NOTE

This manual documents the Model 8502A Digital Multimeter and its assemblies at the revision levels shown in Appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in Appendix 7A for older assemblies.

8502A
Digital Multimeter

Instruction Manual

P/N 471466
March 1978
Rev 1 7/81

FLUKE®

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Rev. 6/81

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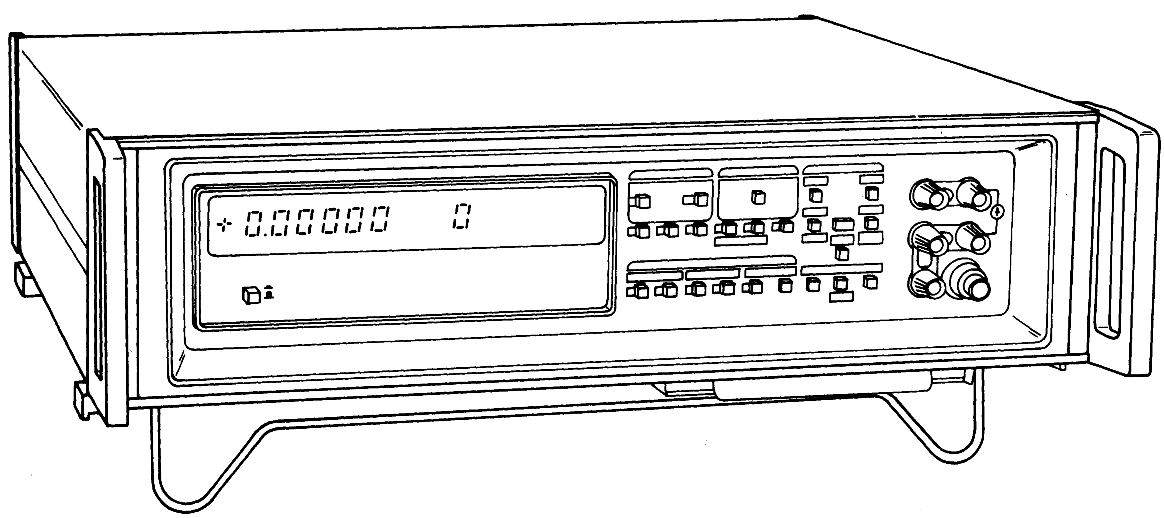


Model 8502A Digital Multimeter

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 Respresentatives).
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. 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 1-1. 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.

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

	H		L		W
cm	10.8	x	42.5	x	43.2
Inches	4.25	x	16.75	x	17

WEIGHT

	Basic	Fully Loaded
kg	9.1	10.92
Lbs	20	24

OPERATING POWER

Basic Instrument	12 watts	115V ac or 230V ac ±10%
Fully Loaded	24 watts	50–60 Hz

WARM-UP

2 hours to rated accuracy

SHOCK AND VIBRATION

Meets requirements of MIL-T-28800 for Class 5 style E equipment.

TEMPERATURE RANGE

Operating	0°C to 50°C
Non Operating	–40°C to 70°C*

**0°C to 50°C operating and non-operating with calibration memory option (–04) installed.*

HUMIDITY RANGE

(Operating to Full Accuracy)

0°C to 18°C	80% RH
18°C to 40°C	75% RH
40°C to 50°C	60% RH

OVERLOAD

LO to Guard	127V max
Guard to Chassis	1000V max
HI Sense to HI Source	127V max
LO Sense to LO Source	127V max
HI Sense to LO Sense	1000V max
HI Source to LO Source	280V max

ACCURACY

Note

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	0.005 + 8
1 V	2.5 V	10 uV	0.001 + 1	0.002 + 1	0.004 + 1
10 V	20 V	100 uV	0.001 or 1*	0.001 + 1	0.002 + 1
100 V	160 V	1 mV	0.001 + 1	0.002 + 1	0.004 + 1
1000 V	1200 V	10 mV	0.001 + 1	0.002 + 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 ± (% of Input + Number of Digits) 24 Hours	90 Days	1 Year
1 V	2.5 V	1 uV	0.001 + 6	0.002 + 8	0.004 + 9
10 V	20 V	10 uV	0.0006 or 6*	0.001 + 8	0.002 + 9
100 V	160 V	100 uV	0.001 + 6	0.002 + 8	0.004 + 9
1000 V	1200 V	1 mV	0.001 + 6	0.002 + 8	0.004 + 9

**Whichever is greater.*

DC Ratio

Ext. Ref. Voltage	Accuracy
$\pm$20V to $\pm$40V	$\pm$(A + B + 10 ppm)
$\pm V_{min.}$* to $\pm$20V	$\pm\left(A + B + \frac{200\ ppm}{\lvert V_{xref}\rvert}\right)$

A =*10V dc Range Accuracy*
B =*Input Signal Function and Range Accuracy*
V_{min} =*Minimum Allowable External Reference Voltage*
$\lvert V_{xref}\rvert$ =*Absolute Value of External Reference Voltage*

**The formula for determining V_{min} is included in Instrument Operating Characteristics*

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 ppm) = $\pm$(.001% + 1 Digit + .001% +1 Digit + .001% = $\pm$(.003% +2 Digits)
   Reading may be between 3.0003 and 2.9997

2. Input = 1.20000V,   Ext. Ref. Input = .12000 (V_{min} for 1V Range)
   A = .001% + 1 Digit,   B = .001% + 1 Digit, $\frac{200\ ppm}{V_{xref}} = \frac{.02\%}{.12} = .1667\%$

   Ratio Accuracy = $\pm$.001% + 1 Digit + .001% +1 Digit + .1667%) = $\pm$(.1687% + 2 Digits)
   Reading may be between .998313 and 1.001686.

INSTRUMENT OPERATING CHARACTERISTICS

DC Volts

TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)

Range	Temperature Coefficient
100 mV	± (3 ppm/reading + 0.5 digit)/°C
1V	±(3 ppm/reading +0.1 digit)/ °C
10 V	± (2 ppm/reading + 0.05 digit)/°C*
100 V	± (3 ppm/reading + 0.1 digit)/°C*
1000 V	± (3 ppm/reading + 0.05 digit)/°C*

**For High Resolution Multiply Digits by 10.*

INPUT IMPEDANCE

Range	Input Impedance
100 mV	>10,000 MΩ
1V	>10,000 MΩ
10 V	>10,000 MΩ
100 V	10 MΩ
1000 V	10 MΩ
Guard to Chassis	∞

INPUT BIAS CURRENT

	At time of Cal	30 Days (23°C ± 1°C)	Temperature Coefficient
Bias Current	<± 5 pA	<± 50 pA	± 3 pA/°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

Better than 5 μV 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.

OVERLOAD

±1200V 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/μsec.

