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600.
4. Bits per character - 5, 6, 7, 8.
5. Parity Bit - Odd, even, high, low, not used.
6. Data Interface Levels - EIA or 20 mA current loop.

606-9. Timing formats conforming to both synchronous and asynchronous operation are shown in Figure 617-1. In asynchronous operation each character is bracketed by both start and stop bits. These bits separate the characters and synchronize both the transmission and receipt of data. When data is not being sent the data line is held high. In synchronous operation a sync character is sent prior to each data stream (a data stream usually consists of a block of characters). When the line is idle, a fill or sync character is continuously transmitted.

606-10. Transmission mode is an overall system requirement. It defines the communication ability of both instruments in the system configuration. Simplex indicates data transmission in one direction only. Half-duplex permits two way communication, but not simultaneously. Simultaneous transmission of data in both directions defines the full duplex system. Obviously, an instrument capable of full duplex operation can be downgraded to simplex operation. However, the reverse is not possible without degrading the system capability.

606-11. Baud rate is usually selectable on the RS-232-C Interface. If it is not, the manufacturer usually offers a choice when the instrument is purchased.

606-12. Character format (bits per character and parity) is somewhat flexible between instruments. Investigate the requirement of both instruments before committing either to a system configuration.

606-13. Data interface levels can occur as either EIA voltage levels or as a 20 mA current loop. At times an interface offers both simultaneously. The 20 mA current loop is used almost exclusively for teletypewriter, or paper tape punch/reader interface. EIA voltage levels are: 1 or OFF = -15 to -3V dc, 0 or ON = +3 to +15V dc.

#### 606-14. OPERATING FEATURES

606-15. Attached to the PCB and accessible through a port on the rear panel (Figure 606-1) are a standard specified connector and a switch module with eight micro-switches. The connector is standard for the RS-232 Interface and is specified by the standard document. The eight switches control the operating modes of the interface and the BAUD rate. The modes selected by the switches are shown in Table 606-1 and Table 606-2. The selection of Odd or Even parity with switch 8 is applicable only if the parity feature has been selected using the jumpers described below.

606-16. The interface is shipped configured for an eight bit character without parity. Selection of parity and five, six or seven bit characters can be accomplished by installing jumpers into the PCB as shown in Table 606-3.

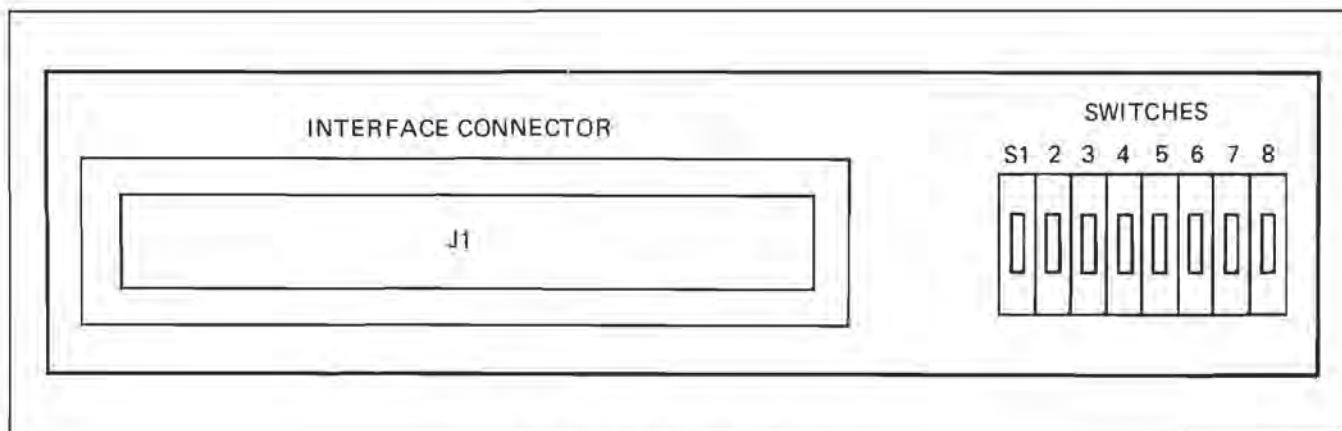


Figure 606-1. Rear Panel Access

Table 606-1. Mode Selection

SW#	SELECTION	SW ON	SW OFF
S1	Current Loop/RS232	Current	RS232
S2	RS232B/RS232C	RS232B	RS232C
S3	Stop Bits	1 Bit	2 Bits
S4	Baud Rate	*	*
S5	Baud Rate	*	*
S6	Baud Rate	*	*
S7	Baud Rate	*	*
S8	Parity	Odd	Even

\* Defined in Table 606-2

Table 606-2. Baud Rate Selection

COUNT	S4	S5	S6	S7	BAUD RATE
0	OFF	OFF	OFF	OFF	110
1	OFF	OFF	OFF	ON	150
2	OFF	OFF	ON	OFF	300
3	OFF	OFF	ON	ON	2400
4	OFF	ON	OFF	OFF	1200
5	OFF	ON	OFF	ON	1800
6	OFF	ON	ON	OFF	4800
7	OFF	ON	ON	ON	9600
8	ON	OFF	OFF	OFF	2400
9	ON	OFF	OFF	ON	600
10	ON	OFF	ON	OFF	200
11	ON	OFF	ON	ON	134.5
12	ON	ON	OFF	OFF	75
13	ON	ON	OFF	ON	50

Table 606-3. Jumper Arrangements

	JUMPER #1 INSTALLED	JUMPER #2 INSTALLED	JUMPER #3 INSTALLED
Bit 5	Yes	Yes	N/A
Bit 6	No	Yes	N/A
Bit 7	Yes	No	N/A
Bit 8	No	No	N/A
Parity	N/A	N/A	Yes
No Parity	N/A	N/A	No

## 606-17. THEORY OF OPERATION

### 606-18. General

606-19. The bit serial interface alters and transmits data between the eight bit (byte) parallel format used on the instrument bus and the bit serial format of the system bus. As shown on the schematic, data inputs from either the system bus or the instrument bus are latched into universal asynchronous receiver transmitter (UART) U9, which is driven by a programmable clock (U3) set at the selected baud rate. Data in the Instrument Bus (ID0-ID7) is latched into the UART on DB1 through DB8 and output from the UART to the instrument bus on RD1 through RD8. Four separate functions are decoded from the control lines, and the receipt of any one generates a common acknowledgement signal (ACK). An interrupt function can be generated to notify the instrument controller the received data is available, allowing polled or interrupt control of the interface.

### 606-20. Functions

606-21. An address of IC0, IC4 and IC6 high with the remaining lines low generates the STATIN function. This generates ACK and enables the tri-state transmitters on the ID0-ID3 lines so that DA (received data available at RD1-RD8), OR (overrun; i.e., a new character received prior to final transmission of the previous character), RVMT (transmitter buffer empty and ready for the next character) and/or FE (framing error; i.e., no stop bit with received character) can be placed on the data lines.

606-22. The DATIN function (IC1, IC4, IC6 only high) strobes the RDE and RDA input to the UART. The UART is enabled to place data on the instrument bus by RDE and to receive another serial character from the system bus by RDA.

606-23. With IC2, IC4 and IC5 high, COUT is decoded to reset the UART and clock U5-3. If ID7 is high with COUT, the interrupt capability is disabled by enabling the reset at U5-10. This action prevents an interrupt signal to the instrument controller until removed. If ID8 is low, the interrupt circuitry is enabled.

606-24. DATOUT is decoded from IC3, IC4 and IC6 high, to strobe the DS input to the UART. The rising edge of DS initiates serial transmission of the character from SO onto the system bus. It is available at both J1-2 for RS-232 and J1-11 for the 20 mA current loop, for the users selection.

### 606-25. Interrupt

606-26. When DA (received data available) goes high, an interrupt is generated (unless it has been disabled by the COUT function) for a low at INT. The instrument

controller responds with an INA, generating an ACK and enabling U8-15 to pass the output of the interrupt flip-flop to the instrument controller for interrupt vectoring. The removal of INA by the instrument controller causes the Interrupt flip-flop to reset itself and prepare the circuit for the next interrupt.

## **606-27. MAINTENANCE**

606-28. Refer to Section 4 of the Instruction Manual for information on module disassembly and cleaning.

## **606-29. PERFORMANCE TEST**

606-30. Operation of the Bit Serial Interface may be verified by programming changes in range, output and mode, and by observing response data.

## **606-31. CALIBRATION**

606-32. The Bit Serial Interface does not require calibration.

## **606-33. TROUBLESHOOTING**

606-34. Troubleshooting for the -06 Bit Serial Asynchronous Remote Interface Option consists of the tabular flow chart in Table 606-4. When a step in the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

## **606-35. PROGRAMMING INSTRUCTIONS**

606-36. Programming commands and instrument responses are explained in Table 606-5.

## **606-37. LIST OF REPLACEABLE PARTS**

606-38. Table 606-6 is a list of replaceable parts for the Bit Serial Interface Option. Refer to Section 5 for an explanation fo the columnar entries.

Table 606-4. Bit Serial Interface Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	<p style="text-align: center;"><i>NOTE</i></p> <p><i>The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.</i></p>		
1	This troubleshooting procedure is based on the assumption that the instrument has been checked in local and found to be operational in all aspects prior to installation of the Bit Serial Interface.		
2	Install the Bit Serial Interface in the instrument and apply power from the front panel switch.		
3	Is the display blank?	4	7
4	Check the address lines and address decoders.		
5	Check for a high ACK line. Repair as required and resume at step 2.		
6	If the display is incorrect (garbled or wrong), check the input ID lines and gates. Repair as required and resume at step 2.		
7	Using the controller, instruct the instrument to go to remote (program the character "J").		
8	Does the instrument go into remote?	10	9
9	Check the input gates (TP1), the UART (U9), the baud rate at TP3, the INT circuit, and the status output buffer.		
10	Program several instructions from the remote controller.		
11	Does the instrument respond correctly to the programmed instructions?	13	12
12	Check the UART (U9), the output gates (U4), and the data input gate (U7). Repair as required and resume at step 10.		
13	Troubleshooting of the Bit Serial Interface, as applicable at this level, is complete.		

Table 606-5. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ♦ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.
2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

#### INITIALIZATION

When power is applied, or the Reset character (\*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

<u>REMOTE CODE</u>	<u>COMMAND</u>
V	Volts DC
R4	1000V range
♦ S5 (8500A)	2 <sup>5</sup> Samples per Reading
♦ S7 (8502A)	2 <sup>7</sup> Samples per Reading
F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
X0	External Reference/Scaling Disabled
P0	Offset Feature Disabled
U0	Limits-Peak Value Storage Disabled
T0	Single Reading Line Synchronous
B0	Single Character ASCII Format
D0	Front Panel Display Active
L0	Deactivate Local Lockout
J0	Deactivate Line Feed Suppression
M0	Enable Cal Memory Factors
♦ Q0 (8502A)	Disable External Trigger
♦ W (8502A)	No Delay
● Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

Remote/Local	Local
Offset	Zeroed
V dc Zero	Zeroed or *
Ohms Zero	Zeroed or *
Cal Memory Factors	*
Peak Values	Cleared
Limits Values	Zeroed
Ext. Ref/Scaling Values	1
● 8/16 Bit Mode (-07 Option only)	8 Bit

\*Retained if Cal Memory Option -04 installed

Table 606-5. Programming Instructions (cont)

**PROGRAM SEQUENCE**

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

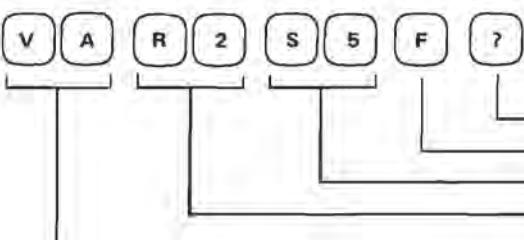
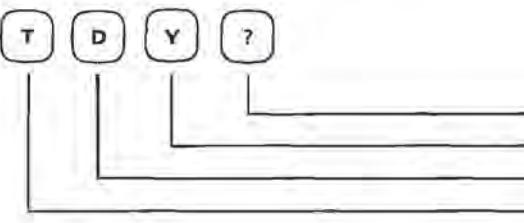
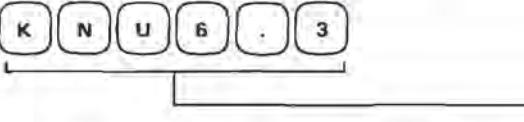
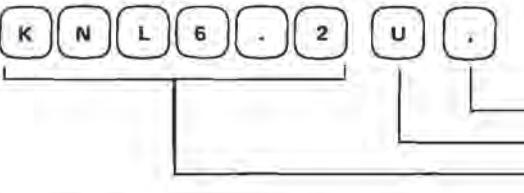
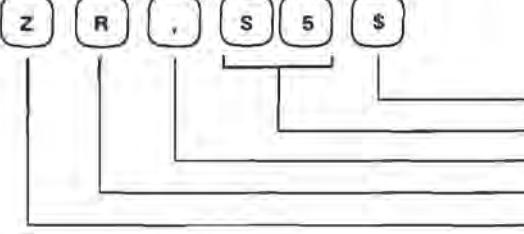
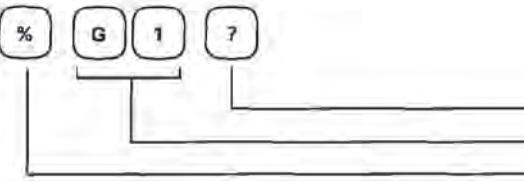
1.  Execute, trigger and transmit  
Slow filter, no time out  
 $2^5$  samples/reading  
10 volt range  
AC voltage
2.  Execute, trigger and transmit  
Echo characters  
Turn display off  
Continuous line synchronized readings
3.  Upper limit  
 Execute  
Enter limits mode  
Lower limit
4.  Clears command string to preceding ", "?" or "@"  
 $2^5$  samples/reading  
Execute  
Auto range  
Ohms
5.  Execute, trigger and transmit  
Get status and transmit on trigger  
Halt reading

Table 606-5. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

- With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

#### IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.



Reset

This immediate character will reset the instrument to the conditions described under INITIALIZATION.

- When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.



Halt

The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used:

From: Continuous Line Synchronous  
To: Single Reading Line Synchronous

From: Continuous Asynchronous  
To: Single Reading Asynchronous



Go To Local - Lock Out Remote

- This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface.
- The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

Table 606-5. Programming Instructions (cont)

#

**Go To Local-Lock Out Remote (cont)**

The state of the instrument, when changing from remote to local operation will be modified as follows:

1. Ohms fast mode will be ignored.
- ◆ 2. Scaling mode will not be in effect (8500A only).
- ◆ 3. If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2<sup>7</sup> (8500A only).

The state of the instrument when changing from local to remote operation will be modified as follows:

1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when place into local.
2. Any error that occurred during local operation will be stored and available for recall.

!

**High Speed Reading Mode**

- The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation.

True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25).

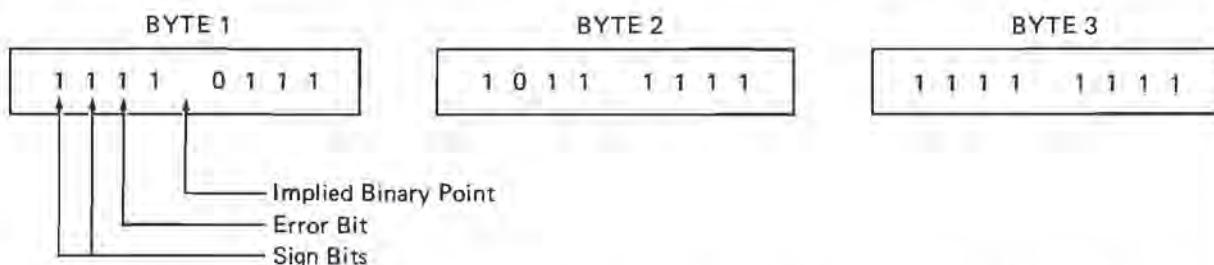
The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value).

- ◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.

Table 606-5. Programming Instructions (cont)

**Voltage and Current Reading In "!"**

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.

$$\begin{array}{r}
 \boxed{0\ 0\ 0\ 0} \quad \boxed{1\ 0\ 0\ 0} \quad + \quad \boxed{0\ 1\ 0\ 0} \quad \boxed{0\ 0\ 0\ 0} \quad + \quad \boxed{0\ 0\ 0\ 0} \quad \boxed{0\ 0\ 0\ 1} \\
 \underbrace{\phantom{0\ 0\ 0\ 0}}_{-(0)} \quad \underbrace{\phantom{1\ 0\ 0\ 0}}_5 \quad + \quad \underbrace{\phantom{0\ 1\ 0\ 0}}_{.015625} \quad \underbrace{\phantom{0\ 0\ 0\ 0}}_0 \quad + \quad \underbrace{\phantom{0\ 0\ 0\ 0}}_0 \quad \underbrace{\phantom{0\ 0\ 0\ 1}}_{.000001}
 \end{array}$$

$$= 0.515626 \times 10 \text{ (the implied scale factor)}$$

Further conversion to calculate the true reading  $R_t$  necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$$(R_t = R_{AD} \times \text{Scale Factor})$$

**Ohms Readings In "!"**

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "!" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.



**8/16 Bit Toggle**

The "/" character is used to toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 606-5. Programming Instructions (cont)

**TERMINATION CHARACTERS**

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.

**Clear the Command String**

- (Normally used only with the Bit-Serial Interface -06 Option.)

This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.

**Execute the Command String**

This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.

**Execute the Command String and Trigger**

This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state.

An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered).

When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.

**Execute, Trigger, and Interrupt when Ready**

This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 606-5. Programming Instructions (cont)


**Execute, Trigger, and Interrupt  
when Ready (cont)**

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

*The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.*

### COMMAND CHARACTERS

Command characters are classified within the following five groups:

1. FUNCTION
2. RANGE
3. MODIFIERS
4. CONTROL
5. MEMORY

### FUNCTION COMMAND CHARACTERS

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.


**DC Volts**

**AC Volts**

**DC Coupled AC Volts**

**DC Current**

**AC Current**

Table 606-5. Programming Instructions (cont)

**Z** Ohms

**Z 1** Fast Ohms

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value Rx is computed from the following measurements:

V1-V2: the voltage across an internal precision resistor (Rr)

V0: the voltage across the unknown resistor (Rx).

The value of Rx is then computed with Ohm's Law:

$$Rx = Rr \frac{V0}{V1-V2}$$

Fast Ohms mode differs in that the value of  $\frac{Rr}{(V1-V2)}$  is stored as a constant. The instrument will then find Rx by measuring V0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

#### NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, Rx is not computed by the DMM.

#### RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
<b>R</b>	Auto	Auto	Auto	Auto
<b>R 0</b>	312 mV	Auto	312 $\mu$ A	31.25Ω
<b>R 1</b>	2.5V	2.5V	2.5 mA	250Ω
<b>R 2</b>	20V	20V	20 mA	2 kΩ
<b>R 3</b>	160V	160V	160 mA	32 kΩ
<b>R 4</b>	1200V	1000V	1.28A	256 kΩ
<b>R 5</b>	Auto	Auto	Auto	4.096 MΩ
<b>R 6</b>	Auto	Auto	Auto	32.768 MΩ
<b>R 7</b>	Auto	Auto	Auto	262.144 MΩ

Table 606-5. Programming Instructions (cont)

**MODIFIER COMMAND CHARACTERS****SAMPLES PER READING COMMAND CHARACTERS**

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

<b>S</b>	<b>0</b>	$2^0 = 1 \text{ Sample/Reading (4 ms)}$
<b>S</b>	<b>1</b>	$2^1 = 2 \text{ Samples/Reading (8 ms)}$
<b>S</b>	<b>2</b>	$2^2 = 4 \text{ Samples/Reading (17 ms)}$
<b>S</b>	<b>3</b>	$2^3 = 8 \text{ Samples/Reading (33 ms)}$
<b>S</b>	<b>4</b>	$2^4 = 16 \text{ Samples/Reading (67 ms)}$
<b>S</b>	<b>5</b>	$2^5 = 32 \text{ Samples/Reading (134 ms)}$
<b>S</b>	<b>6</b>	$2^6 = 64 \text{ Samples/Reading (267 ms)}$
<b>S</b>	<b>7</b>	$2^7 = 128 \text{ Samples/Reading (534 ms)}$
<b>H</b>	<b>0</b>	$2^8 = 256 \text{ Samples/Reading (1.1s)}$
<b>H</b>	<b>1</b>	$2^9 = 512 \text{ Samples/Reading (2.1s)}$
<b>H</b>	<b>2</b>	$2^{10} = 1,024 \text{ Samples/Reading (4.3s)}$
<b>H</b>	<b>3</b>	$2^{11} = 2,048 \text{ Samples/Reading (8.5s)}$
<b>H</b>	<b>4</b>	$2^{12} = 4,096 \text{ Samples/Reading (17.1s)}$
<b>H</b>	<b>5</b>	$2^{13} = 8,192 \text{ Samples/Reading (34.1s)}$
<b>H</b>	<b>6</b>	$2^{14} = 16,384 \text{ Samples/Reading (68.3s)}$
<b>H</b>	<b>7</b>	$2^{15} = 32,768 \text{ Samples/Reading (137s)}$
<b>H</b>	<b>8</b>	$2^{16} = 65,536 \text{ Samples/Reading (273s)}$
<b>H</b>	<b>9</b>	$2^{17} = 131,072 \text{ Samples/Reading (546s)}$

Table 606-5. Programming Instructions (cont)

**FILTER COMMAND CHARACTERS**

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

- |          |                                 |   |
|----------|---------------------------------|---|
| <b>F</b> | Slow filter, time-out disabled. |   |
| <b>F</b> | <b>O</b>                        | Fast filter, time-out disabled.                       |
| <b>F</b> | <b>1</b>                        | Bypass filter.  |
| <b>F</b> | <b>2</b>                        | Slow filter, time-out enabled (approximately 500 ms). |
| <b>F</b> | <b>3</b>                        | Fast filter, time-out enabled (approximately 50 ms).  |

**TRIGGER COMMAND CHARACTERS**

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

- |          |  |  |
|----------|--|--|
| <b>T</b> | Continuous reading mode/line synchronized. |  |
| <b>T</b> | <b>O</b>                                   | Single reading mode/line synchronized.     |
| <b>T</b> | <b>1</b>                                   | Continuous reading mode/line asynchronous. |
| <b>T</b> | <b>2</b>                                   | Single reading mode/line asynchronous.     |

*NOTE*

*When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.*

- ◆ When in the continuous mode, any character (except "%" HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"), and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 606-5. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

#### *NOTE*

*The front panel display does not update in this mode unless the controller asks for a reading.*

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

#### OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

- ◆ When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from  $\pm 1 \times 10^9$  to  $\pm 1 \times 10^{-9}$  (including 0.0).



Offset subtracted (ON).



Offset not subtracted (OFF).

#### EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.



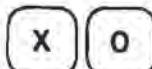
External Reference On, Scaling Off

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle.

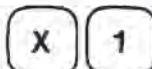
- ◆ Minimum Vxref =  $\pm 0.0001V$  or the input divided by the maximum display with the volts range, whichever is greater (8500A only).
- ◆ For the 8502A, the minimum Vxref is the input divided by  $10^9$ .

Maximum Vxref =  $\pm 40V$  between Ext Ref Hi and Lo terminals, providing neither terminal is greater than  $\pm 20V$  relative to the Sense Lo or Ohms Guard Terminals.

Table 606-5. Programming Instructions (cont)



**External Reference Off,  
Scaling Off**



**External Reference Off,  
Scaling On**

The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read value may not be used as a scaling factor.

- ◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A.
- ◆ For the 8502A minimum =  $10^{-6}$ . Factors less than this will be set to 0, which is not a valid scale factor.

Maximum scaling factor =  $\pm 100$  (8500A), or Input/Max Scale factor  $< 10^{-6}$  (8502A).

#### *NOTE*

*The "X" and "X1" modes are mutually exclusive.*

#### LIMITS AND PEAKS COMMAND CHARACTERS

The "U" command characters specify selection of Limits or Peaks modes.



**Limits Testing On**

When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows:

"0" is transmitted for a reading within limits.

"1" is transmitted for a reading greater than the upper limit.

"-1" is transmitted for a reading less than the lower limit.

"2" is transmitted if an error occurs (e.g., overranging).



**Disable Limits and  
Peak Mode(s)**



**Save Highest and Lowest  
Values (Peaks On)**

Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 606-5. Programming Instructions (cont)

**U**    **1**

**Save Highest and Lowest Values (Peaks On) (cont)**

- ◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

**NOTE**

*Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.*

**CONTROL COMMAND CHARACTERS**

**Output Format**

The "B" characters activate binary or ASCII output format.

**B**

**Single Byte Binary Format**

**B**    **O**

**Single Byte ASCII Format**

● **B**    **1**

**Binary 16-Bit Parallel**

● **B**    **2**

**16-Bit Parallel**

"B1", "B2" used with Parallel ASCII Interface (Option -07) only.

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

**The Binary Output Format**

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

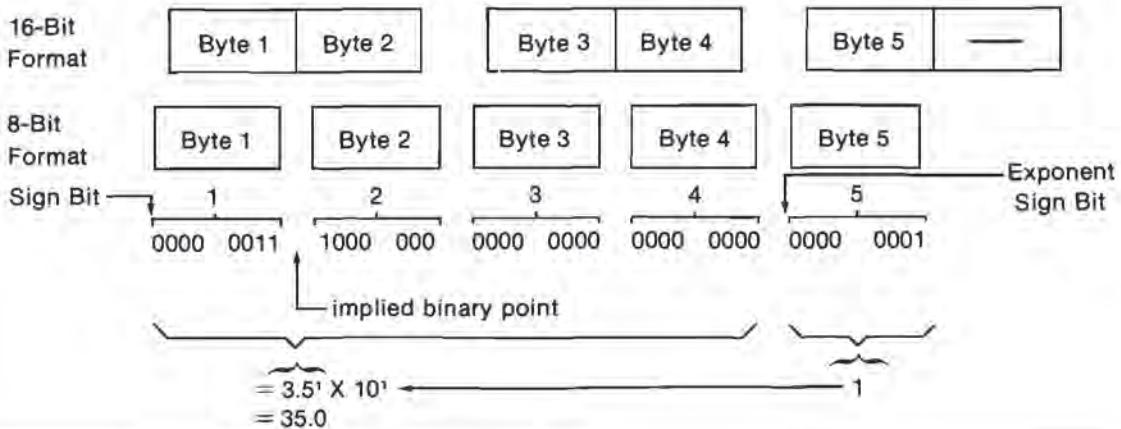
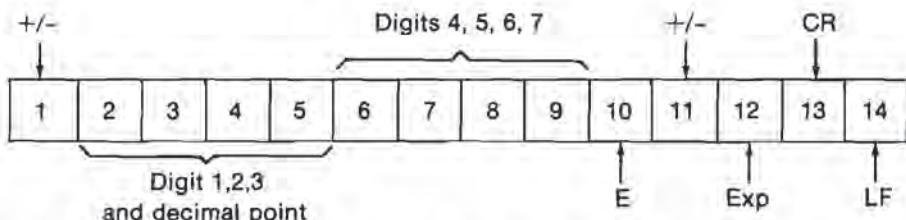


Table 606-5. Programming Instructions (cont)

**NOTE**

*In dc volts and ac volts, the exponent is always 1.  
In dc and ac current, the exponent is always -2.  
The exponent is range dependent in ohms function (1 for ohm ranges, 4 for kohm ranges, and 7 for Mohm ranges).*

Errors will be indicated by 5 bytes of 0.

**ASCII Data Output Format**

The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument. (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

**DISPLAY CONTROL**

The "D" command characters turn the DMM front panel display on or off.

**D** Display Off

**D O** Display On

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

**LOCAL LOCKOUT CONTROL**

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.

**L** Local Lockout On

**L O** Local Lockout Off

**ECHO COMMAND CHARACTERS**

● (used with Bit Serial Option -06 only)

**Y** ECHO ON (Full-Duplex)

**Y O** ECHO OFF (Half-Duplex)

Table 606-5. Programming Instructions (cont)

**LINE FEED CONTROL COMMAND CHARACTERS**

- |                   |                                     |   |
|-------------------|-------------------------------------|---|
| <b>J</b>          | <b>Suppress Line Feed Character</b> | This character suppresses the LF character normally sent at the end of a response line.   |
| <b>J</b> <b>O</b> | <b>Transmit Line Feed Character</b> | This character disables the "J" character; the "LF" character will be sent.   |
| <b>J</b> <b>1</b> | <b>Suppress Output of Readings</b>  | ◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode. |

**CALIBRATION CONSTANT**

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

- |                   |   |
|-------------------|---|
| <b>M</b>          | <b>Inhibit Calibration Memory Factors</b> |
| <b>M</b> <b>O</b> | <b>Enable Calibration Memory Factors</b>  |

**TRIGGER COMMAND CHARACTERS**

◆ This set of command characters is available for the 8502A with the Isolator Option -08A.

- |                   |  |   |
|-------------------|--|---|
| <b>Q</b>          | <b>Activate External Triggering Mode, Interrupt when Ready</b> | This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ). |
| <b>Q</b> <b>O</b> | <b>Deactivate External Triggering Mode</b>                     |   |
| <b>Q</b> <b>1</b> | <b>Activate External Triggering Mode, Transmit when Ready</b>  | The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.                     |

**NOTE**

*The "?" and "@" characters remain operative during External Triggering.*

Table 606-5. Programming Instructions (cont)

**◆ EXTERNAL TRIGGER DELAY COMMAND CHARACTERS  
(-08A with 8502A only)**

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

<b>W</b>	<b>No Delay</b>		
<b>W</b>	<b>0</b>	<b>2.083 ms</b>	
<b>W</b>	<b>1</b>	<b>4.166 ms</b>	
<b>W</b>	<b>2</b>	<b>8.332 ms</b>	
<b>W</b>	<b>3</b>	<b>16.66 ms</b>	
<b>W</b>	<b>4</b>	<b>33.33 ms</b>	
<b>W</b>	<b>5</b>	<b>66.66 ms</b>	
<b>W</b>	<b>6</b>	<b>133.3 ms</b>	
<b>W</b>	<b>7</b>	<b>266.6 ms</b>	
<b>W</b>	<b>8</b>	<b>533.2 ms</b>	
<b>W</b>	<b>9</b>	<b>1.066s</b>	
<b>W</b>	<b>1</b>	<b>0</b>	<b>2.133s</b>
<b>W</b>	<b>1</b>	<b>1</b>	<b>4.266s</b>
<b>W</b>	<b>1</b>	<b>2</b>	<b>8.532s</b>
<b>W</b>	<b>1</b>	<b>3</b>	<b>17.06s</b>
<b>W</b>	<b>1</b>	<b>4</b>	<b>34.13s</b>
<b>W</b>	<b>1</b>	<b>5</b>	<b>68.26s</b>

Table 606-5. Programming Instructions (cont)

**MEMORY COMMAND CHARACTERS****STORE**

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

**K** Store Last Reading as Offset

◆ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.

**K O** Store Last Voltage Taken as VDC Zero (on R0 Only)

**K 1** Store Last Reading as Ohms Zero (on R0 Only)

**K N P** Store Numeric Value Following as Offset

**K N X** Store Numeric Value Following as Scaling Factor

(Note: The read value may not be stored as a Scaling Factor.)

**K N U** Store Numeric Value Following as Upper Limit

**K N L** Store Numeric Value Following as Lower Limit

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

**K N P 1 0**

Keep Numeric offset of 10.0

**K N X 1 0 . 3 E - 1**

Keep numeric scaling factor of  $10.3 \times 10^{-1}$  or 1.03

**K N U 7 . 6 E 4**

Keep numeric upper limit of  $7.6 \times 10^4$

**K N L - 1 2 3 . 4 5 6 E + 0**

Keep numeric lower limit of -123.456

Table 606-5. Programming Instructions (cont)

An example of an illegal numeric string is:



Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

#### *NOTE*

*Numeric entries are limited to the maximum display value. These values are:*

*+1.00000 E +9 to +1.00000 E -9, and -1.00000 E -9 to -1.00000 E +9*

*Numbers less than the ±1.00000 E -9 are treated as zero.*

#### **RECALL**

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

**G**      Recall Previous Reading and Send on Next Trigger

**G** **O**      Recall DC Zero and Send on Next Trigger

**G** **1**      Recall Status and Send on Next Trigger

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

#### **Error Codes**

1	2					
---	---	--	--	--	--	--

Characters 1 and 2 define error code status. Each error code contains two digits: those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

- 00 No Error
- 06 System Error
- 07 Illegal Numeric Entry
- 08 Remote Command String Error
- 09 Remote Overrange
- 10 V DC Zero/Ohms Zero Error
- ◆ 11 Offset Error (850QA) Store during Overrange (8502A)

Table 606-5. Programming Instructions (cont)

**Error Codes (cont)**

- 12 Filter Module Faulty or not installed
- 13 DC Signal Conditioner Module Faulty or not installed
- 14 Excessive voltage present at terminals for Ohms/Current Measurement
- 15 Fast A/D Converter Faulty or not installed
- 16 Numeric Display Overflow
- 17 Magnitude of External Reference Input >20V
- 18 Controller Module Faulty
- 19 Function Module selected not installed

**Range Codes**

		3				
--	--	---	--	--	--	--

The third character of the status response contains the following range information:

- 0 100 mV dc, 100  $\mu$ A, 10 $\Omega$
- 1 1V dc, 1V ac, 1 mA, 100 $\Omega$
- 2 10V dc, 10V ac, 10 mA, 1k $\Omega$
- 3 100V dc, 100V ac, 100 mA, 10 k $\Omega$
- 4 1000V dc, 1000V ac, 1A, 100 k $\Omega$
- 5 1 M $\Omega$
- 6 10 M $\Omega$
- 7 100 M $\Omega$

**Sample Codes**

			4			
--	--	--	---	--	--	--

The fourth status response character contains sample information identified by the following codes:

- 0 1 Sample per Reading
- 1 2 Samples per Reading
- 2 4 Samples per Reading
- 3 8 Samples per Reading
- 4 16 Samples per Reading
- 5 32 Samples per Reading
- 6 64 Samples per Reading
- 7 128 Samples per Reading or Greater

**Function Codes**

				5	<CR>	<LF>
--	--	--	--	---	------	------

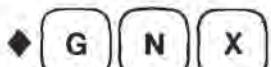
The fifth response character identifies function:

- 0 DC Volts
- 1 AC Volts
- 2 DC Amps
- 3 AC Amps
- 4 Ohms
- 5 DC Coupled AC Volts
- 7 Function Not Defined

Table 606-5. Programming Instructions (cont)

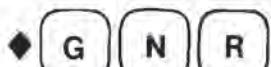
G N P

Recall Offset and Send on Next Trigger

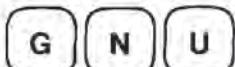
♦ G N X

Recall External Ref or Scaling Factor and Send on Next Trigger (8500A)

Recall Scaling Factor (8502A)

♦ G N R

Recall External Reference Factor and Send on Next Trigger (8502A)

G N U

Recall Upper and Send on Next Trigger

G N L

Recall Lower Limit and Send on Next Trigger

*NOTE*

*The instrument will replay to "GNU" or "GNL" by transmitting the stored limit value.*

G N Q

Recall Lowest (Peak) Value Found and Send on Next Trigger

G N W

Recall Highest (Peak) Value Found and Send on Next Trigger

Table 606-6. Bit Serial Asynchronous Interface Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	BIT SERIAL ASYNCHRONOUS INTERFACE ASSY FIGURE 606-2 (MIS-4170)			OPTION MIS-06	1		
C1	CAP, TANT, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	3		
C2	CAP, TANT, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP, TANT, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C4	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	2		
C5	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C7	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C8	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C9	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, HIGH-SPEED SWITCHING	203323	07910	IN4448	1		
H1	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H2	SCREW, 6-32 X 1/4	320093	89536	320093	2		
H3	SPRING, COIL	424465	83553	C0120-014-0380	1		
H4	SPRING CLIP ASSY KIT	330134	02660	17-529	1		
H5	SCREW, 4-40 X 3/8	256164	89536	256164	1		
J1	CONNECTOR, D, SUB-MINI	413898	71785	DB25PV	1		
MP1	BAG, ANTI-STATIC (NOT SHOWN)	453548	89536	453548	1		
MP2	CASE HALF, MODULE	402990	89536	402990	1		
MP3	CASE HALF, MODULE, MODIFIED	412031	89536	412031	1		
MP4	COVER, MODULE CASE	402974	89536	402974	1		
MP5	DECAL	413492	89536	413492	1		
MP6	DECAL, CAUTION	454504	89536	454504	1		
MP7	GUARD, REAR	383364	89536	383364	1		
MP8	SHIELD, COVER	411983	89536	411983	1		
MP9	SHIELD, FRONT	383372	89536	383372	1		
Q1	XSTR, NPN, SI	218396	04713	2N3904	1	1	
Q2	XSTR, PNP, SI	226290	04713	MPS3640	1	1	
Q3	XSTR, PNP, SI	195974	04713	2N3906	1	1	
R1	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	2		
R2	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	1		
R3	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	1		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	REF		
R5	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
R6	RES, COMP, 33K +/-5%, 1/4W	148155	01121	CB3335	1		
R7	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	2		
R8	RES, COMP, 2.2K +/-5%, 1/4W	148049	01121	CB2225	1		
R9	RES, COMP, 47 +/-5%, 1/4W	147892	01121	CB4705	1		
R10	RES, COMP, 750 +/-5%, 1/4W	218024	01121	CB7515	1		
R11	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	3		
R12	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R13	RES, COMP, 620 +/-5%, 1/4W	221903	01121	CB6215	1		
R14	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	REF		
R15	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
S1	SWITCH, SPST, 8-POS.	414490	00779	435166-5	1		
U1	IC, TTL, DUAL EIA/MIL LINE RECEIVER	354704	18324	8T16A	1	1	
U2	IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	1	1	
U3	IC, C-MOS, PRGMBLE BIT RATE GEN	418731	07263	F4702/34702	1	1	
U4	IC, TTL, MSI, DUAL EIA/MTL	354696	18324	N8T15A	1	1	

Table 606-6. Bit Serial Asynchronous Interface Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U5	② IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U6	② IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	2	1	
U7	② IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	REF		
U8	② IC, C-MOS, TRI, HEX, NON INV BUFFERS	407759	12040	MM80C97N	1	1	
U9	IC, UA, RECEIVER TRANSMITAL	354753	05828	AY-5-1013	1	1	
U10	② IC, C-MOS, TRIPLE, 3-INPUT AND GATE	408807	02735	CD4073BE	1	1	
U11	② IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U12	② IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	1	1	
U13	② IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	REF		
V1	CRYSTAL, QUARTZ	435370	89536	435370	1		
XU9	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		

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## Option —08 Isolator

### **608-1. INTRODUCTION**

608-2. When an i/o interface (Options —05, —06, or —07) is installed, the Isolator must be installed to maintain the guarded nature of the analog bus. The module serially isolates the analog signal processing and conversion from the digital processing, control display, and input/output. The maximum allowable difference in potential between guard and logic common is 1000 volts.

### **608-3. INSTALLATION**

608-4. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing a module. The isolator should replace the Interconnect pcb. The interconnect diagram in Section 8 contains a table showing the location of the slot.

### **608-5. OPERATING NOTES**

608-6. Installation of the Isolator does not affect the operation of the instrument.

### **608-7. THEORY OF OPERATION**

608-8. The Isolator accepts parallel data and address bytes, shifts them to serial format for transfer across isolation transformers, and converts them back to parallel format. Seven address lines are used for addressing analog modules with two lines (IC5 and 6) always low. Only one analog module sends data back to the controller; the A/D Converter uses ID7 to form its bit serial data stream. When the Isolator is installed Vcc and Vss in the unguarded bus are isolated from analog common. Refer to the schematic, Figure 608-3, for the following discussion.

608-9. Two types of addresses may be sent from the controller to an analog module: a 3-of-7 address accompanied by data used to set up a module or a 2-of-7 indirect address sent to the A/D Converter to obtain a data bit. Address lines IC0-4 are applied through inverters

to shift registers U3 and U7. Module set-up addresses must have one of IC0, 3, or 4 high, which places a low at one input of U10-6. U6-2 goes low, inhibiting U9-11 and enabling U10-8 to go high. All analog module addresses are formed with ones on IC0-4 so IC5 and 6 will be low. U12-11 and U12-3 go high enabling U10-12 to go low. The low going signal from U10-12 clocks a one-shot, U8-4. The consequent low from U8-4 loads data on ID0-7 and the address into U3 and U7. The low from U8-4 also disables a relaxation oscillator, U9-6 and U9-3, which runs at approximately 7.5 MHz. At the end of the load time determined by R2 and C2, U8-4 goes high which enables the oscillator.

608-10. Oscillator pulses from U11-4 and U11-10 clock data serially out of U7 and U3 (from U3-9), through U4 and the isolation transformers (T1, T2, T3, T4) and into U20 and U16. Note that one data input to U3-5 is Vcc, which ensures that data bit is high. As data is clocked serially into U20 and U16, U16-11 goes high when data loading is complete. This puts a high on U19-12, disabling the clock pulses from U24-4, and a high on U23-10, clocking U23-12 low, which enables the address gates, U22 and U26-4. Data from U20 and U16 is applied through buffers to the ID lines.

608-11. The low from U23-12 also enables U19-1 so that when the ACK is returned, U25-6 goes low and U19-1 goes high. U19-1 high enables a clock pulse from U24-4 and U24-12 to be applied through U15-3, U15-6, T8, and T7 to clock U8-10, resulting in an ACK signal from U8-12 through U5-6 and Q1.

608-12. In the case of indirect address, IC1, 2, U9-11 is no longer disabled. The above sequence of address and data transfer takes place. Of course there is no data to be sent to the A/D Converter; instead the controller is requesting data to be sent on ID7. Outputs from the address gates, U22 and U26-4, are decoded by U25-9 and U18-4 to cause a high at U18-3. This places U21-13 in the high impedance mode and enables U19-4 through U25-10. The data bit

returned on ID7 is applied through U26-3 and U19-4 to enable U15-8 and U15-11. A clock pulse from U24-4 and U24-12 through U15-11, U15-8, T6, and T5 clocks U14-5. This places a high at U13-10 (provided ID7 is high). U13-9 is enabled by U9-11 through U12-10 and U12-4. If ID7 is low, U19-4 does not go high.

608-13. During the load period (a low from U8-4), the clock (U9-3, U9-6) is disabled. Clock pulses from U24-4 are applied to a retriggerable monostable multivibrator, U23-13. When the clock pulses are disabled, U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

#### 608-14. TROUBLESHOOTING

608-15. Figure 608-1 gives a symptom analysis approach to troubleshooting the Isolator module.

#### 608-16. PARTS LIST

608-17. Table 608-1 gives a parts breakdown for the Isolator module. Refer to Section 5 of this manual for ordering information.

**CAUTION** 

Indicated devices are subject to damage by static discharge.