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 KΩ 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

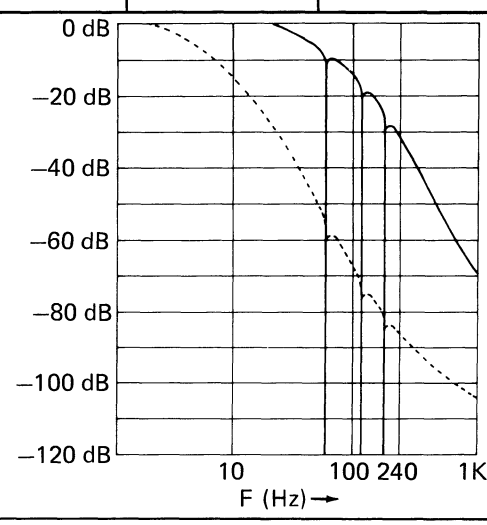


Table 1-3. Specifications (Cont)

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)

** Ohms Guard available through rear input (–16 or –17 Option)*

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

Settling Time

Sense Input Fast Filter < 50 ms to 0.001% of change
Sense Input Slow Filter < 500 ms to 0.001% of change

Digitizing Time

NOTE

The Sense Input is measured prior to measuring Ext Ref HI and LO.

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

Sense Input		
Line Volt	**Approx. Rdg. Rate**	**Digitizing Time**
60 Hz	4½ rdg/s 1½ rdg/s	136 ms 536 ms
50 Hz	3½ rdg/s 1¼ rdg/s	162 ms 642 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.

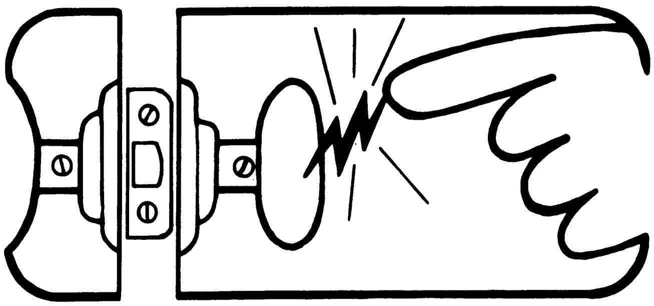
Minimum Ext Ref Voltage = ±0.0001V, or $\frac{V_{input}}{10^9}$ (whichever is greater)

MAXIMUM DISPLAY— Ratio, Scaling or Offset Mode = ±1.00000 x 10^9 in all Ranges

static awareness

A Message From

John Fluke Mfg. Co., Inc.



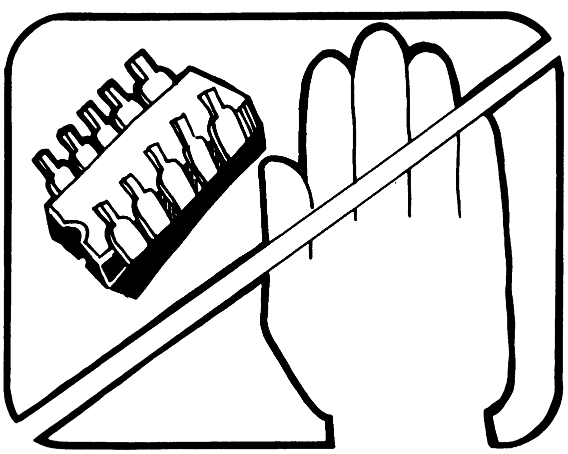
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

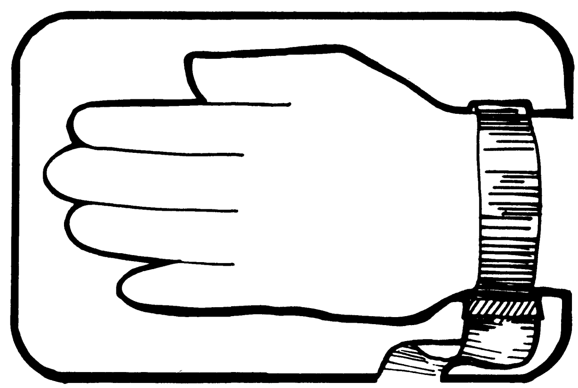
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol

" "

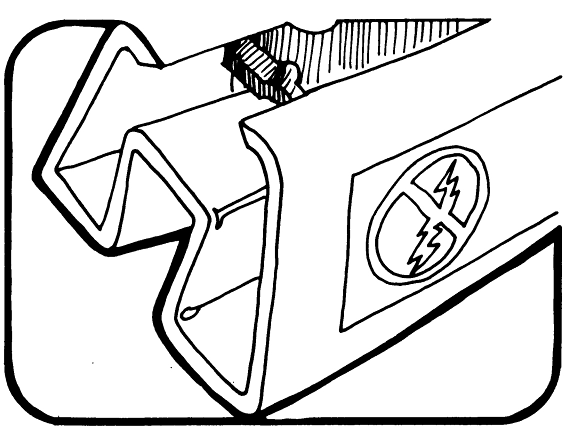
The following practices should be followed to minimize damage to S.S. devices.



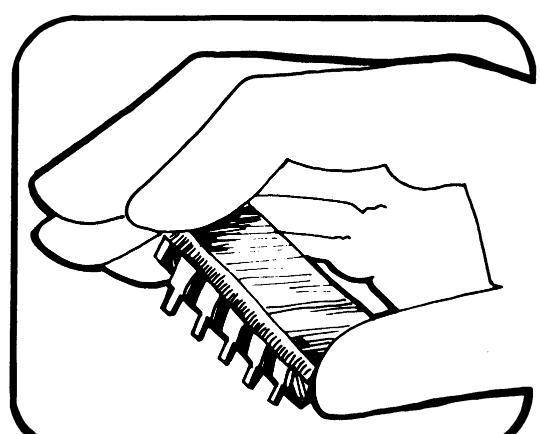
1. MINIMIZE HANDLING



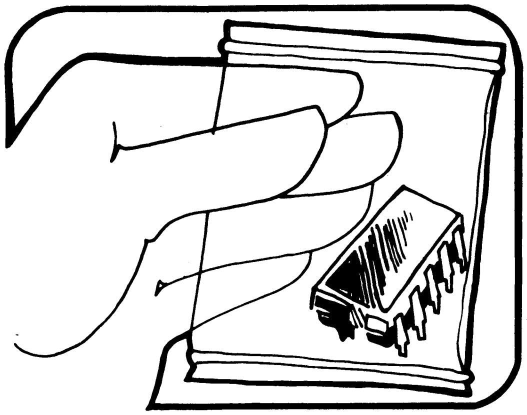
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



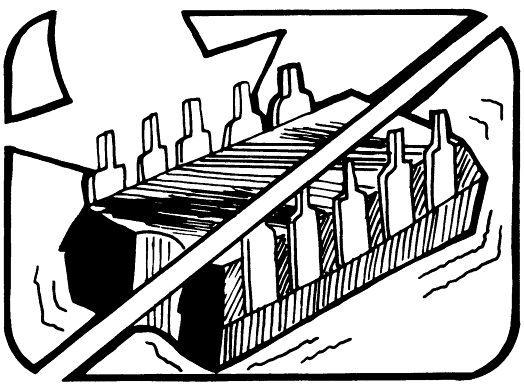
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



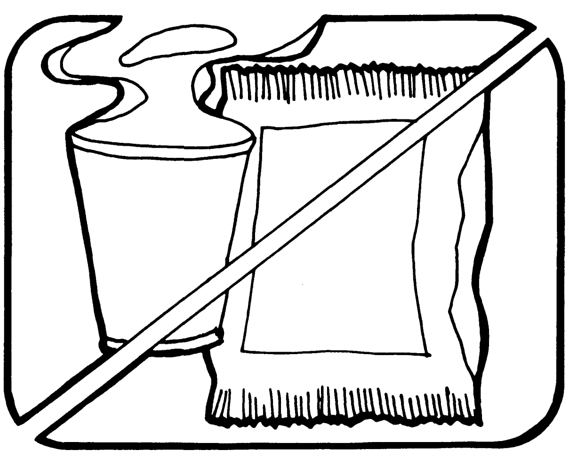
4. HANDLE S.S. DEVICES BY THE BODY



5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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WITH PERMISSION FROM TEKTRONIX, INC.
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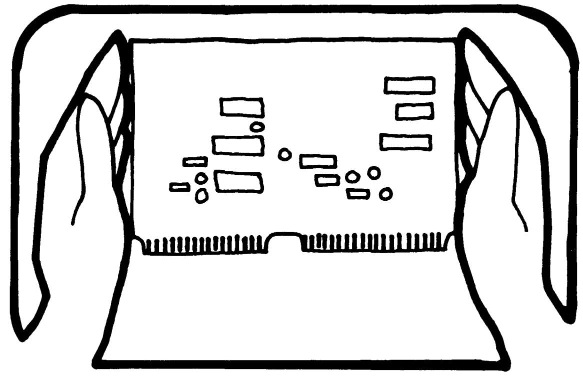
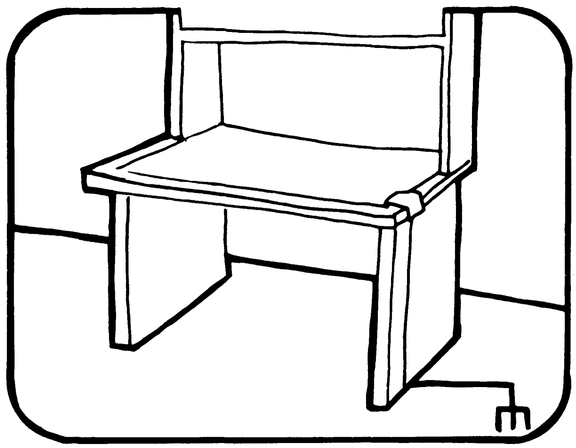
® Dow Chemical



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
453522	6" X 8" Bag
453530	8" X 12" Bag
453548	16" X 24" Bag
454025	12" X 15" Bag
Pink Poly Sheet	Wrist Strap
30"x60"x60 Mil	P/N TL6-60
P/N RC-AS-1200	$7.00
$20.00	

J0089B-07U7810/SE EN Litho in U.S.A.

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 ±10% or 230V ac ± 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.

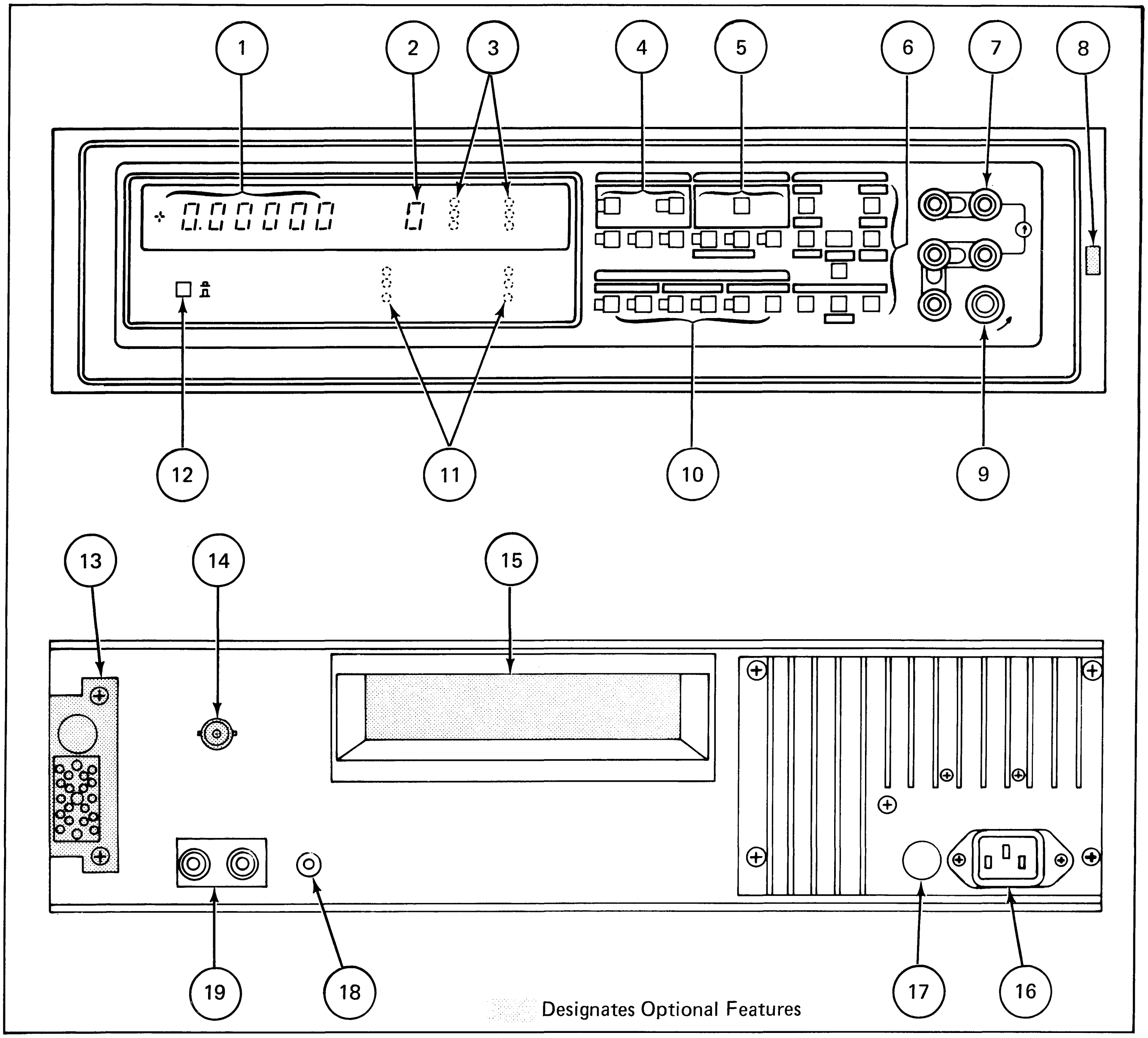


Figure 2-1. 8502A Controls and Indicators

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

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.