Figure 608-1. Isolator Troubleshooting

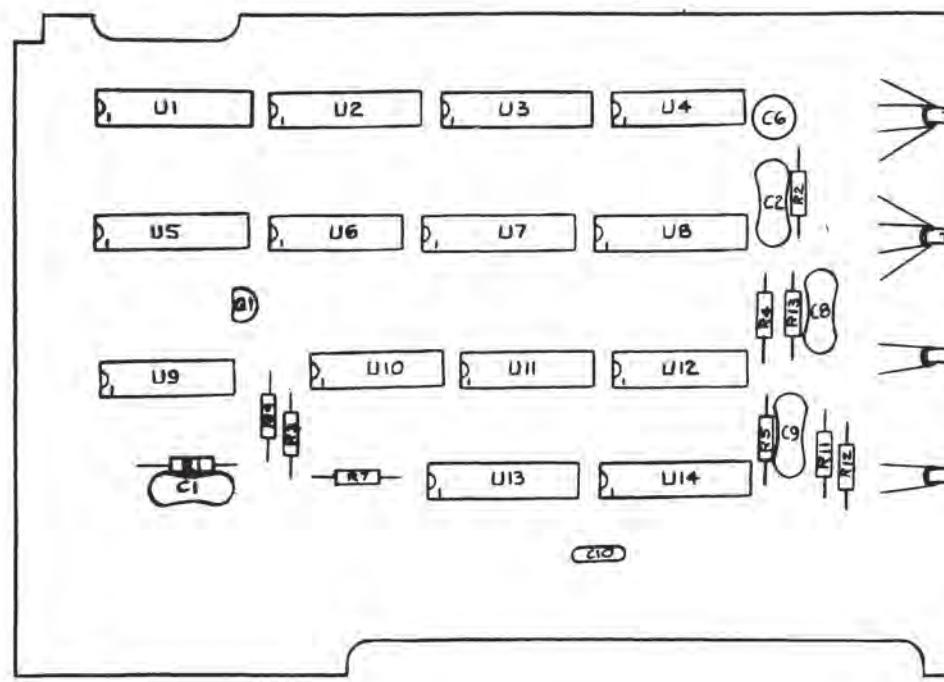
SYMPTOM	POSSIBLE FAILURE
No Display at Power On	IC line held low U5, U12
Display Bad	IC line held high U5, U12 ID line held high or low U1, U2, U13
<b>UNGUARDED SECTION</b>	
Error 9 at Power On	Oscillator check U11 – 10 Shift Register U13 – 1, U7 Not transferring pulses U4, core windings ACK bad U9, U5, Q1, U6, U7
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U14, U13, core winding U12, U10, U9
<b>GUARDED SECTION</b>	
Error 9 or Configuration Wrong	U19 – 10, U16 – 1, U23 – 13 (Address, Data) U25, U19, U15, U24 (ACK) U24, U23 (Address)
Can't Call Proper Ranges	U16, U21, U18
Constant Bad Reading Displayed	U18, U26, U25, U19, U15 (ID7)

Table 608-1. MIS-4181 Isolator Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
⊗	<b>ISOLATOR ASSEMBLY</b> Figure: 608-2	383877	89536	383877	REF		
C1, C4	Cap, mica, 220 pF $\pm 5\%$ , 500V	170423	72136	DM15F220J	2		
C2	Cap, mica, 18 pF $\pm 5\%$ , 500V	266585	72136	DM15C180J	1		
C3	Cap, mica, 180 pF $\pm 5\%$ , 500V	148460	72136	DM15F181J	1		
C5	Cap, mica, 68 pF $\pm 5\%$ , 500V	148510	72136	DM15F680J	1		
C6	Cap, Ta, 39 uF $\pm 20\%$ , 6V	163915	56289	196D396X0006 KA1	1		
C7	Cap, elect, 150 uF $-10/+50\%$ , 16V	186296	73445	ET151X016A5	1	1	
C8, C9	Cap, mica, 27 pF $\pm 5\%$ , 500V	177998	72136	DM15E270J	2		
C10, C12, C13	Cap, cer, 0.22 uF $\pm 20\%$ , 50V	309849	71590	CW30C224K	3		
C11	Cap, cer, 4700 pF $\pm 10\%$ , 500V	106724	71590	CF472	1		
Q1	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, comp, 220 $\pm 5\%$ , 1/4W	147959	01121	CB2215	1		
R2, R5, R8 thru R13	Res, comp, 10k $\pm 5\%$ , 1/4W	148106	01121	CB1035	8		
R3	Res, comp, 47k $\pm 5\%$ , 1/4W	148163	01121	CB4735	1		
R4, R7	Res, comp, 4.7k $\pm 5\%$ , 1/4W	148072	01121	CB4725	2		
R6	Res, comp, 1k $\pm 5\%$ , 1/4W	148032	01121	CB1025	1		
R14	Res, comp, 150 $\pm 5\%$ , 1/4W	147934	01121	CB1515	1		
R15	Res, comp, 470 $\pm 5\%$ , 1/4W	147983	01121	CB4715	1		
T1, T3, T6, T8	Inductor	437608	89536	437608	4		
T2, T4, T5, T7	Inductor	437590	89536	437590	4		
U1, U2, U5	⊗ IC, Dgtl, C-MOS, hex, buffer/inverter	381830	02735	CD4050AE	3	1	
U3, U7	IC, TTL, MSI, 8-bit shift register	293118	01295	SN74165N	2	1	
U4, U15	IC, Dgtl, TTL, quad, 2-input, hi-vol, NAND	408021	01295	SN7426N	2	1	

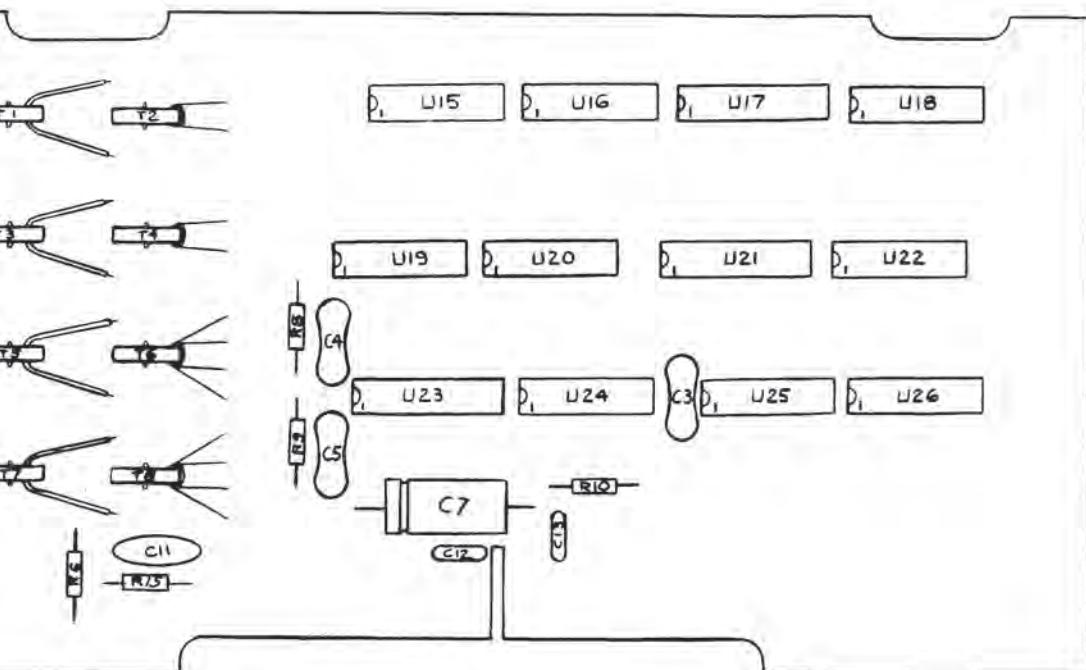
Table 608-1. MIS-4181 Isolator Assembly (Concluded)

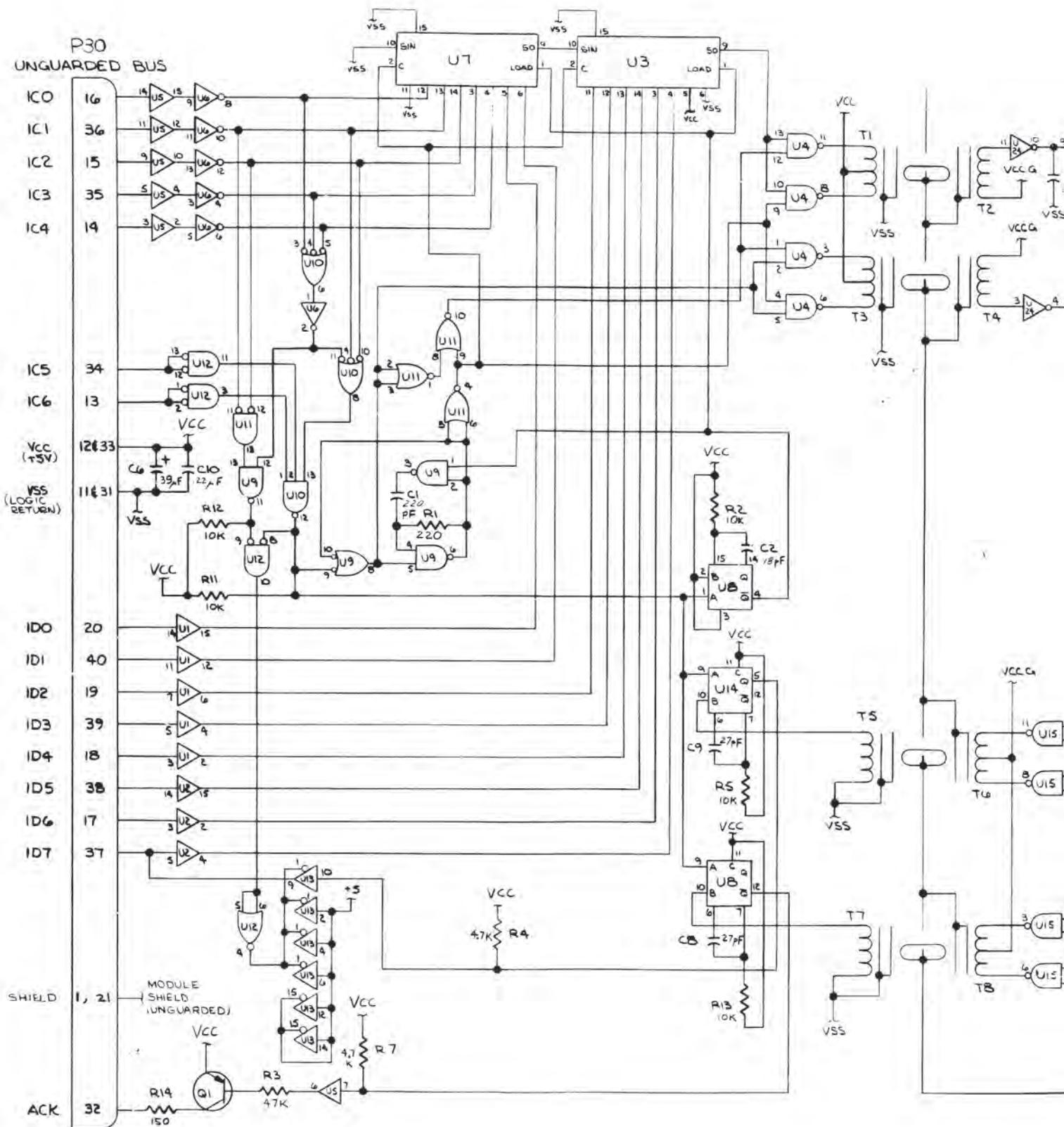
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U6, U24	IC, Dgtl, TTL, hex inverter	393058	01295	SN74LS04N	2	1	
U8, U14, U23	IC, Dgtl, TTL, lo-pwr	404186	01295	SN74LS123N	3	1	
U9	IC, Dgtl, TTL, quad 2-input, NAND gate	363580	01295	SN74S00N	1	1	
U10	IC, Dgtl, TTL, triple, input, POS NAND gates	393074	01295	SN74LS10N	1	1	
U11, U19	IC, Dgtl, POS NOR gates, w/totempole output	393041	01295	SN74LS02N	2	1	
U12, U22, U26	IC, Dgtl, COS/MOS, NOR gates	355172	02735	CD4001AE	3	1	
U13, U21	IC, Dgtl, C-MOS, tri-state, hex, non-inverting buffers	407759	12040	MM80C97N	2	1	
U16, U20	IC, TTL, 8-bit serial-in parallel-out, shift register	272138	01295	SN74164N	2	1	
U17	Res Network, 10k, 16 pin	355305	89536	355305	1	1	
U18	IC, Dgtl, C-MOS, quad, 2-input AND gate	408401	02735	CD4081BE	1	1	
U25	IC, C-MOS, NOR gates	355180	02735	CD4025AE	1	1	
	Case half, module	402990	89536	402990	2		
	Cover, module case	402974	89536	402974	1		
	Decal Isolator	413534	89536	413534	1		
	Guard, front, left	437921	89536	437921	1		
	Guard, front, right	401513	89536	401513	1		
	Guard, rear, left	437947	89536	437947	1		
	Guard, rear, right	383349	89536	383349	1		
	Shield, cover	437939	89536	437939	2		



**NOTES:**

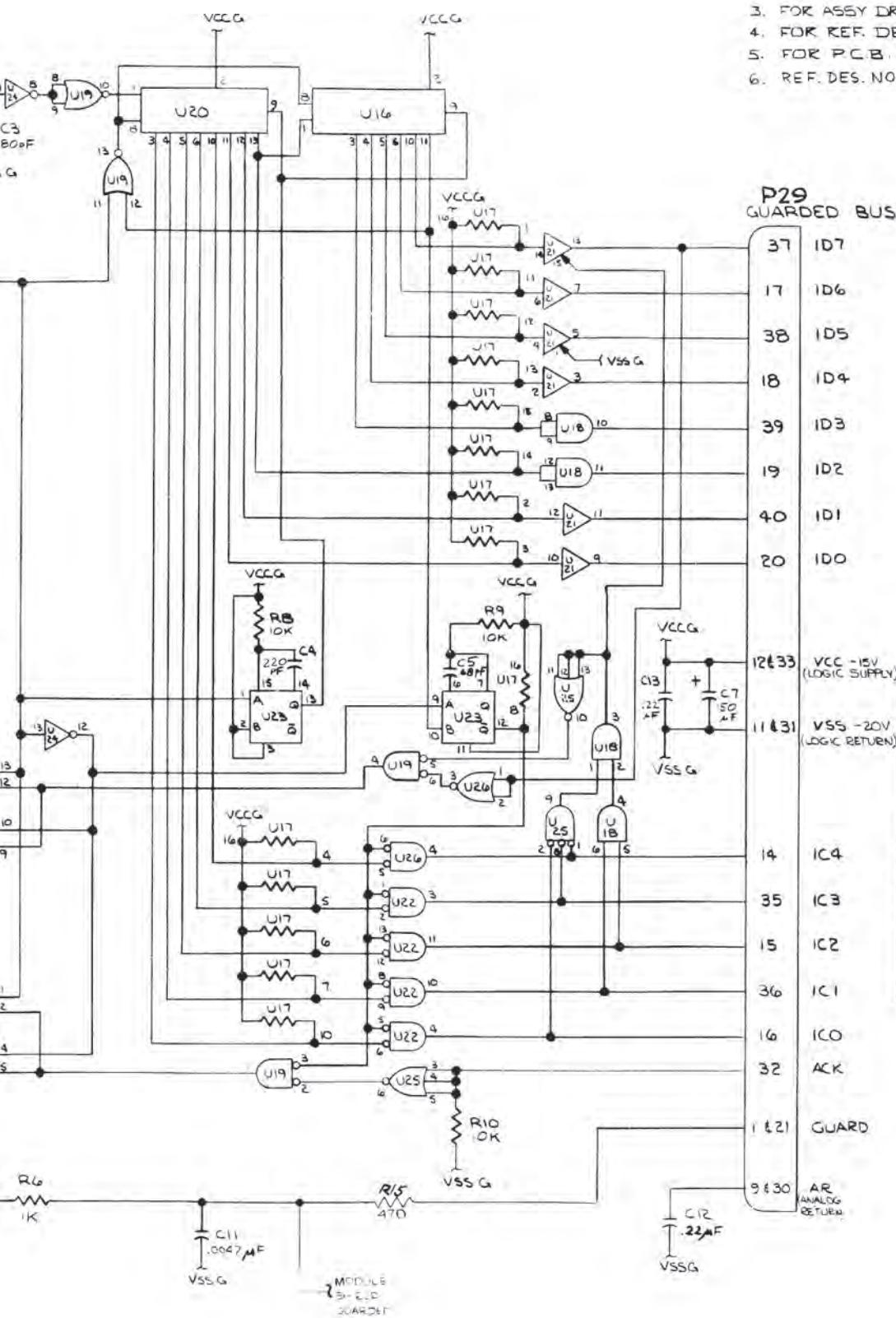
1. FOR ASSY DRAWING SEE M.I.S. - 4181.
2. FOR PCB SEE M.I.S. - 3181.
3. FOR SCHEMATIC SEE M.I.S. - 1181





NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C. 1/4W ±%
3. FOR ASSY DRAWING SEE M15-4181
4. FOR REF. DES. DRAWING SEE M15-1781
5. FOR P.C.B. SEE M15-3181
6. REF. DES. NO. LAST USED C13, R15, U26, Q1, TB.

**P29 GUARDED BUS**

37 ID7  
17 ID6  
38 ID5  
18 ID4  
39 ID3  
19 ID2  
40 ID1  
20 ID0

UNGUARDED BUS SIDE		
I.C. NO.	VCC	VSS
U1	1, 9	B
U2	1, 9, 11	B, 7
U3, U7, U8, U13, U14	16	B
U4, U6, U9, U10, U11, U12	14	7
U5	1	B

GUARDED BUS SIDE		
I.C. NO.	VCC G	VSS G
U15, U16, U1B, U19, U20, U22, U24, U25	14	7
U21, U23	16	B
U26	B, 9, 12, B, 14	7

16 IC0  
32 ACK  
1421 GUARD

9E30 AR ANALOG RETURN

## Option —09A AC/DC Converter (RMS)

### **609A-1. INTRODUCTION**

609A-2. The AC/DC Converter (RMS) is used to provide accurate ac or ac + dc measurements without error due to waveform distortion. Measurements up to 1000 Vac in four ranges with a bandwidth of 10 Hz to 300 kHz may be made (input volt-hertz product not to exceed  $2 \times 10^7$ ). Input impedance is  $1 \text{ M}\Omega$  shunted by less than 100 pf.

### **609A-3. SPECIFICATIONS**

609A-4. Table 609-1 lists the specifications for the true RMS Converter.

### **609A-5. INSTALLATION**

609A-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the AC/DC Converter (RMS) module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

### **609A-7. OPERATING NOTES**

609A-8. Operation of the front panel controls is the same as described in Section 2. An ac voltage on a dc level may be measured by depressing both the Vdc and the Vac function switches at the same time. The reading displayed will be the rms value of the two voltages combined. External reference inputs at the rear panel must be dc voltages only. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.

### **609A-9. THEORY OF OPERATION**

609A-10. The function of the RMS Converter is to accept signals from either the input terminals or the optional

Current Shunts module and to convert the input signal to a dc level proportional to the rms value of the input. The dc output from the RMS Converter is routed on the Guarded Bus to the Active Filter module and then to the A/D Converter. True rms conversion is mathematically obtained by averaging the squared value of the input, then taking the square root ( $V_{rms} = \sqrt{V_{in}^2}$ ). Limitations to the realization of this mathematical formula using operational techniques are crest factor (ratio of peak value to rms value, limited by the dynamic range of the amplifiers), frequency response, and accuracy.

609A-11. Input signals are applied to the Range Amplifier (Q1, U3) to be brought within the 1V rms range. Refer to Figure 609A-1. Before a signal can be operationally squared, it must be converted to an absolute value. Balance Amplifier (U4, Q10) performs this function by inverting and rectifying the signal from U3. Outputs from the Range Amplifier and the Balance Amplifier are applied through R33 and R31 to the summing node of the Squaring Amplifier (U5, Q11). Due to the ratio of R33 to R31, the inverted negative half-cycles from the Balance Amplifier are twice the amplitude of the negative half-cycles from the Range Amplifier. When summed, the waveform is the absolute value of the output from the Range Amplifier. The conversion to rms is performed by the Squaring Amplifier, Integrator, and Square Root Amplifier. Implementation of these functions depends on the logarithmic response of PN junctions. Since two PN junctions are used in each of two parts of a feedback loop, a double logarithmic response is generated ( $2 \log X = \log X^2$ ). The Squaring Amplifier converts the signal to a current flowing through the emitters of two transistors, Q8A and Q12A. These two transistors are configured with two additional transistors, Q12B and Q8B, in a feedback loop which constrains the output voltage to be the square root of the integral of the square of the current flowing in Q8A and Q12A.

Table 609A-1. AC/DC Converter (RMS) Specifications

ACCURACY									
(Refer to Section 1 for required environmental conditions)									
Accuracy (0.1% of Range to Full Scale)									
Frequency	24 Hours			90 Days			1 Year		
	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC
DC	0.075	—	0.03	0.1	—	0.03	0.2	—	0.06
10 Hz to 20 Hz	0.75	0.04	0.06	1.0	0.04	0.06	2.0	0.08	0.12
20 Hz to 50 Hz	0.35	0.012	0.03	0.5	0.012	0.03	1.0	0.04	0.06
50 Hz to 10 kHz	0.075	0.012	0.03	0.1	0.012	0.03	0.2	0.04	0.06
10 kHz to 30 kHz	0.15	0.04	0.06	0.2	0.04	0.06	0.4	0.08	0.12
30 kHz to 50 kHz	0.2	0.1	0.12	0.3	0.1	0.12	0.6	0.6	0.25
50 kHz to 100 kHz	0.75	0.3	0.3	1.0	0.3	0.3	2.0	0.6	0.6
100 kHz to 300 kHz	1.5	0.5	0.5	2.0	0.5	0.5	4.0	1.0	1.0
300 kHz to 1 MHz	2.9	1.2	1.3	—	—	—	—	—	—

NOTES: 1. Slow Filter must be used for full accuracy below 400 Hz.

2. Volt-Hertz product not to exceed  $2 \times 10^7$

3. For inputs above 500V, multiply accuracy by:

$$\left( \frac{2000V + V_{in}}{2000V} \right)$$

INSTRUMENT OPERATING CHARACTERISTICS																		
INPUT CHARACTERISTICS					SETTLING TIME (To within 0.1%)													
Range	Full Scale	Resolution		Impedance														
		Normal	High		100 ms, Fast Filter	500 ms, Slow Filter												
1V	2.5V	10 uV	1 uV	1 MΩ, <100 pF	COMMON MODE REJECTION (100Ω Unbalance) 120 dB, dc to 60 Hz													
10V	20V	100 uV	10 uV															
100V	160V	1 mV	100 uV															
1000V	1000V	10 mV	1 mV															
MAXIMUM INPUT																		
1000V rms of $2 \times 10^7$ volt-hertz product, whichever is less.																		
TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)																		
AC* Only		$\pm(40 \text{ ppm or Reading} + 20 \text{ ppm f.s.})/\text{°C}$		DIGITIZING	Same as dc volts													
AC* + DC		$\pm(40 \text{ ppm of Reading} + 40 \text{ ppm f.s.})/\text{°C}$																
*Frequencies <10 kHz																		

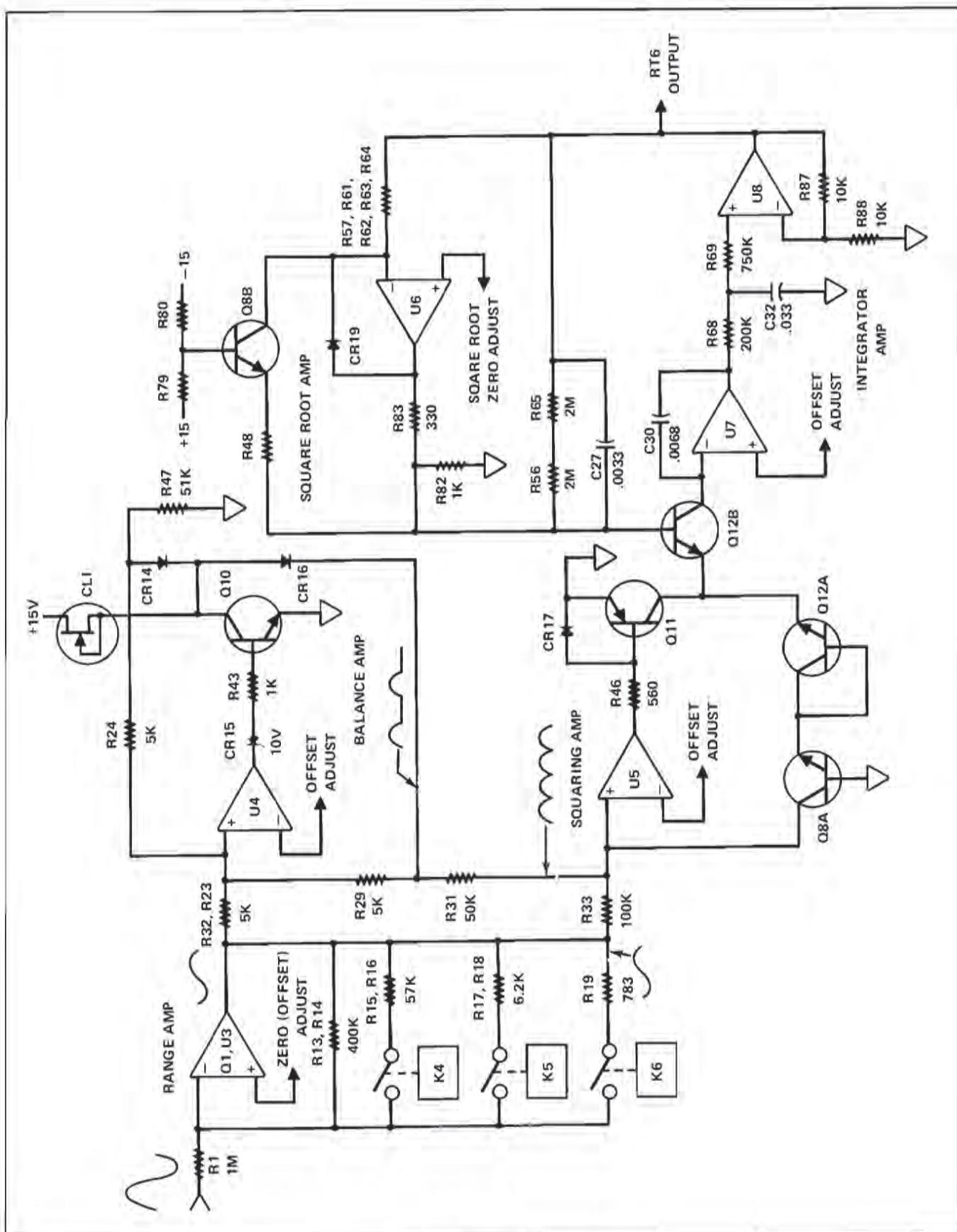


Figure 609A-1. AC/DC Converter (RMS)

**609A-12. Circuit Description**

609A-13. Refer to the schematic for the following discussion.

**609A-14. RANGE AMPLIFIER**

609A-15. The Range Amplifier is an inverting amplifier with gain control provided by switching feedback impedances. Feedback impedances are controlled by relays K4, K5, or K6, and consist of parallel resistors and capacitors adjusted for proper gain and frequency response. Relays K1, K2, and K7 control the input to the amplifier. K1 is energized for inputs from the input terminals. K7 is energized for inputs from the Current Shunts module. K2 is energized when selecting ac + dc measurements. Gain of the amplifier is set for a 1V rms output with a full-scale sine wave input with the exception of the 1000V range in which the full-scale output is .8V rms. Q1 and U3 provide the forward gain of the amplifier. CR6, CR7, CR21, and CR22 provide input protection. Q2 drives the guard for the summing node of the operational amplifier.

**609A-16. BALANCE AMPLIFIER**

609A-17. The Balance Amplifier is an inverting, unity-gain amplifier with diodes in the feedback paths to provide rectification. CL1 and Q10 are configured as a current source driven by U4. A high impedance current source is used to minimize the effects of the diodes on the gain of the amplifier. Due to the unity gain of the inverting amplifier and the ratio of R33 to R31, the negative half-cycles from the Range Amplifier are summed with positive half-cycles having twice the amplitude from the Balance Amplifier. The result is the absolute value of the output from the Range Amplifier. Q6 is used to extend the frequency response of the amplifier.

**609A-18. COMPUTATION**

609A-19. The Squaring Amplifier, Square Root Amplifier, and Integrator Amplifier work together to perform the rms conversion. This is accomplished by regulating the current in four transistors, Q8A, Q12A, Q8B, and Q12B, matched for temperature coefficient and response characteristics. The Squaring Amplifier sums the outputs from the Range Amplifier and the Balance Amplifier such that the current flowing through its feedback path (Q8A, Q12A) is proportional to the absolute value of the input signal. Forward gain of the amplifier is provided by U5 and Q11 with Q7 extending the frequency response.

609A-20. Q12B is configured such that the integral of its collector current is the output voltage. U7 and U8 integrate the collector current of Q12B. Q8B is configured such that its collector current is proportional to the output voltage. The current through Q8B controls the gain of U6, the Square Root Amplifier, which in turn partially controls the current flowing in Q12B. The integrating time constant

of U7 and U8 is determined by R56 and R65 in parallel with C27 or C27 plus C28, depending on which filter is selected from the front panel. The proportionality constant of the converter is such that a full-scale input produces a 20V output on RT6.

**609A-21. MAINTENANCE****609A-22. Performance Test**

609A-23. Use the following procedure as a performance determination for the AC/DC Converter (RMS). The DC Volts Performance Test given in Section 4 should be done first to ensure proper DC accuracy.

1. Select AC Volts and Autoranging.
2. Connect the AC Calibrator output to the instrument input terminals.
3. Sequentially apply the input voltages and frequencies listed in Table 609A-2, verifying that the instrument reading is within the listed tolerance.
4. Disconnect the AC Calibrator and connect the DC Calibrator.
5. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
6. Select an output from the DC Calibrator of +10.0000 Vdc.
7. The instrument display should be within 9.9840 and 10.0160.
8. Reverse the leads at the output of the DC Calibrator. The display should still read within the limits of Step 8.

**Table 609A-2. Performance Test**

INPUT		8500A READING	
FREQ	VOLTAGE	LOW	HIGH
10 kHz	1 V	0.99870	1.00130
50 kHz	1 V	0.99450	1.00550
10 kHz	10 V	9.9876	10.0124
50 kHz	10 V	9.9500	10.0500
10 kHz	100 V	99.881	100.119
50 kHz	100 V	99.540	100.460
10 kHz	1000 V	998.48	1001.52

**609A-24. Calibration**

609A-25. Before calibrating the RMS Converter, perform the DC Calibration procedure in Section 4. Remove the Calibration Memory if installed and allow a one hour warm-up. Allow adequate warm-up time for the Calibrator used, as specified in the Calibrator manual. After calibration is complete, reinstall the Calibration Memory and enter new values at the cardinal points of each range (zero may be entered).

609A-26. Use the following procedure to calibrate the AC/DC Converter (RMS). All adjustments given are on the RMS Converter and are accessible at the top of the module. R66, R55, C24 and R38 are adjustments not accessible from the top of the module which should not require adjustment unless parts have been replaced. Adjustment procedures for these adjustments are given in Troubleshooting in this section of the manual.

609A-27. Range Zero Adjustment is accomplished using the following steps:

1. Select the 10V range.
2. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
3. Connect the test DVM HI to TP5, LO to TP1.
4. Short the input terminals.
5. Adjust R12, RANGE ZERO, for a reading on the test DVM of  $0 \pm 30 \mu V$ .
6. Remove the input short and the test DVM.

609A-28. Balance Zero Adjustment is accomplished using the following steps:

1. Apply -0.2000000 to the input terminals from the DC Calibrator. Record the reading.
2. Reverse the polarity of the input.
3. Adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
4. Reverse polarity again. Readjust R42 until the readings are within  $10 \mu V$  for either polarity without further adjustment.

609A-29. Balance Gain Adjustment is accomplished using the following steps:

1. Select the Cal mode (CAL switch down, CAL indicator illuminated). Ignore the cal digit for the remainder of this procedure.

**NOTE**  
*Entering the cal mode allows over-range inputs without the over-range indication flashing.*

2. Apply -20.00000 Vdc to the input from the DC Calibrator. Note the reading.
3. Reverse the polarity.
4. Adjust R32, BALANCE GAIN, to the reading noted.
5. Reverse the polarity again. Readjust R32 until the readings with both polarities are within 10 digits without further adjustment.

609A-30. AC Zero Adjustment is accomplished using the following steps:

1. Select AC Volts, 1V range.
2. Connect the AC Calibrator to the input terminal.
3. Apply 2.5 mV AC, 500 Hz to the input.
4. Adjust R45, AC ZERO, for a reading between 0.00245 and 0.00255.

**609A-31. Calibration Adjustments**

609A-32. Sequentially apply the input voltages and frequencies listed in Table 609A-3, performing the adjustments as necessary to bring the reading within the stated tolerance. Select AC Volts and manual ranging for these adjustments. If in the first step R64 does not have the required range, perform the coarse calibration in the troubleshooting section. Steps 9 and 24 require a  $50\Omega$  termination at the instrument input terminals and the use of four-wire sensing with the AC Calibrator. Two test cables, each with twisted wires, may be used.

**609A-33. Troubleshooting**

609A-34. Troubleshooting procedures for the AC/DC Converter (RMS) follow the format used in Section 4. Table 609A-4 assures that the problem actually is in the RMS Converter. Figure 609A-2 gives a symptom analysis approach to troubleshooting, with possible failures listed in order of probability, and gives the address and data field used to set up the module. DO NOT remove or install modules with the power on.

609A-35. If Q8 or Q12 are replaced, the module must be returned to the factory (attn: PARTS) for temperature compensation. This is also the only time R38, CREST FACTOR ADJUST, should require readjustment. Do not attempt to adjust R38 as no crest factor generators are commercially available.

Table 609A-3. Calibration Adjustment

STEP	RANGE	INPUT		ADJUST/ CHECK	TOLERANCE	
		VOLTAGE	FREQUENCY		LOW	HIGH
1	1000V	500V <sup>1</sup>	500 Hz	R64	499.90	500.10
2	1000V	500V <sup>1</sup>	50 kHz	C4	499.80	500.20
3	1000V	1000V <sup>1</sup>	10 kHz	Wait 30 sec. Check	999.20	1000.80
4	1V	2.5V	500 Hz	R14	2.49975	2.50025
5	1V	2.5V	50 kHz	C9	2.49900	2.50100 <sup>A</sup>
6	10V	20V	500 Hz	R16	19.9980	20.0020
7	10V	20V	50 kHz	C11	19.9900	20.0100
8	10V	10V	1 MHz	Check (R75) <sup>2</sup>	19.8000	20.2000
9	1V	1V	1 MHz <sup>3</sup>	Check (R75) <sup>2</sup>	0.9800	1.02000
10	1V	2.5V	300 kHz	Check	2.48000	2.52000
11	1V	2.5V	20 kHz	Check	2.49900	2.50100
12	1V	2.5V	50 Hz <sup>4</sup>	Check	2.49900	2.50100
13	1V	2.5V	100 kHz	Check	2.49900	2.51000
14	1V	.25V	100 kHz	Check	0.24600	0.25400
15	1V	2.5 mV	50 kHz	Check	0.00150	0.00350
16	1V	2.5 mV	500 Hz	Check	0.00230	0.00270
17	1V	.8V	500 Hz	Check	0.79960	0.80040
18	100V	160V <sup>1</sup>	500 Hz	R18	159.960	160.020
19	100V	160V <sup>1</sup>	50 kHz	C14	159.960	160.040
20	100V	67V	300 kHz	Check	66.800	68.200
21	10V	20V	300 kHz	Check	19.7500	20.2500
22	1V	.8V	300 kHz	Check	0.78500	0.81500
23	1V	.2V	300 kHz	Check	0.18800	0.21200
24	1V	.1V	1 MHz <sup>3</sup>	Check	0.07000	0.13000

1. Use CAUTION, Dangerous voltage.
2. If R75 is adjusted, repeat the previous steps.
3. Terminate cable in  $50\Omega$ ; use four-wire sense on Calibrator as explained in the text.
4. FILTER must be ON.

Table 609-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		Section
2	Is DC Volts within tolerance?	3	4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following:		
	1. Digital Logic Bad,      2. K1 or K2 shorted,      3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows:		
	VA1 = +14.24 to 15.75V	VA4 = -29 to -32V	
	VA2 = -14.25 to -15.75V	Vcc = -15V Difference = 4.9	
	VA3 = +29 to 32V	Vss = -20V to 5.2	
14	Are the supply voltages OK?		15
15	Go to Figure 609-2.		Section 4

SYMPTOM	POSSIBLE FAILURE
High reading on display with open inputs, 1000V range	C24 misadjusted, Q9, Q10, U4
High frequency (300 kHz) bad	C24 misadjusted or bad, U3
Reading not stable	U3, U4
Crest factor bad	Q8, Q12
AC breaks down (overload source above 500V)	K7
AC out of tolerance in slow filter mode	Q13 and Q14, Q16 and Q17
One range bad	Digital Logic Range Relays, CR14, CR16
All ranges bad	U3, Q1, U5, Q7, U7, U8, K8, K1
Excessive noise	U3, Q2
Display blanks	U1, U10
The largest single failure items tend to be relays and electrolytic capacitors	
<i>Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.</i>	
Address IC 0, 2, 4 high	
ID0 = 0, ID1 = 0	-DC Coupled AC
ID0 = 1, ID1 = 0	-AC Volts
DIO = 0, ID1 = 1	-RT1 input for AC Current
ID2 = 0	-Filter On
ID3 = 0	-10V range
ID4 = 0	-100V range
ID5 = 0	-1000V range
ID3 through ID5 = 1-1V range	

Figure 609-2. Symptom Analysis

609A-36. If other parts are replaced, it may be necessary to make the following adjustments before continuing with the calibration procedure. To assure proper functioning of the module the following procedure should be completed. Many of the adjustments must be performed again in the final calibration procedure. Always perform final calibration from the beginning of the procedure. Select the cal mode by placing the CAL switch in the down position. Ignore the cal digit for this procedure. Some of these adjustments are not accessible from the top of the module. Center all adjustments before beginning calibration except for R38, C24, and R64. R64 should be set fully counterclockwise. R38 should NOT be changed.

#### CAUTION

**When high voltages are applied to the input terminals and the module is not enclosed in the case, hazardous voltages are present on the board. Use an insulated tool for making adjustments while keeping hands away from the PCB.**

1. Select AC Volts and the 1V range (manually) and short the input terminals.
2. Short TP3 and TP4 to the metal divider on the board.
3. Connect the test DVM HI to TP2 and LO to TP1.
4. Adjust R66, INTEGRATOR ZERO, for 0V  $\pm 100 \mu V$ .
5. Remove the short from TP3.
6. Add a jumper from the bottom of R57 (junction with R61) to a jumper added across R48.
7. Connect the test DVM HI to TP3.
8. Adjust R55, SQUARE ROOT ZERO, for 0V  $\pm 100 \mu V$ .
9. Remove the short from TP4 and the jumper from R48.
10. Simultaneously select AC Volts and DC Volts; manually select the 10V range.
11. Connect the test DVM HI to TP5.
12. Adjust R12, RANGE ZERO, for 0V  $\pm 30 \mu V$ .
13. Disconnect the test DVM and remove the short from the input terminals.
14. Center R45, AC ZERO, and apply -0.2V from the DC Calibrator to the input terminals. Note the reading on the display.
15. Reverse the polarity of the input and adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
16. Reverse the polarity again and readjust R42 until the readings obtained with both polarities are within 10 digits without further adjustment.
17. Apply -20V DC to the input and note the reading.
18. Reverse the input polarity and adjust R32, BALANCE GAIN, for the same reading as noted in the last step  $\pm 5$  digits.
19. Apply -0.02V DC and adjust R45, AC Zero, for a reading of 0.0200  $\pm 5$  digits.
20. Disconnect the DC Calibrator and connect the AC Calibrator.
21. Select AC Volts and the 1000V range.
22. Set R64 fully counterclockwise.
23. Apply 500V @ 500 Hz to the input from the AC Calibrator.
24. Note the reading and clip links according to Table 609A-5. Link 1 is across R61, link 2 is across R62, and link 3 is across R63.
25. Adjust R64, 1000V LOW FREQ, ADJUST, for a reading of 500.000V  $\pm 20$  digits.
26. Change the frequency to 50 kHz and adjust C4, 1000V HIGH FREQ ADJUST, for 500.000V  $\pm 20$  digits.
27. Apply 2.5V @ 500 Hz to the input and manually select the 1V range.
28. Adjust R14, 1V LF, for 2.50000  $\pm 10$  digits.
29. Change the input frequency to 500 kHz and adjust C9, 1V HF-1, for 2.50000  $\pm 100$  digits.
30. Change the input frequency to 500 kHz and adjust C24, 1V HF-2, to bring the reading toward 2.5V. Adjusting C24 will require readjusting C9. Alternately adjust C9 as in step 29, than C24 @ 500 kHz until a reading of 2.50000V  $\pm 3000$  digits is obtained.

**NOTE**

*C9 has approximately twice the effect at 500 kHz as at 50 kHz. If C24 hasn't enough range, adjust R75, 1 MHz. Turn it CW to raise the reading or CCW to lower the reading (½ turn is about 3000 digits).*

31. Check the stability by selecting the 1000V range and applying 1000V @ 10 kHz. The reading should be  $1000.00 \pm .80$  digits. Wait thirty seconds. If the reading is out of tolerance, with caution and an insulated tool, adjust C24 slightly beyond the point where a stable reading is displayed. Recheck steps 29 and 30.
32. Apply 20V @ 500 Hz and select the 10V range.
33. Adjust R16, 10V LF, for a reading of  $20.0000 \pm .20$  digits.
34. Change the frequency to 50 kHz and adjust C11, 10V HF, for  $20.0000 \pm .100$  digits.
35. Apply 10V @ 1 MHz using four-wire sensing (without the  $50\Omega$  termination).
36. Adjust R75, 1 MHz, for a reading of  $10.000 \pm .100$  digits.
37. Apply 1V @ 1 MHz using four-wire sensing with the  $50\Omega$  termination at the input terminals. Manually select the 1V range.
38. Initially note the reading without adjusting R75. If this reading is not  $1.00000V \pm .036V$ , adjust C24 until the reading is within  $\pm .036V$  and note this reading. Adjust R75 until the reading is halfway between the noted reading and  $1.00000V$ . This final reading, then, should be  $1.00000V \pm .018V$ .
39. Apply 500V @ 50 kHz. The reading should be  $500.00 \pm .20$  digits (adjust C4 if necessary).
40. Apply 2.5V @ 500 kHz and check reading for  $2.50000 \pm .03V$ . Adjust C24 if necessary to bring the reading within the specification.
41. If C24 was adjusted in Step 40, check the stability by applying 1000V @ 10 kHz. The reading should be stable at  $1000.00 \pm .8V$ . Re-adjust C24 and repeat Step 40 if the reading is unstable.
42. Apply 2.5V @ 50 kHz. Adjust C9 if necessary for a reading of  $2.50000 \pm .001V$ .
43. Apply 20V @ 50 kHz and adjust C11 if necessary for a reading of  $20.0000 \pm .01V$ .
44. Apply 10V @ 1 MHz using a four-wire cable. The reading should be  $10.0000 \pm .02V$ .
45. Apply 1V @ 1 MHz using a four-wire cable with a  $50\Omega$  termination. The reading should be  $1.00000 \pm .02V$ .
46. If Steps 44 or 45 are out of tolerance repeat Steps 36 through 45.
47. Select the 100V range and apply 160V @ 500 Hz. Verify that R18, 100V LF, will adjust the reading to  $160.000V \pm .50$  digits.
48. Check the output ripple by turning the filter off and applying 2.5V @ 200 Hz from a lab oscillator on the 1V range and adjust the oscillator output for a reading of  $2.50000V \pm 1000$  digits. Connect the oscilloscope HI to TP2, LO to shield. The ripple should be less than 20 mV P-P.
49. Change the frequency to 20 Hz and turn the filter on. Readjust the voltage as in step 44. The ripple should be less than 80 mV P-P.
50. Perform the Calibration procedure (Paragraph 609A-24).

**Table 609A-5. High Voltage, Low Frequency Coarse Adjust**

Reading	Links Previously Clipped	Clip Links	Replace Links
500 - 495.5 N/A (Pot R64 should adjust properly)		None	None
495.5 - 491.1	1	2	1
	2	1	None
	1 & 2	3	1 & 2
	3	1	None
	1 & 3	2	1
	2 & 3	1	None
500 - 504.5	1	None	1
	2	1	2
	1 & 2	None	1
	3	1 & 2	3
	1 & 3	None	1
	2 & 3	1	3
	1, 2, & 3	None	1

### 609A-37. PARTS LIST

609A-38. Table 609A-6 gives a parts breakdown for the AC/DC Converter (RMS). Refer to Section 5 for ordering information.