NOTE

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^2 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).

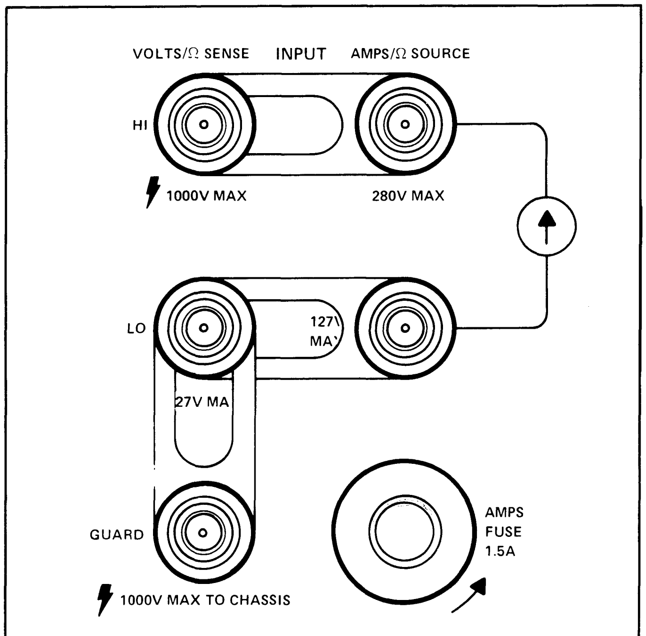


Figure 2-2. Front Panel Terminal Interconnections

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.

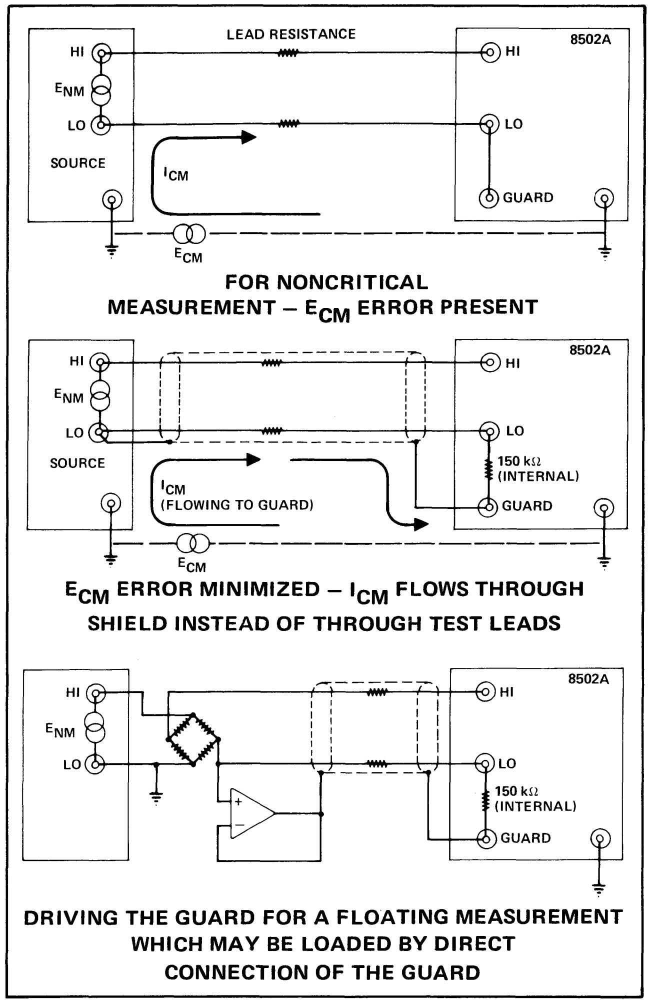


Figure 2-3. Guard Connections

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 ±20V 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 ±100 uV, 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)

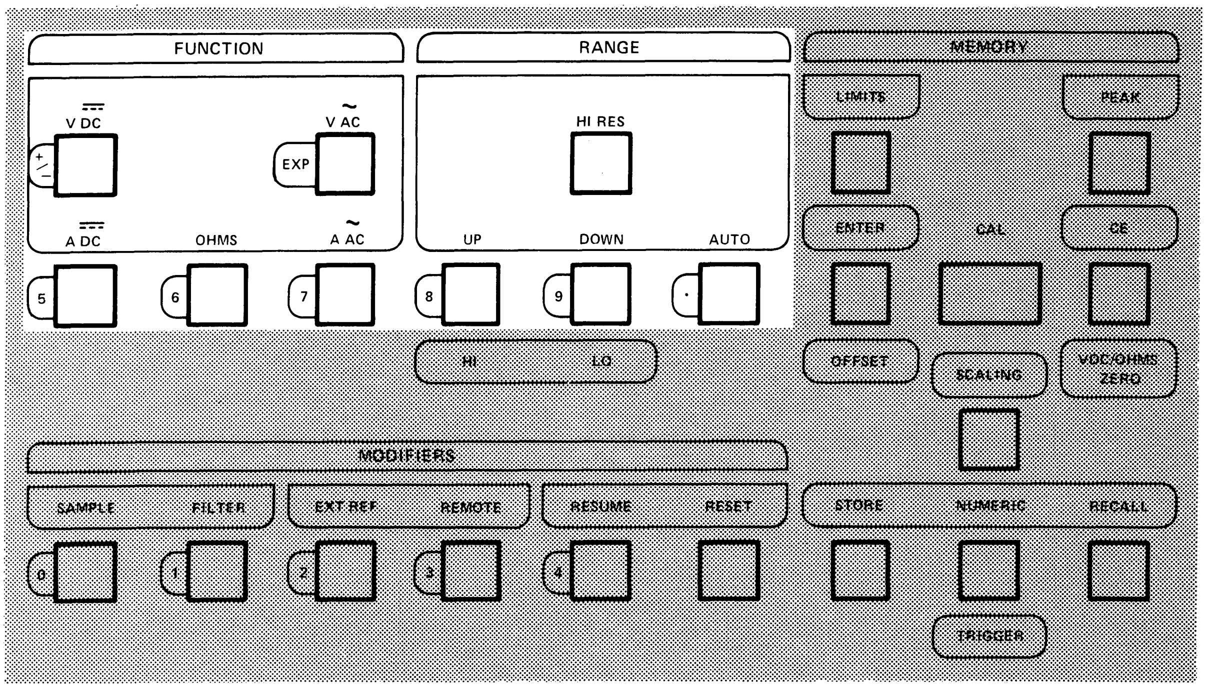
5. Offset – off and zeroed
Scaling – off and set to 1
Peaks – off and set to 0
Ext Ref – off
Trigger – Auto
VDC/Ohmx Aero – zeroed
Remote – out, in local.

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)

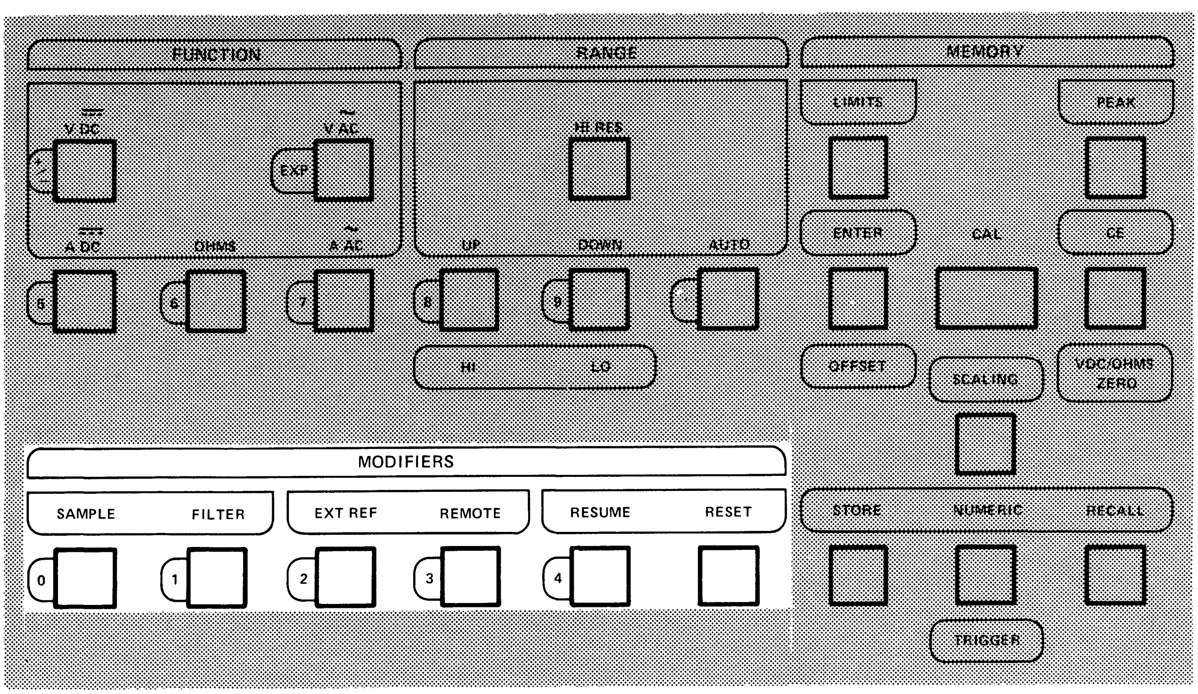


Figure 2-5. Modifiers

☐ SAMPLE ☐

1. Press SAMPLE to toggle between samples/reading rates 5 and 7.

2. Alternately, any rate between 0 and 17 may be programmed from the front panel. Press:

   STORE → NUMERIC → SAMPLE → (rate number) → ENTER

   The new rate will go into effect as soon as ENTER is pressed.

3. To display the samples/reading rate, press:

   RECALL → SAMPLE

   The rate will be displayed as long as SAMPLE is held depressed.

4. The SAMPLE LED will flash at the samples/reading rate selected. With more than 128 samples/reading (rate 7) there will be no distinguishable rate difference from the LED's indications at rate 7.

☐ FILTER ☐

1. Press FILTER to toggle between filter modes F and F0. The FILTER LED will come on for F (slow filter).

2. Use the following switches to select filter modes F, F0, F1, F2, or F3:

   STORE → NUMERIC → FILTER → (–, 0, 1, 2, or 3) → ENTER

3. Display the filter mode in effect by pressing:

   RECALL → FILTER

   The mode will be displayed as long as FILTER is held depressed.

4. If modes F1 or F3 are in effect, subsequent use of FILTER will toggle the 8502A back to mode F. If mode F2 is in effect, pressing FILTER will toggle back to mode F0.

☐ EXTERNAL REFERENCE ☐

1. Press EXT REF to enter the External Reference mode (EXT REF LED will flash). The external reference voltage applied at the rear panel terminals will be displayed as long as EXT REF is held depressed. Release of the switch enters the 8502A into the External Reference mode.

2. For proper external reference operation; the resistance between SENSE LO on the front panel and external reference HI or LO on the rear panel must be less than 20 Kohms. Apply a direct connection between these two points to insure correct operation.

☐ REMOTE ☐

1. Use REMOTE to toggle between local and remote operation with either the RS 232 (Option –06) or or the Parallel (Option –07) Interface installed.

2. Use REMOTE to toggle into local only if in remote with the IEEE (Option –05) installed.

Figure 2-5. Modifiers (cont)

☐ 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)

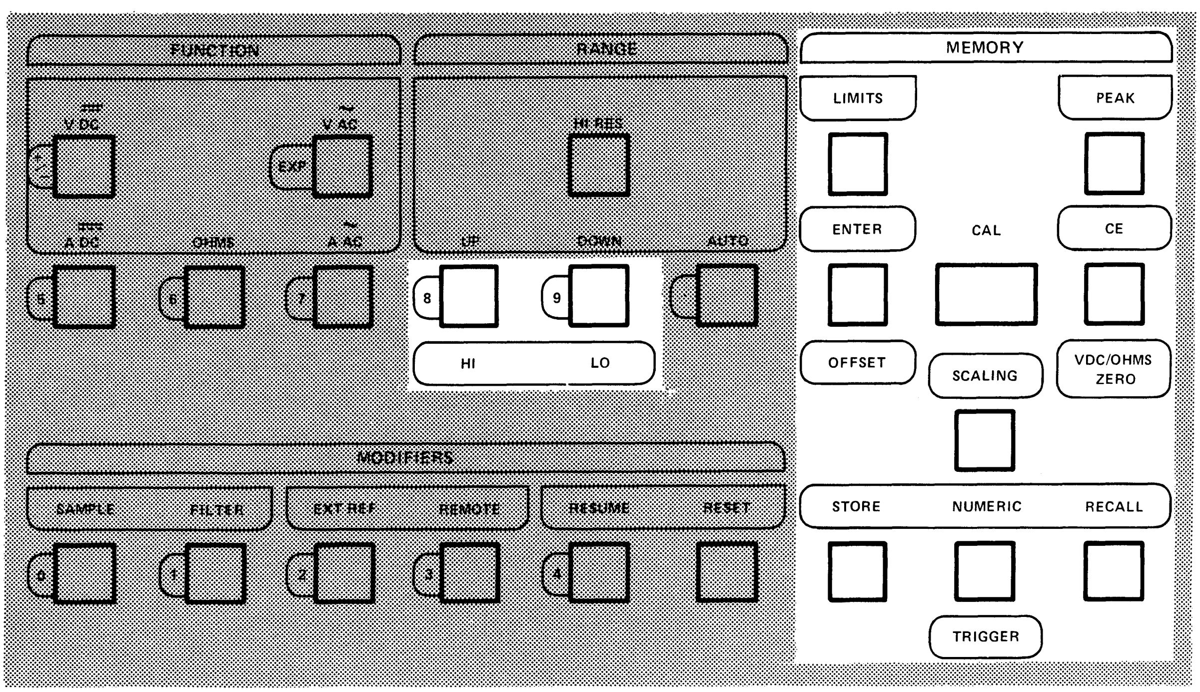


Figure 2-6. Memory

DISPLAY INDICATIONS WHEN PROGRAMMING THE 8502A

The display will respond to memory programming as in the following example:

PRESS	DISPLAY RESPONDS
STORE	"?"
NUMERIC	YES?
OFFSET	Go
(numbers)	1, 2, 3 . . .
ENTER	Return to normal display.