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

Table 609A-6. RMS Converter Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	<b>RMS CONVERTER ASSEMBLY (MIS-4103) Figure: 609A-3</b>	383935	89536	383935			
C1	Cap, mylar, 0.22 $\mu$ F $\pm$ 20%, 1200V	268904	84411	JF-65	1		
C2	Cap, porc 1.5 pF $\pm$ 0.25 pF, 1.7V ACK	461004	95275	VY10CA1R5CA	1		
C3	Cap, mica, 220 pF $\pm$ 5%, 500V	170423	72136	DM15F221J	1		
C4	Cap, var, 0.25–1.5 pF, 2000V	218206	72982	530-000	2	1	
C7	Cap, mylar, 0.10 $\mu$ F $\pm$ 10%, 100V	393439	73445	C280MAH/A100K	3		
C8	Cap, porc, 5.6 pF $\pm$ 0.25 pF, 1000V	460568	95275	VY10CA5R6CA	1		
C9	Cap, var, 0.25–1.5 pF, 2000V	218206	72982	530-000		REF	
C10	Cap, mica, 43 pF $\pm$ 1%, 500V	277202	72136	DM15E430F	1		
C11	Cap, var, 0.8–10.0 pF, 250V	229930	91293	JMC2951	1	1	
C12	Cap, poly film, 0.047 $\mu$ F $\pm$ 10%, 250V	162008	73445	C280MAE/A47K	1		
C13	Cap, mica, 390 pF $\pm$ 1%, 500V	355339	72136	DM15F391F	1		
C14	Cap, var, 9-35 pF, 350V	289637	72982	538-006D9-35	1	1	
C15	Cap, mica, 3600 pF $\pm$ 2%, 500V	176644	72136	DM19F362G	1		
C16	Cap, mica, 27 pF $\pm$ 5%, 500V	177998	72136	DM15F270J	6		
C17	Cap, mica, 8 pF $\pm$ 10%, 500V	216986	72136	DM15C080K	1		
C18	Cap, mica, 27 pF $\pm$ 5%, 500V	177998	72136	DM15F270J		REF	
C19	Cap, mica 1000 pF $\pm$ 5%, 500V	148387	72136	DM19F102J	2		
C20	Cap, mica, 27 pF $\pm$ 5%, 500V	177998	72136	DM15F270J		REF	
C21	Cap, mica, 2 pF $\pm$ 0.5 pF, 500V	175208	72136	DM15C020E	1		
C22	Cap, mica, 1000 pF $\pm$ 5%, 500V	148387	72136	DM19F102J		REF	
C23	Cap, Ta, elect, 15 $\mu$ F $\pm$ 10%, 20V	153056	56289	150D156X-9020B2	3	1	
C24	Cap, var, 1.7–10 pF, 250V	321109	56289	GKB10000	1	1	
C25	Cap, mica, 390 pF $\pm$ 5%, 500V	148437	72136	DM15F391J	1		
C26	Cap, mica, 27 pF $\pm$ 5%, 500V	177998	72136	DM15F270J	1		
C27	Cap, mylar, 0.0033 $\mu$ F $\pm$ 10%, 50V	402867	06001	75F1R5A-333	2		
C28	Cap, poly film, 0.01 $\mu$ F $\pm$ 10%, 400V	402818	73445	C280MAF/A10K	1		
C29	Cap, mylar, 0.022 $\mu$ F $\pm$ 10%, 250V	234484	73445	C280MAE/A22K	2		
C30	Cap, mylar, 0.0068 $\mu$ F $\pm$ 20%, 200V	106070	56289	192P68202	1		
C31	Cap, mica, 27 pF $\pm$ 5%, 500V	177998	72136	DM15F270J		REF	
C32	Cap, mylar, 0.033 $\mu$ F $\pm$ 10%, 250V	234492	73445	C280MAE/A33K	2		
C33	Cap, mylar, 0.0047 $\mu$ F $\pm$ 10%, 50V	260844	06001	75F1R5A347	1		
C34	Cap, mylar, 0.10 $\mu$ F $\pm$ 10%, 100V	393439	73445	C280AH/A100K		REF	

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C35	Cap, mylar, 0.033 $\mu$ F $\pm$ 10%, 250V	234492	73445	C280MAE/A33K	REF		
C36, C37	Cap, Ta, elect, 15 $\mu$ F $\pm$ 10%, 20V	153056	56289	150D156X-9020B2	REF		
C38	Cap, mica, 4 pF $\pm$ 0.5%, 500V	190397	72136	DM15C040E	2		
C39	Cap, mylar 0.10 $\mu$ F $\pm$ 10%, 100V	393439	73445	C280MAH/A100K	REF		
C40	Cap, mica, 15 pF $\pm$ 5%, 500V	148569	72136	DM15C150J	2		
C41	Cap, mylar, 0.022 $\mu$ F $\pm$ 10%, 250V	234484	73445	C280MAE/A22K	REF		
C42	Cap, mylar, 0.0033 $\mu$ F $\pm$ 10%, 50V	402876	06001	75F1R5A333	REF		
C43	Cap, Ta, 6.8 $\mu$ F $\pm$ 20%, 35V	363713	56289	196D685X-0035HA1	1		
C44	Cap, mica, 4 pF $\pm$ 0.5%, 500V	190397	72136	DM15C040E	REF		
C45	Cap, mica, 27 pF $\pm$ 5%, 500V	177998	72136	DM15F270J	REF		
C46	Cap, mica, 15 pF $\pm$ 5%, 500V	148569	72136	DM15C150J	REF		
C47	Cap, mylar, 0.001 $\mu$ F $\pm$ 10%, 200V	159582	56289	192P10292	1		
CL1	Diode, FET, current regulator	285106	07910	TCR5309	1		
CR2 thru CR5	Diode, Si, hi-speed switch	203323	07910	IN4448	8	2	
CR6, CR7	Diode, Si lo-cap, lo-leakage	375907	07263	FD7222	4	1	
CR8, CR9	Diode, Si, hi-speed switch	203323	07910	IN4448	REF		
CR10							
CR11	Diode, zener	246611	07910	1N961B	4	1	
CR14	Diode, Si sm sig	313247	28480	HP5082-6264	2	1	
CR15	Diode, zener	246611	07910	1N961B	REF		
CR16	Diode, Si, sm sig	313247	28480	HP5082-6264	REF		
CR17	Diode, Si, hi-speed switch	203323	07910	IN4448	REF		
CR18	Diode, zener	246611	07910	1N961B	REF		
CR19	Diode, Si, rect, lo-vol, lo-leak	180594	07910	TD12599	1	1	
CR21, CR22	Diode, zener	260695	07910	1N754A	2	1	
CR24	Diode, zener	246611	07910	1N961B	REF		
K1	Coil, reed relay	272070	71707	UD-6-P	2		
K2	Coil, reed relay	269019	71707	U-6-P	1		
K4, K5, K6	Relay, dry reed	357566	71707	UF40069	4		
K7	Coil, reed relay	272070	71707	UD-6-P	REF		
K8	Relay, dry reed	357566	71707	UF40069	REF		

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q1	Xstr, FET, dual, N-channel	267963	89536	267963	1	1	
Q2	Xstr, FET, N-channel	343103	89536	343103	3	1	
Q4	Xstr, Si, NPN	218396	04713	2N3904	4	1	
Q6, Q7	Xstr, FET, N-channel	343103	89536	343103	REF		
Q8, Q12	Xstr, matched set	341057	89536	341057	1	1	
Q10	Xstr, Si, NPN	218396	04713	2N3904	REF		
Q11	Xstr, Si, PNP	195974	04713	2N3906	1	1	
Q13	Xstr, FET, N-channel	288324	89536	288324	3	1	
Q14	Xstr, FET, N-channel	393314	89536	393314	1	1	
Q15	Xstr, Si, PNP	218388	07236	2N3645	1	1	
Q16, Q17	Xstr, FET, N-channel	288324	89536	288324	REF		
Q18, Q19	Xstr, Si, NPN	218396	04713	2N3904	REF		
Q20	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, mtl film, $1M \pm 0.1\%$ , 1W	340265	03888	PME75	1		
R2	Res, mtl film, $13k \pm 1\%$ , 1/8W	335539	91637	CMF551302F	1		
R3	Res, mtl film, $2k \pm 1\%$ , 1/8W	235226	91637	CMF552001F	1		
R6, R7	Res, mtl film, $50k \pm 0.1\%$ , 1/8W	340257	91637	CMF555002B	3		
R9	Res, comp, $1M \pm 5\%$ , 1/4W	182204	01121	CB1055	6		
R10	Res, comp, $470 \pm 5\%$ , 1/4W	147983	01121	CB4715	1		
R11	Res, comp, $12k \pm 5\%$ , 1/4W	159731	01121	CB1235	1		
R12	Res, var, cermet, $1M \pm 10\%$ , 1/2W	334722	89536	334722	3	1	
R13	Res, mtl film, $399.0k \pm 0.1\%$ , 1/8W	417212	91637	CMF553993B	1		
R14	Res, var, cermet, $2k \pm 10\%$ , 1/2W	285163	89536	285163	1	1	
R15	Res, mtl film, $56.89k \pm 0.1\%$ , 1/8W	417220	91637	CMF5556891B	1		
R16	Res, var, cermet, $500 \pm 10\%$ , 1/2W	291120	89536	291120	1	1	
R17	Res, mtl film, $6324 \pm 0.1\%$ , 1/8W	417238	91637	CMF556324B	1		
R18	Res, var, cermet, $50 \pm 10\%$ , 1/2W	285122	89536	285122	2	1	
R19	Res, mtl film, $782.8 \pm 0.1\%$ , 1/8W	417246	91637	CMF55782R8B	1		
R20	Res, comp, $4.7k \pm 5\%$ , 1/4W	148072	01121	CB4725	2		
R21	Res, comp, $100 \pm 5\%$ , 1/4W	147926	01121	CB1015	1		
R22	Res, comp, $330 \pm 5\%$ , 1/4W	147967	01121	CB3315	1		
R23	Res, mtl film, $4.975 \pm 0.1\%$ , 1/8W	340232	91637	CMF554975B	1		
R24	Res, comp, $5.1k \pm 5\%$ , 1/4W	193342	01121	CB5125	1		
R25	Res, comp, $3k \pm 5\%$ , 1/4W	193508	01121	CB3025	1		
R26	Res, comp, $3.9k \pm 5\%$ , 1/4W	148064	01121	CB3925	1		

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R27	Res, mtl film, $1M \pm 1\%$ , 1/8W	268797	91637	CMF551004F	2		
R28	Res, mtl film, $121 \pm 1\%$ , 1/8W	343160	91637	CMF551210F	1		
R29	Res, mtl film, $5k \pm 0.1\%$ , 1/8W	340240	91637	CMF555001B	1		
R30	Res, comp, $5.6k \pm 5\%$ , 1/4W	148080	01121	CB5625	3		
R31	Res, mtl film, $50k \pm 0.1\%$ , 1/8W	340257	91637	CMF555002B	REF		
R32	Res, var, cermet, $50 \pm 10\%$ , 1/2W	285122	89536	285122	REF		
R33	Res, mtl film, $100k \pm 0.1\%$ , 1/8W	340166	91637	CMF551003B	1		
R34	Res, mtl film, $35.7k \pm 1\%$ , 1/8W	288480	91637	CMF553572F	1		
R35	Res, comp, $1M \pm 5\%$ , 1/4W	182204	01121	CB1055	REF		
R36	Res, comp, $82 \pm 5\%$ , 1/4W	149484	01121	CB8205	1		
R37	Res, comp, $5.6k \pm 5\%$ , 1/4W	148080	01121	CB5625	REF		
R38	Res, var, cermet, $3 \pm 25\%$ , 1/2W	347963	32997	3329H-J81-3R0	1		
R40	Res, comp, $5.6k \pm 5\%$ , 1/4W	148080	01121	CB5625	REF		
R42	Res, var, cermet, $1M \pm 10\%$ , 1/2W	334722	89536	334722	1		
R43	Res, comp, $1k \pm 5\%$ , 1/4W	148023	01121	CB1025	2		
R44	Res, comp, $9.1k \pm 5\%$ , 1/4W	193318	01121	CB9125	1		
R45	Res, var, cermet, $1M \pm 10\%$ , 1/2W	334722	89536	334722	REF		
R46	Res, comp, $560 \pm 5\%$ , 1/4W	147991	01121	CB5615	3		
R47	Res, comp, $51k \pm 5\%$ , 1/4W	193334	01121	CB5135	1		
R49	Res, comp, $330 \pm 5\%$ , 1/4W	147967	01121	CB3315	2		
R50	Res, comp, $22 \pm 5\%$ , 1/4W	147884	01121	CB2205	1		
R51	Res, comp, $47k \pm 5\%$ , 1/4W	148163	01121	CB4735	1		
R52	Res, mtl film, $4.02M \pm 1\%$ , 1/4W	417253	91637	CMF604024F	1		
R53	Res, comp, $1M \pm 5\%$ , 1/4W	182204	01121	CB1055	REF		
R54	Res, comp, $560 \pm 5\%$ , 1/4W	147991	01121	CB5615	REF		
R55	Res, var, cermet, $1M \pm 10\%$ , 1/2W	276691	89536	276691	2		
R56	Res, mtl film, $2M \pm 0.25\%$ , 1/2W	327502	91637	CMF652004C	2		
R57	Res, mtl film, $930k \pm 0.25\%$ , 1/4W	417345	91637	CMF609303C	1		
R58	Res, mtl film, $1M \pm 1\%$ , 1/8W	268797	91637	CMF551004F	REF		
R59	Res, comp, $1M \pm 5\%$ , 1/4W	182204	01121	CB1055	REF		
R60	Res, comp, $560 \pm 5\%$ , 1/4W	147991	01121	CB5615	REF		
R61	Res, mtl film, $17.4k \pm 1\%$ , 1/8W	236802	91637	CMF551742F	1		
R62	Res, mtl film, $34k \pm 1\%$ , 1/8W	261602	91637	CMF553402F	1		
R63	Res, mtl film, $68.1k \pm 1\%$ , 1/8W	236828	91637	CMF556812F	1		

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R64	Res, var, cermet, 20k $\pm$ 10%, 1/2W	291609	89536	291609	1	1	
R65	Res, mtl film, 2M $\pm$ 0.25%, 1/2W	327502	91637	CMF652004C	REF		
R66	Res, var, cermet, 1M $\pm$ 10%, 1/2W	276691	89536	276691	REF		
R67	Res, comp, 1M $\pm$ 5%, 1/4W	182204	01121	CB1055	REF		
R68	Res, comp, 200k $\pm$ 5%, 1/4W	248781	01121	CB2045	1		
R69	Res, comp, 750k $\pm$ 5%, 1/4W	221937	01121	CB7545	1		
R70	Res, comp, 1M $\pm$ 5%, 1/4W	182204	01121	CB1055	REF		
R71	Res, comp, 470k $\pm$ 5%, 1/4W	188411	01121	CB4745	1		
R72	Res, comp, 22k $\pm$ 5%, 1/4W	148130	01121	CB2235	1		
R73	Res, comp, 100k $\pm$ 5%, 1/4W	148189	01121	CB1045	1		
R74	Res, comp, 20k $\pm$ 5%, 1/4W	221614	01121	CB2035	2		
R75	Res, var, cermet, 10k $\pm$ 10%, 1/2W	285171	89536	285171	1		
R76	Res, comp, 1k $\pm$ 5%, 1/4W	148023	01121	CB1025	REF		
R77	Res, mtl, film, 23.2k $\pm$ 1%, 1/8W	291351	91637	CMF552322	1		
R78	Res, mtl film, 10 $\pm$ 1%, 1/8W	268789	91637	CMF55A100F	1		
R81	Res, thermistor, temp sensitive	104596	73168	JA41J1	1		
R82	Res, comp, 1k $\pm$ 5%, 1/4W	148023	01121	CB1025	REF		
R83	Res, comp, 330 $\pm$ 5%, 1/4W	147967	01121	CB3315	REF		
R84	Res, comp, 4.7k $\pm$ 5%, 1/4W	148072	01121	CB4725	REF		
R85	Res, comp, 20k $\pm$ 5%, 1/4W	221614	01121	CB2035	REF		
R86	Res, comp, 150 $\pm$ 5%, 1/4W	147934	01121	CB1515	2		
R87, R88	Res, comp, 10k $\pm$ 5%, 1/4W	148106	01121	CB1035	3		
R89	Res, mtl film, 42.2k $\pm$ 1%, 1/8W	221655	91637	CMF554222F	1		
R90	Res, comp, 150 $\pm$ 5%, 1/4W	147934	01121	CB1515	REF		
R92	Res, comp, 10k $\pm$ 5%, 1/4W	148106	01121	CB1035	REF		
U1	IC, C-MOS, NAND gates	375147	02735	CD4023AE	1	1	
U2	IC, ttl, hex inverter, buffer/driver	288605	01295	SN7416N	1	1	
U3	IC, lin, op amp	329912	12040	LM318H	1	1	
U4	IC, op amp	225961	24355	AD3092	1	1	
U5	- IC, lin, op amp	288928	12040	LM308AH	1	1	
U6, U7	IC, lin, op amp	284760	12040	LM308H	2	1	
U8	IC, lin, op amp	381889	12040	LM201AH	1	1	
U9	IC, C-MOS, hex buffer/inverter	381848	20735	CD4049AE	1	1	

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U10	IC, C-MOS, hex D F-F	404509	12040	MM74C174N	1	1	
XK1, XK7	Switch, dry reed	219097	95348	MR5972	2		
XK1, XK2, XK7	Switch, dry reed	284091	95348	MR138	3		
XK1, XK2, XK7	Foil wrap	313833	89536	313833	5		
XQ15	Transipad	152207	07047	10123DAP	1		
	Feed-thru, teflon	281865	12615	SL-841-777	4		
	Hardware:						
	Screw	256164	89536	256164	1		
	Heatsink	347740	05820	260-18D	1		
	Shield, input	468470	89536	468470	1		
	Socket	343285	00779	2-331272-6	5		
	Spring	424465	83553	C0120-014-0380	1		
	Stand-off, teflon	275719	15849	1497B	5		
	Transipad	175125	89536	175125	1		

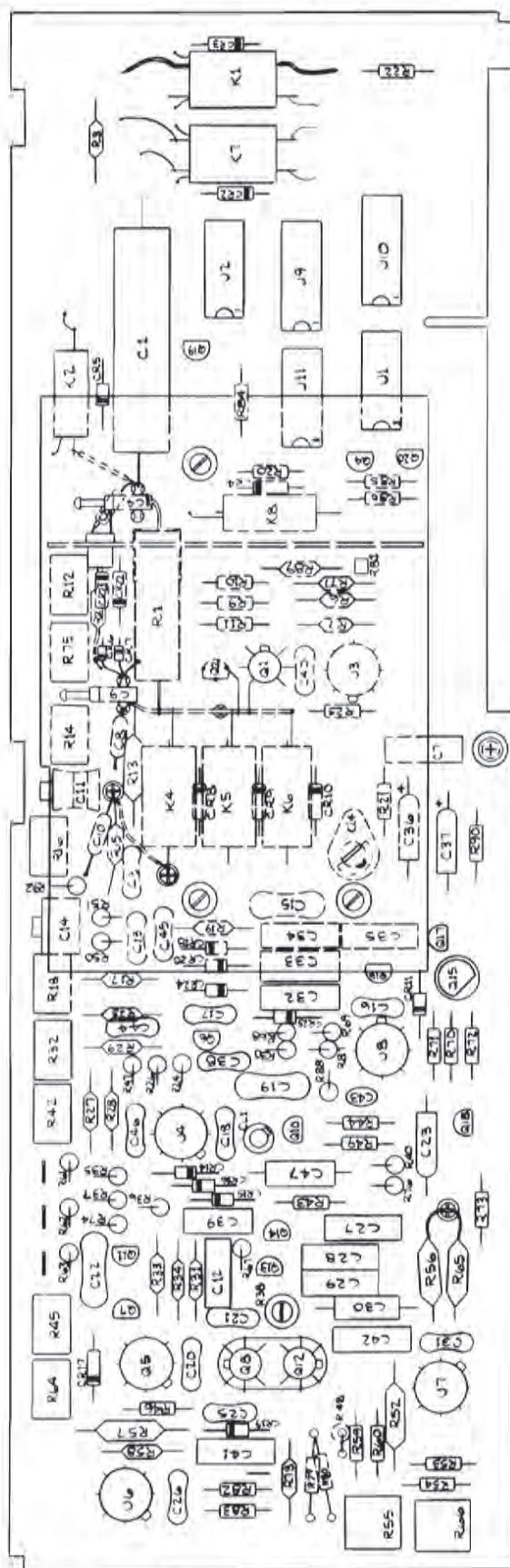
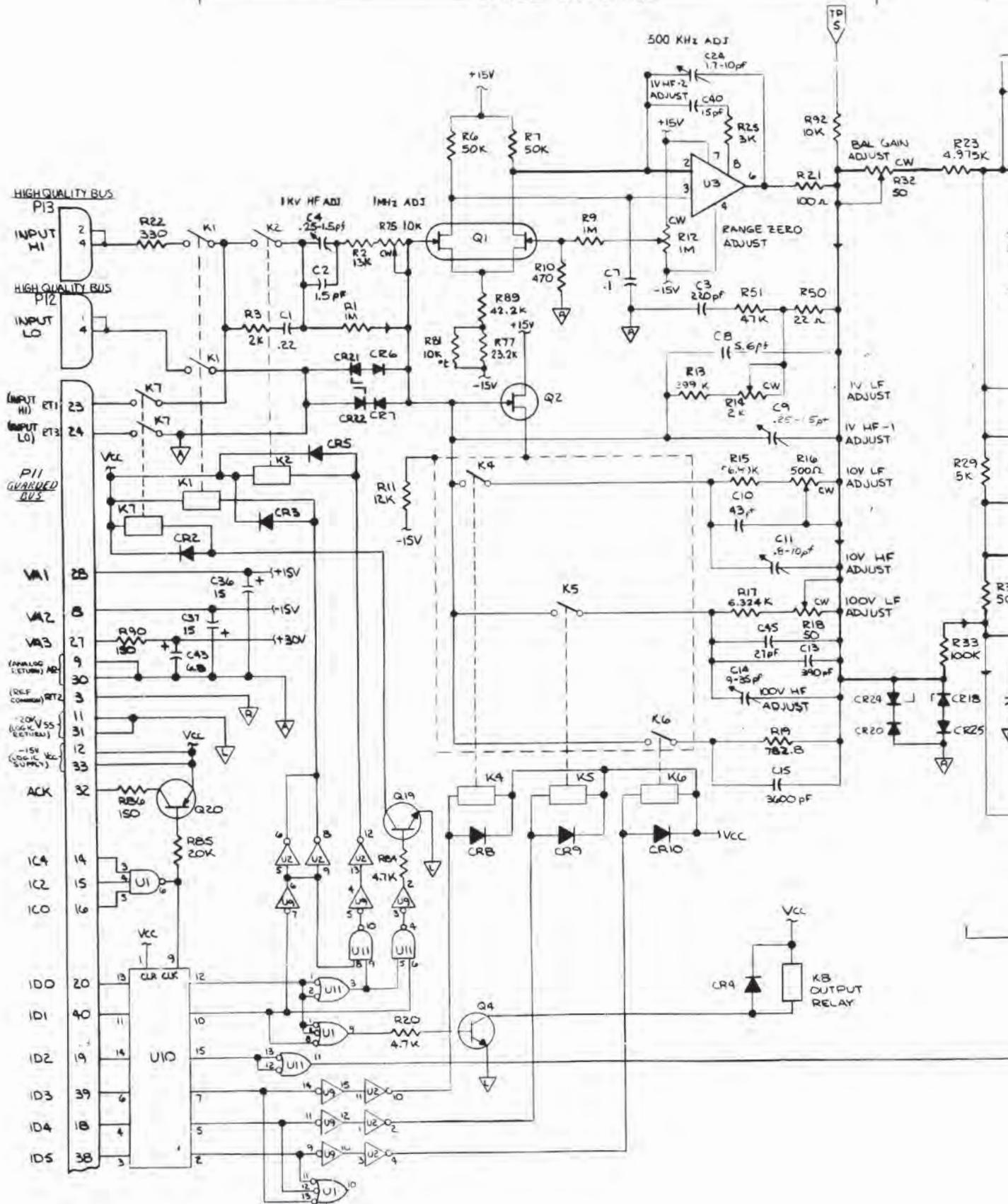
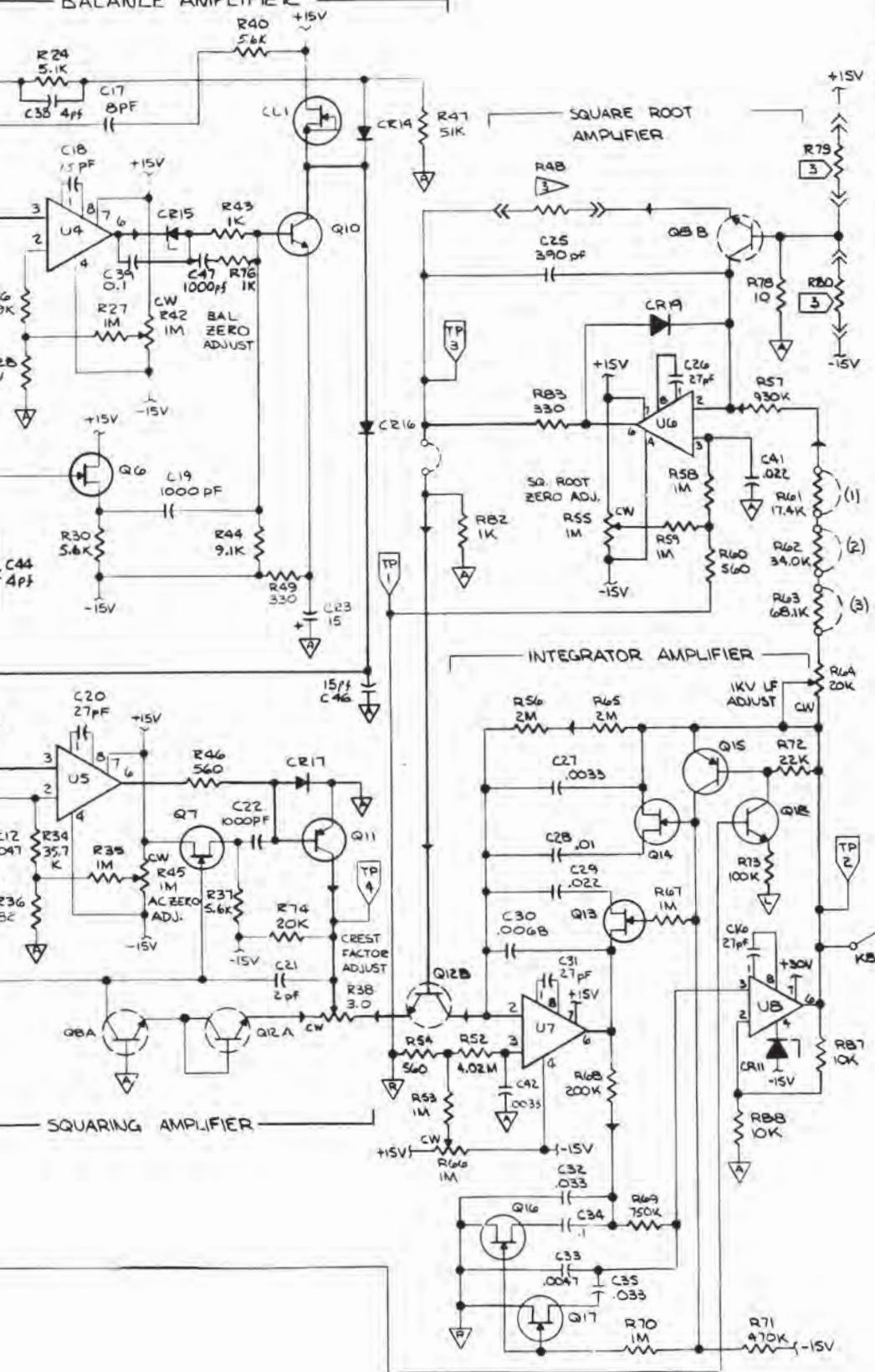


Figure 609A-3. RMS Converter PCB Assembly (Sheet 1 of 2) (MIS-1703)

- RANGE AMPLIFIER -



## -BALANCE AMPLIFIER



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IS IN OHMS.
  2. ALL CAPACITANCE IS IN MICROPARASALS.
  3. FACTORY SELECTED PART.
  4. ← PRIMARY SIGNAL FLOW.
  5. FOR P.C.B. SEE M.I.S.-B103.

8. REF. DES. LAST USED: R 92, C47,  
U 11, CR 25, CL 1, KB, Q20  
9. REF. DES. NOT USED: Q5, Q9,  
K3, CR1, CR12, CR13, CR25, R4,  
R5, RB, R41, R91

IC. NO.	TYPE	Vcc	Vss
U1	4023	14	7
U2	7416	14	7
U3	4049	1	8
U10	74C174	16	8
U11	4011	14	7

**Figure 609A-3.** RMS Converter PCB Assembly

## **Section 7**

### **General Information**

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

**Federal Supply Codes for Manufacturers**

00213 Nytronics Comp. Group Inc. Subsidiary of Nytronics Inc. Formerly Sage Electronics Rochester, New York	02660 Bunker Ramo Corp., Conn Div. Formerly Amphenol-Borg Electric Corp. Broadview, Illinois	04946 Standard Wire & Cable Los Angeles, California	06751 Components, Inc. Semicor Div. Phoenix, Arizona
00327 Welwyn International, Inc. Westlake, Ohio	02799 Aero Capacitors, Inc. Chatsworth, California	05236 Jonathan Mfg. Co. Fullerton, California	06860 Gould Automotive Div. City of Industry, California
00656 Aerovox Corp. New Bedford, Massachusetts	03508 General Electric Co. Semiconductor Products Syracuse, New York	05245 Components Corp. now Corcom, Inc. Chicago, Illinois	06961 Vernitron Corp., Piezo Electric Div. Formerly Clevite Corp., Piezo Electric Div. Bedford, Ohio
00686 Film Capacitors, Inc. Passaic, New Jersey	03614 Replaced by 71400	05277 Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pennsylvania	06980 Elmac Div. Varian Associates San Carlos, California
00779 AMP Inc. Harrisburg, Pennsylvania	03651 Replaced by 44655	05278 Replaced by 43543	07047 The Ross Milton Co. South Hampton, Pennsylvania
01121 Allen-Bradley Co. Milwaukee, Wisconsin	03797 Eldema Div. Genisco Technology Corp. Compton, California	05279 Southwest Machine & Plastic Co. Glendora, California	07115 Replaced by 14674
01281 TRW Electronic Comp. Semiconductor Operations Lawndale, California	03877 Transistron Electronic Corp. Wakefield, Massachusetts	05397 Union Carbide Corp. Materials Systems Div. New York, New York	07138 Westinghouse Electric Corp., Electronic Tube Div. Horsehead, New York
01295 Texas Instruments, Inc. Semiconductor Group Dallas, Texas	03888 KDI Pyrofilm Corp. Whippany, New Jersey	05571 Use 56289 Sprague Electric Co. Pacific Div. Los Angeles, California	07233 TRW Electronic Components Cinch Graphic City of Industry, California
01537 Motorola Communications & Electronics Inc. Franklin Park, Illinois	03911 Clairex Electronics Div. Clairex Corp. Mt. Vernon, New York	05574 Viking Industries Chatsworth, California	07256 Silicon Transistor Corp. Div. of BBF Group Inc. Chelmsford, Massachusetts
01686 RCL Electronics Inc. Manchester, New Hampshire	03980 Muirhead Inc. Mountainside, New Jersey	05704 Replaced by 16258	07261 Aumet Corp. Culver City, California
01730 Replaced by 73586	04009 Arrow Hart Inc. Hartford, Connecticut	05820 Wakefield Engineering Inc. Wakefield, Massachusetts	07263 Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
01884 Use 56289 Sprague Electric Co. Dearborn Electronic Div. Lockwood, Florida	04062 Replaced by 72136	06001 General Electric Co. Electronic Capacitor & Battery Products Dept. Columbia, South Carolina	07344 Bircher Co., Inc. Rochester, New York
02114 Ferroxcube Corp. Saugerties, New York	04202 Replaced by 81312	06136 Replaced by 63743	07597 Burndy Corp. Tape/Cable Div. Rochester, New York
02131 General Instrument Corp. Harris ASW Div. Westwood, Maine	04211 Aemco, Div. of Midtex Inc. Mankato, Minnesota	06383 Panduit Corp. Tinley Park, Illinois	07792 Lerma Engineering Corp. Northampton, Massachusetts
02395 Rason Mfg. Co. Brooklyn, New York	04222 AVX Ceramics Div. AVX Corp. Myrtle Beach, Florida	06473 Bunker Ramo Corp. Amphenol SAMS Div. Chatsworth, California	07910 Teledyne Semiconductor Formerly Continental Device Hawthorne, California
02533 Snelgrove, C.R. Co., Ltd. Don Mills, Ontario, Canada M3B 1M2	04423 Telonic Industries Laguna Beach, California	06555 Beede Electrical Instrument Co. Penacook, New Hampshire	07933 Use 49956 Raytheon Co. Semiconductor Div. HQ Mountain View, California
02606 Fenwal Labs Div. of Travenal Labs. Morton Grove, Illinois	04645 Replaced by 75376	06739 Electron Corp. Littleton, Colorado	08225 Industro Transistor Corp. Long Island City, New York
	04713 Motorola Inc. Semiconductor Products Phoenix, Arizona	06743 Clevite Corp. Cleveland, Ohio	

**Federal Supply Codes for Manufacturers (cont)**

08261 Spectra Strip Corp. Garden Grove, California	11726 Qualidyne Corp. Santa Clara, California	13606 Use 56289 Sprague Electric Co. Transistor Div. Concord, New Hampshire	16299 Corning Glass Electronic Components Div. Raleigh, North Carolina
08530 Reliance Mica Corp. Brooklyn, New York	12014 Chicago Rivet & Machine Co. Bellwood, Illinois	13839 Replaced by 28732	16332 Replaced by 28478
08806 General Electric Co. Miniature Lamp Products Dept Cleveland, Ohio	12040 National Semiconductor Corp. Danbury, Connecticut	14099 Semtech Corp. Newbury Park, California	16473 Cambridge Scientific Ind. Div. of Chemed Corporation Cambridge, Maryland
08863 Nylomatic Corp. Norrisville, Pennsylvania	12060 Diodes, Inc. Chatsworth, California	14140 Edison Electronic Div. Mc Gray-Edison Co. Manchester, New Hampshire	16742 Paramount Plastics Fabricators, Inc. Downey, California
08988 Use 53085 Skottie Electronics Inc. Archbald, Pennsylvania	12136 Philadelphia Handle Co. Camden, New Jersey	14193 Cal-R-Inc. formerly California Resistor, Corp. Santa Monica, California	16758 Delco Electronics Div. of General Motors Corp. Kokomo, Indiana
09214 G E. Co. Semi-Conductor Products Dept. Power Semi-Conductor Products OPN Sec. Auburn, New York	12300 Potter-Brimfield Div. AMF Canada LTD. Guelph, Ontario, Canada	14298 American Components, Inc. an Insilco Co. Conshohocken, Pennsylvania	17001 Replaced by 71468
09353 C and K Components Watertown, Massachusetts	12327 Freeway Corp. formerly Freeway Washer & Stamping Co. Cleveland, Ohio	14655 Cornell-Dublier Electronics Division of Federal Pacific Electric Co. Govt. Control Dept. Newark, New Jersey	17069 Circuit Structures Lab. Burbank, California
09423 Scientific Components, Inc. Santa Barbara, California	12443 The Budd Co. Polychem Products Plastic Products Div. Bridgeport, Pennsylvania	14752 Electro Cube Inc. San Gabriel, California	17545 Atlantic Semiconductors, Inc. Asbury Park, New Jersey
09922 Burndy Corp. Norwalk, Connecticut	12615 U.S. Terminals Inc. Cincinnati, Ohio	14869 Replaced by 96853	17856 Siliconix, Inc. Santa Clara, California
09969 Dale Electronics Inc. Yankton, S. Dakota	12617 Hamlin Inc. Lake Mills, Wisconsin	14936 General Instrument Corp. Semi Conductor Products Group Hicksville, New York	17870 Replaced by 14140
10059 Barker Engineering Corp. Formerly Amerace, Amerace ESNA Corp. Kenilworth, New Jersey	12697 Clarostat Mfg. Co. Dover, New Hampshire	15636 Elec-Trol Inc. Saugus, California	18178 Vactec Inc. Maryland Heights, Missouri
11236 CTS of Berne Berne, Indiana	12749 James Electronics Chicago, Illinois	15801 Fenwal Electronics Inc. Div. of Kidde Walter and Co., Inc. Framingham, Massachusetts	18324 Signetics Corp. Sunnyvale, California
11237 CTS Keene Inc. Paso Robles, California	12856 Micrometals Sierra Madre, California	15818 Teledyne Semiconductors, formerly Amelco Semiconductor Mountain View, California	18612 Vishay Resistor Products Div. Vishay Intertechnology Inc. Malvern, Pennsylvania
11358 CBS Electronic Div. Columbia Broadcasting System Newburyport, Minnesota	12954 Dickson Electronics Corp. Scottsdale, Arizona	15849 Litton Systems Inc. Useco Div. formerly Useco Inc. Van Nuys, California	18736 Voltronics Corp. Hanover, New Jersey
11403 Best Products Co. Chicago, Illinois	12969 Unitrode Corp. Watertown, Massachusetts	15898 International Business Machines Corp. Essex Junction, Vermont	18927 GTE Sylvania Inc. Precision Material Group Parts Division Titusville, Pennsylvania
11503 Keystone Columbia Inc. Warren, Michigan	13103 Thermalloy Co., Inc. Dallas, Texas	15909 Replaced by 14140	19451 Perine Machinery & Supply Co. Seattle, Washington
11532 Teledyne Relays. Hawthorne, California	13327 Solitron Devices Inc. Tappan, New York	16258 Space-Lok Inc. Burbank, California	19701 Electro-Midland Corp. Mepco-Electra Inc. Mineral Wells, Texas
11711 General Instrument Corp. Rectifier Division Hicksville, New York	13511 Amphenol Cadre Div. Bunker-Ramo Corp. Los Gatos, California	20584 Enochs Mfg. Inc. Indianapolis, Indiana	

**Federal Supply Codes for Manufacturers (cont)**

20891 Self-Organizing Systems, Inc. Dallas, Texas	28480 Hewlett Packard Co. Corporate HQ Palo Alto, California	43543 Nytronics Inc. Transformer Co. Div. Geneva, New York	70903 Belden Corp. Geneva, Illinois
21604 Bucheye Stamping Co. Columbus, Ohio	28520 Heyman Mfg. Co. Kenilworth, New Jersey	44655 Ohmite Mfg. Co. Skokie, Illinois	71002 Birnback Radio Co., Inc. Freeport, New York
21845 Solitron Devices Inc. Transistor Division Riveria Beach, Florida	29083 Monsanto, Co., Inc. Santa Clara, California	49671 RCA Corp. New York, New York	71400 Bussmann Mfg. Div. of McGraw-Edison Co. Saint Louis, Missouri
22767 ITT Semiconductors Palo Alto, California	29604 Stackpole Components Co. Raleigh, North Carolina	49956 Raytheon Company Lexington, Massachusetts	71450 CTS Corp. Elkhart, Indiana
23050 Product Comp. Corp. Mount Vernon, New York	30148 AB Enterprise Inc. Ahoskie, North Carolina	50088 Mostek Corp. Carrollton, Texas	71468 ITT Cannon Electric Inc. Santa Ana, California
23732 Tracor Inc. Rockville, Maryland	30323 Illinois Tool Works, Inc. Chicago, Illinois	50579 Litronix Inc. Cupertino, California	71482 Clare, C.P. & Co. Chicago, Illinois
23880 Stanford Applied Engrng. Santa Clara, California	31091 Optimax Inc. Colmar, Pennsylvania	51605 Scientific Components Inc. Linden, New Jersey	71590 Centrelab Electronics Div. of Globe Union Inc. Milwaukee, Wisconsin
23936 Pamotor Div., Wm. J. Purdy Co., Burlingame, California	32539 Mura Corp. Great Neck, New York	53021 Sangamo Electric Co. Springfield, Illinois	71707 Coto Coil Co., Inc. Providence, Rhode Island
24248 Replaced by 94222	32767 Griffith Plastic Corp. Burlingame, California	54294 Cutler-Hammer Inc. formerly Shallcross, A Cutler-Hammer Co. Selma, North Carolina	71744 Chicago Miniature Lamp Works Chicago, Illinois
24355 Analog Devices Inc. Norwood, Massachusetts	32879 Advanced Mechanical Components Northridge, California	55026 Simpson Electric Co. Div. of Am. Gage and Mach. Co. Elgin, Illinois	71785 TRW Electronics Components Cinch Connector Operations Div. Elk Grove Village Chicago, Illinois
24655 General Radio Concord, Massachusetts	32897 Erie Technological Products, Inc. Frequency Control Div. Carlisle, Pennsylvania	56289 Sprague Electric Co. North Adams, Massachusetts	72005 Wilber B. Driver Co. Newark, New Jersey
24759 Lenox-Fugle Electronics Inc. South Plainfield, New Jersey	32997 Bourns Inc. Trimpot Products Division Riverside, California	58474 Superior Electric Co. Bristol, Connecticut	72092 Replaced by 06980
25088 Siemen Corp. Isilen, New Jersey	33173 General Electric Co. Products Dept. Owensboro, Kentucky	60399 Torin Corp. formerly Torrington Mfg. Co. Torrington, Connecticut	72136 Electro Motive Mfg. Co. Williamantic, Connecticut
25403 Amperex Electronic Corp. Semiconductor & Micro-Circuits Div. Slaterville, Rhode Island	34333 Silicon General Westminster, California	63743 Ward Leonard Electric Co., Inc. Mount Vernon, New York	72259 Nytronics Inc. Pelham Manor, New Jersey
27014 National Semiconductor Corp. Santa Clara, California	34335 Advanced Micro Devices Sunnyvale, California	64834 West Mfg. Co. San Francisco, California	72619 Dialight Div. Amperex Electronic Corp. Brooklyn, New York
27264 Molex Products Downers Grove, Illinois	34802 Electromotive Inc. Kenilworth, New Jersey	65092 Weston Instruments Inc. Newark, New Jersey	72653 G.C. Electronics Div. of Hydrometals, Inc. Brooklyn, New York
28213 Minnesota Mining & Mfg. Co. Consumer Products Div. St. Paul, Minnesota	37942 P.R. Mallory & Co., Inc. Indianapolis, Indiana	66150 Winslow Tele-Tronics Inc. Eaton Town, New Jersey	72665 Replaced by 90303
28425 Serv-/Link formerly Bohanan Industries Fort Worth, Texas	42498 National Radio Melrose, Massachusetts	70485 Atlantic India Rubber Works Chicago, Illinois	72794 Dzus Fastener Co., Inc. West Islip, New York
28478 Deltrol Controls Div. Deltrol Corporation Milwaukee, Wisconsin		70563 Amerite Company Union City, New Jersey	72928 Gulton Ind. Inc. Gudeman Div. Chicago, Illinois

**Federal Supply Codes for Manufacturers (cont)**

72982 Erie Tech. Products Inc. Erie, Pennsylvania	75382 Kulka Electric Corp. Mount Vernon, New York	80583 Hammarlund Mfg. Co., Inc. Red Bank, New Jersey	83594 Burroughs Corp. Electronic Components Div. Plainfield, New Jersey
73138 Bechman Instrument Inc. Hellipot Division Fullerton, California	75915 Littlefuse Inc. Des Plaines, Illinois	80640 Arnold Stevens, Inc. South Boston, Massachusetts	83740 Union Carbide Corp. Battery Products Div. formerly Consumer Products Div. New York, New York
73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, California	76854 Oak Industries Inc. Switch Div. Crystal Lake, Illinois	81073 Grayhill, Inc. La Grange, Illinois	84171 Arco Electronics Great Neck, New York
73445 Amperex Electronic Corp. Hicksville, New York	77342 AMF Inc. Potter & Brumfield Div Princeton, Indiana	81312 Winchester Electronics Div. of Litton Industries Inc. Oakville, Connecticut	84411 TRW Electronic Components TRW Capacitors Ogallala, Nebraska
73559 Carling Electric Inc. West Hartford, Connecticut	77638 General Instrument Corp. Rectifier Division Brooklyn, New York	81483 Therm-O-Disc Inc. Mansfield, Ohio	84613 Fuse Indicator Corp. Rockville, Maryland
73586 Circle F Industries Trenton, New Jersey	77969 Rubbercraft Corp. of CA LTD. Torrance, California	81483 International Rectifier Corp. Los Angeles, California	84682 Essex International Inc. Industrial Wire Div. Peabody, Massachusetts
73734 Federal Screw Products, Inc. Chicago, Illinois	78189 Shakeproof Div. of Illinois Tool Works Inc. Elgin, Illinois	81590 Korry Mfg. Co. Seattle, Washington	86577 Precision Metal Products of Malden Inc. Stoneham, Massachusetts
73743 Fischer Special Mfg. Co. Cincinnati, Ohio	78277 Sigma Instruments, Inc. South Braintree, Massachusetts	81741 Chicago Lock Co. Chicago, Illinois	86684 Radio Corp. of America Electronic Components Div. Harrison, New Jersey
73899 JFD Electronics Co. Components Corp. Brooklyn, New York	78488 Stackpole Carbon Co. Saint Marys, Pennsylvania	82305 Palmer Electronics Corp. South Gate, California	86928 Seastrom Mfg. Co., Inc. Glendale, California
73949 Guardian Electric Mfg. Co. Chicago, Illinois	78553 Eaton Corp. Engineered Fastener Div. Tinnerman Plant Cleveland, Ohio	82415 North American Phillips Controls Corp. Frederick, Maryland	87034 Illuminated Products Inc. Subsidiary of Oak Industries Inc. Anaheim, California
74199 Quan Nichols Co. Chicago, Illinois	79136 Waldes Kohinoor Inc. Long Island City, New York	82872 Roanwell Corp. New York, New York	88219 Gould Inc. Industrial Div. Trenton, New Jersey
74217 Radio Switch Corp. Marlboro, New Jersey	79497 Western Rubber Company Goshen, Indiana	82877 Rotron Inc. Woodstock, New York	88245 Litton Systems Inc. Useco Div. Van Nuys, California
74276 Signalite Div. General Instrument Corp. Neptune, New Jersey	79963 Zierick Mfg. Corp. Mt. Kisko, New York	82879 ITT Royal Electric Div. Pawtucket, Rhode Island	88419 Cornell-Dubilier Electronic Div. Federal Pacific Co. Fuquay-Varina, North Carolina
74306 Piezo Crystal Co. Carlisle, Pennsylvania	80031 Electro-Midland Corp. Mepco Div. A North American Phillips Co. Norristown, New Jersey	83003 Varo Inc. Garland, Texas	88486 Plastic Wire & Cable Jewitt City, Connecticut
74542 Hoyt Elect. Instr. Works Penacook, New Hampshire	80145 LFE Corp., Process Control Div. formerly API Instrument Co. Chesterland, Ohio	83058 The Carr Co., United Can Div. of TRW Cambridge, Massachusetts	88690 Replaced by 04217
74970 Johnson E.F., Co. Waseca, Minnesota	80183 Use 56289 Sprague Products North Adams, Massachusetts	83298 Bendix Corp. Electric Power Div. Eatontown, New Jersey	89536 John Fluke Mfg. Co., Inc. Seattle, Washington
75042 TRW Electronics Components IRC Fixed Resistors Philadelphia, Pennsylvania	80294 Bourns Inc., Instrument Div. Riverside, California	83330 Herman H. Smith, Inc. Brooklyn, New York	89730 G.E. Co., Newark Lamp Works Newark, New Jersey
75376 Kurz-Kaschi Inc. Dayton, Ohio		83478 Rubbercraft Corp. of America, Inc. West Haven, Connecticut	
75378 CTS Knights Inc. Sandwich, Illinois			

**Federal Supply Codes for Manufacturers (cont)**

90201 Mallory Capacitor Co. Div. of P.R. Mallory Co., Inc. Indianapolis, Indiana	91836 King's Electronics Co., Inc. Tuckahoe, New York	95354 Methode Mfg. Corp. Rolling Meadows, Illinois	98291 Selectro Corp. Mamaroneck, New York
90211 Use 56365 Square D Co. Chicago, Illinois	91929 Honeywell Inc. Micro Switch Div. Freeport, Illinois	95712 Bendix Corp. Electrical Components Div. Microwave Devices Plant Franklin, Indiana	98388 Royal Industries Products Div. San Diego, California
90215 Best Stamp & Mfg. Co. Kansas City, Missouri	91934 Miller Electric Co., Inc. Div. of Aunet Woonsocket, Rhode Island	95987 Weckesser Co. Inc. Chicago, Illinois	98743 Replaced by 12749
90303 Mallory Battery Co. Div. of Mallory Co., Inc. Tarrytown, New York	92194 Alpha Wire Corp. Elizabeth, New Jersey	96733 San Fernando Electric Mfg. Co. San Fernando, California	98925 Replaced by 14433
91094 Essex International Inc. Suglex/IWP Div. Newmarket, New Hampshire	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts	96853 Gulton Industries Inc. Measurement and Controls Div. formerly Rustrak Instruments Co. Manchester, New Hampshire	99120 Plastic Capacitors, Inc. Chicago, Illinois
91293 Johanson Mfg. Co. Boonton, New Jersey	94145 Replaced by 49956	96881 Thomson Industries, Inc. Manhasset, New York	99217 Bell Industries Elect. Comp. Div. formerly Southern Elect. Div. Burbank, California
91407 Replaced by 58474	94154 Use 94988 Wagner Electric Corp. Tung-Sol Div. Newark, New Jersey	97540 Master Mobile Mounts, Div. of Whitehall Electronics Corp. Ft. Meyers, Florida	99392 STM Oakland, California
91502 Associated Machine Santa Clara, California	94222 Southco Inc. formerly South Chester Corp. Lester, Pennsylvania	97913 Industrial Electronic Hardware Corp. New York, New York	99515 ITT Jennings Monrovia Plant Div. of ITT Jennings formerly Marshall Industries Capacitor Div. Monrovia, California
91506 Augat Inc. Attleboro, Massachusetts	95146 Alco Electronic Products Inc. Lawrence, Massachusetts	97945 Penwalt Corp. SS White Industrial Products Div. Piscataway, New Jersey	99779 Use 29587 Bunker-Ramo Corp. Barnes Div. Landsdowne, Pennsylvania
91637 Dale Electronics Inc. Columbus, Nebraska	95263 Leecraft Mfg. Co. Long Island City, New York	97966 Replaced by 11358	99800 American Precision Industries Inc. Delevan Division East Aurora, New York
91662 Elco Corp. Willow Grove, Pennsylvania	95264 Replaced by 98278	98094 Replaced by 49956	99942 Centrelab Semiconductor Centrelab Electronics Div. of Globe-Union Inc. El Monte, California
91737 Use 71468 Gremar Mfg. Co., Inc. ITT Cannon/Gremar Santa Ana, California	95275 Vitramon Inc. Bridgeport, Connecticut	98159 Rubber-Tek, Inc. Gardena, California	Toyo Electronics (R-Ohm Corp.) Irvine, California
91802 Industrial Devices, Inc. Edgewater, New Jersey	95303 RCA Corp. Receiving Tube Div. Cincinnati, Ohio	98278 Malco A Microdot Co., Inc. Connector & Cable Div. Pasadena, California	National Connector Minneapolis, Minnesota
91833 Keystone Electronics Corp. New York, New York	95348 Gordo's Corp. Bloomfield, New Jersey		

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## Appendix 7A Manual Change Information

### INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configurations of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual with an X.