☐ LIMITS ☐

1. Select the Limit mode by depressing the LIMIT switch. A display of HI, LO, or PASS will indicate that the mode has been entered. Depress LIMIT a second time to exit the mode.

2. To store any displayed value as a limit value; use the following sequence:

   STORE → HI

   STORE → LO

   The value being entered will be displayed as long as HI or LO are held depressed. Release of either switch will enter the value as the respective limit. LIMIT must be separately depressed before or after entering values to enter the Limit mode.

3. To enter numeric values as limit values, press:

   STORE → NUMERIC → HI or LO → (value numbers) → ENTER

   LIMIT must be depressed to enter the mode.

4. To display the stored limits, press:

   RECALL → HI or LO → LIMIT

   The respective value will be displayed as long as LIMIT is held depressed.

☐ PEAK ☐

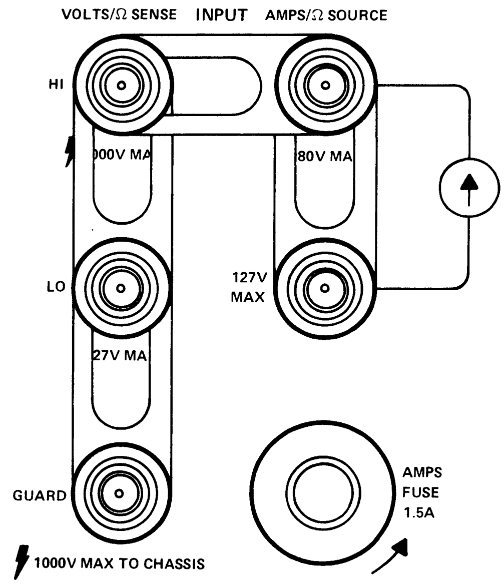
1. Press PEAK to toggle into or out of the Peak mode (PEAK LED will come on).

2. To display the readings recorded in this mode, use the following sequence:

   RECALL → HI or LO → PEAK

Figure 2-6. Memory (cont)

☐ VDC/OHM ZERO ☐



1. 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.

2. 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 ☐

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

2. Store any currently displayed value with the following procedure:

   STORE → OFFSET

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

   STORE → NUMERIC → OFFSET → (numbers) → ENTER

4. 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)

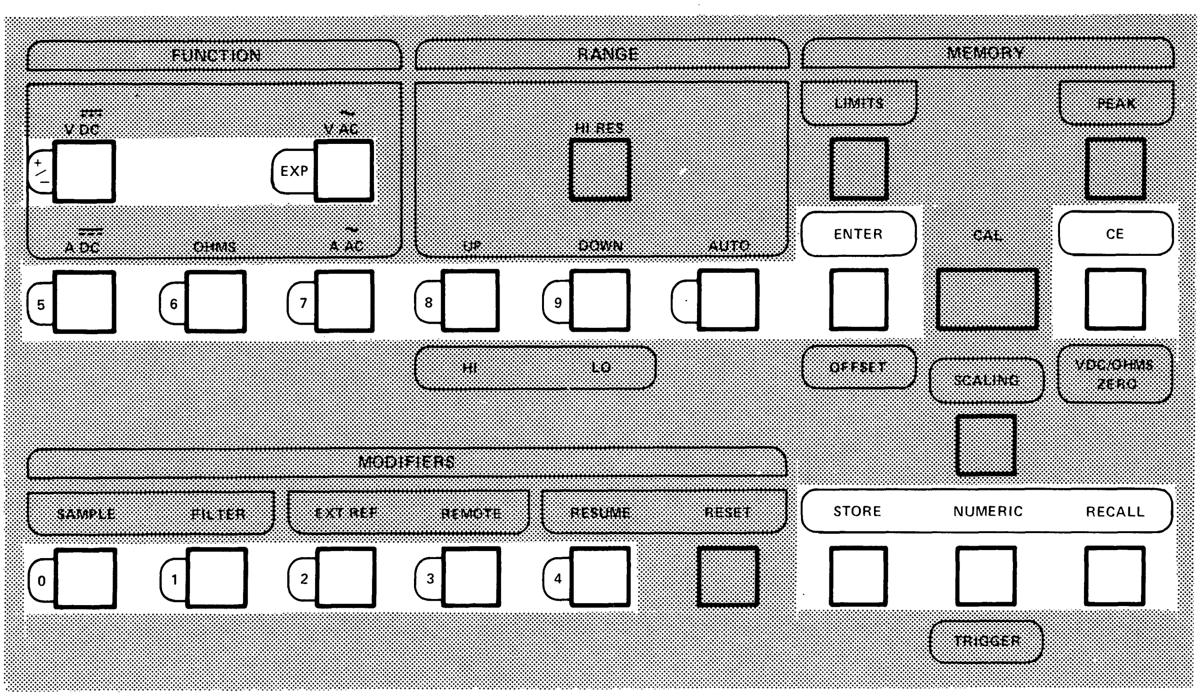


Figure 2-7. Numerics

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

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.

Figure 2-7. Numerics (cont)

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 procecure when measuring ac and dc voltage:

1. The RMS AC Converter module must be installed.

2. Depress both V DC and V AC awitches 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

$$\text{STORE} \longrightarrow \left\{ \begin{array}{l} \text{OFFSET} \\ \text{VDC/OHM ZERO} \\ \text{SCALING} \\ \text{HI} \\ \text{LO} \end{array} \right.$$

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: Perform V DC Zeroing for internal drift. Apply low thermal short between INPUT HI and LO (at the terminals). Press:

STORE → VDC/OHMS ZERO

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.

Apply power supply reading of −20.08V as a scaling factor. Press:

STORE → SCALING → SCALING

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.

Display will now yield the ratio of subsequent readings to the scaling factor, e.g., an input of 22.08V yields a ratio of:

$$\frac{22.088}{20.08} = 1:1$$

STORING A NUMERIC ENTRY

STORE → NUMERIC →
- **OFFSET / SCALING / HI / 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: Set high and low limits. Press:

STORE → NUMERIC → HI → 1 → 5 → . → 1 → ENTER

STORE → NUMERIC → LO → 1 → 4 → . → 9 → ENTER

Select LIMITS. The 8502A will now display "HI", "LO", or "PASS" for each power supply.