### NEWER INSTRUMENTS

Changes and improvements made to the instrument are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted in the front of the manual.

### OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table 7A-1.

### CHANGES

There are no backdating changes at this printing. All pcb assemblies are documented at their original revision level.

### OPTIONS

Change/errata information and backdating data for options will be included with the option instructions. These instructions are included with the option when shipped and can easily be added to the instrument's Instruction Manual.

**Table 7A-1. Manual Status and Back Dating Information**

\* X = The PCB revision levels documented in this manual

**X** = The PCB revision levels documented in this manual.

● = These revision letters were never

--= No revision letter on the PCB.

**Table 7A-1. Manual Status and Back Dating Information (cont)**

1. A2 Motherboard Assy (8502A-4001) — To modify from Rev B to Rev A:

**DELETE THE FOLLOWING ITEMS:**

H5	WASHER, FLAT, #8	110270	73734	1406	2
H6	WASHER, SPLIT	403923	89536	403923	2

2. A2 Motherboard Assy — To modify from Rev A to Rev —:

**CHANGE J41 and J42 as follows:**

FROM: J41	BINDING POST, BLACK	493973	32767	820-45	1
J42	BINDING POST, RED	493981	32767	820-65	1
TO:	J41 BINDING POST, BLACK	275560	32767	820-45	1
J42	BINDING POST, RED	275552	32767	820-65	1

3. A4 Power Supply (8500A-4041) — To modify from Rev E to Rev D:

**ADD THE FOLLOWING ITEM:**

R1	RES, DEP CAR, 3.3K±5%, 1/4W	348813	80031	CR251-4-5P3K3	2
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**CHANGE the QTY of R2 from 1 to REF**

**DELETE THE FOLLOWING ITEMS:**

R7	RES, DEP CAR, 240±5%, 1/4W	376624	80031	CR251-4-5P240E	1
R8	RES, DEP CAR, 2K±5%, 1/4W	441493	80031	CR251-4-5P2K	1
R9	RES, VAR, 500±20%, 1/2W	226068	19701	501	1

4. A4 Power Supply (8500A-4041) — to modify from Rev D to Rev C:

**CHANGE BR4 as follows:**

FROM: BR4	BRIDGE RECTIFIER	428839	09713	MDA970-1	1
TO:	BR4 BRIDGE RECTIFIER	296509	09432	FB200	REF

**CHANGE the QTY of BR1 from 4 to 3**

5. A4 Power Supply (8500A-4041) — To modify from Rev C to Rev B:

**CHANGE MP5 as follows:**

FROM: MP5	INSULATOR, MTG (NOT SHOWN)	508630	55285	7403-09FR-51	5
TO:	MP5 INSULATOR, MTG (NOT SHOWN)	428821	55285	7403-10-51	5

6. A6 Controller Assy (8502A-4185T) — To modify from Rev A to Rev —:

**CHANGE U3 through U7 as follows:**

FROM: U3	PROM 2716	490003	89536	490003	1
U4	PROM 2716	489997	89536	489997	1
U5	PROM 2716	489989	89536	489989	1
U6	PROM 2716	489971	89536	489971	1
U7	PROM 2716	489963	89536	489963	1
TO:	U3 PROM 2716	472225	89536	472225	1

U4	PROM	2716	472233	89536	472233	1
U5	PROM	2716	472241	89536	472241	1
U6	PROM	2716	472258	89536	472258	1
U7	PROM	2716	472266	89536	472266	1

**DELETE THE FOLLOWING ITEM:**

U8	PROM	2716	489955	89536	489955	1
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7. A6A1 Controller PCB (8502A-4185) — To modify from Rev D to Rev C:

**CHANGE R26 as follows:**

FROM: R26	RES, CAR DEP, 47K±5%, 1/4W	348896	80031	CR251-4-5P47K	1
TO:	R26 RES, CAR DEP, 30K±5%, 1/4W	368753	80031	CR251-4-5P30K	1

8. A6A1 Controller PCB (8502A-4185) — To modify from Rev C to Rev B:

**CHANGE C8 as follows:**

FROM: C8	CAP	148569			1
TO:	C8 CAP, MICA, 4PF±0.5PF, 500V	190397	72136	DM15C040E	2

**CHANGE the quantity of R9 from 1 to REF****CHANGE the times noted in the  $\phi$  pulse train of Figure 4-6 as follows:**

FROM:	$\geq$ 60ns	TO: >70ns
FROM:	80±ns	TO: blank
FROM:	95±5ns	TO: $\geq$ ns (no overlap)
FROM:	588ns	TO: 508ns

9. A6A1 Controller PCB (8502A-4185) — To modify from Rev A to Rev —:

**CHANGE C1 as follows:**

FROM: C1	CAP, MICA, 22PF±5%, 500V	148551	72136	DM15E220J	1
TO:	C1 CAP, MICA, 15PF±5%, 500V	148569	72136	DM15C150J	1

**DELETE THE FOLLOWING ITEM:**

CR2 DIODE, SI, HI-SPEED SWITCHING	203323	07910	IN4448	1
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10. A6A2 PROM ROM PCB (8502A-4088) — To modify from Rev B to Rev A:

**DELETE THE FOLLOWING ITEM:**

C8	CAP, CER, 0.22UF±20%, 25V	309849	71590	CW30C224K	REF
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**CHANGE the quantity of C3 from 6 to 5**

11. A7 Front Panel Display (8502A-4023) — To modify from Rev A to Rev —:

**CHANGE H1 as follows:**

FROM: H1	SPACER (NOT SHOWN)	448432	89536	448432	1
TO:	H1 SPACER (NOT SHOWN)	446641	11897	167-PB-0588	1

12. A8 DC Signal Conditioner (MIS-4100) — To modify Rev R to Rev P:

**CHANGE Q18 as follows:**

FROM: Q18	585109	1
TO: Q18 TRANSISTOR, NPN, SI	284075 32293 IT1099	1

13. A8 DC Signal Conditioner (MIS-4100) — To modify Rev L to Rev K:

**DELETE THE FOLLOWING ITEM:**

CR5 DIODE	348177 XXXXX1	1
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14. A8 DC Signal Conditioner (MIS-4100) — To modify Rev K to Rev J:

**CHANGE U3 and U4 as follows:**

FROM: U3 IC, OP AMP, J-FET	357830	12040	LH0042C	2	1
U4 IC, OP AMP, J-FET	357830	12040	LH0042C	REF	
TO: U3 IC, OP AMP, J-FET	310037	12040	LH0042CH	2	1
U4 IC, OP AMP, J-FET	310037	12040	LH0042CH	REF	

15. A8 DC Signal Conditioner (MIS-4100) — To modify Rev J to Rev H:

**CHANGE K1 and K2 as follows:**

FROM: K1 RELAY, ARMATURE, LO-PROFILE	515437	89536	515437	2	
K2 RELAY, ARMATURE, LO-PROFILE	515437	89536	515437	REF	
TO: K1 RELAY, ARMATURE, LO-PROFILE	441261	77342	R40-E0186-1	2	
K2 RELAY, ARMATURE, LO-PROFILE	441261	77342	R40-E0186-1	REF	

16. A9 Active Filter (MIS-4130) — To modify Rev H to Rev G:

**DELETE the following item and change the quantity of Q14 from 15 to 14:**

Q33 TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF
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17. A10A1 A/D Analog Assy (MIS-4140) — To modify Rev P to Rev N:

**CHANGE R25 and R26 as follows:**

FROM: R25 RES, MF, 42.2K±1%, 1/8W	221655	91637	MFF1-84222F	2	
R26 RES, MF, 42.2K±1%, 1/8W	221655	91637	MFF1-84222F	REF	
TO: R25 RES, MF, 49.9K±1%, 1/8W	268821	91637	MFF1-84992F	2	
R26 RES, MF, 49.9K±1%, 1/8W	268821	91637	MFF1-84992F	REF	

18. A10A1 A/D Analog Assy (MIS-4140) — To modify Rev M to Rev L:

**DELETE the following items and change the quantity of C16 from 4 to 2:**

C22 CAP, CER, 0.22UF±20%, 50V	309849	71590	CW30C224K	REF
C23 CAP, CER, 0.22UF±20%, 50V	309849	71590	CW30C224K	REF

19. A10A2 A/D Digital Assy (MIS-4141) — To modify Rev E to Rev D:

**CHANGE U38 as follows:**

FROM: U38 IC, LINEAR, 5XSTR ARRAY	477778	89536	477778	REF
TO: U38 IC, LINEAR, 5SXTR ARRAY	380188	02735	CA318E	REF

**CHANGE the quantity of U14 from 3 to 4.**  
**CHANGE the quantity of U23 from 2 to 1.**

20. A10A2 A/D Digital Assy (MIS-4141) — to modify Rev C to Rev B:

**CHANGE U23 as follows and change the quantity of U14 from 4 to 5**

FROM: U23 IC, LINEAR, 5XSTR ARRAY	477778	89536	477778	1
TO: U23 IC, LINEAR, 5XSTR ARRAY	380188	02735	CA3183	REF

21. Opt -01 AC/DC Converter (Averaging) (MIS-4101) — To modify Rev P to Rev N:

**CHANGE R3 as follows:**

FROM: R3 RES, DEP CAR, 120K±5%, 1/4W	441386	80031	CR251-4-5P120K	2
TO: R3 RES, DEP CAR, 270K±5%, 1/4W	348961	80031	CR251-4-5P270K	1

**CHANGE the quantity of R50 from REF to 1.**

22. Opt -01 AC/DC Converter (Averaging) (MIS-4101) — To modify Rev N to Rev M:

**CHANGE R3 as follows:**

FROM: R3 RES, DEP CAR, 270K±5%, 1/4W	348961	80031	CR251-4-5P270K	1
TO: R3 RES, MF, 221K±1%, 1/2W	182527	91637	CMF651-2-1P221K	1

**DELETE R55 as follows and change the quantity of R17 from 3 to 2:**

R55 RES, VAR, CERMET, 100K±10%, 1/2W	288308	89536	288308	REF
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23. Opt -01 AC/DC Converter (Averaging) (MIS-4101) — To modify Rev N to Rev M:

**CHANGE R3 as follows:**

FROM: R3 RES, MF, 221K±1%, 1/2W	182527	91637	CMF651-2-1P221K	1
TO: R3 RES, COMP, 120K±5%, 1/4W	193458	01121	CB1245	1

**CHANGE R19 as follows:**

FROM: R19 RES, VAR, CERMET, 5K±10%, 1/2W	288282	89536	288282	1
TO: R19 RES, VAR, CERMET, 2K±10%, 1/2W	285163	89536	285163	1

**CHANGE R13 as follows and change the quantity of R26 from 3 to REF**

FROM: R13 RES, DEP CAR, 75K±5%, 1/4W	394130	80031	CR251-4-5P75K1	
TO: R13 RES, DEP CAR, 47K±5%, 1/4W	348896	80031	CR251-4-5P47K	4

**CHANGE the quantity of SOCKET, COMPONENT LEAD (343285) from 8 to 4:**

24. Opt -02 Ohms Converter (MIS-4110) — to modify from Rev J to Rev H

**CHANGE R14 as follows:**

FROM: R14 RES, DEP CAR, 20K±5%, 1/4W	441477	80031	CR251-4-5P20K	1
TO: R14 RES, DEP CAR, 120K±5%, 1/4W	441386	80031	CR251-4-5P120K	5

**CHANGE the quantity of R47 from 4 to REF.**

25. Opt -02 Ohms Converter (MIS-4110) — To modify from Rev G to Rev F:

**CHANGE K1 as follows:**

FROM: K1 RELAY ARMATURE	515429	89536	515437	1
TO: K1 RELAY ARMATURE	441261	77342	R40-E0186-1	1

26. Opt -02 Ohms Converter (MIS-4110) — To modify from Rev F to Rev E:

**CHANGE R63, R64, and R65 as follows:**

FROM: R63 RES, MF, 15.8K±1%, 1/8W	293688	91637	MFF1-81582F	1
R64 RES, MF, 73.2K±1%, 1/8W	237222	91637	MFF1-87322F	1
R65 RES, MF, 30.1K±1%, 1/8W	168286	91637	MFF1-83012F	1
TO: R63 RES, MF, 28K±1%, 1/8W	291835	91637	MFF1-82802F	1
R64 RES, MF, 21K±1%, 1/8W	229484	91637	MFF1-82102F	1
R65 RES, MF, 17.8K±1%, 1/8W	349183	91637	MFF1-81782F	1

27. Opt -03 Current Shunts (MIS-4104) — To modify from Rev L to Rev K:

**DELETE C14 as follows:**

C14 CAP, MICA, 390PF±5%, 500V	148437	72316	DM15F391J	1
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28. Opt -03 Current Shunts (MIS-4104) — To modify from Rev K to Rev J:

**CHANGE CR5, CR6, CR7, CR8, CR9, CR10, as follows:**

FROM: CR5 DIODE, SI, 1A, 600 PIV	112383	05277	FN4822	6
CR6 DIODE, SI, 1A, 600 PIV	112383	05277	FN4822	REF
CR7 DIODE, SI, 1A, 600 PIV	112383	05277	FN4822	REF
CR8 DIODE, SI, 1A, 600PIV	112383	05277	FN4822	REF
CR9 DIODE, SI, 1A, 600 PIV	112383	05277	FN4822	REF
CR1 DIODE, SI, 1A, 600 PIV	112383	05277	FN4822	REF
TO: CR5 DIODE, SI, RECT	347559	05277	1N5400	6
CR6 DIODE, SI, RECT	347559	05277	1N5400	REF
CR7 DIODE, SI, RECT	347559	05277	1N5400	REF
CR8 DIODE, SI, RECT	347559	05277	1N5400	REF
CR9 DIODE, SI, RECT	347559	05277	1N5400	REF
CR1 DIODE, SI, RECT	347559	05277	1N5400	REF

29. Opt -03 Current Shunts (MIS-4104) — to modify from Rev H to Rev G:

**DELETE C12 and C13 as follows:**

C12 CAP, CER, 0.22UF±20%, 50V	309849	71590	CW30C224K	2
C13 CAP, CER, 0.22UF±20%, 50V	309848	71590	CW30224K	REF

30. Opt -05 IEEE-488 Interface (MIS-4172) — To modify from Rev H to Rev G:

**CHANGE J3 as follows:**

FROM: J3 CONNECTOR,	534107	1	
TO: J3 CONN, CABLE, 24-PIN, MODIFIED	441337 02660	57-20240-14	1

31. Opt -05 IEEE-488 Interface (MIS-4074) — To modify from Rev B to Rev A:

**CHANGE P2 and P2-1 as follows:**

FROM: P2	447110	1	
P2-1 1	447102	1	
TO: P2 CONNECTOR, SOCKET, 4-PIN	417311 20447	SS-109-1-04	5
P2-1 CONNECTOR, SOCKET, 12-PIN	417733 20447	SS-109-1-12	3

32. Opt -07 Parallel Interface (MIS-4171) — To modify from Rev F to Rev E:

**CHANGE J2 as follows:**

FROM: J2 CONNECTOR	447110	2	
J2 SOCKET, 12-PIN	425744 89536	425744	2
TO: J2-1 SOCKET, 4-PIN	417311 20447	SS-109-1-041	4

33. Opt -07 Parallel Interface (MIS-4171) — to modify from Rev E to Rev D:

**DELETE R7 as follows:**

R7 DEP CAR, 100K±5%, 1/4W	348920 80031	CR251-4-5P100K	1
---------------------------	--------------	----------------	---

34. Opt -07 Parallel Interface (MIS-4175) — To modify from Rev C to Rev B:

**CHANGE J2 as follows:**

FROM: J2 CONNECTOR	447110	2	
J2 SOCKET, 12-PIN	425744 89536	425744	2
TO: J2-1 SOCKET, 4-PIN	417311 20447	SS-109-1-041/4	

35. Opt -07 Parallel Interface (MIS-4175) — To modify from Rev B to Rev A:

**DELETE R7 as follows:**

R7 DEP CAR, 100K±5%, 1/4W	348920 80031	CR251-4-5P100K	1
---------------------------	--------------	----------------	---

36. Opt -08A Isolator (External Trigger) (8502A-4181) — To modify from Rev B to Rev A:

**DELETE L1 as follows:**

L1 CHOKE, 6-TURN	320911 89536	320911	1
------------------	--------------	--------	---

37. Opt -08A Isolator (External Trigger) (8502A-4181) — To modify from Rev A to Rev —:

**CHANGE R18 as follows:**

FROM: R18 RES, DEP CAR, 100K±5%, 1/4W	348920 80031	CR251-4-5P100K	1
TO: R18 RES, DEP CAR, 100±5%, 1/4W	348771 80031	CR251-4-5P100E	1

38. Opt -09A AC/DC Converter (RMS) (MIS-4103) — To modify from Rev K to Rev J:

**CHANGE C39 as follows:**

FROM: C39 CAP, TA, ELECT, 15UF $\pm$ 10%, 20V	153056	56289	150D156X9020B2	REF
TO: C39 CAP, MYLAR, 0.1UF $\pm$ 10%, 100V	393439	73445	C280MAH/A100K	REF

**CHANGE the quantity of C3 from 4 to 3.****CHANGE the quantity of C7 from 2 to 3.**

39. Opt -09A AC/DC Converter (RMS) (MIS-4103) — To modify from Rev J to Rev H:

**CHANGE R3 as follows:**

FROM: R3 RES, DEP CAR, 200 $\pm$ 5%, 1/4W	441451	80031	CR251-4-5P200E	1
TO: R3 RES, COMP, 200 $\pm$ 5%, 1/2W	169839	01121	EB2015	1

40. Opt-09A AC/DC Converter (RMS) (MIS-4103) — To modify from Rev H to Rev G:

**CHANGE R14 as follows:**

FROM: R14 RES, VAR, CER, 5K $\pm$ 10%, 1/2W	288282	89536	288282	1	1
TO: R14 RES, VAR, CERMET, 2K $\pm$ 10%, 1/2W	285163	89536	285163	1	1

41. Opt -09A AC/DC Converter (RMS) (MIS-4103) — To modify from Rev G to Rev F:

**CHANGE CL1 as follows:**

FROM: CL1 DIODE, FET, CURRENT REGULATOR	429373	89536	429373	1
TO: CL1 DIODE, FET, CURRENT REGULATOR	285106	07910	1CR5309	1

42. Opt -09A AC/DC Converter (RMS) (MIS-4103) — To modify from Rev F to Rev E:

**CHANGE U5 as follows:**

FROM: U5 IC, LIN, OP AMP	418368	12040	LM208A	1	1
TO: U5 IC, LIN, OP AMP	288928	12040	LM308AH	1	1

43. Opt 09A AC/DC Conerter (RMS) (MIS-4103) — To modify from Rev D to Rev C:

**CHANGE R25 as follows:**

FROM: R25 RES, DEP CAR, 2K $\pm$ 5%, 1/4W	441469	80031	CR251-4-5P2K	1
TO: R25 RES, COMP 3K $\pm$ 5%, 1/4W	193508	01121	CB3025	1

44. Opt -09A AC/DC Converter (RMS) MIS-4103 — To modify from Rev C to Rev B:

**CHANGE R3 as follows:**

FROM: R3 RES, COMP, 200 $\pm$ 5%, 1/2W	169839	01121	EB2015	1
TO: R3 RES, MF, 2K $\pm$ 1%, 1/8W	235226	91637	CMF552001F	1

**CHANGE R2 as follows:**

FROM: R2 RES, MF, 13K $\pm$ 1%, 1/8W	335539	91637	CMF551302F	1
TO: R2 RES, MF, 16.9k $\pm$ 1%, 1/8W	267146	91637	CMF551692F	1

45. Opt -09A AC/DC Converter (RMS) (MIS-4103) — To modify from Rev B to Rev A:

**CHANGE C18 as follows:**

FROM: C18 CAP, MICA, 15PF±5%, 500V	148569	72136	DM15C150J	3
TO: C18 CAP, MICA, 27PF±5%, 500V	177998	72136	DM15F270J	REF

**CHANGE the quantity of C16 from 5 to 6.**

**CHANGE the quantity of C40 from REF to 2.**



## Section 8

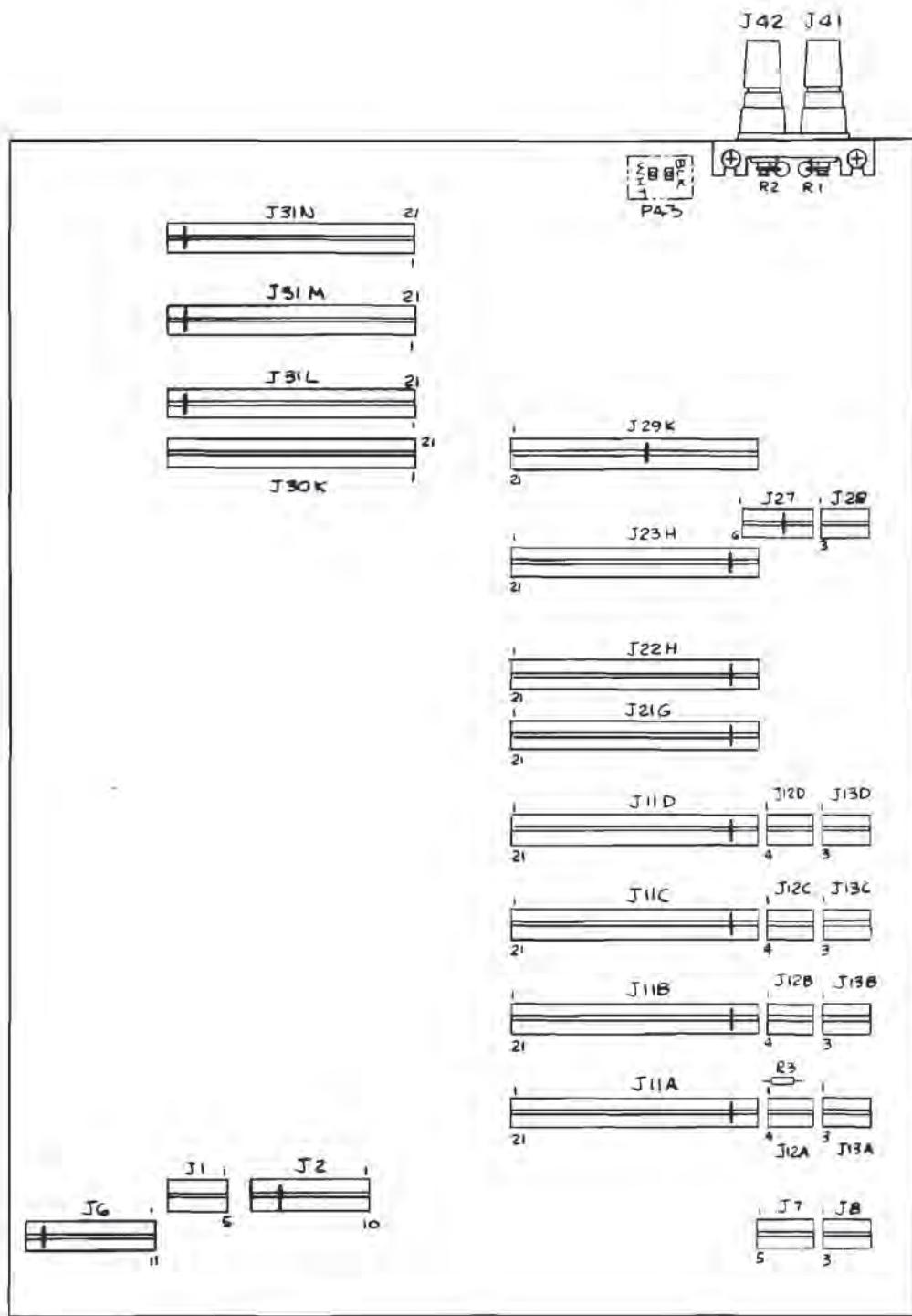
# Schematic Diagrams

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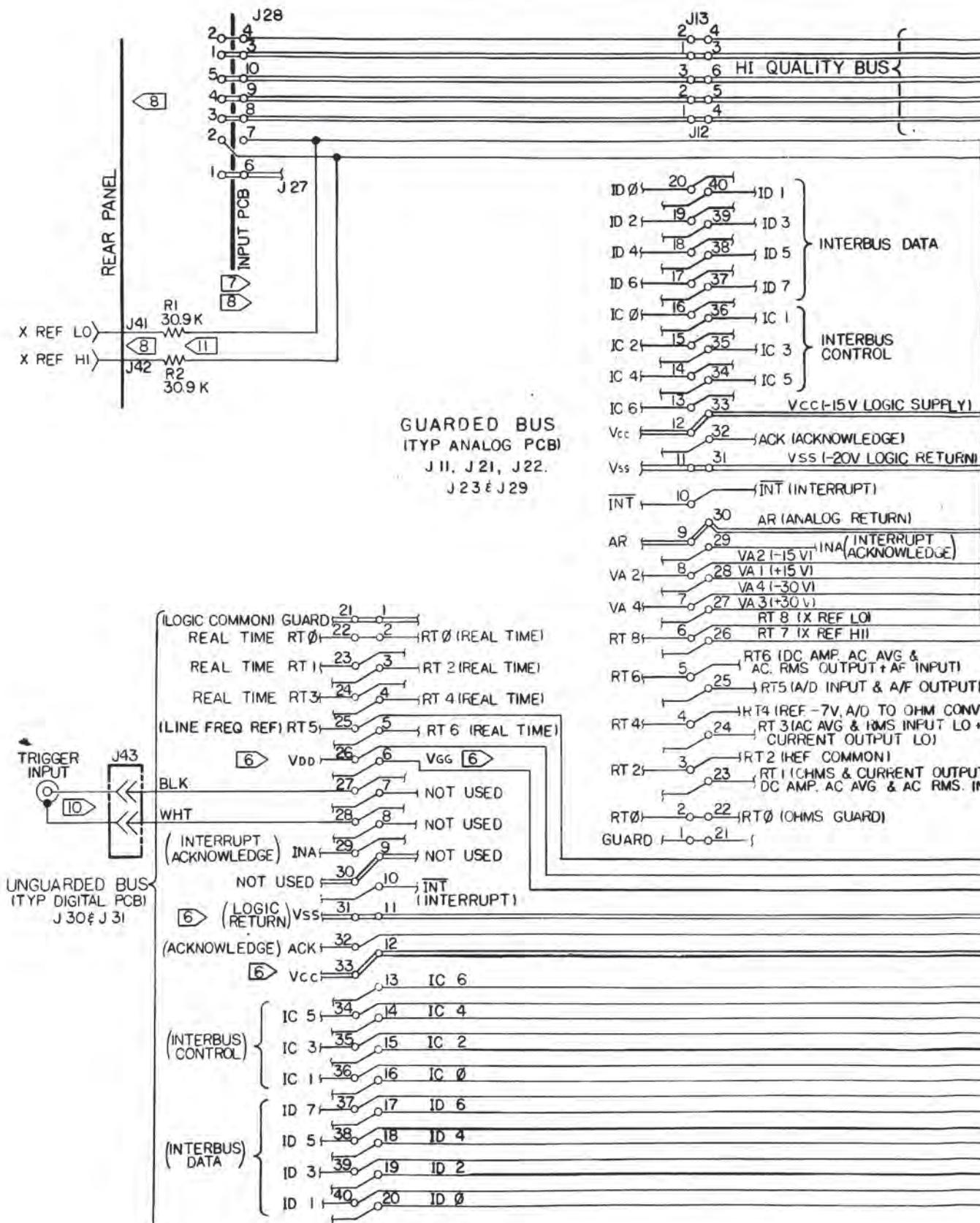
## List of Mnemonics -

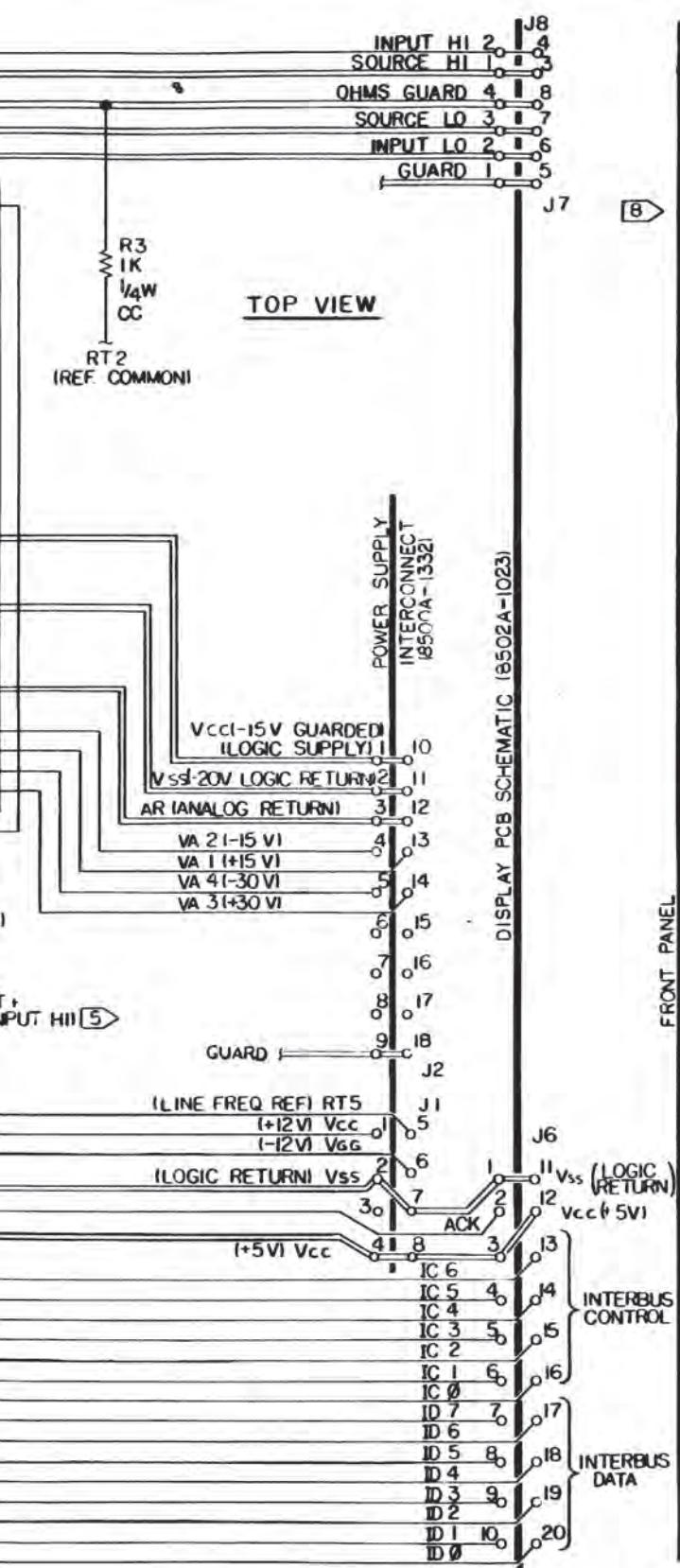
ACK	- acknowledge
ACK LAT	- acknowledge late
AR	- analog return
DB	- data bus
DBIN	- data bus input signal (from $\mu$ P)
DLD ACK	- delayed ACK
EN INT	- enable interrupt
HLDA	- hold acknowledge
IB ADX	- interbus address
IBIN	- interbus input signal
IC	- interbus control
ID	- interbus data
IINT	- internal interrupt
INA	- interrupt acknowledge (from controller)
INT	- interrupt
INTA	- Interrupt acknowledge (status word from $\mu$ P)
INTE	- interrupt enable (from $\mu$ P)
MEM RD	- memory read
MS ADDR BYTE	- memory select address byte
$\phi$ 1	- clock pulse
$\phi$ 2	- clock pulse
$\phi$ LL	- phase-locked loop
RAM	- random access memory
ROM	- read only memory
RRDY	- reset ready
RST	- reset
RT	- real time
R/W	- read/write
$\mu$ P	- microprocessor
VA	- analog supply voltage
$V_{CC} \phi$ 2	- 5V clock pulse
$V_{DD} \phi$ 2	- 12V clock pulse
SRDY	- set ready
SYN IINT	- synchronized internal interrupt
TTL PU	- TTL pull-up
WO	- write out
WR	- write



8502A-1601

Figure 8-1. A2 Motherboard PCB Assembly





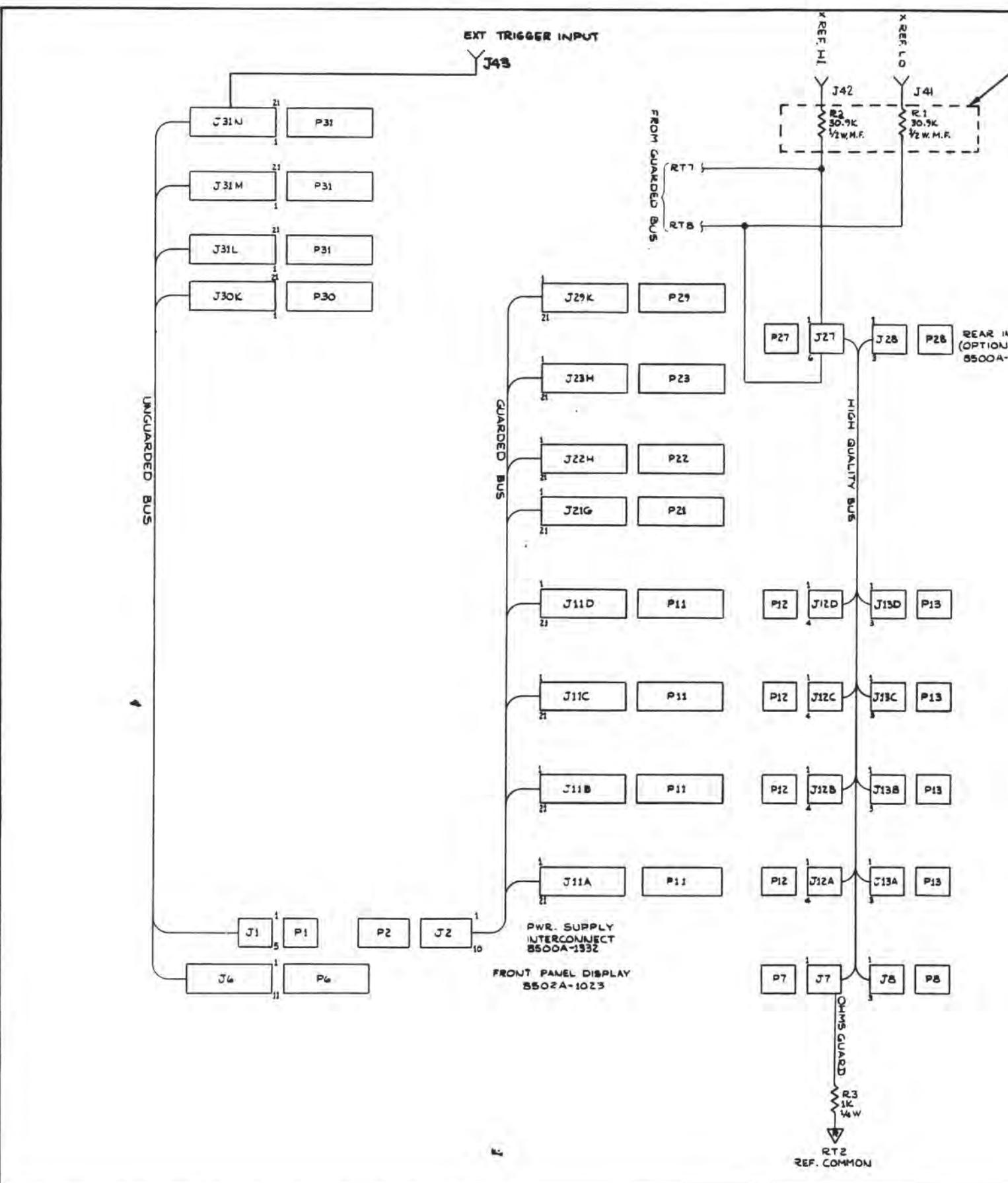
- [5] THIS BUS LINE IS INTERCONNECTED ON J21, J22, J23 & J29 BUT HAS NO USE ON 8502A APPLICATIONS IN THESE LOCATIONS.  
FUNCTION INDICATED IS FOR JII ONLY.  
NO INTERCONNECT EXISTS BETWEEN JII, PIN 23 & OTHER CONNECTORS ON GUARDED BUS
- [6] FUNCTION WILL VARY DEPENDING UPON BUS INTERCONNECTION INSTALLED IN UNIT.

FUNCTION	ISOLATOR (OPTION-OII)	BUS INTERCONNECT (MIS-108I)
V <sub>SS</sub>	0	-20V
V <sub>DD</sub>	+12V	-8V
V <sub>GG</sub>	-12V	-32V
V <sub>CC</sub>	+5V	-15V

- [7] CONNECTION FOR PARALLEL REAR INPUT-017 SEE 8500A-1314.
- [8] CONNECTION FOR SWITCHED FRONT/REAR INPUT-016 SEE 8502A-10II.
- [9] CONNECTION FOR FRONT PANEL INPUT SEE 8502A-16.
- [10] USED ON -06I ONLY.
- [11] RESISTORS R1 & R2 REMOVED ON -16 OPTION.