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 = 2.6847×10^4.
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, LO } → { PEAK, LIMIT } }

APPLICATION 7

REQUIREMENT:	Determine the highest and lowest readings encountered in measuring a group of 28V power supplies.
METHOD:	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.

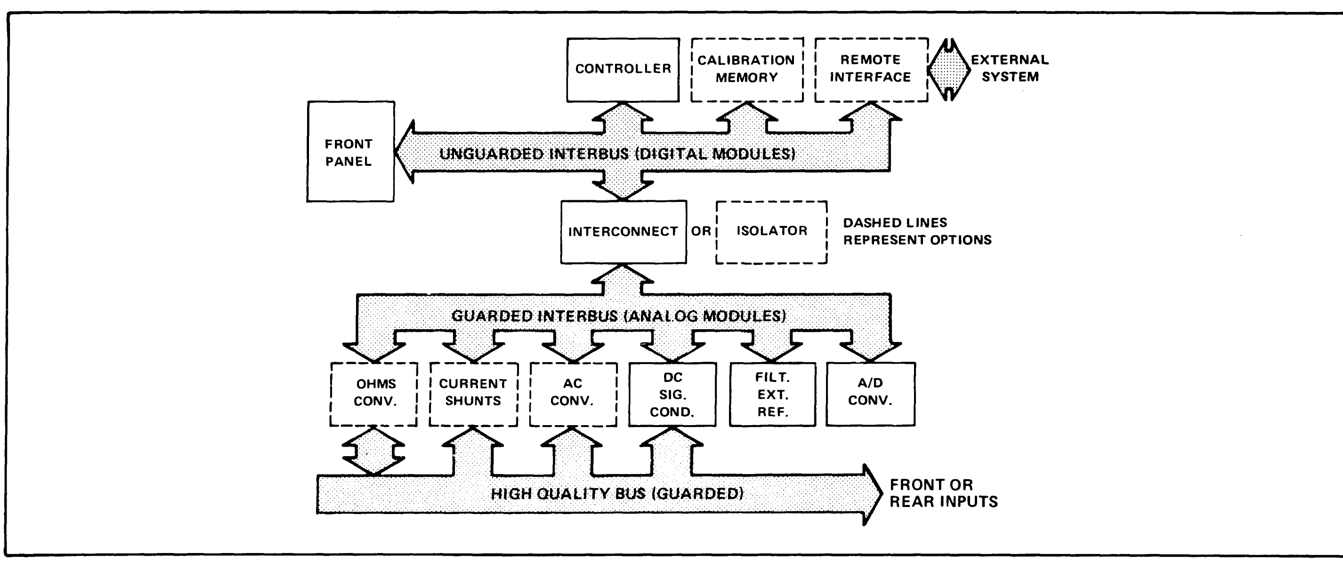


Figure 3-1. 8502A Block Diagram

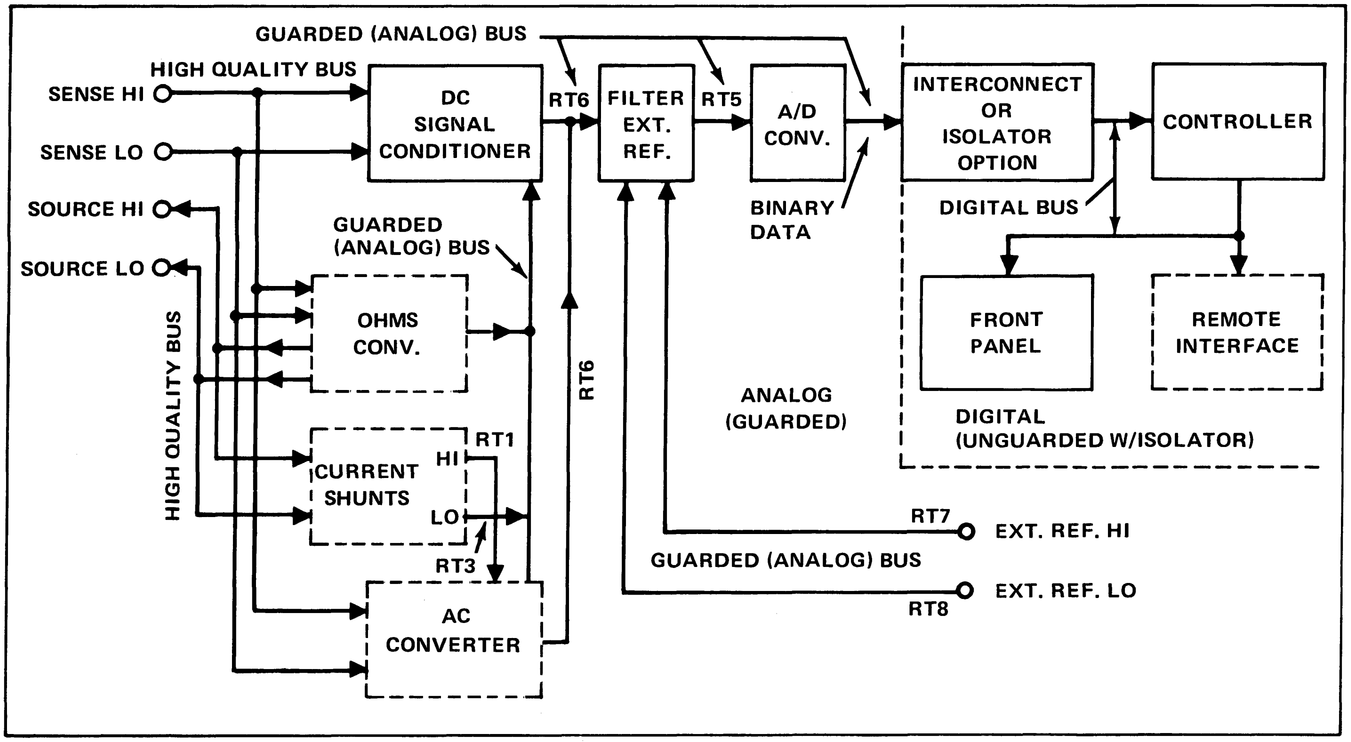


Figure 3-2. 8502A Analog Signal Flow

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^2 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.