8502A-1001

Figure 8-1. A2 Motherboard PCB Assembly (cont)



JPT  
-16% 17)  
1314

MODULE INSTALLATION LOCATIONS			
MODULE DESCRIPTION	SCHEMATIC DWG NO.	PREFERRED SLOT	PERMISSABLE SLOTS
D.C. SIGNAL COND.	M.I.S.-1100	A	A B C D
AC. CONV. (OPTION -01)	M.I.S.-1101	B	A B C D
R.M.S. CONV. (OPTION -09)	M.I.S.-1102	B	A B C D
CURRENT SHUNT (OPTION -03)	M.I.S.-1104	C	A B C D
DHMS CONV. (OPTION -02)	M.I.S.-1110	D	A B C D
FILTER	M.I.S.-1130	G	G
A/D CONV.	M.I.S.-1140 M.I.S.-1141	H	H
BUS INTERCONNECT	M.I.S.-1081	K	K
ISOLATOR (OPTION -08)	8502A-1181	K	K
CONTROLLER	8502A-1185	N (MEN 120 NOT INSTALLED)	L M N
CALIBRATION MEMORY (OPTION -04)	M.I.S.-1160	M	L M N
BIT SERIAL (OPTION -06)	M.I.S.-1170	M	L M N
PARALLEL INTERFACE (OPTION -07)	M.I.S.-1171	M	L M N
IEEE INTERFACE (OPTION -05)	M.I.S.-1072 M.I.S.-1172	M	L M N

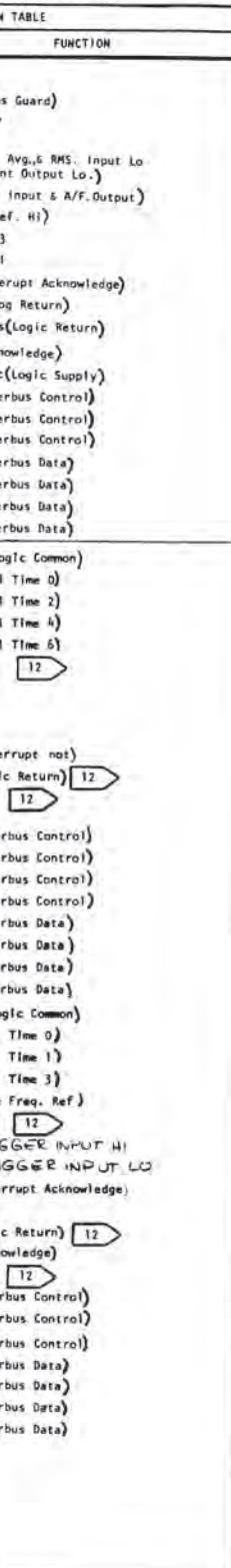
NOTES:

4 REMOVE FOR -16 OPTION

SERVICE / FIELD AIDS - LOCATIONS			
DESCRIPTION	SCHEMATIC DWG. NO.	PREFERRED SLOT	PERMISSABLE SLOTS
STATIC CONTROLLER M.I.S.-7190K	M.I.S.-1190	L M N	A B C D L M N
TEST MODULE M.I.S.-7191K	M.I.S.-1191	A B C D	A B C D L M N
EXTENDER M.I.S.-7011K		NONE	ANY
BUS INTERCONNECT & MONITOR M.I.S.-7013K		K	ANY

Figure 8-2. Interconnect Diagram Mother Assembly

FUNCTION TABLE			FUNCTION TABLE			FUNCTION TABLE		
CONNECTOR	PIN NO.	FUNCTION	CONNECTOR	PIN NO.	FUNCTION	CONNECTOR	PIN NO.	FUNCTION
J1 (unguarded Bus)	1	+12V Vdd	J1A	17	ID6(Interbus Data)	J2G	21	Guard
	2	Vss(Logic Return)	J1B	18	ID4(Interbus Data)	J2H	22	RTO(Ref. Common)
	3	NC	J1C	19	ID2(Interbus Data)	J23H	23	11
	4	+15V Vcc	J1D	20	ID0(Interbus Data)	J29K	24	RT3(AC. Avg. & RMS. Input Hi.)
	5	RTS (Line Freq. Ref.)	(Guarded Bus)	21	Guard	(Guarded Bus)	25	RT5(A/D)
	6	-12V Vgg		22	RTO(Ohms Guard)		26	RT7(X.R)
	7	Vss(Logic Return)		23	RT1(Ohms & Current Output Hi. +DC. AMP., AC. Avg., & AC. RMS. Input Hi.)		27	+30V VA
	8	+5V Vcc		24	RT3(AC. Avg., & RMS. Input Lo) + (Current Output Lo.)		28	+15V VA
J2 (Guarded Bus)	1	-15V Vcc(Logic Supply)		25	RT5(A/D Input & A/F Output)		29	INA(Interrupt Acknowledge)
	2	-20V Vss(Logic Return)		26	RT7(X.Ref. Hi)		30	AR(Analog Return)
	3	AR(Analog Return)		27	+30V VA3		31	-20V Vs
	4	-15V VA2		28	+15V VA1		32	ACK(Acknowledge)
	5	-30V VA4		29	INA(Interrupt Acknowledge)		33	-15V Vcc(Logic Supply)
	6	NC		30	AR(Analog Return)		34	IC5(Interbus Control)
	7	NC		31	-20V Vss(Logic Return)		35	IC3(Interbus Control)
	8	NC		32	ACK(Acknowledge)		36	IC1(Interbus Control)
	9	Guard		33	-15V Vcc(Logic Supply)		37	ID7(Interbus Data)
	10	-15V Vcc(Logic Supply)		34	IC5(Interbus Control)		38	ID5(Interbus Data)
	11	-20V Vss(Logic Return)		35	IC3(Interbus Control)		39	ID3(Interbus Data)
	12	AR(Analog Return)		36	IC1(Interbus Control)		40	ID1(Interbus Data)
	13	+15V VA1		37	ID7(Interbus Data)			
	14	+30V VA3		38	ID5(Interbus Data)			
	15	NC		39	ID3(Interbus Data)			
	16	NC		40	ID1(Interbus Data)			
	17	NC						
	18	Guard						
J6 (unguarded Bus)	1	Vss (Logic Return)	J12A	1	Input Lo	J30K	1	Guard(L)
	2	ACK (Acknowledge)	J12B	2	Source Lo	J31N	2	RTO(Rea)
	3	+5V Vcc	J12C	3	Ohms Guard	J31M	3	RT2(Rea)
	4	IC5 (Interbus Control)	J12D	4	Input Lo	J31L	4	RT4(Rea)
	5	IC3 (Interbus Control)	(High Quality Bus)	5	Source Lo			
	6	IC1 (Interbus Control)		6	Ohms Guard			
	7	ID7 (Interbus Data)	J13A	1	Source HI			
	8	ID5 (Interbus Data)	J13B	2	Input HI			
	9	ID3 (Interbus Data)	J13C	3	Source HI			
	10	ID1 (Interbus Data)	J13D	4	Input HI			
	11	Vss (Logic Return)	J27	1	Guard			
	12	+5V Vcc	(High Quality Bus)	2	X Ref. HI			
	13	IC6 (Interbus Control)		3	Input Lo			
	14	IC4 (Interbus Control)		4	Source Lo			
	15	IC2 (Interbus Control)		5	Ohms Guard			
	16	IC0 (Interbus Control)		6	Guard			
	17	ID6 (Interbus Data)		7	X Ref. Lo			
	18	ID4 (Interbus Data)		8	Input Lo			
	19	ID2 (Interbus Data)		9	Source Lo			
	20	ID0 (Interbus Data)		10	Ohms Guard			
J7 (High Quality Bus)	1	Guard	J28	1	Source HI			
	2	Input Lo		2	Input HI			
	3	Source Lo		3	Source HI			
	4	Ohm's Guard		4	Input HI			
	5	Guard	J2G	1	Guard			
	6	Input Lo	J22H	2	RTO(Ohms Guard)			
	7	Source Lo	J23H	3	RT2(Ref. Common)			
	8	Ohm's Guard	J29K	4	RT4(Ref. -7V, A/D to R Conv.)			
J8 (High Quality Bus)	1	Source HI	(Guarded Bus)	5	RT6(AC. AMP., AC. Avg., & AC. RMS. Output. +A/F. Input)			
	2	Input HI		6	RT8(X. Ref. Lo.)			
	3	Source HI		7	-30V VA4			
	4	Input HI		8	-15V VA2			
J11A J11B J11C J11D (Guarded Bus)	1	Guard		9	AR(Analog Return)			
	2	RTO (Ohm's Guard)		10	INT(Interrupt not)			
	3	RT2 (Ref. Common)		11	-20V Vss(Logic Return)			
	4	RT4 (Ref. -7V, A/D to Ohm's Conv.)		12	-15V Vcc(Logic Supply)			
	5	RT6 (DC. AMP., AC. Avg., & AC. RMS. Output. +A/F. Input)		13	IC6(Interbus Control)			
	6	RT8 (X. Ref. Lo.)		14	IC4(Interbus Control)			
	7	-30V VA4		15	IC2(Interbus Control)			
	8	-15V VA2		16	IC0(Interbus Control)			
	9	AR (Analog Return)		17	ID6(Interbus Data)			
	10	INT (Interrupt not)		18	ID4(Interbus Data)			
	11	-20V Vss (Logic Return)		19	ID2(Interbus Data)			
	12	-15V Vcc (Logic Supply)		20	ID0(Interbus Data)			
	13	IC6 (Interbus Control)						
	14	IC4 (Interbus Control)						
	15	IC2 (Interbus Control)						
	16	IC0 (Interbus Control)						

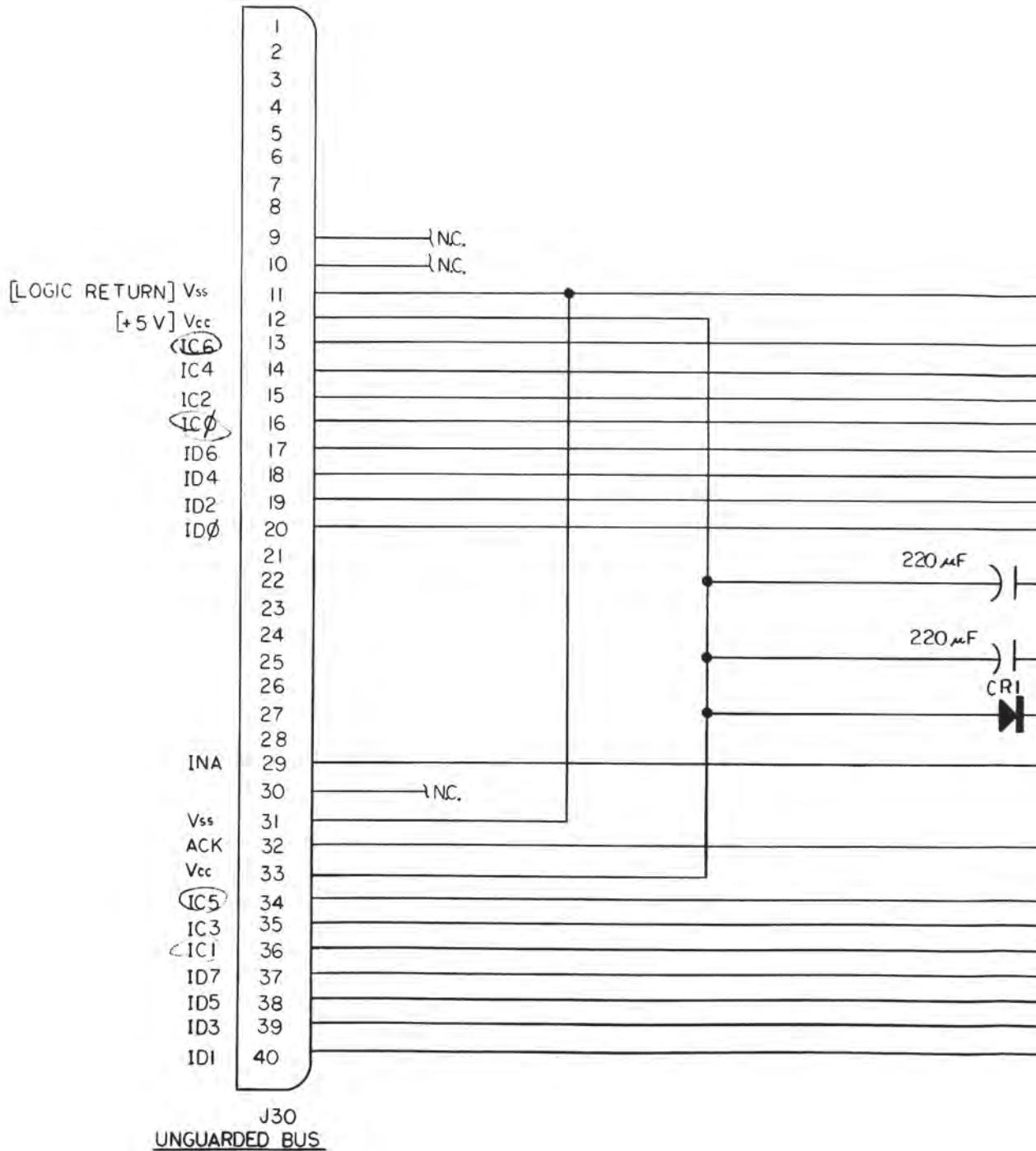
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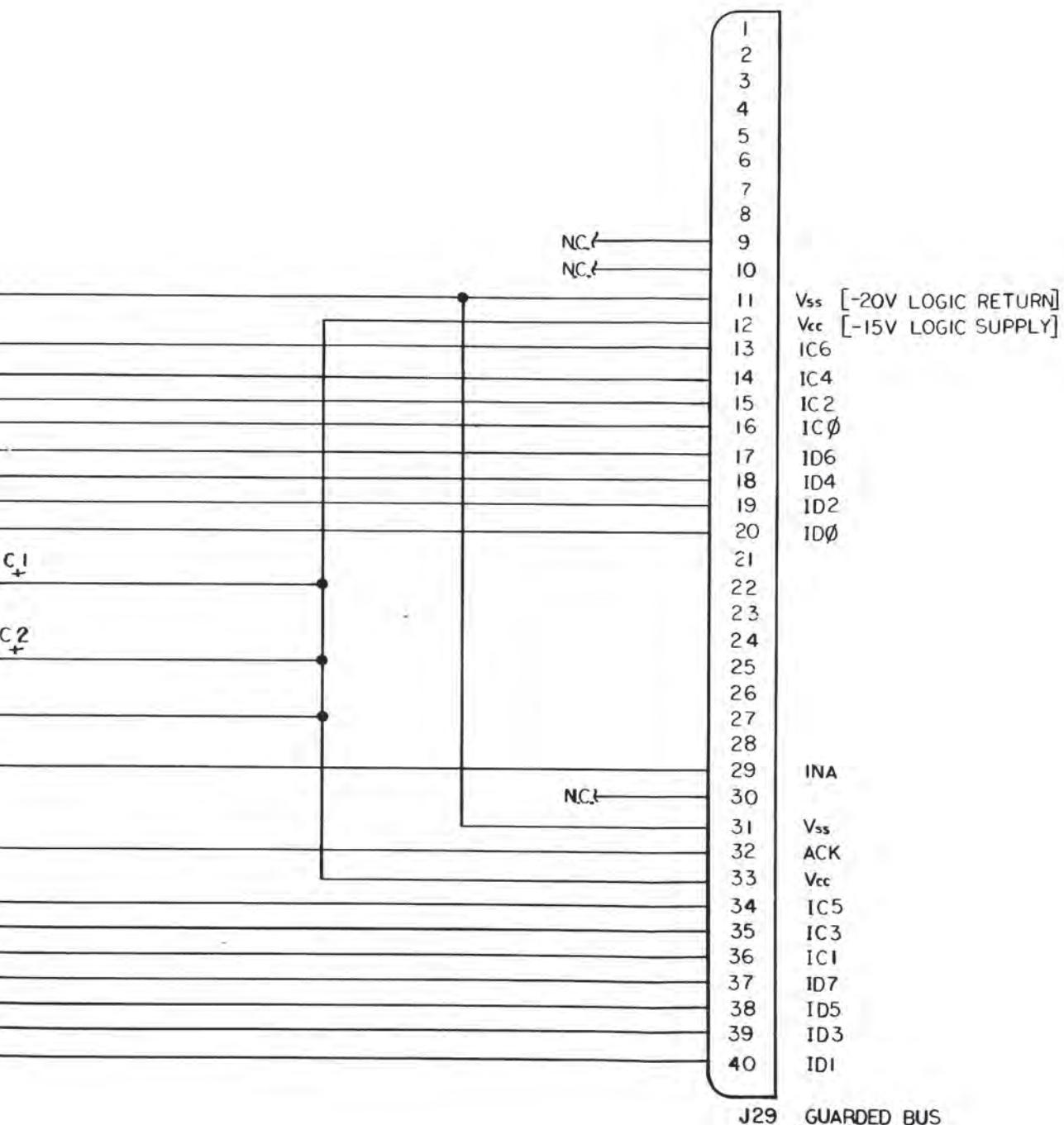
11. This Bus line is not used for 8502A applications, but it is Interconnected on J21G, J22H, J23H, & J29K. No connection is made with J11 Pin 23.
12. Functions will vary depending upon type of Bus Interconnection installed in unit.

Function	Isolator (option-081)	Bus Interconnect (MIS-1081)
Vss	0	-20V
Vdd	+12V	-8V
Vgg	-12V	-32V
Vcc	+5V	-15V

8502A-1301  
Sht 2 of 2

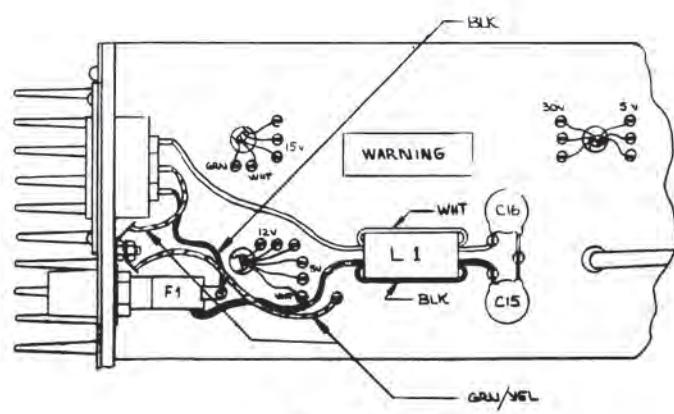
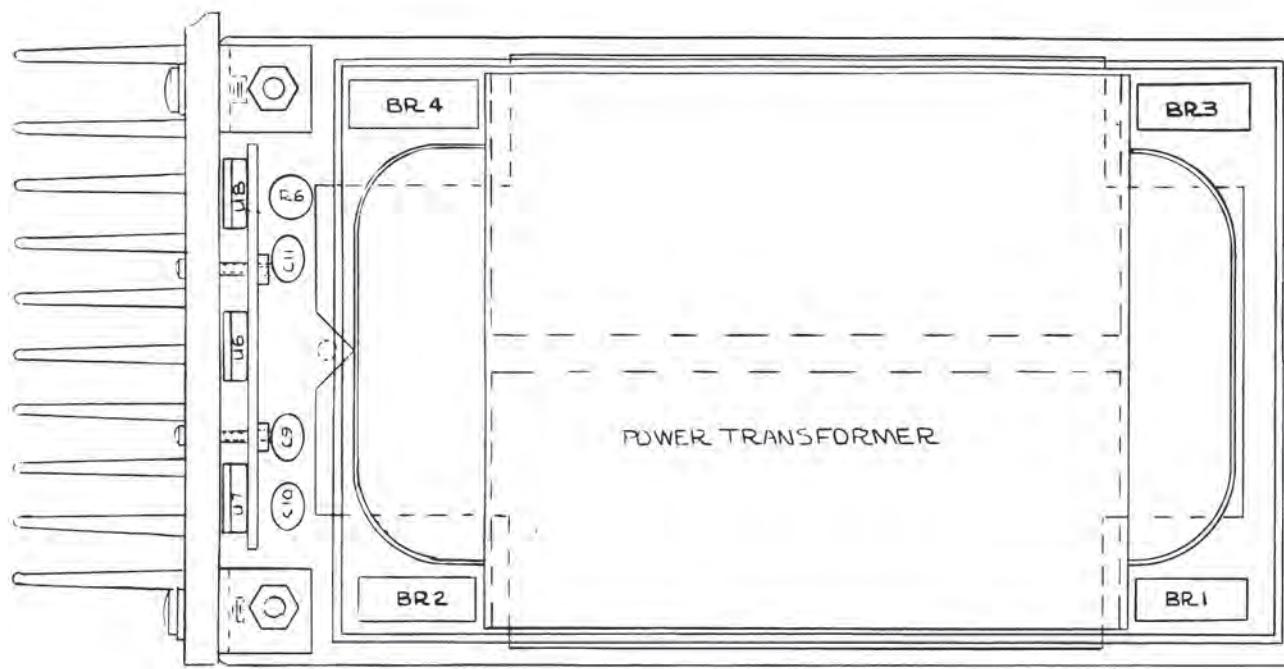
Figure 8-2. Interconnect Diagram  
Mother Assembly (cont)



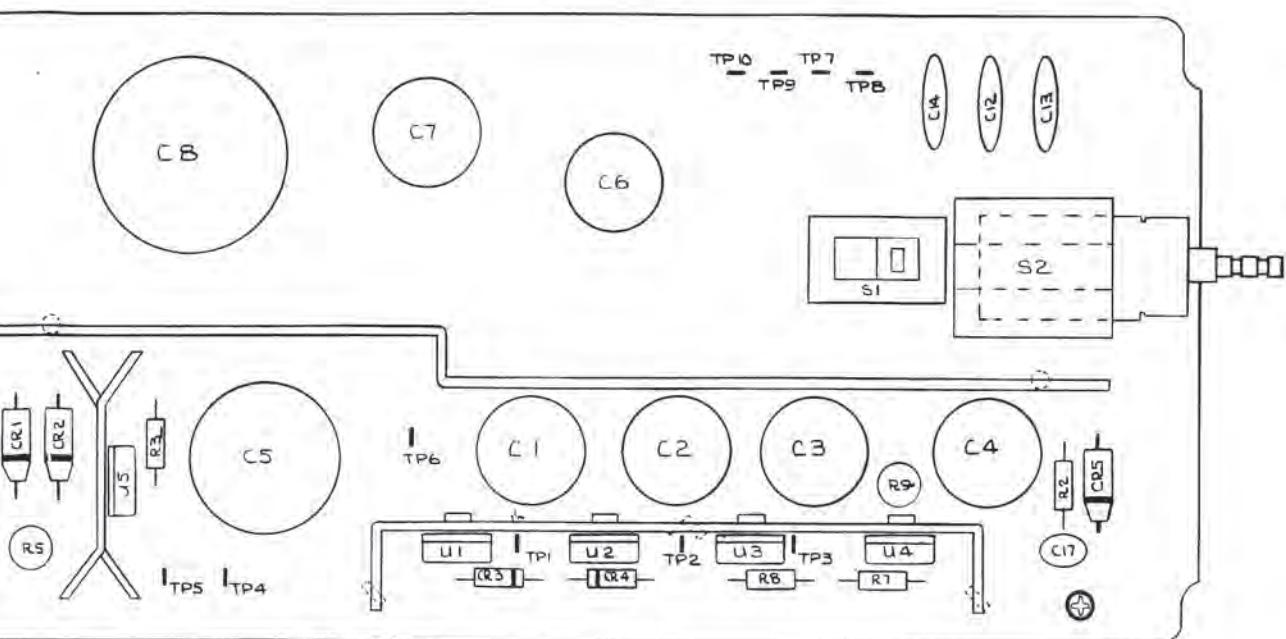


MIS-1081

Figure 8-3. Bus Interconnect

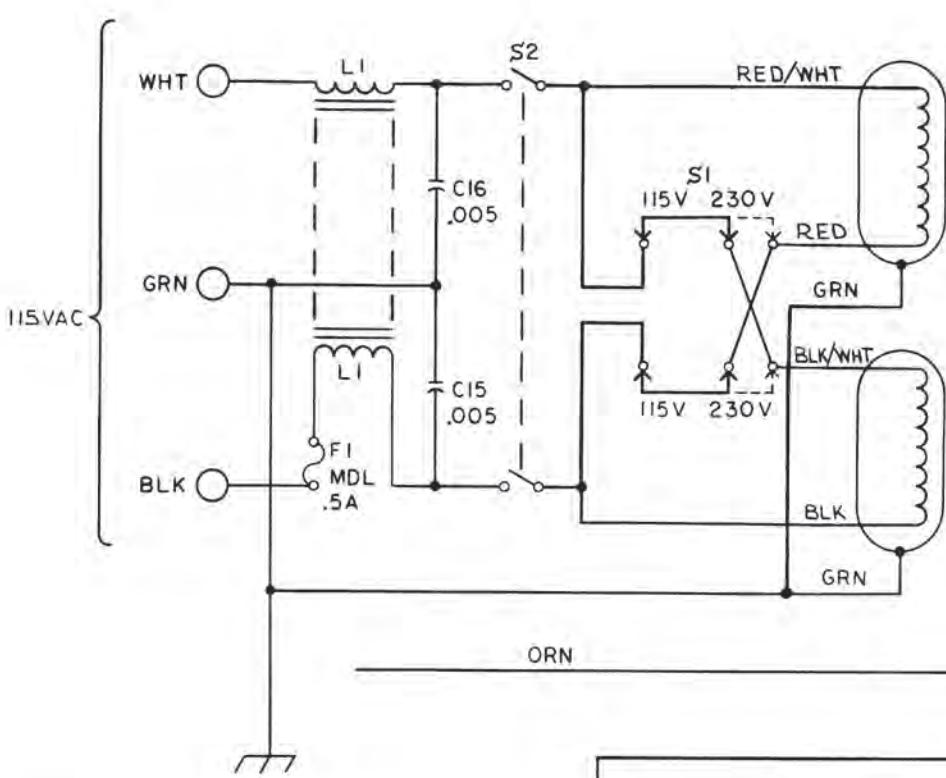


DETAIL OF CKT 1



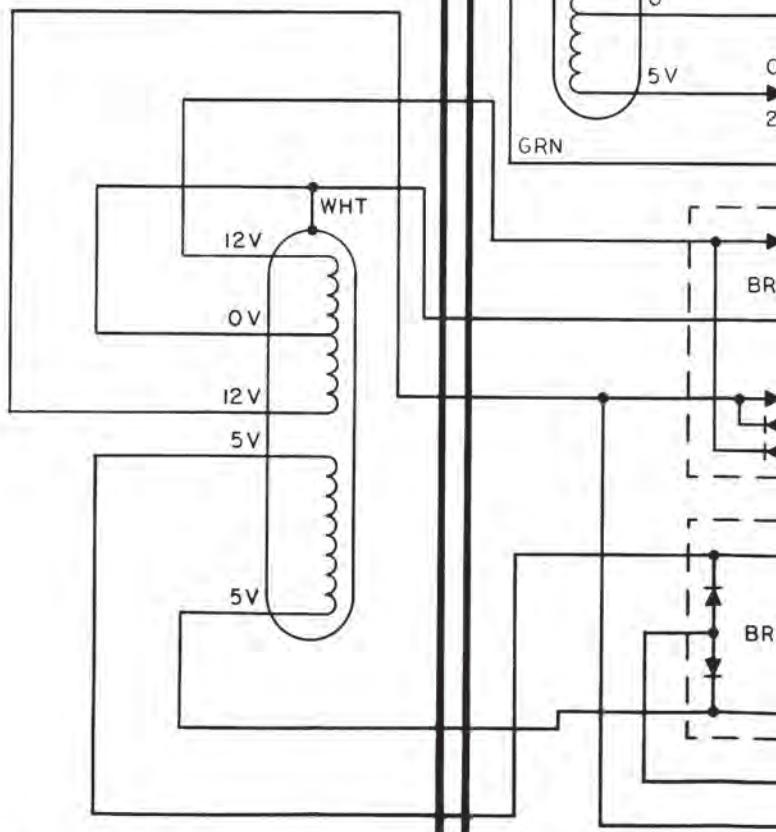
8500A-1651

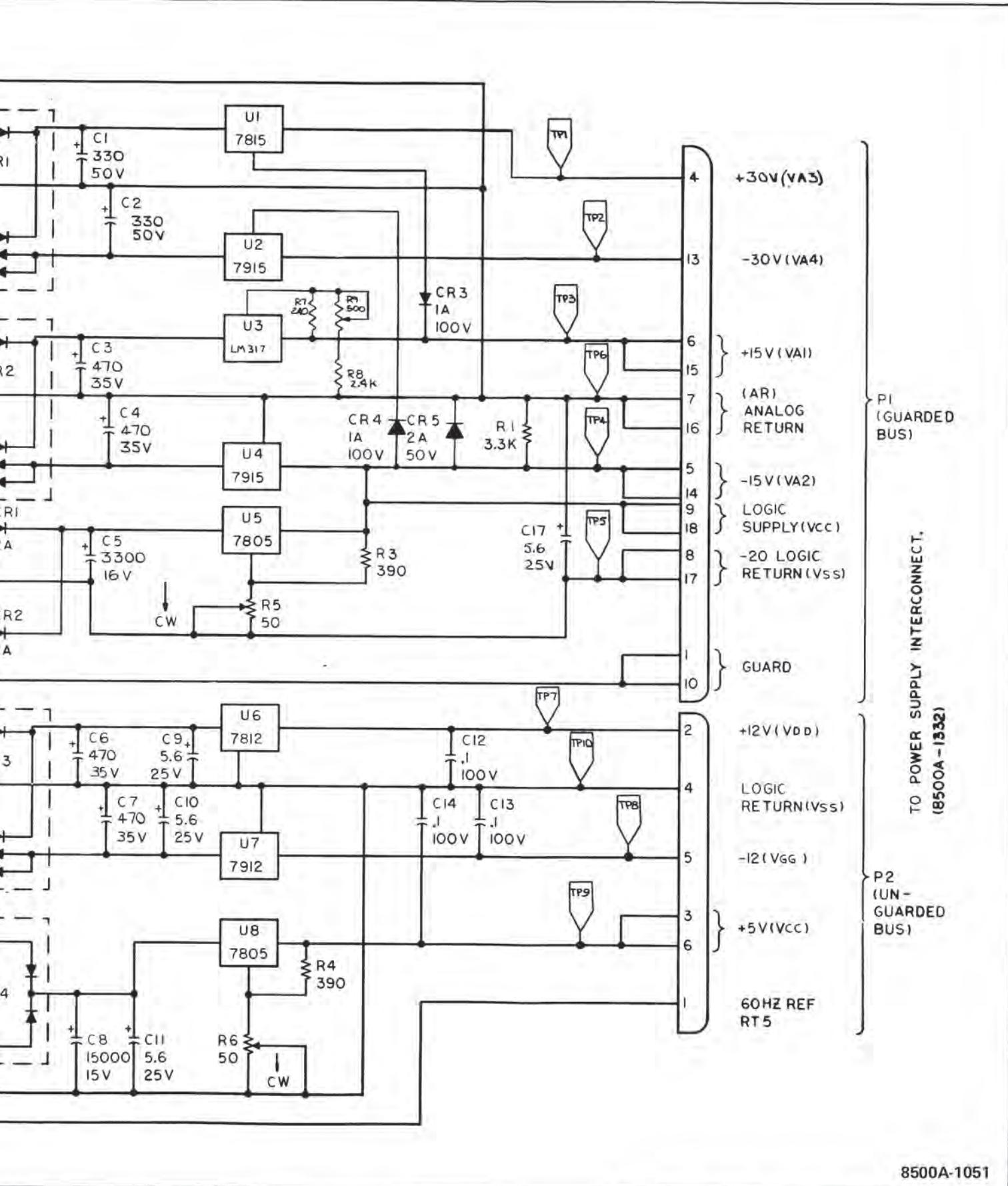
Figure 8-4. A4 Power Supply PCB Assembly—  
Type 51



NOTES (UNLESS OTHERWISE SPECIFIED)

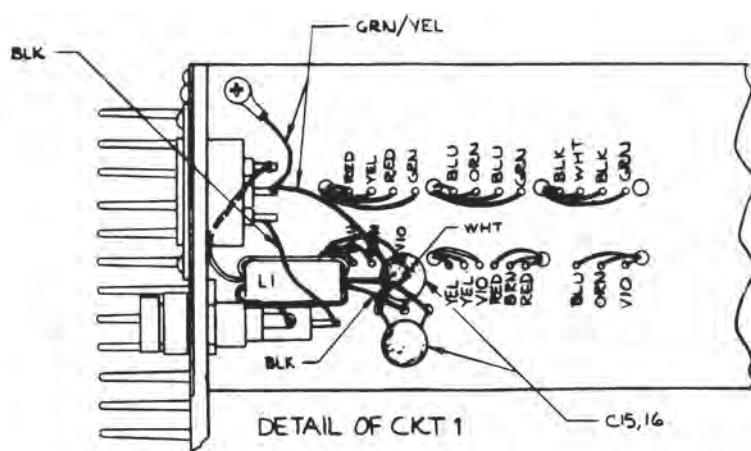
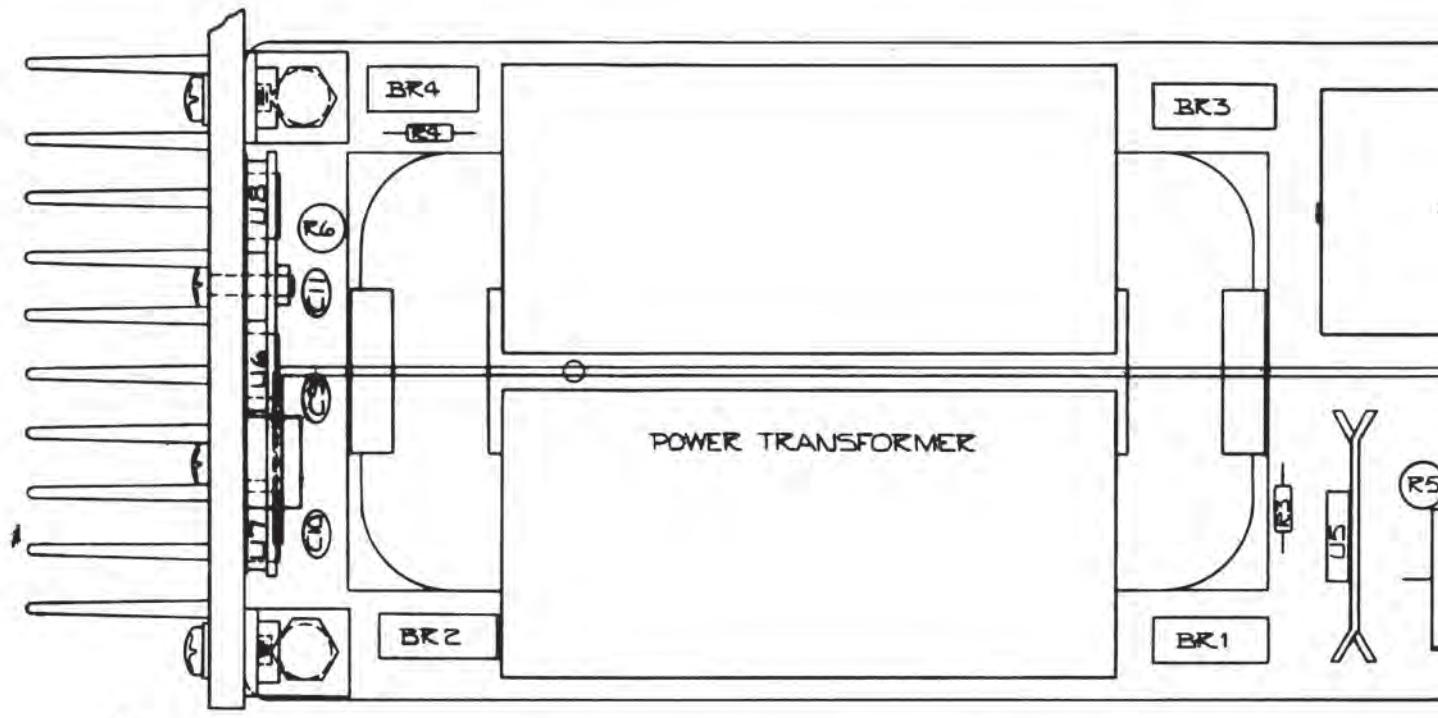
1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.F., 1/4W, 5%.
3. ALL CAPACITANCE IN MICROFARADS.

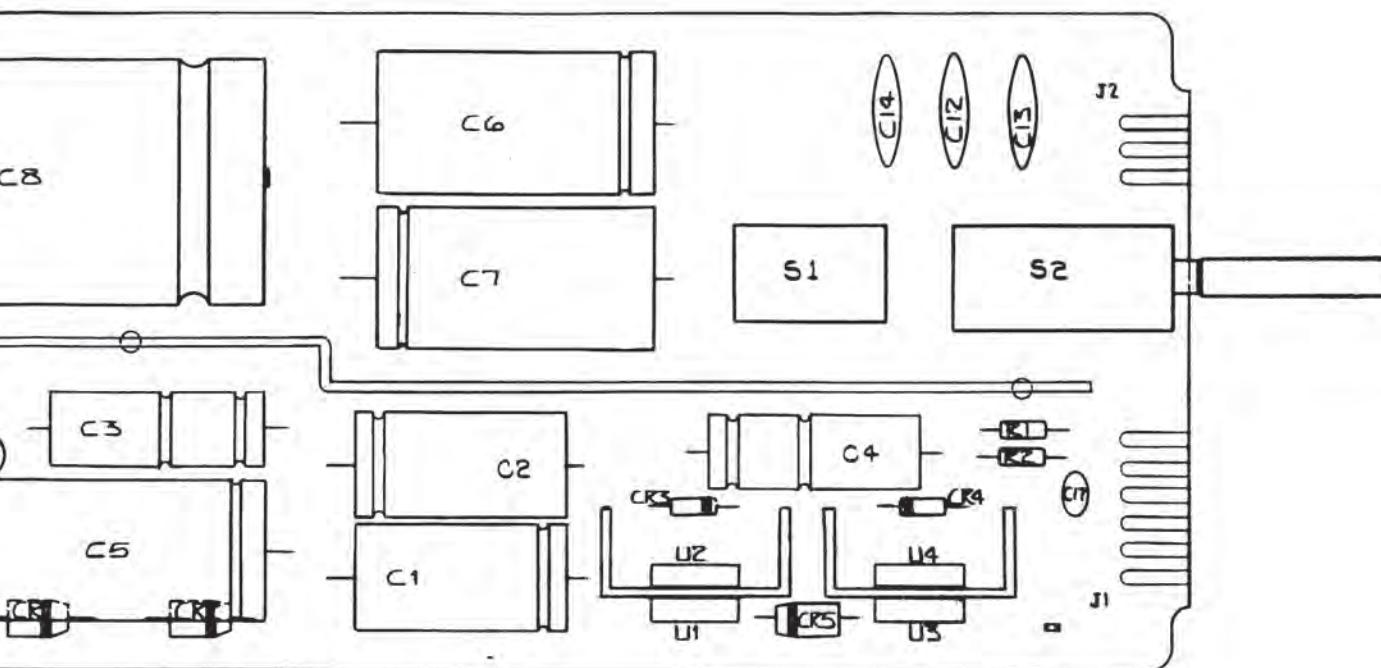




8500A-1051

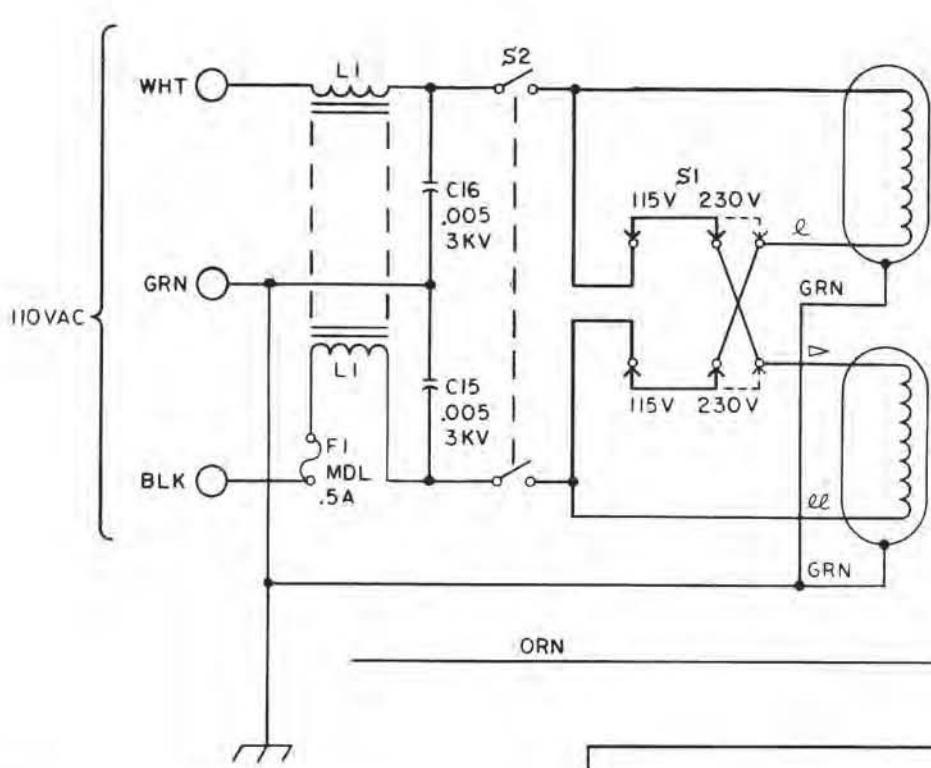
Figure 8-4. A4 Power Supply PCB Assembly – Type 51 (cont)





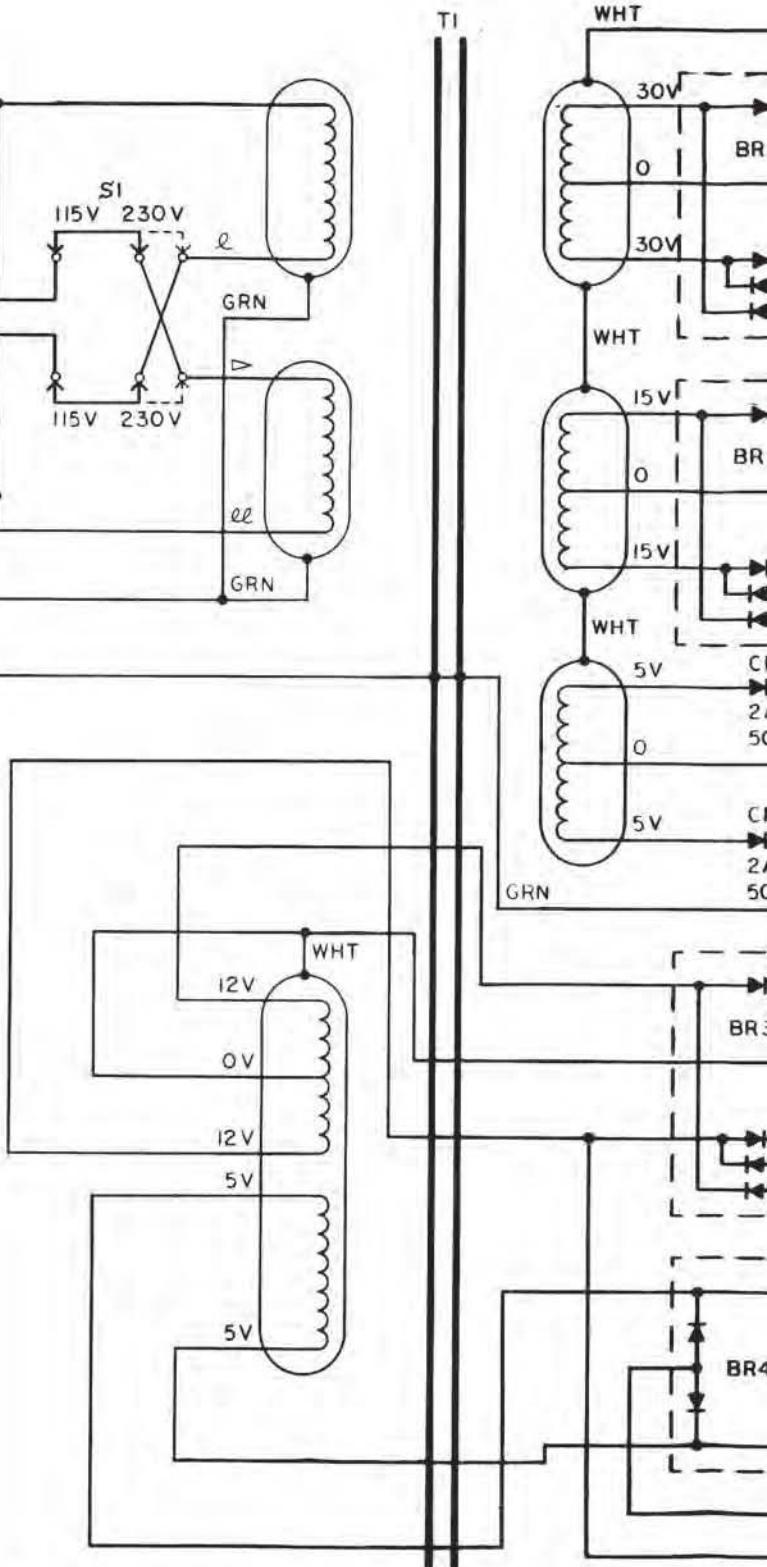
8500A-1641

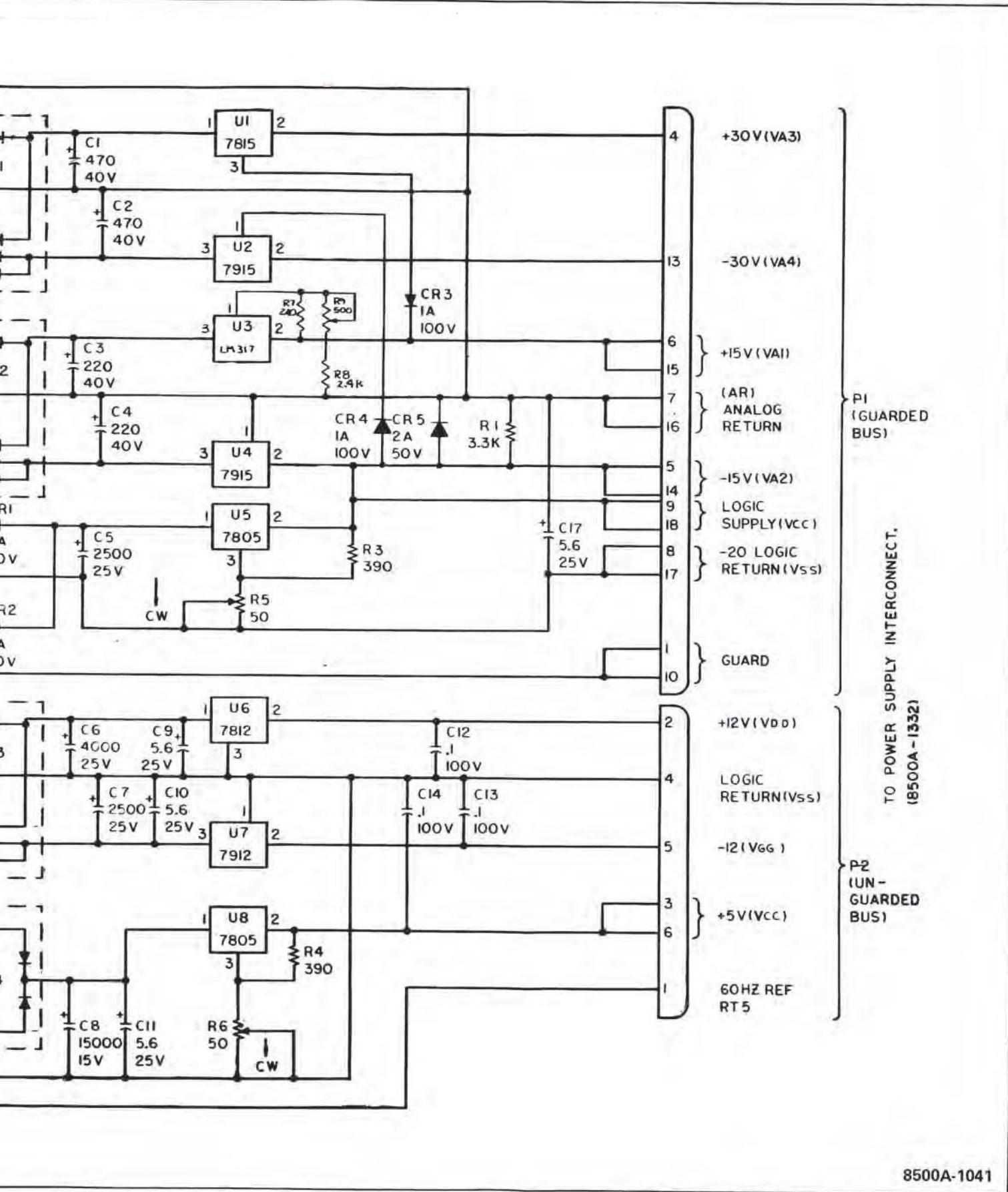
Figure 8-5. A4 Power Supply PCB Assembly—  
Type 41



NOTES (UNLESS OTHERWISE SPECIFIED)

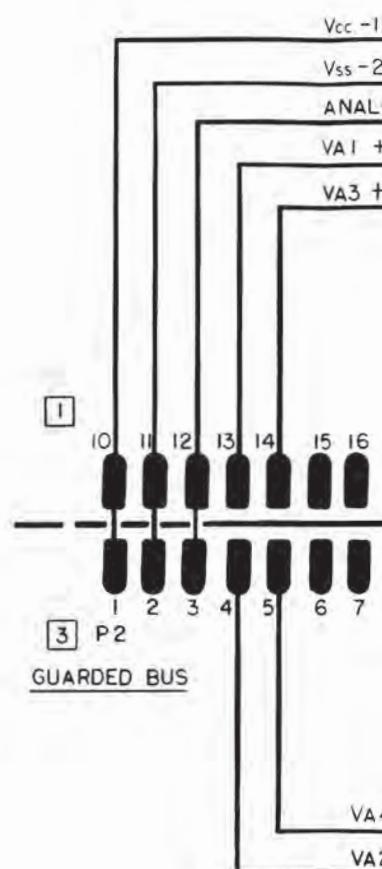
1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C., 1/4W, 5%.
3. ALL CAPACITANCE IN MICROFARADS.





8500A-1041

Figure 8-5. A4 Power Supply PCB Assembly—  
Type 41 (cont)



5V (GUARDED) LOGIC SUPPLY

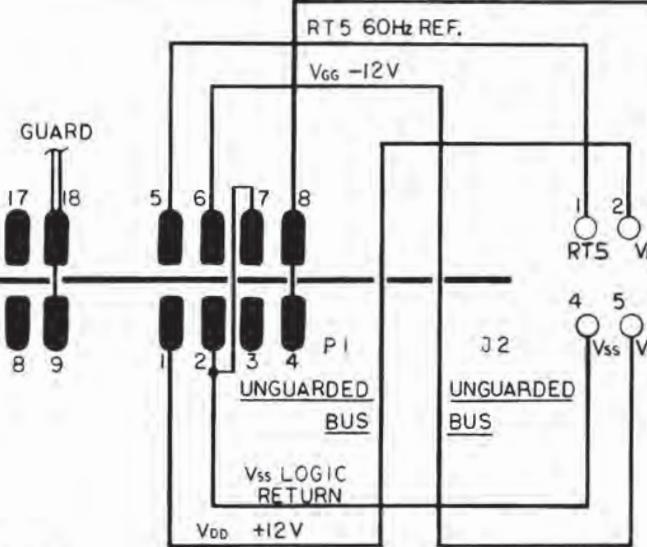
OV LOGIC RETURN

OG. RETURN

-15V

30V

Vcc +5V (UNGUARDED)



GUARD

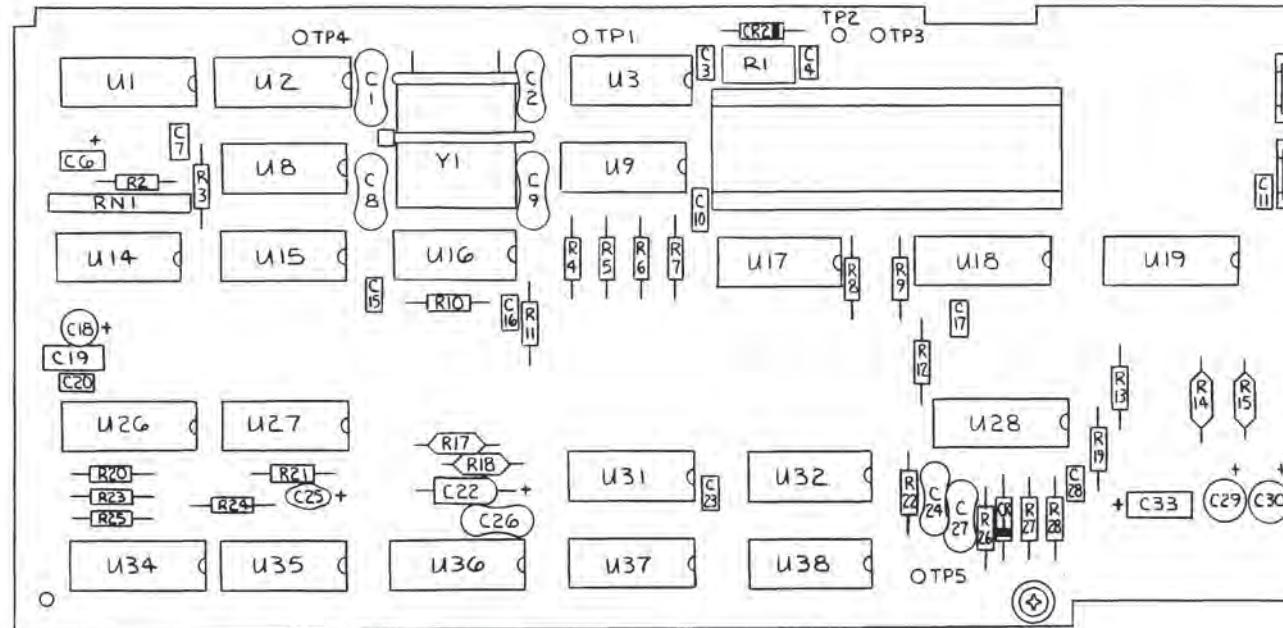
1 2 3  
4 5 6  
10 11 12  
13 14 15  
16 17 18Vcc  
VA3  
VA4  
VA2  
VAI  
AR  
Vss  
VccJ1  
GUARDED BUS

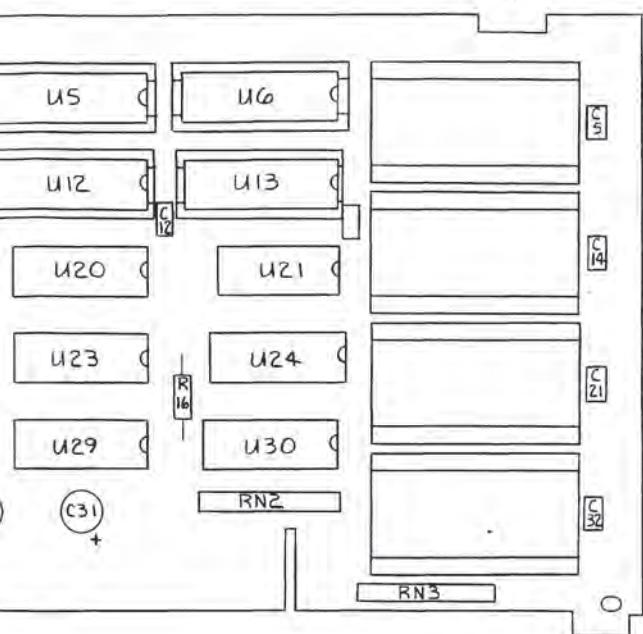
4-30V

2-15V

8500A-1332

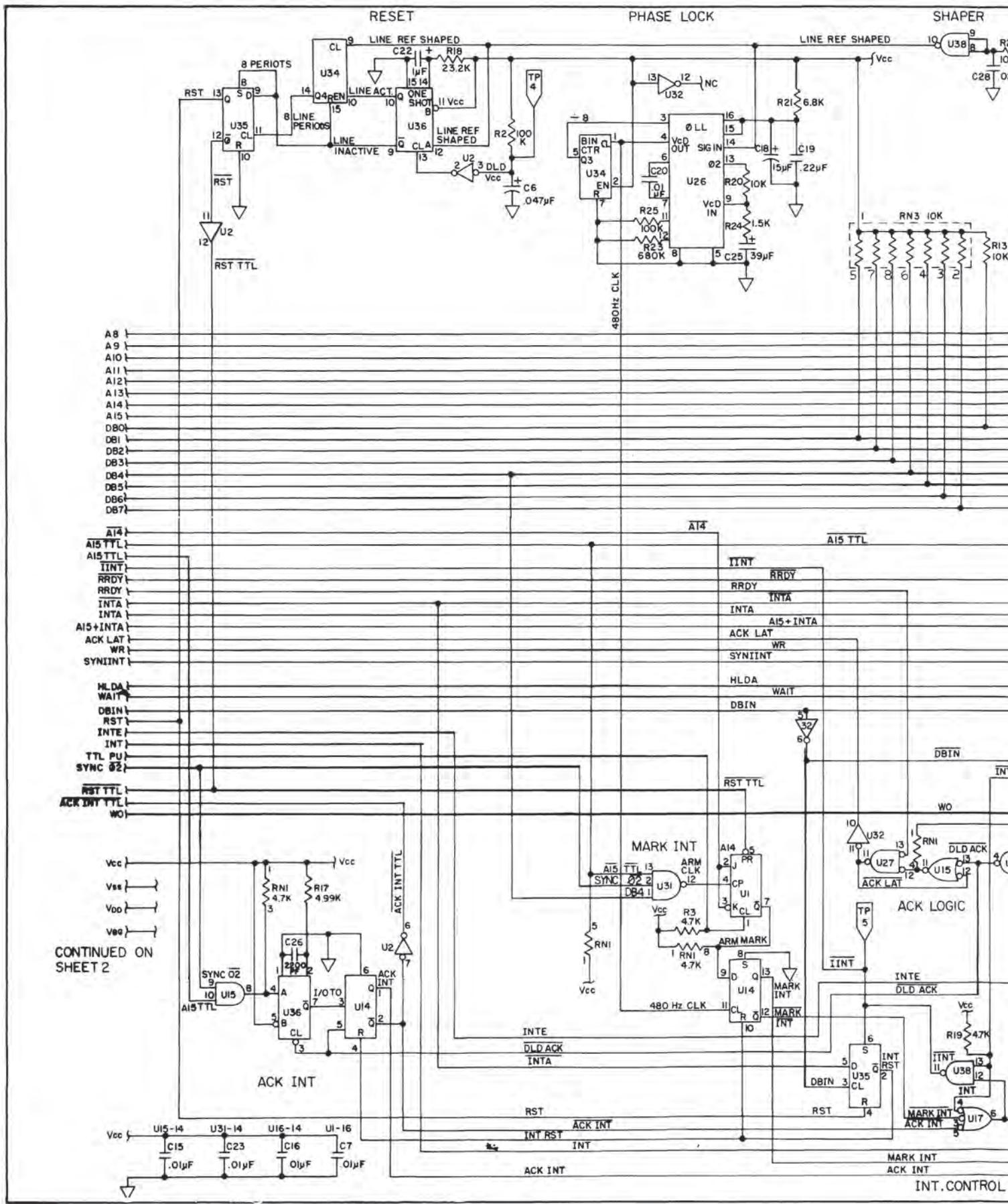
Figure 8-6. A5 Power Supply Interconnect

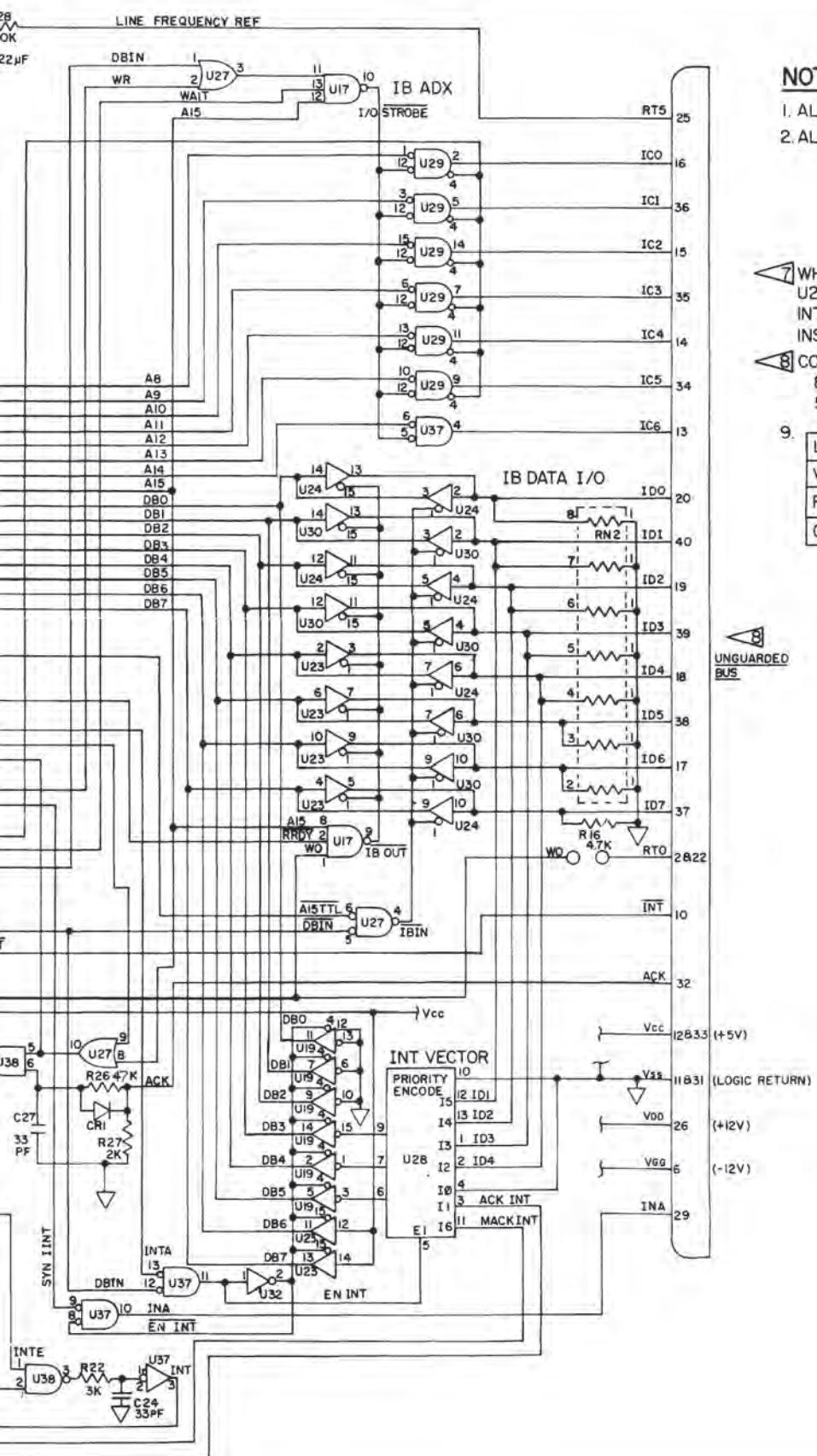




8502A-1786

Figure 8-7. A6 Controller PCB Assembly—  
Single PCB Version



**NOTES:** (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS CC. 1/4 W, 5% (EXCEPT R18 & R19)

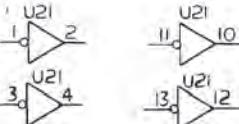
7 WHEN USING EXPANDED MEMORY (PROM PCB),  
U25 LOCATION WILL BE UTILIZED AS AN  
INTERCONNECT & 8316 ROM WILL NOT BE  
INSTALLED SEE MIS-1085 FOR PROM SCHEMATIC

8 CONNECTOR NO. VARIES BY INSTRUMENT  
8500 SERIES - P31  
5100 SERIES - P29

## 9. LAST REF. DES. USED

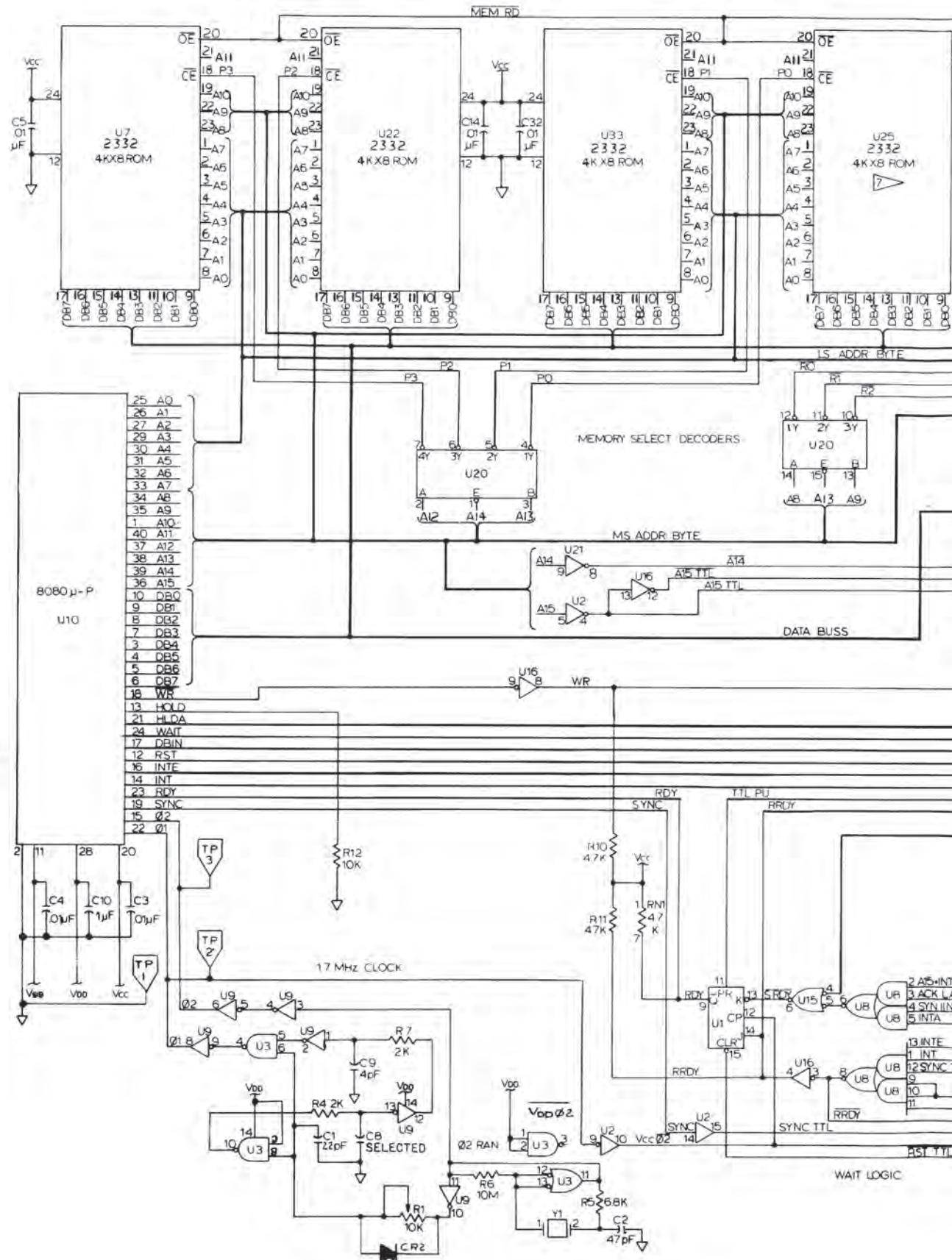
VI	U38
RN 3	R28
CR 2	C33

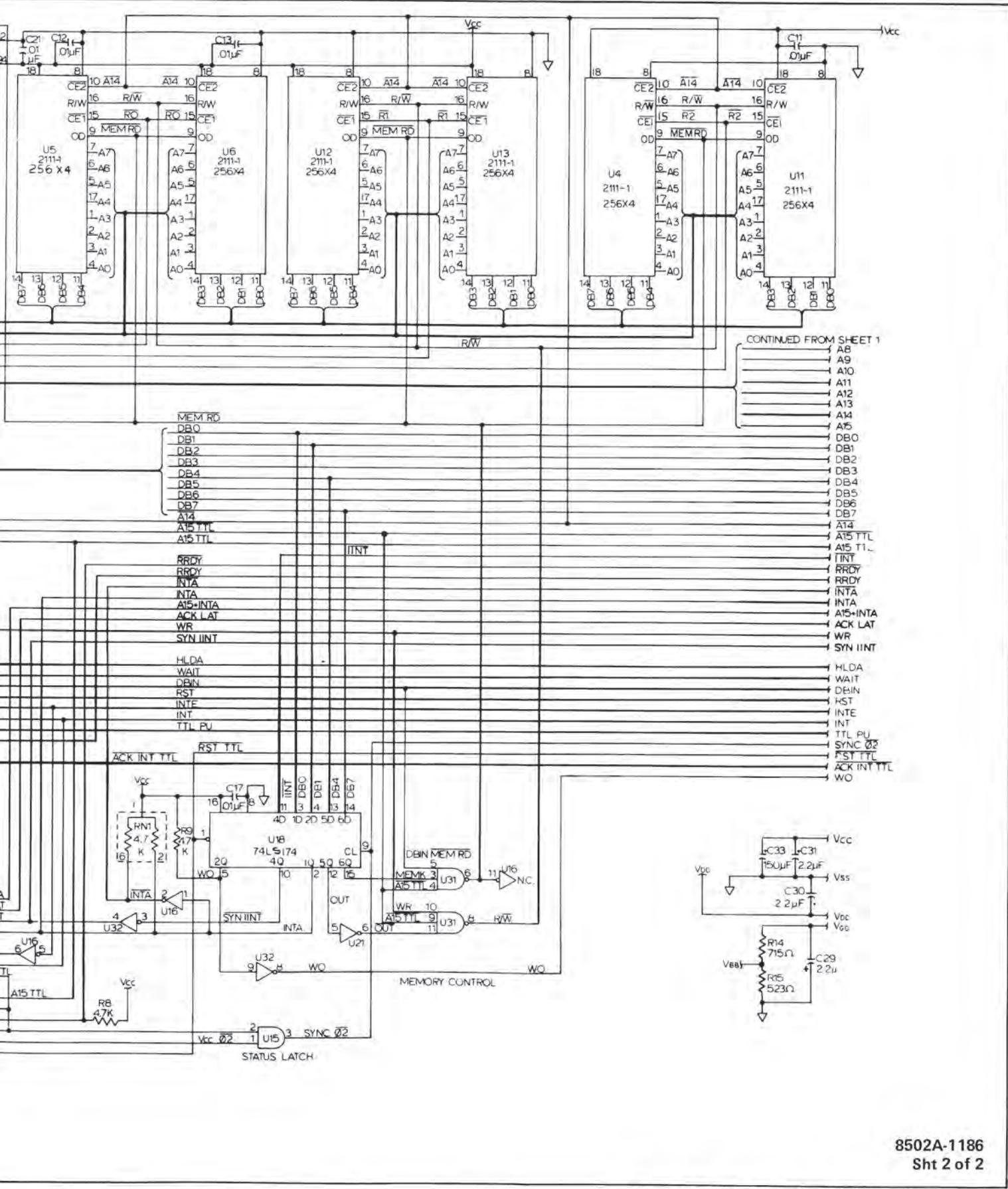
## SPARE GATES

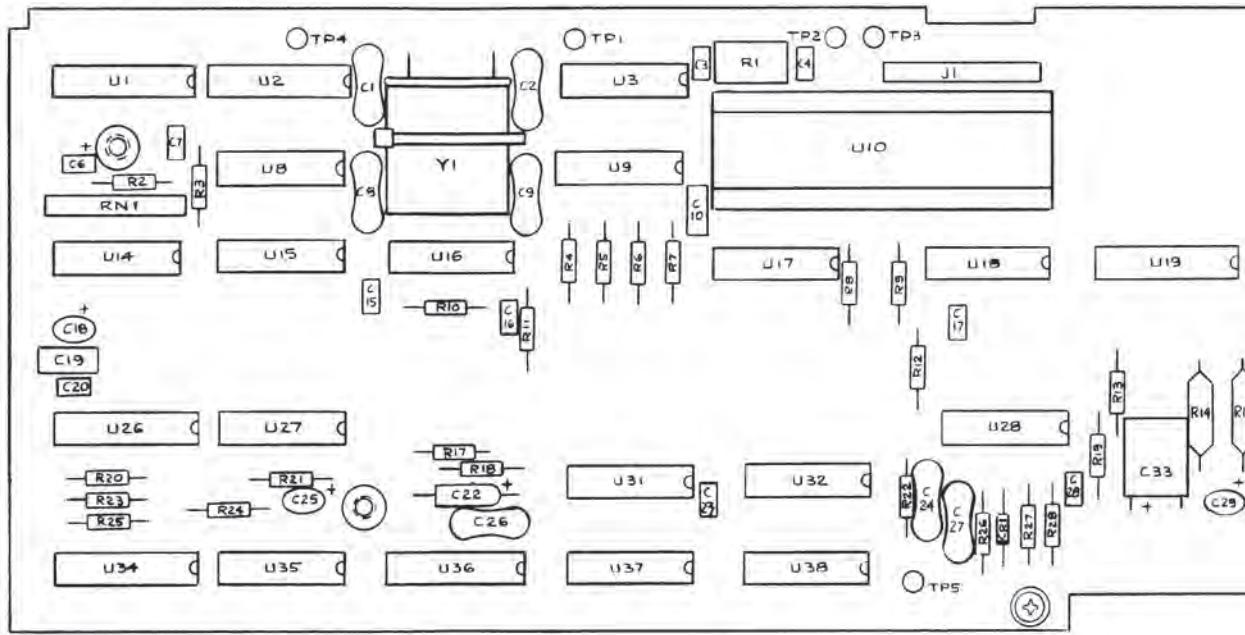
UNGUARDED  
BUS

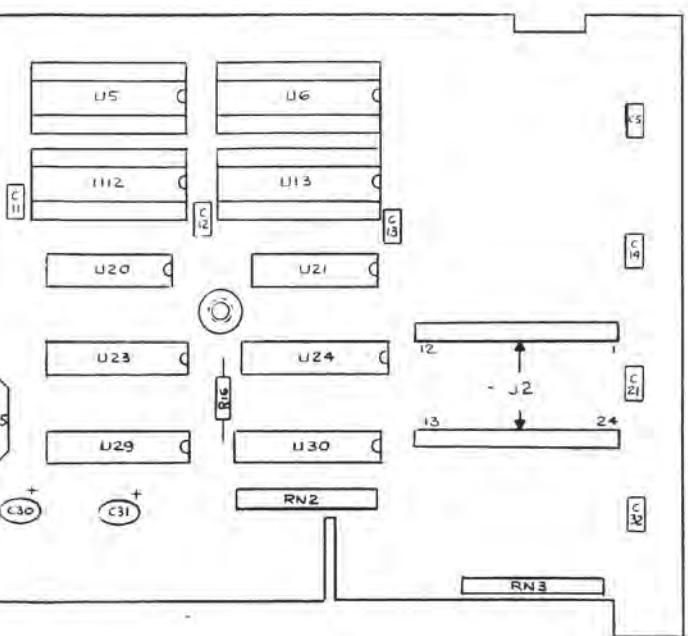
8502A-1186  
Sht 1 of 2

Figure 8-7. A6 Controller PCB Assembly—  
Single PCB Version (cont)



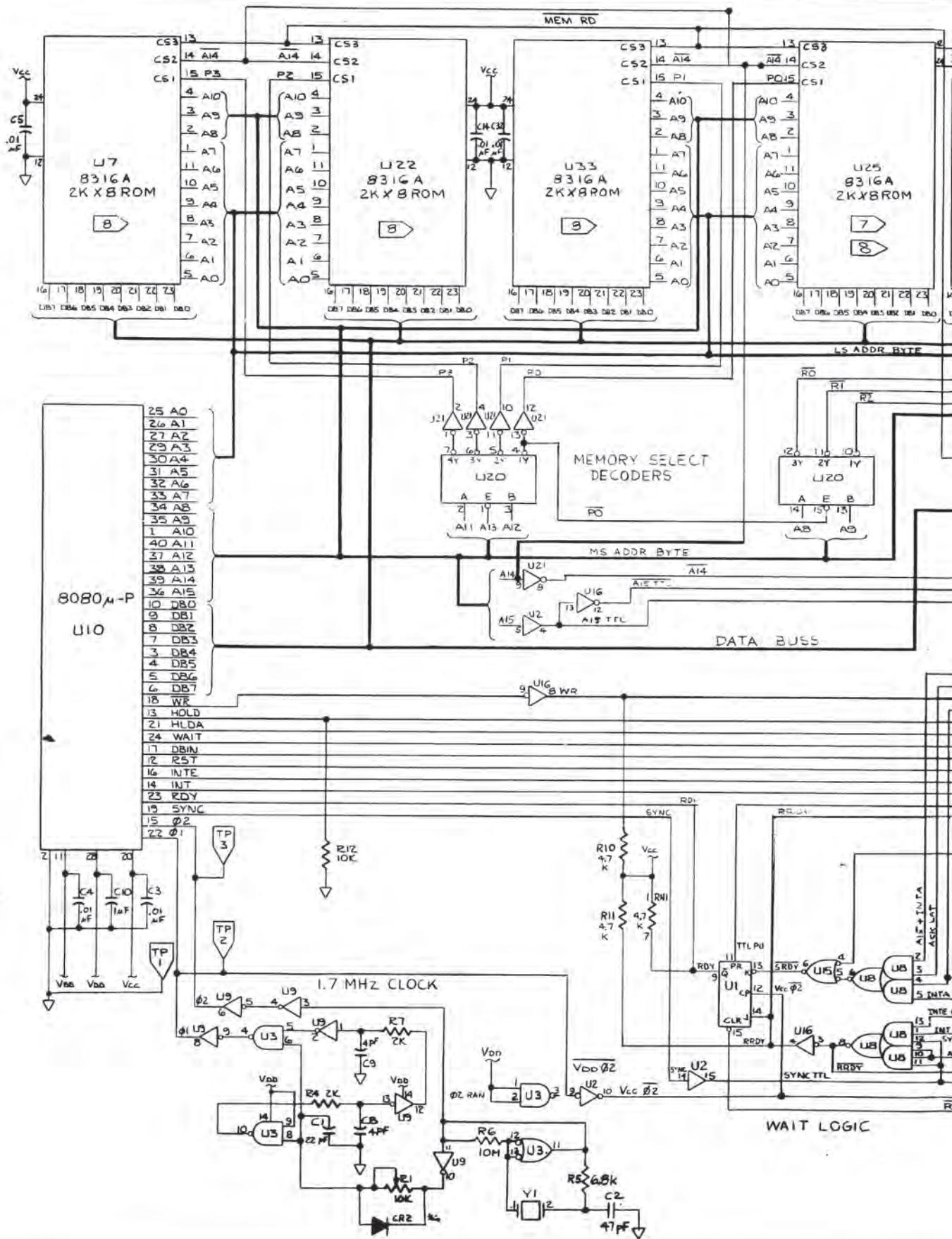


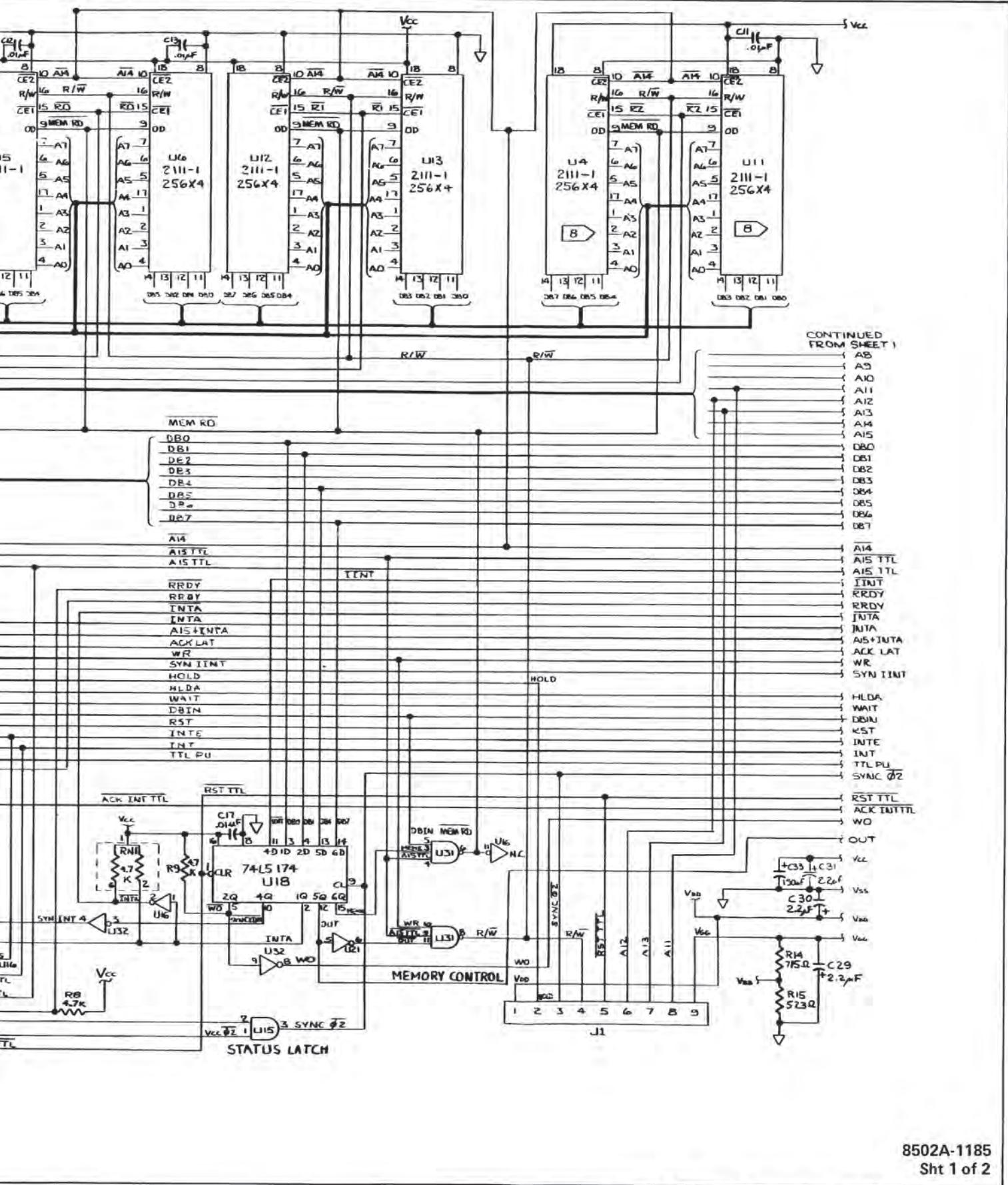




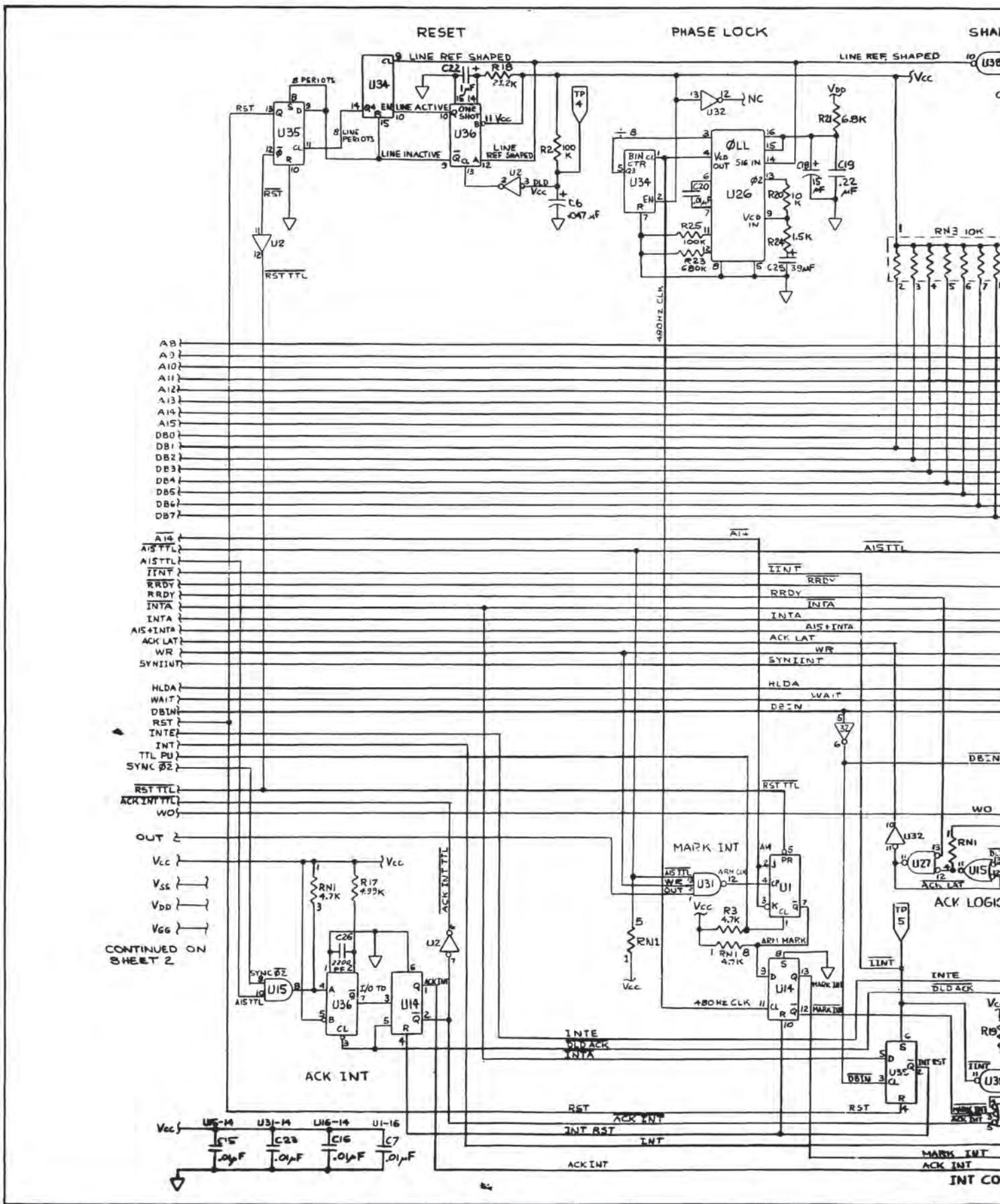
8502A-1785

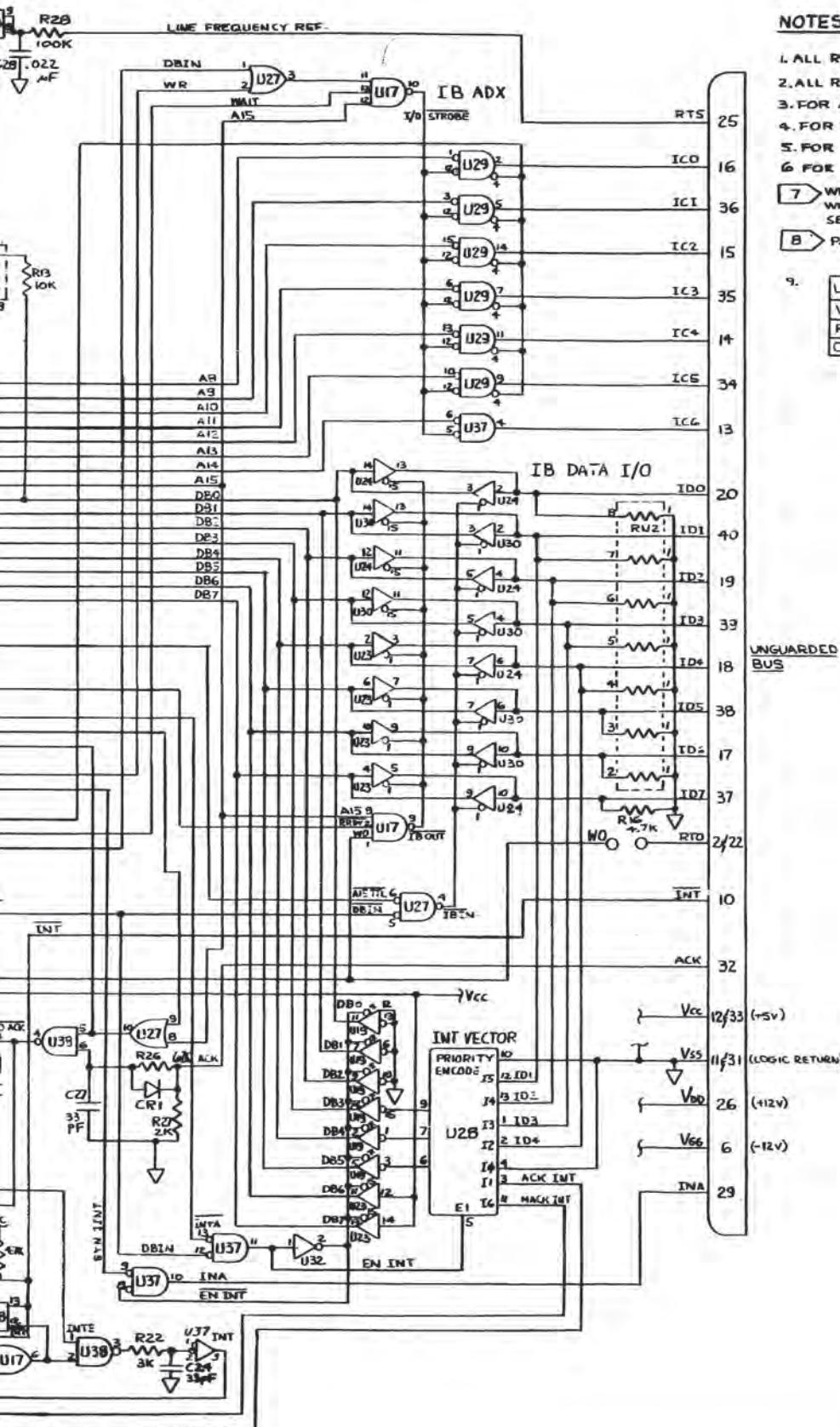
Figure 8-8. A6A1 Controller PCB Assembly—  
Double PCB Version

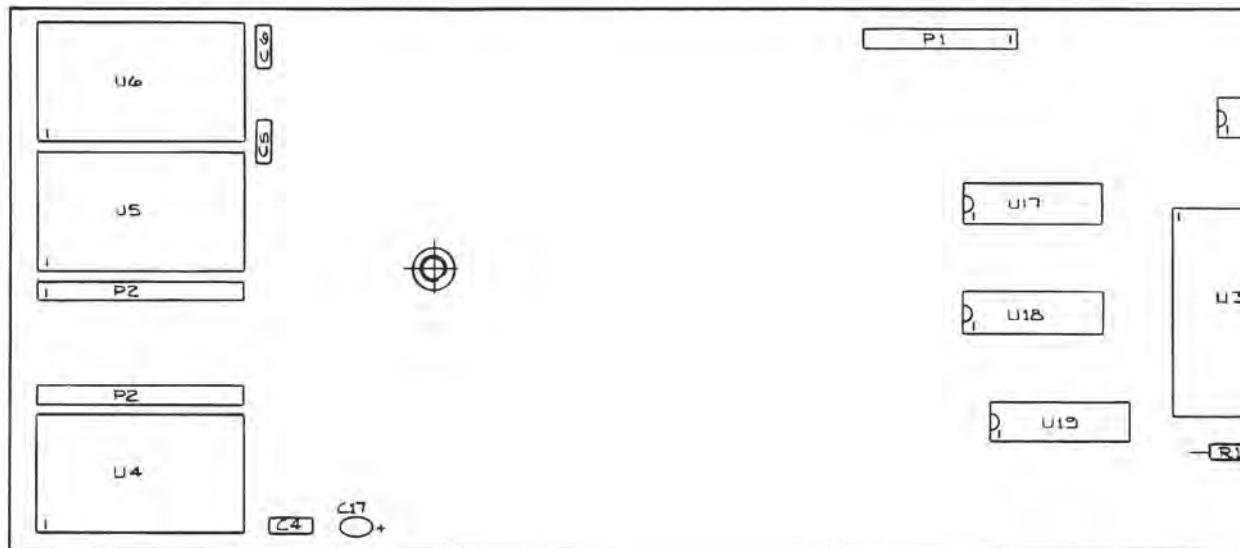


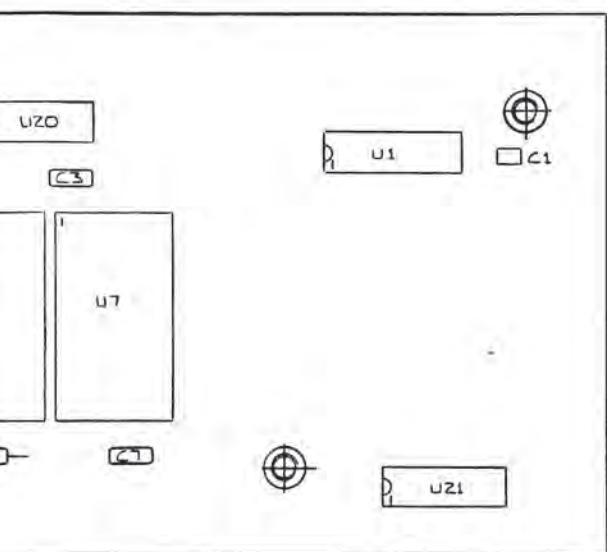


**Figure 8-8. A6A1 Controller PCB Assembly—  
Double PCB Version (cont)**



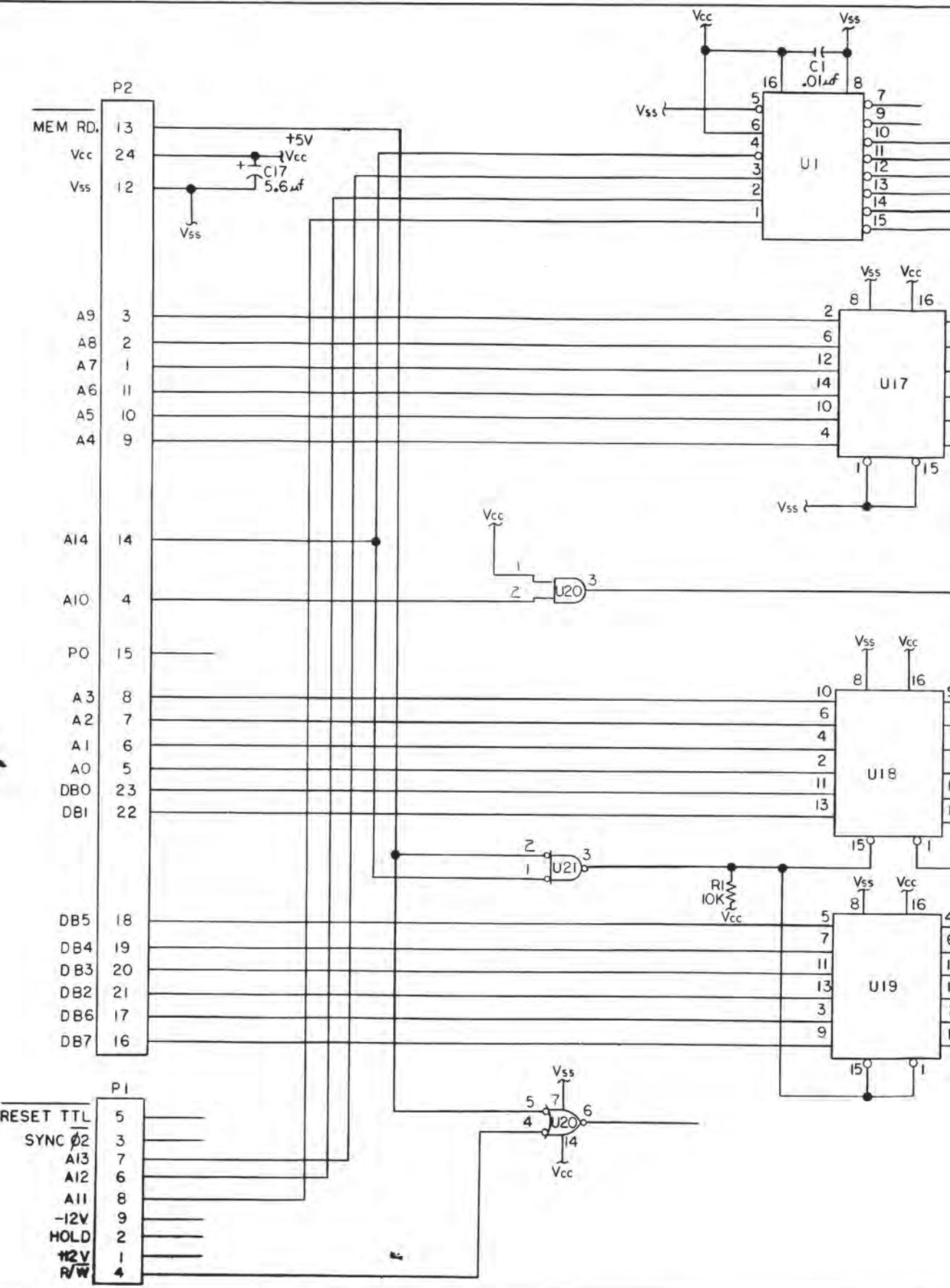


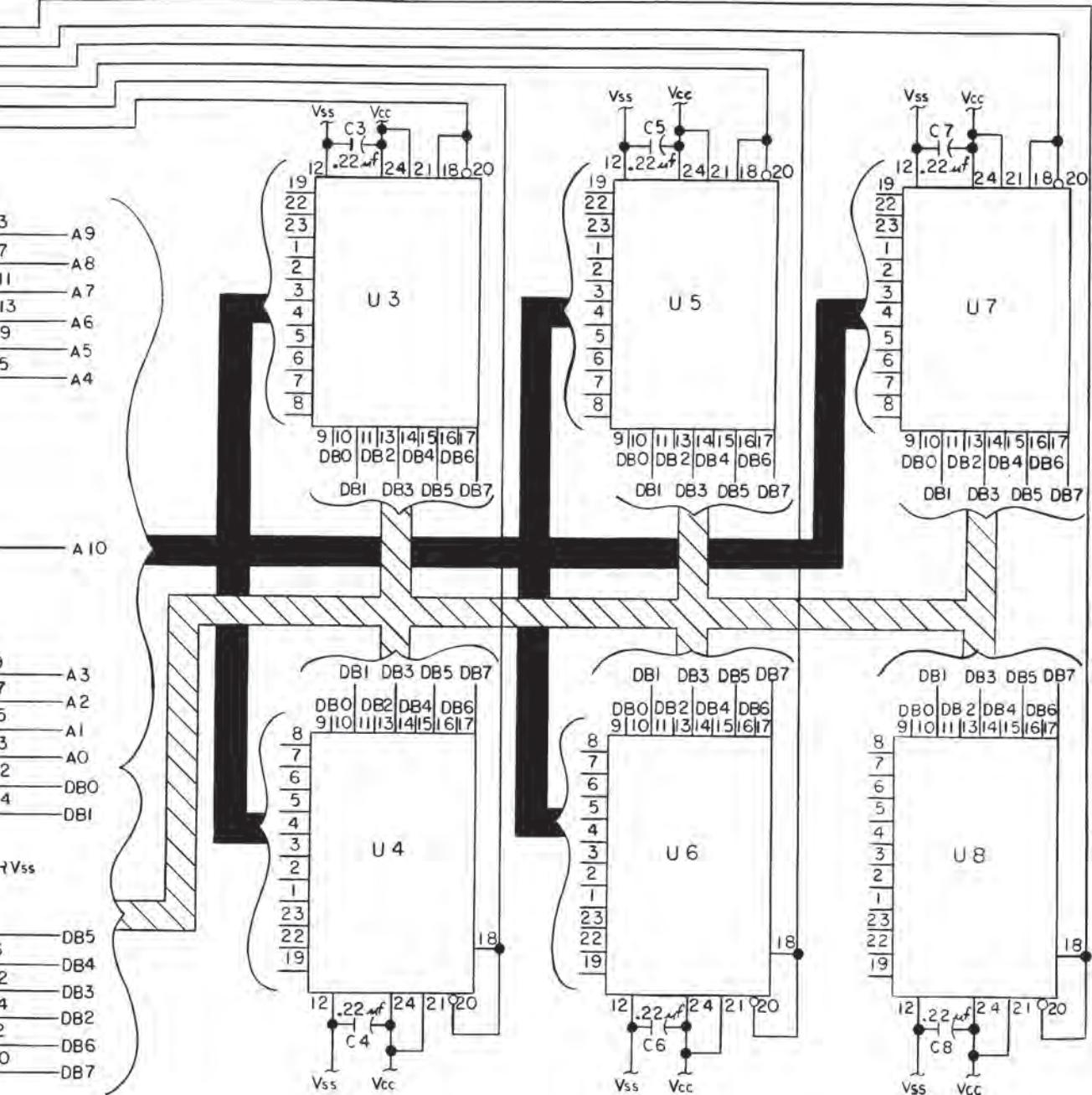




8502A-1688

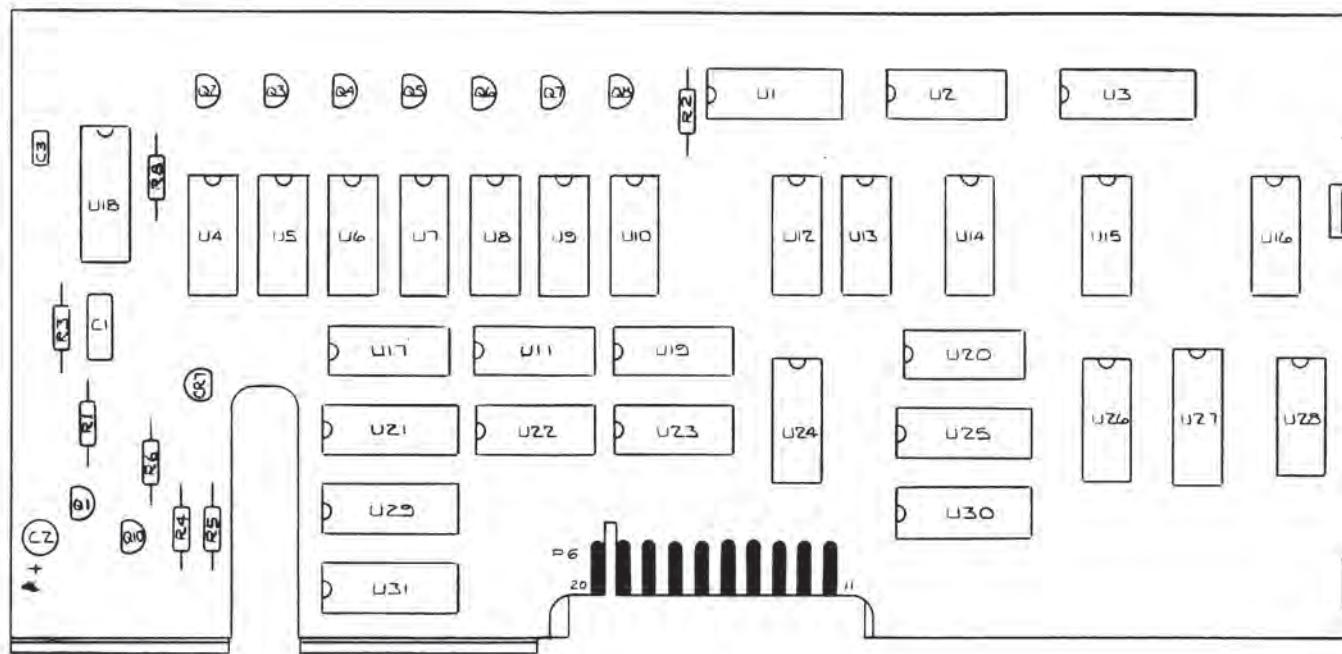
Figure 8-9. A6A2 Prom Rom PCB Assembly—  
Double PCB Version

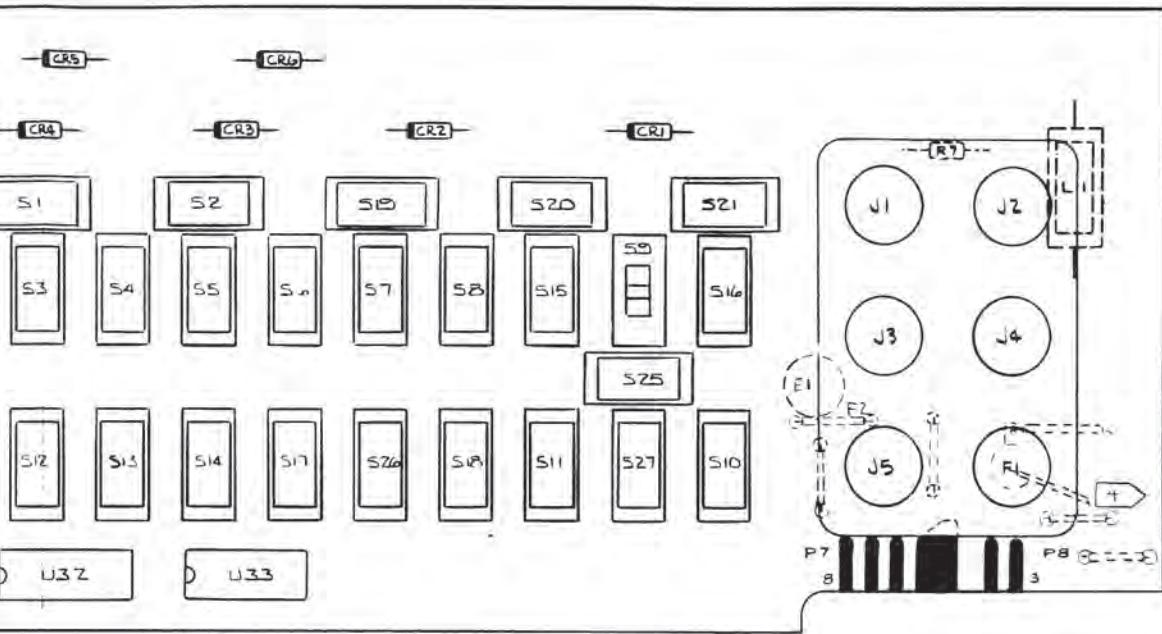




8502A-1088

Figure 8-9. A6A2 Prom Rom PCB Assembly—  
Double PCB Version (cont)



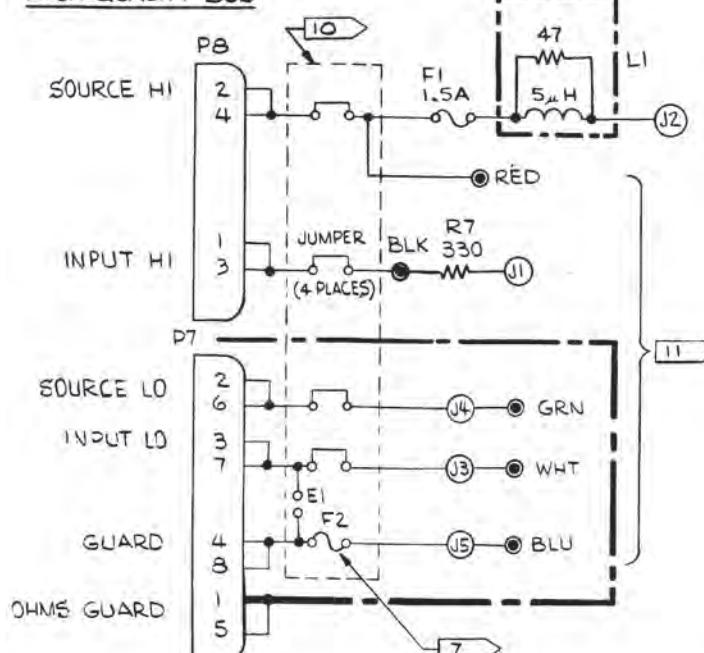
NOTES:

JUMPER AND FUSE CONNECTIONS, FAR SIDE

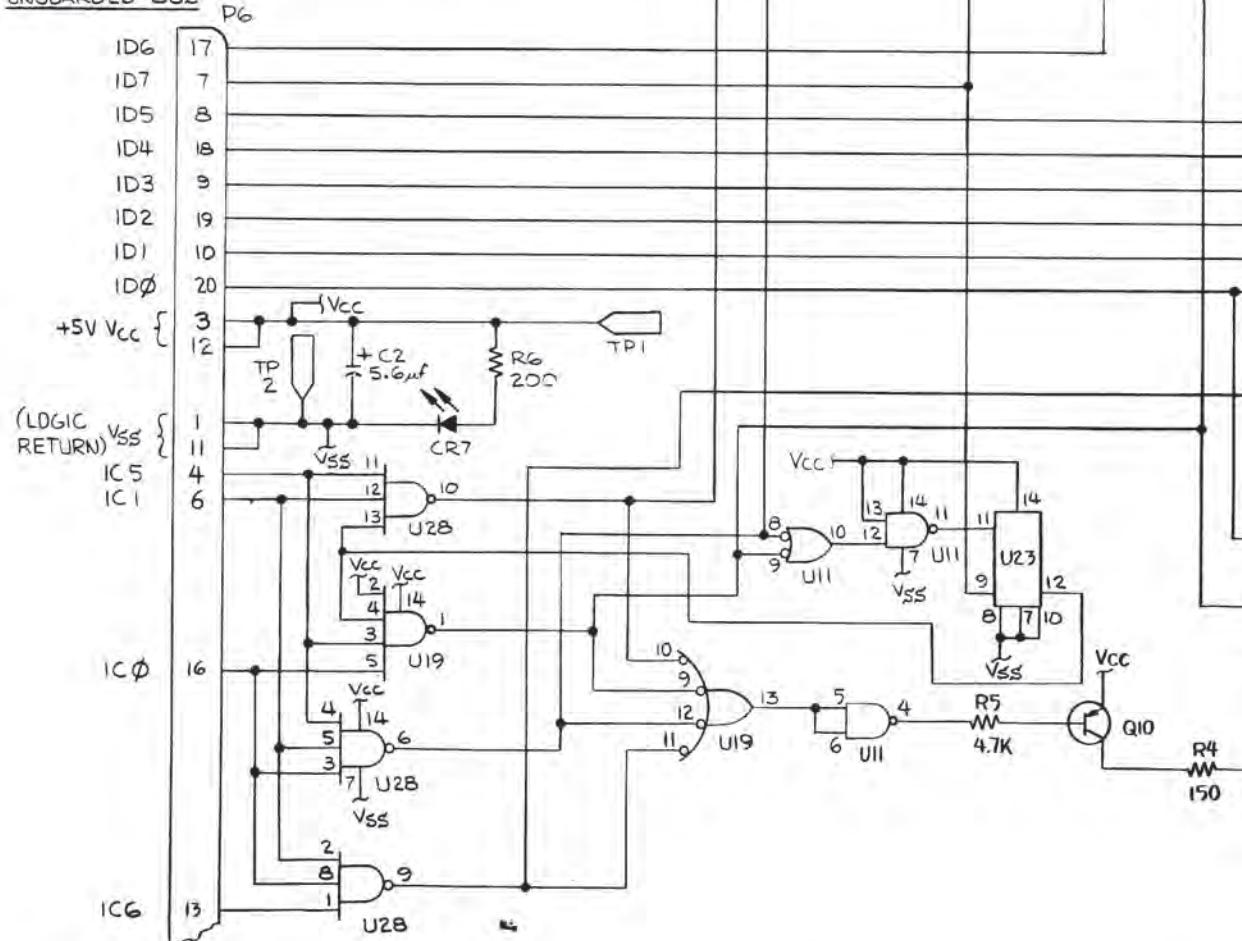
8502A-1623

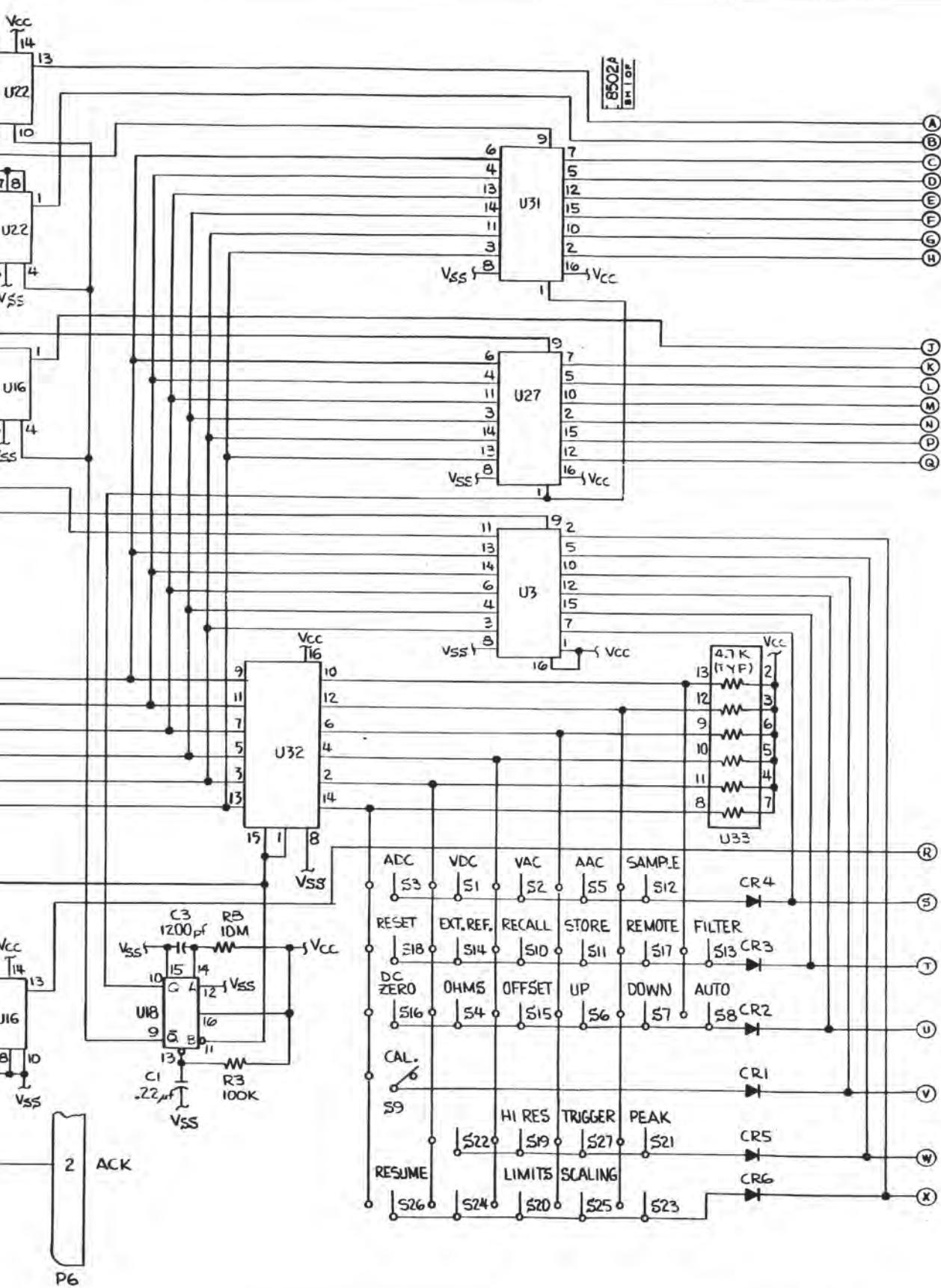
Figure 8-10. A7 Front Panel Display PCB Assembly

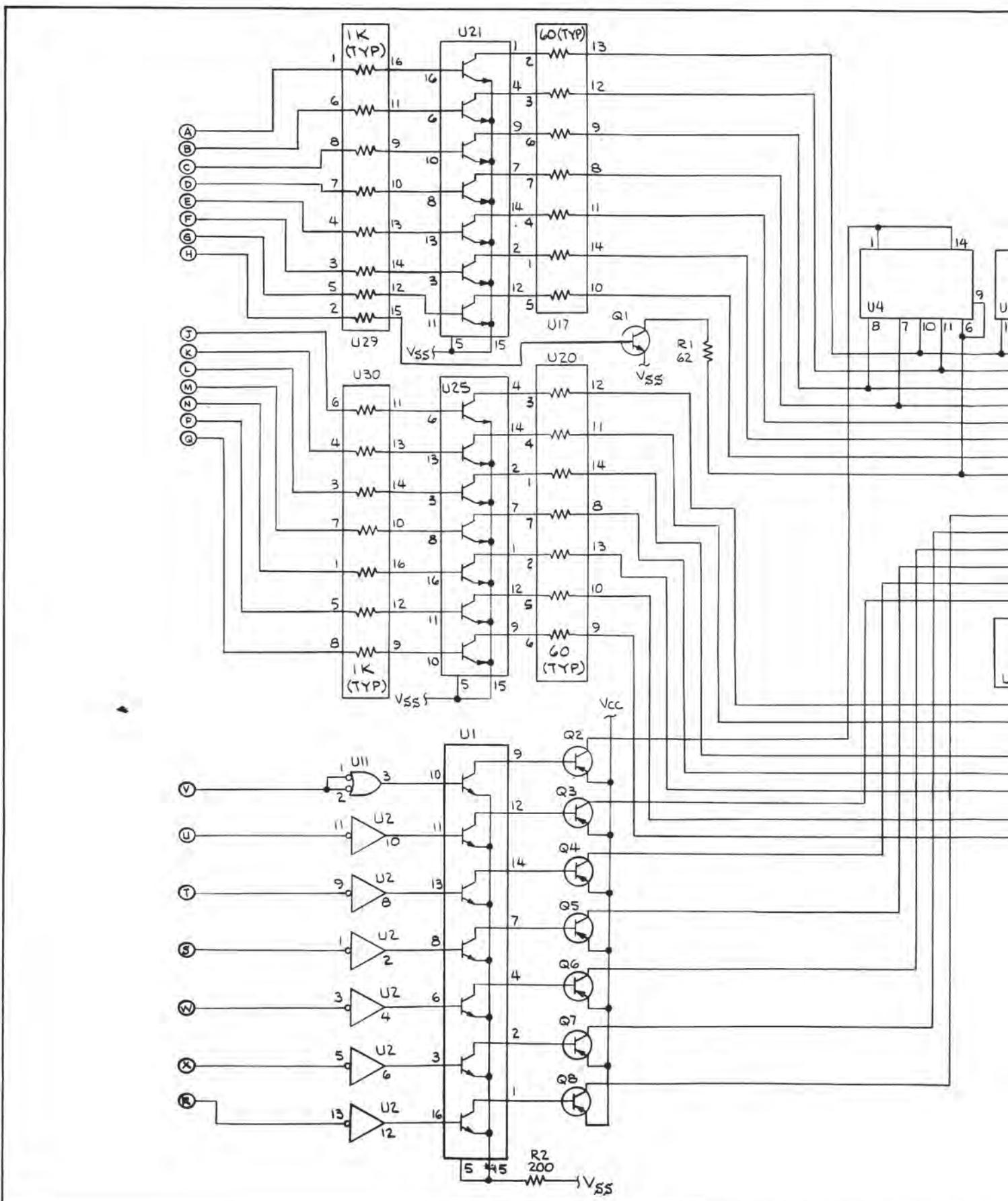
HIGH QUALITY BUS

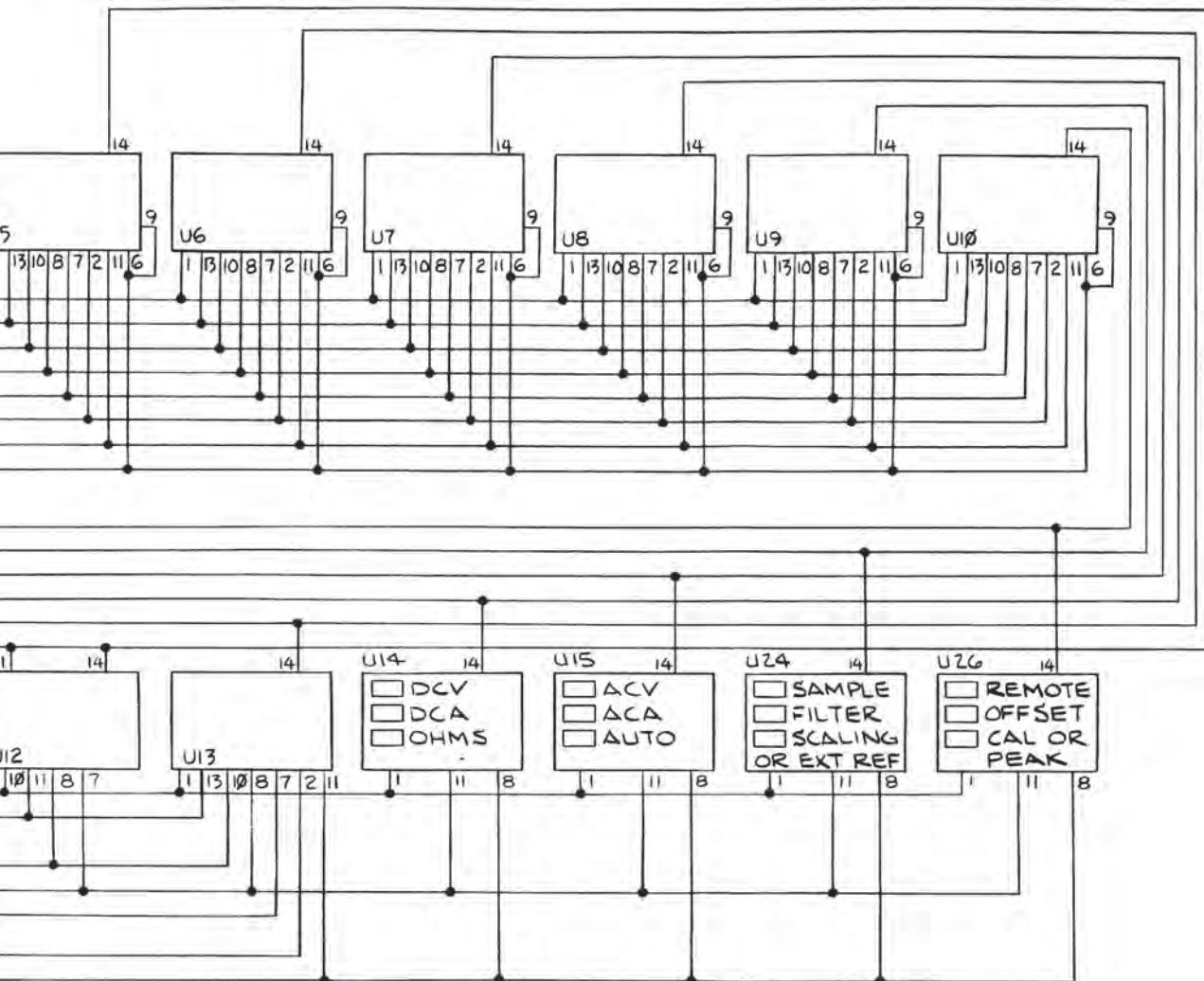
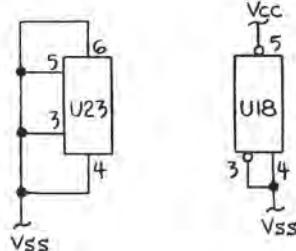


UNGUARDED BUS



8502A-1023  
Sht 1 of 2Figure 8-10. A7 Front Panel Display  
PCB Assembly (cont)



NOTES: (UNLESS OTHERWISE SPECIFIED)

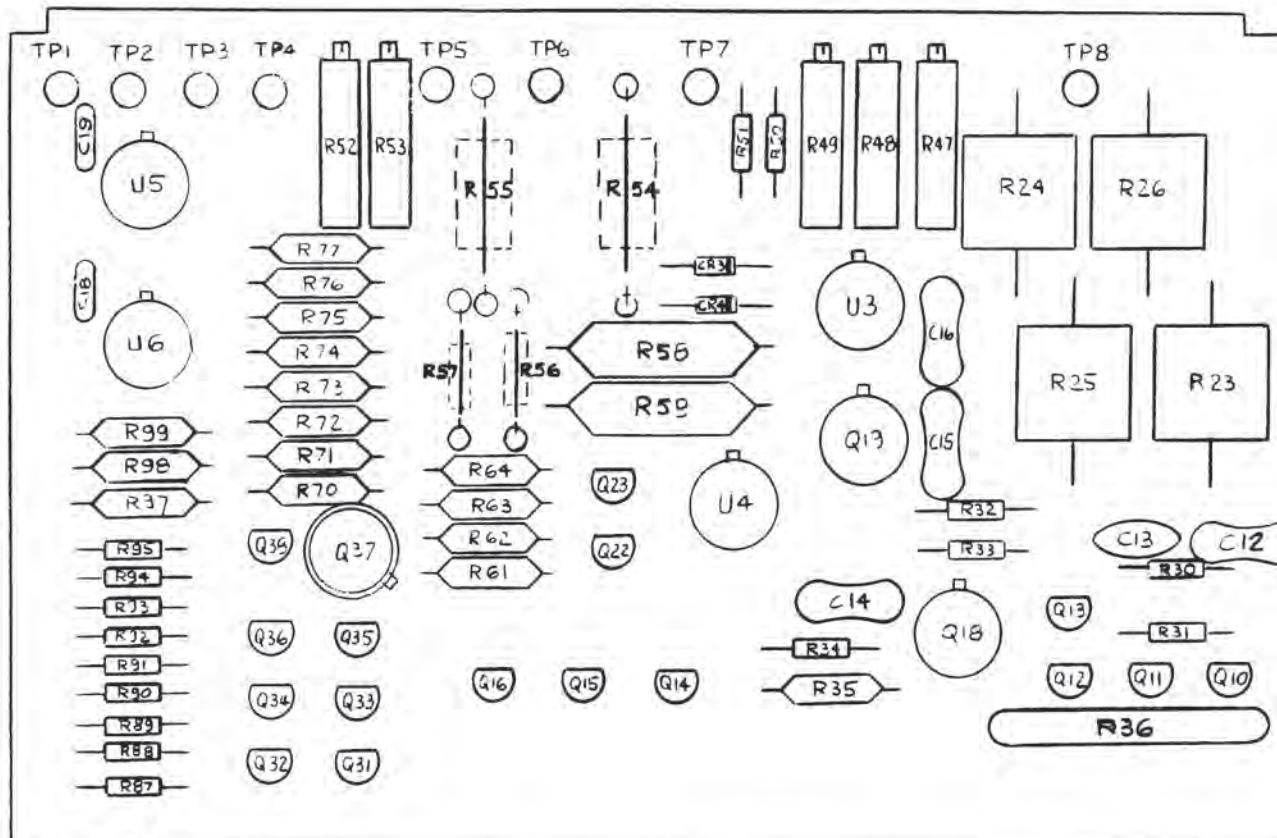
4. ALL RESISTANCE VALUES IN OHMS.
5. REF. DES. NUMBERS NOT USED - Q9.
6. LAST REF DES USED - J5, C3, Q10, U33, S27, RB, CR7, L1, E1, F2.

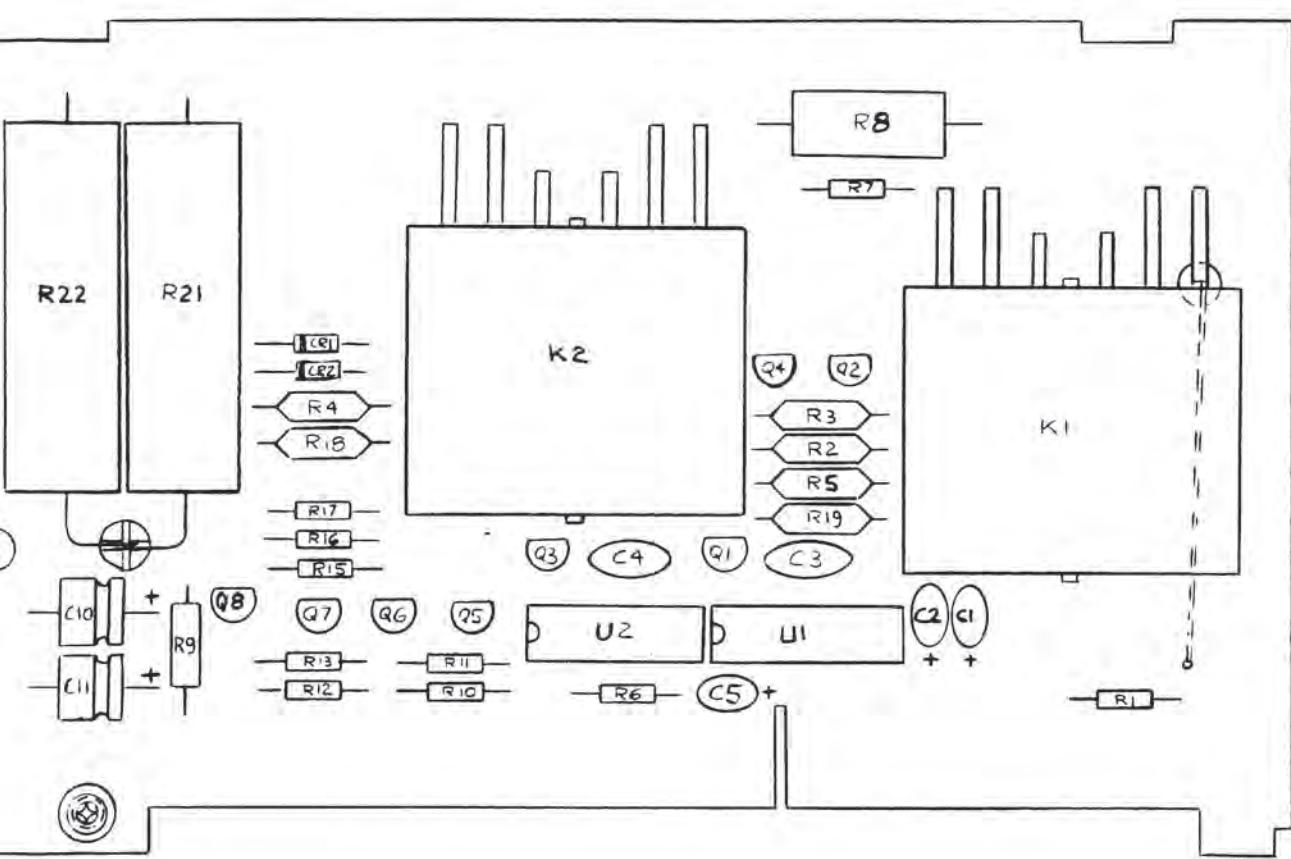
- 7. #36 WIRE X .50 LONG AND #22 TEFLON SLEEVING.
- 8. FOR MOTHER INTERCONNECT DIAGRAM, SEE 8500A-1301
- 9. S22, S23, & S24 NOT USED
- 10. E1, F2 & JUMPERS ARE REMOVED ON -16 OPTION ONLY.
- 11. CABLE, FRONT INPUT, INSTALLED ON -16 OPTION ONLY.

8502A-1023  
Sht 2 of 2

Figure 8-10. A7 Front Panel Display  
PCB Assembly (cont)

R54, R55, R56 & R57 WILL BE DETERMINED  
DURING TESTING. RESISTORS MAY BE INSTALLED.

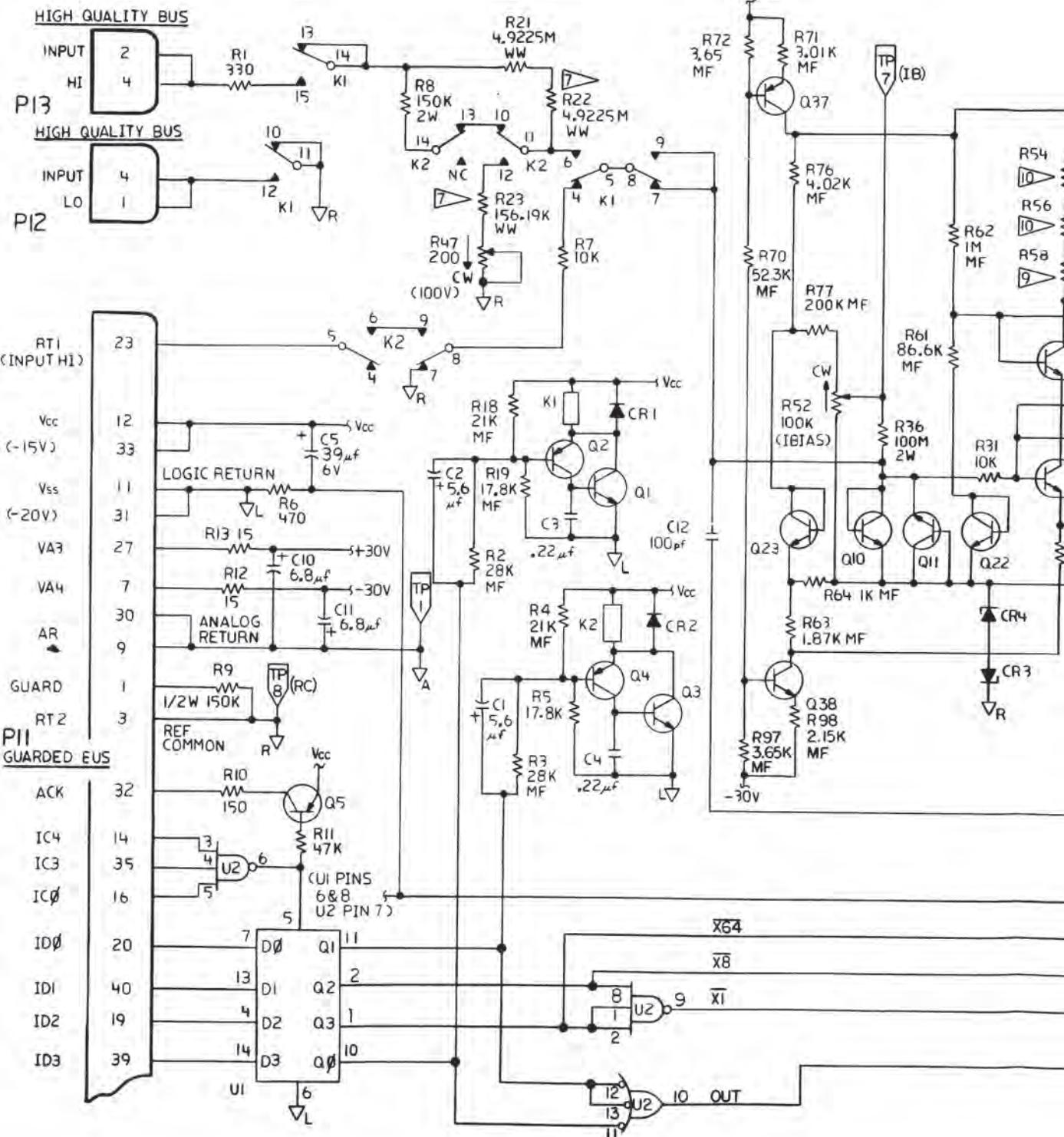


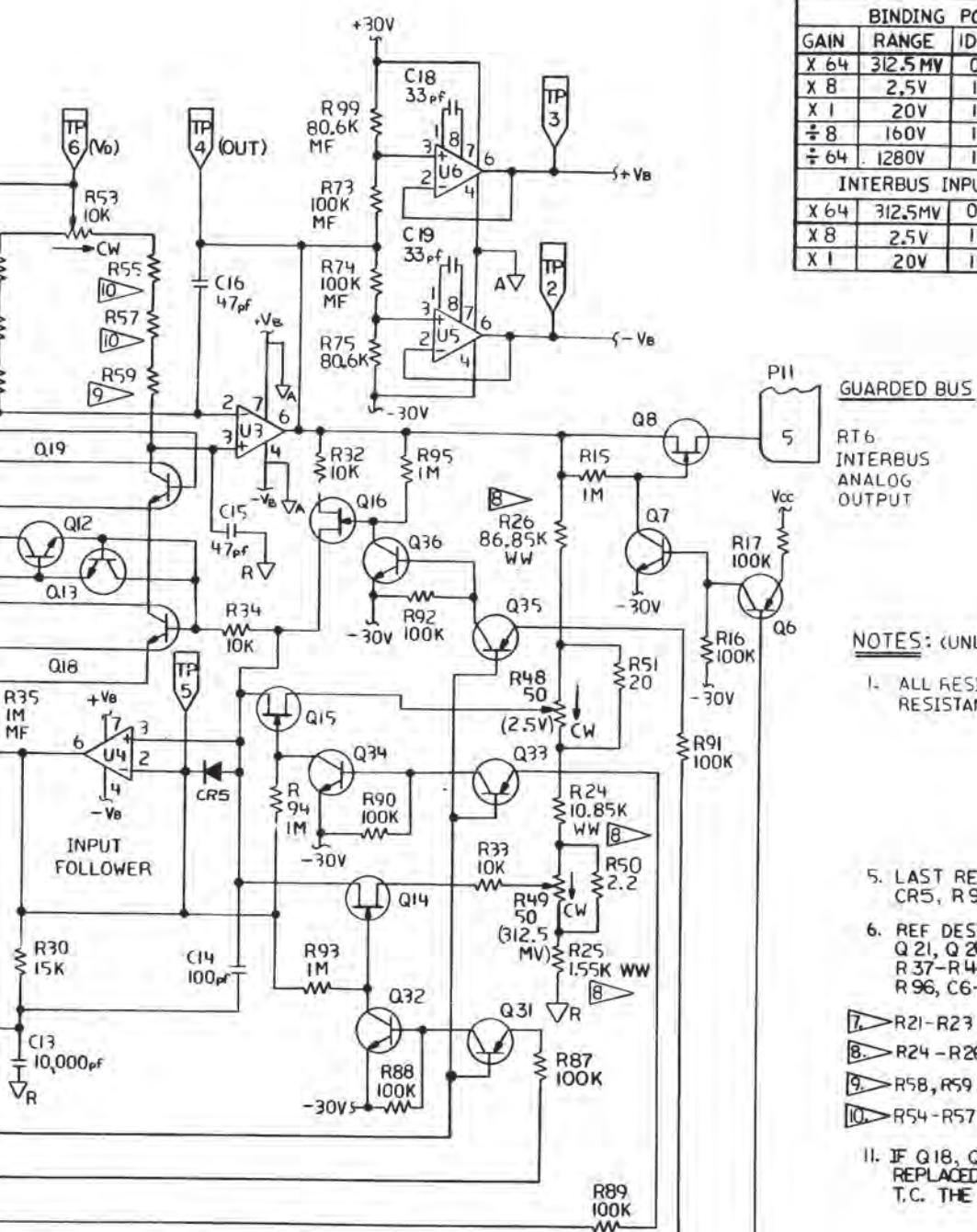


MIS-1700

Figure 8-11. A8 DC Signal Conditioner  
PCB Assembly

IC	Vcc (PIN)
U1	16
U2	14





BINDING POST INPUT				
GAIN	RANGE	ID3	ID2	ID1
X 64	312.5 MV	0	1	1
X 8	2.5V	1	0	1
X 1	20V	1	1	1
$\frac{1}{8}$	160V	1	0	0
$\frac{1}{64}$	1280V	1	1	0

INTERBUS INPUT (RT2)				
GAIN	RANGE	ID3	ID2	ID1
X 64	312.5 MV	0	1	1
X 8	2.5V	1	0	0
X 1	20V	1	1	0

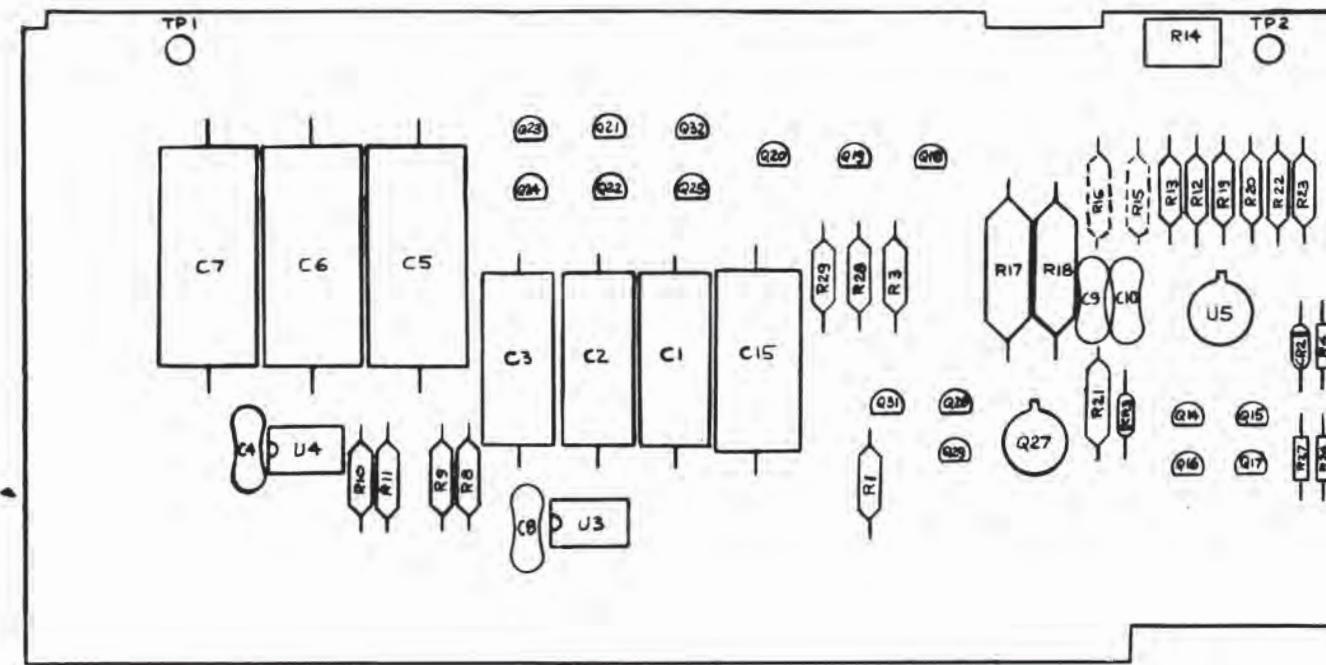
PII GUARDED BUS  
RT6 INTERBUS ANALOG OUTPUT

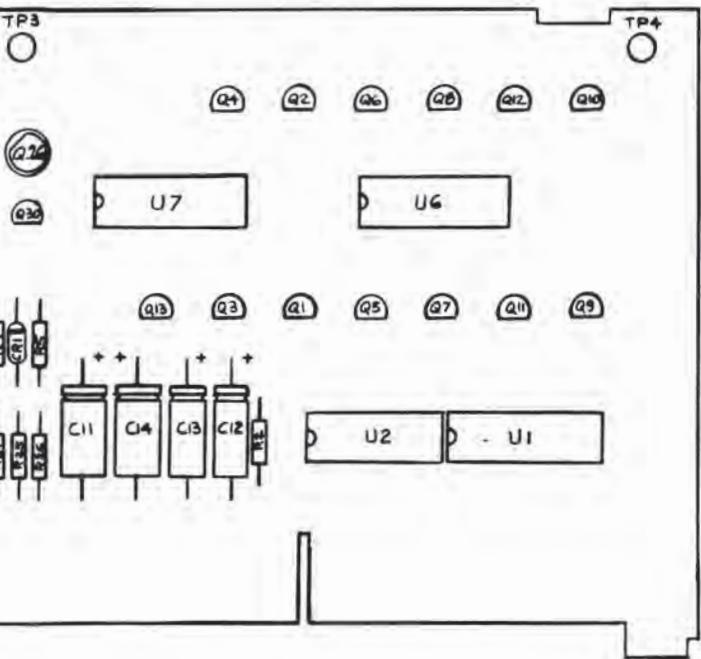
NOTES: (UNLESS OTHERWISE NOTED)

- I. ALL RESISTORS 1/4 W, CC, AND ALL RESISTANCE IN OHMS.
- II. IF Q18, Q19, Q22, R54 OR R55 ARE REPLACED IT WILL BE NECESSARY TO T.C. THE MODULE
5. LAST REF DES NO'S USED: U6, Q38, CR5, R99, C21.
6. REF DES NO'S NOT USED: Q 9, Q 17, Q 20, Q 21, Q 24-Q 30, R 14, R 20, R 27-R 29, R 37-R 46, R 60, R 65-R 69, R 78-R 86, R 96, C6-C9, C17.
7. R21-R23 INPUT DIVIDER RESISTOR SET.
8. R24-R26 DC RANGE RESISTOR SET.
9. R58, R59 MATCHED RESISTOR SET.
10. R54-R57 FACTORY SELECTED PARTS.

MIS 1100

Figure 8-11. A8 DC Signal Conditioner PCB Assembly (cont)





NOTES:

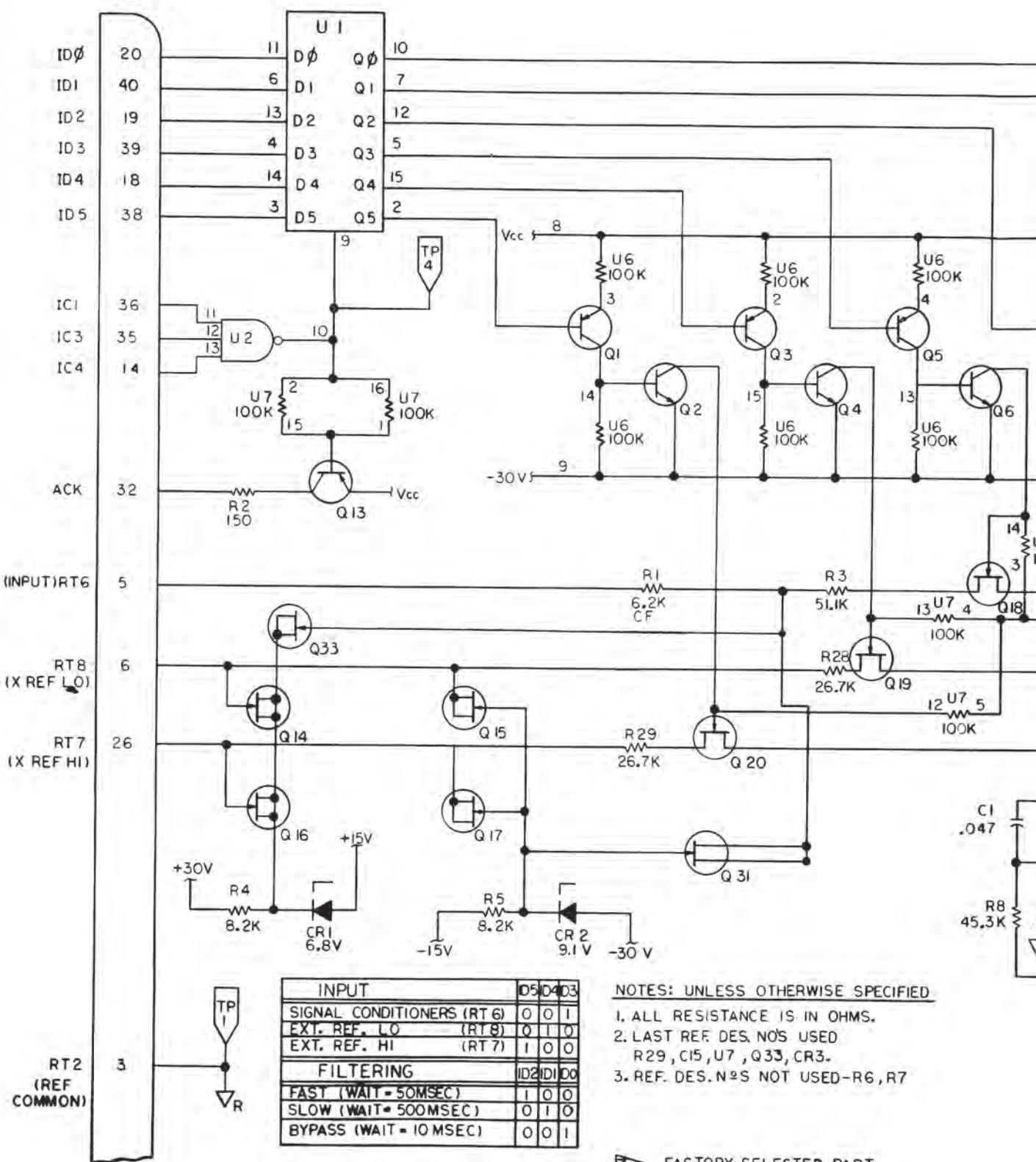
4. R15 + R16 WILL BE SELECTED DURING TEST.

MIS-1730

Figure 8-12. A9 Active Filter PCB Assembly

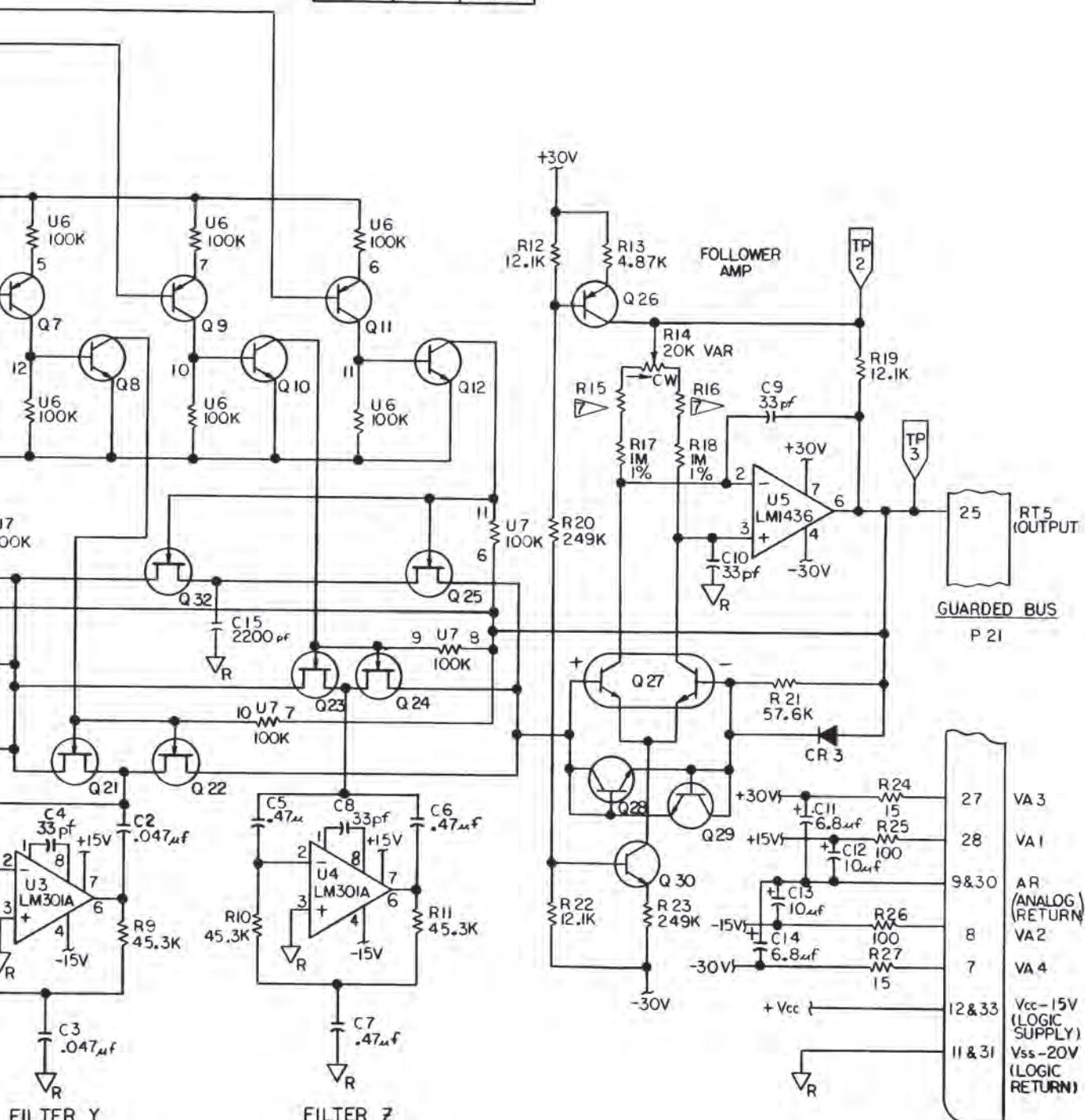
## GUARDED BUS

P21



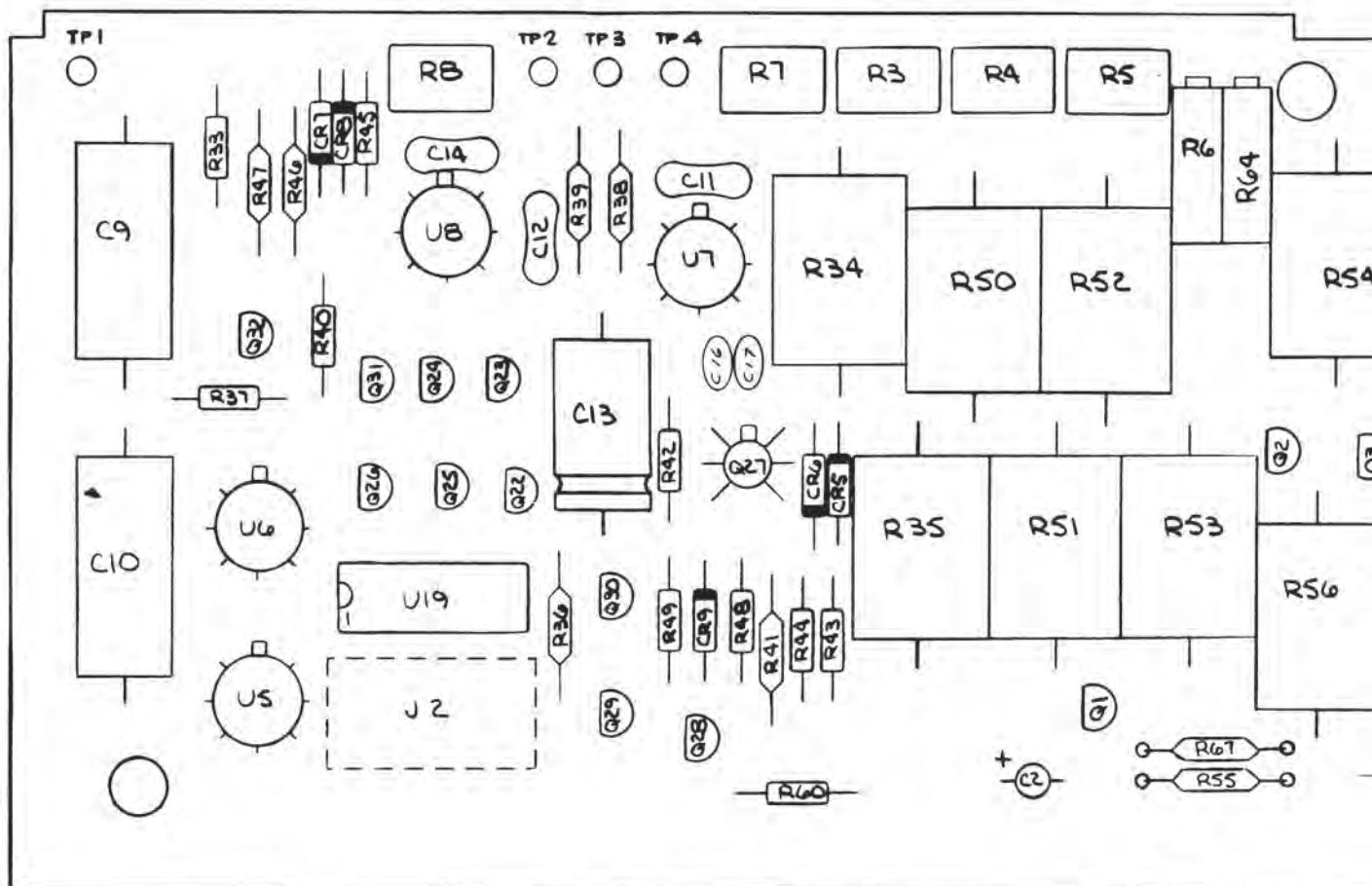
► FACTORY SELECTED PART.

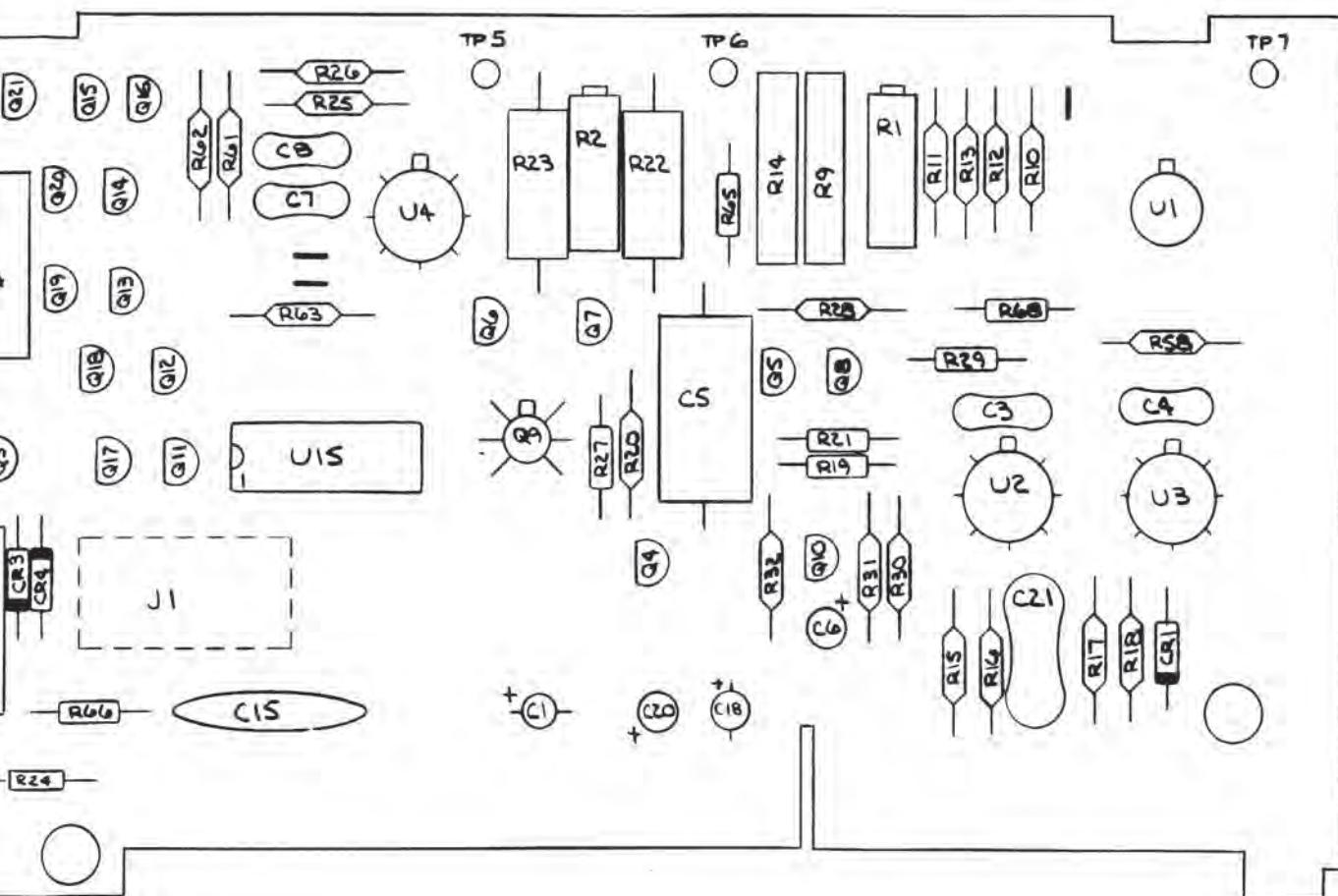
U №	Vcc	$\nabla_L$
1	I,16	8
2	I4	2,3,4,5,7



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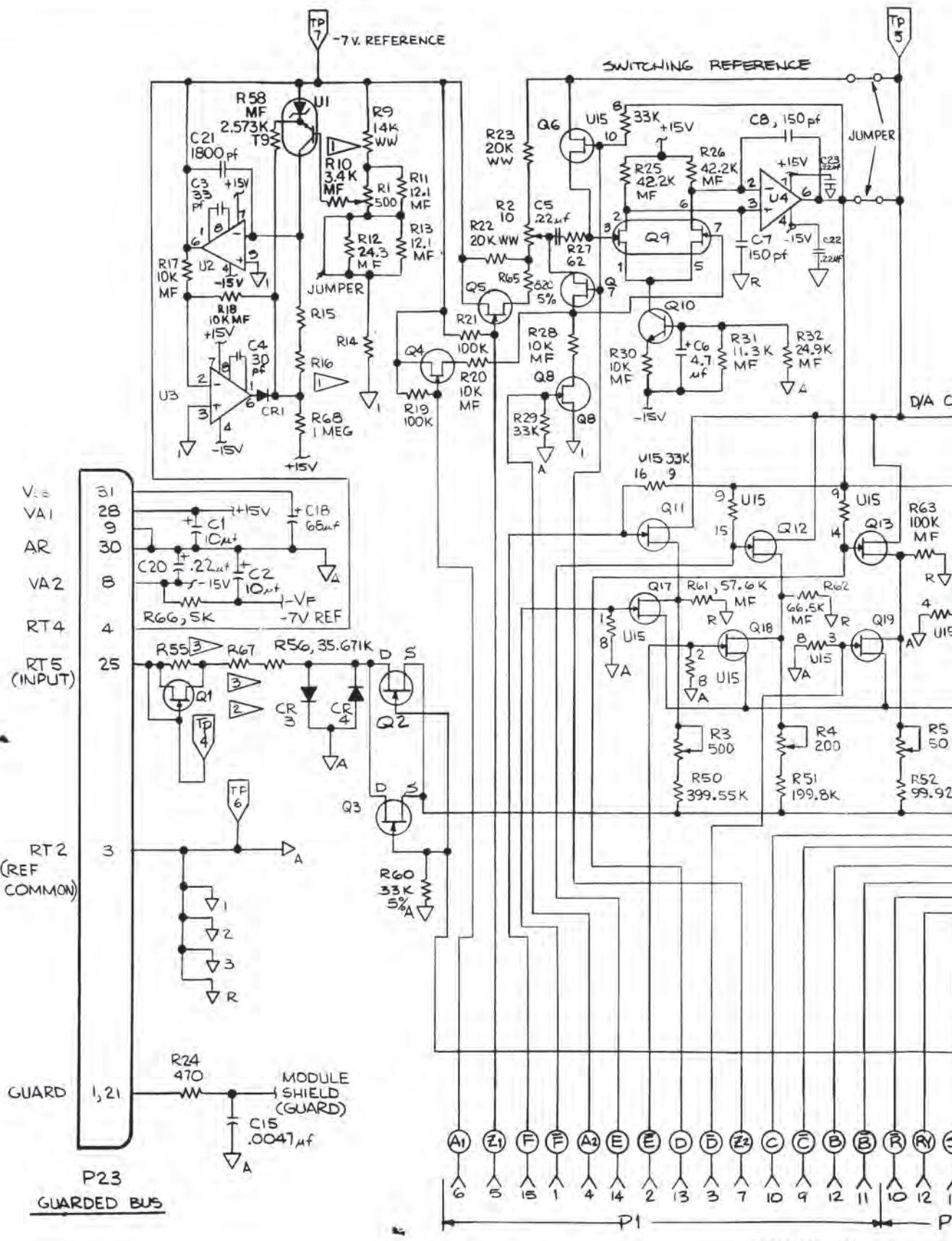
Figure 8-12. A9 Active Filter PCB Assembly (cont)





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Figure 8-13. A10A1 Analog Display PCB Assembly



NOTES:

1) U1, R9, R14-R16 COMPRIZE A REF. AMP SET 8500A.

2) R34, R35, R50-R54, R56  
COMPRIZE A FAST R<sup>2</sup>-A/D  
SUMMING RESISTOR SET.

3) SELECTED AT TEST.

4. REF. DES. NR'S NOT USED:

R57, 59, 65, C16, 17, 18, 19, CR2

U9, 10, 11, 12, 13, 14, 16, 17, 18,

5. LAST REF. DES. NR'S USED:

R68, C21, CR9, Q32, U19

6. IF U1, R9, R14, R15, R16, R34,

R35, R50-R54, Q1-Q3, Q11-

Q16, Q25 OR Q26 ARE RE-

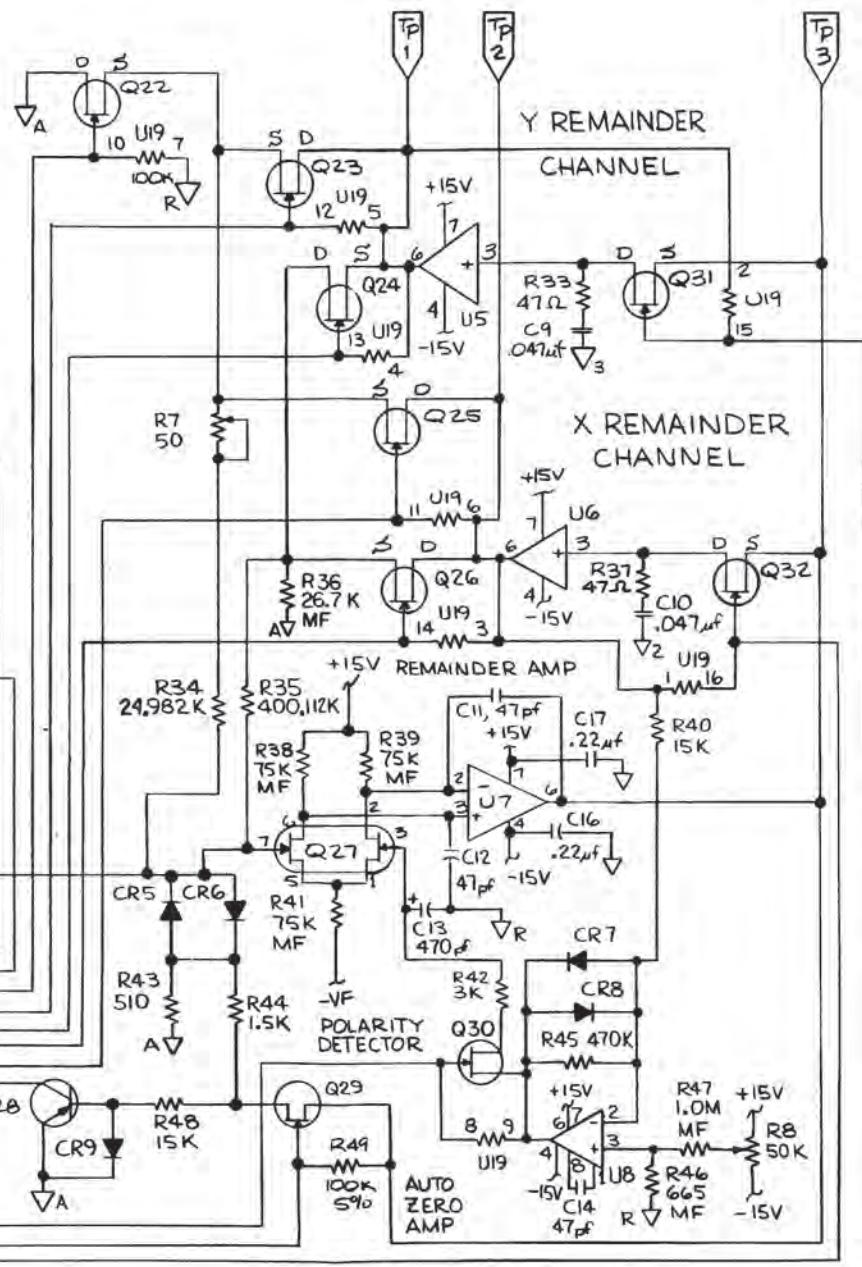
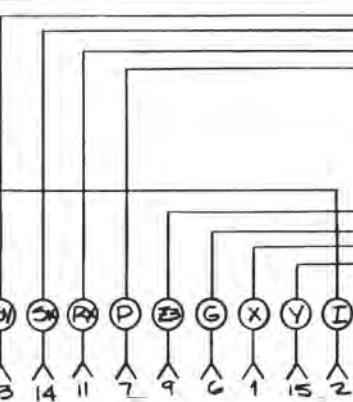
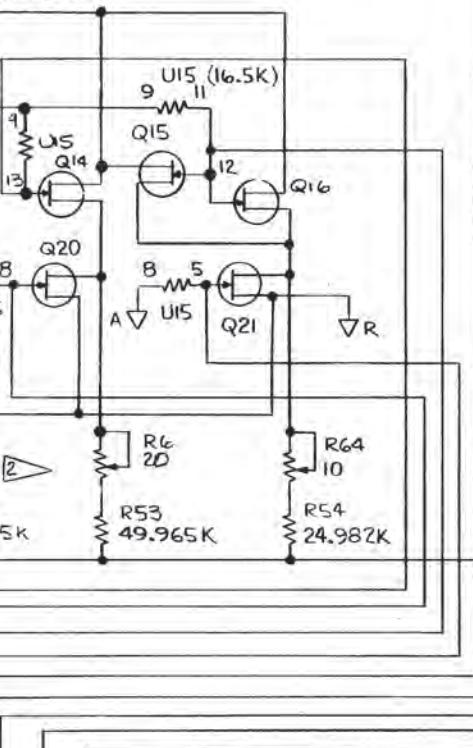
PLACED, IT BECOMES NECESSARY

TO T.C. THE MODULE PER MIS-4140-151 TEST

PROCEDURE

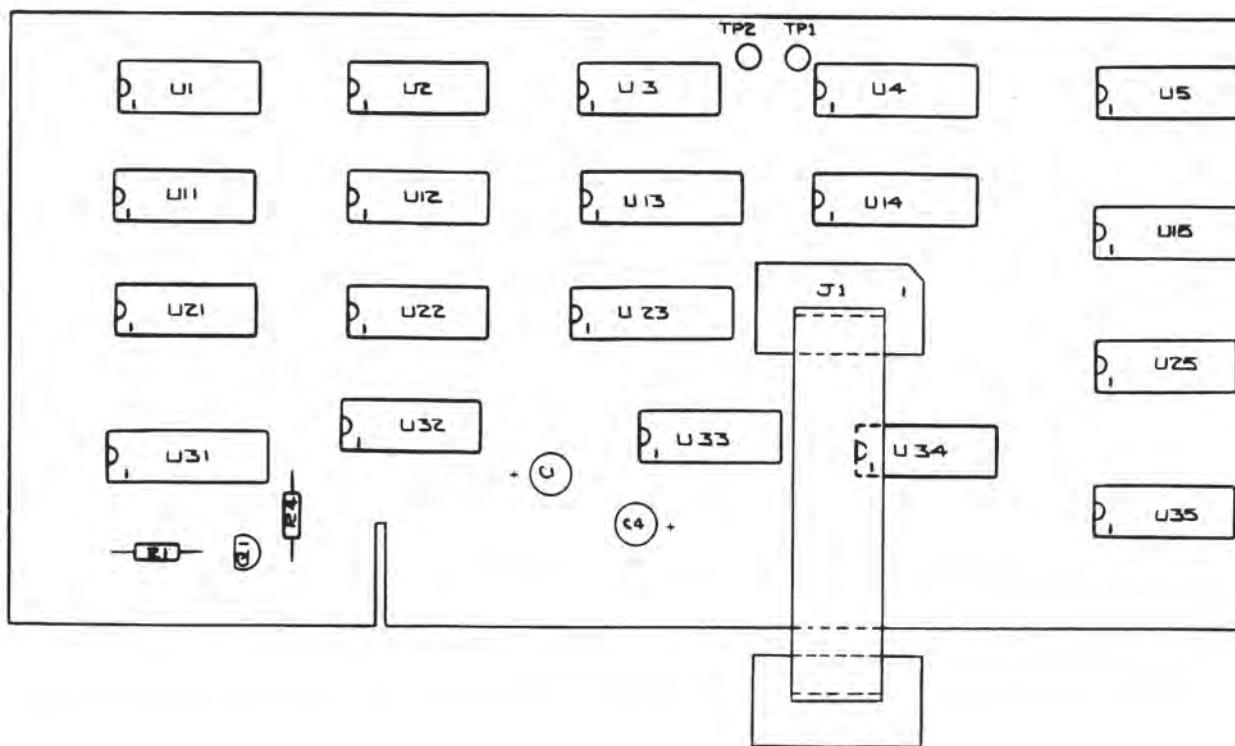
7. ALL RESISTANCE IS IN OHMMS

## ONVERTER



MIS-1140

Figure 8-13. A10A1 Analog Display  
PCB Assembly (cont)



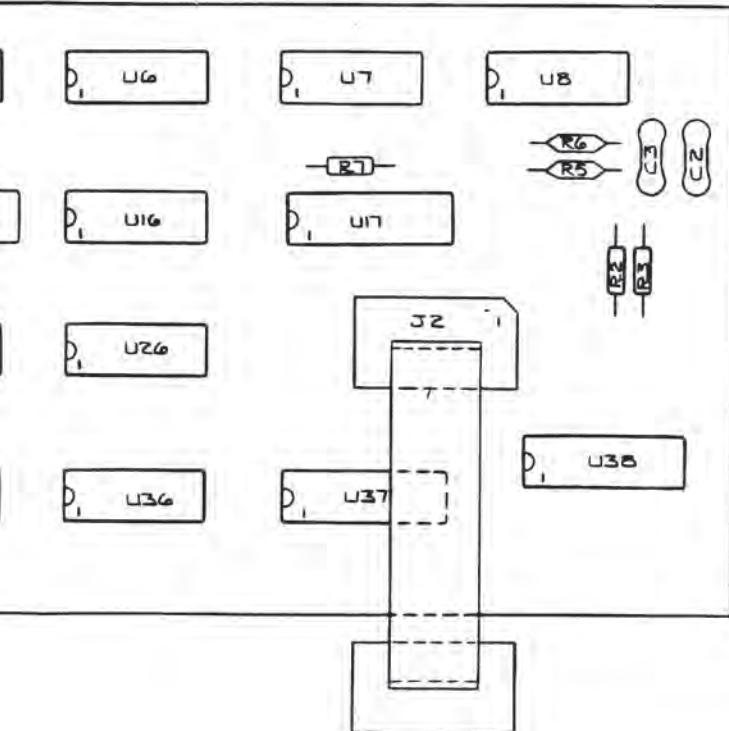
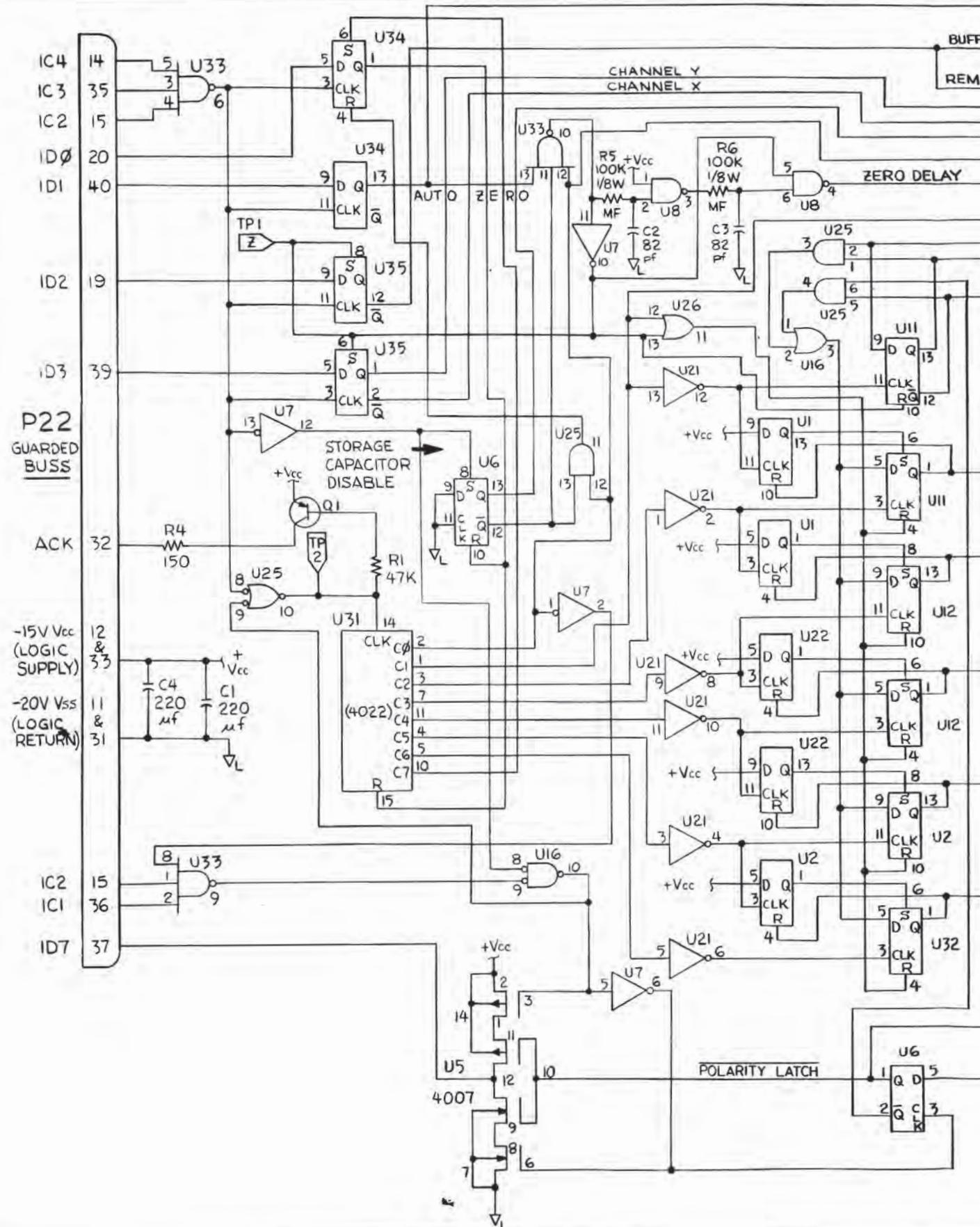
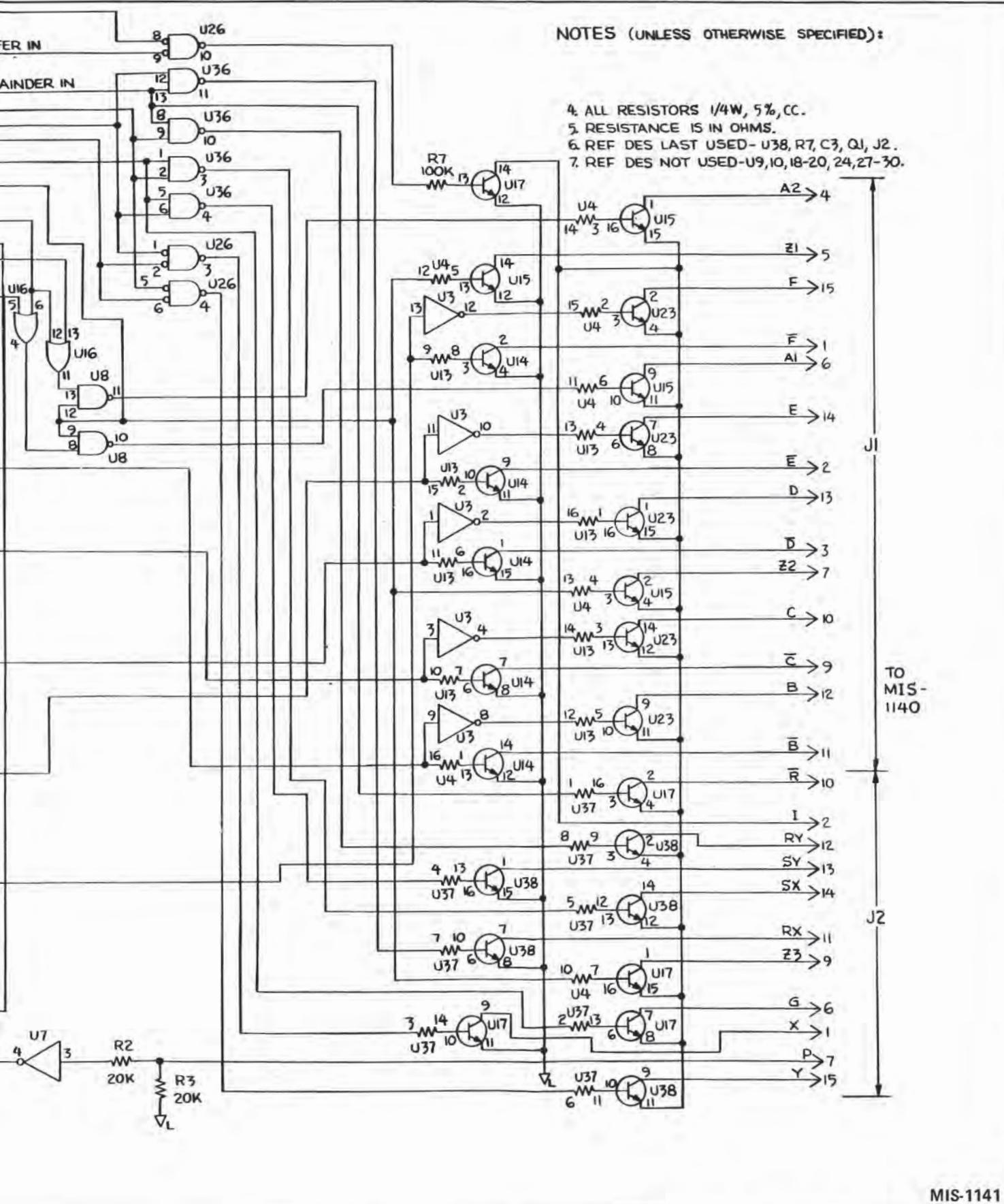


Figure 8-14. A10A2 Fast RR A/D Converter  
Digital PCB Assembly

MIS-1741





**Figure 8-14. A10A2 Fast FF A/D Converter  
Digital PCB Assembly (cont)**