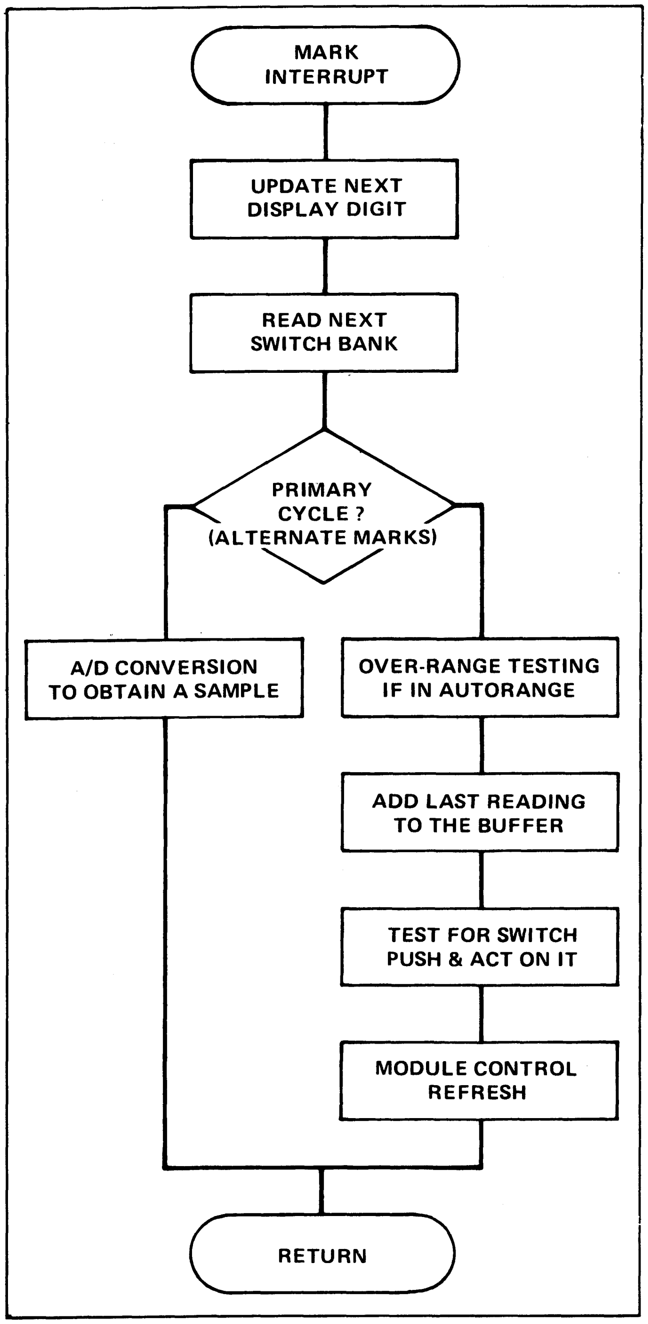


Figure 3-3. Background Software Process

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.

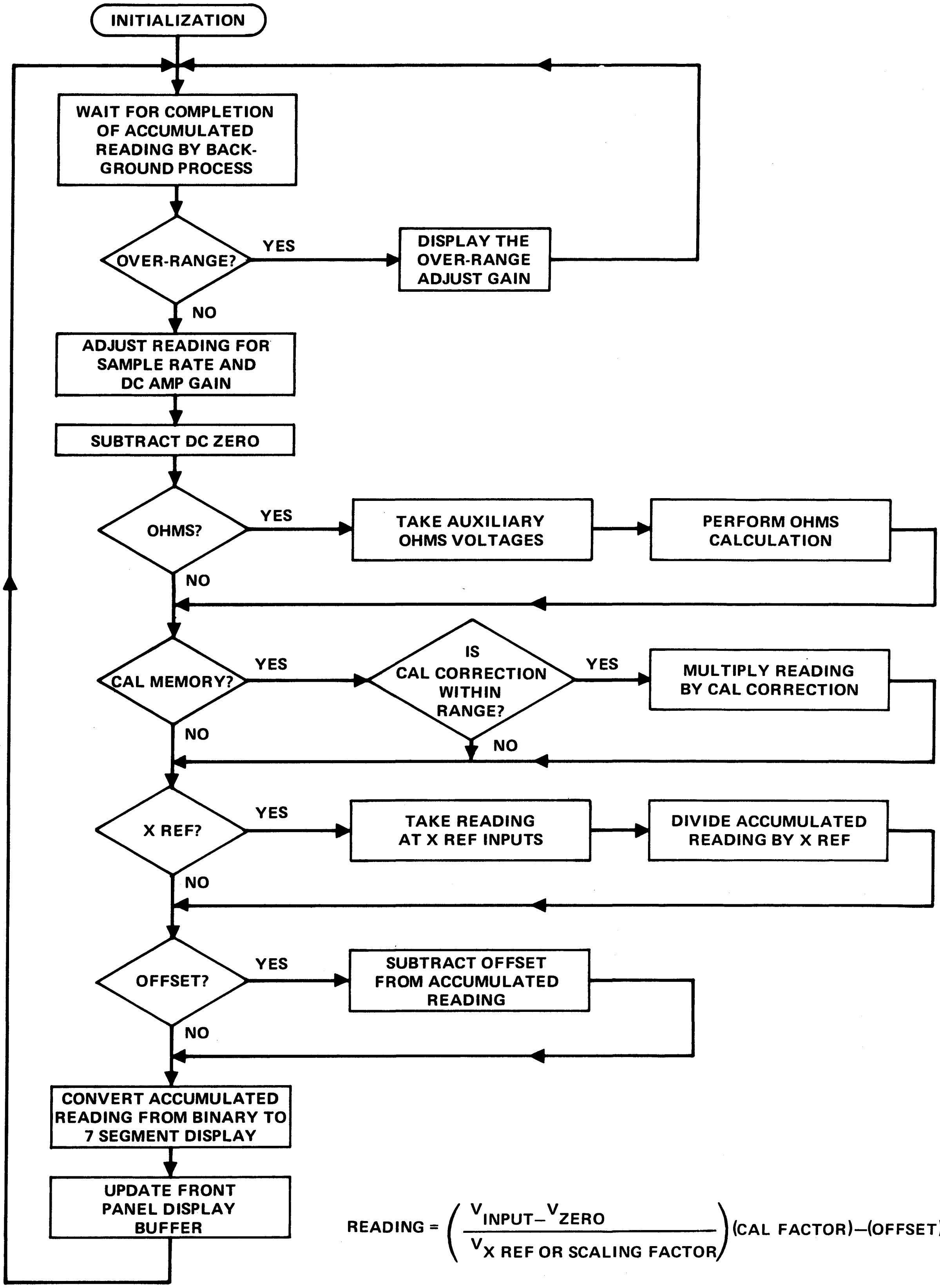
3-15. Software for the 8502A is stored in five ROM's. These read only memories are mounted on a "piggy-back" board, which is connected to the main controller pcb at the socket for U25. Four RAMs (random access memory) are used for temporary storage of data by the microprocessor. Data lines (DB0-DB7) 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 soutines. 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 RT5 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.



$$\text{READING} = \left(\frac{V_{\text{INPUT}} - V_{\text{ZERO}}}{V_{\text{X REF OR SCALING FACTOR}}} \right) (\text{CAL FACTOR}) - (\text{OFFSET})$$

Figure 3-4. Foreground Software Process

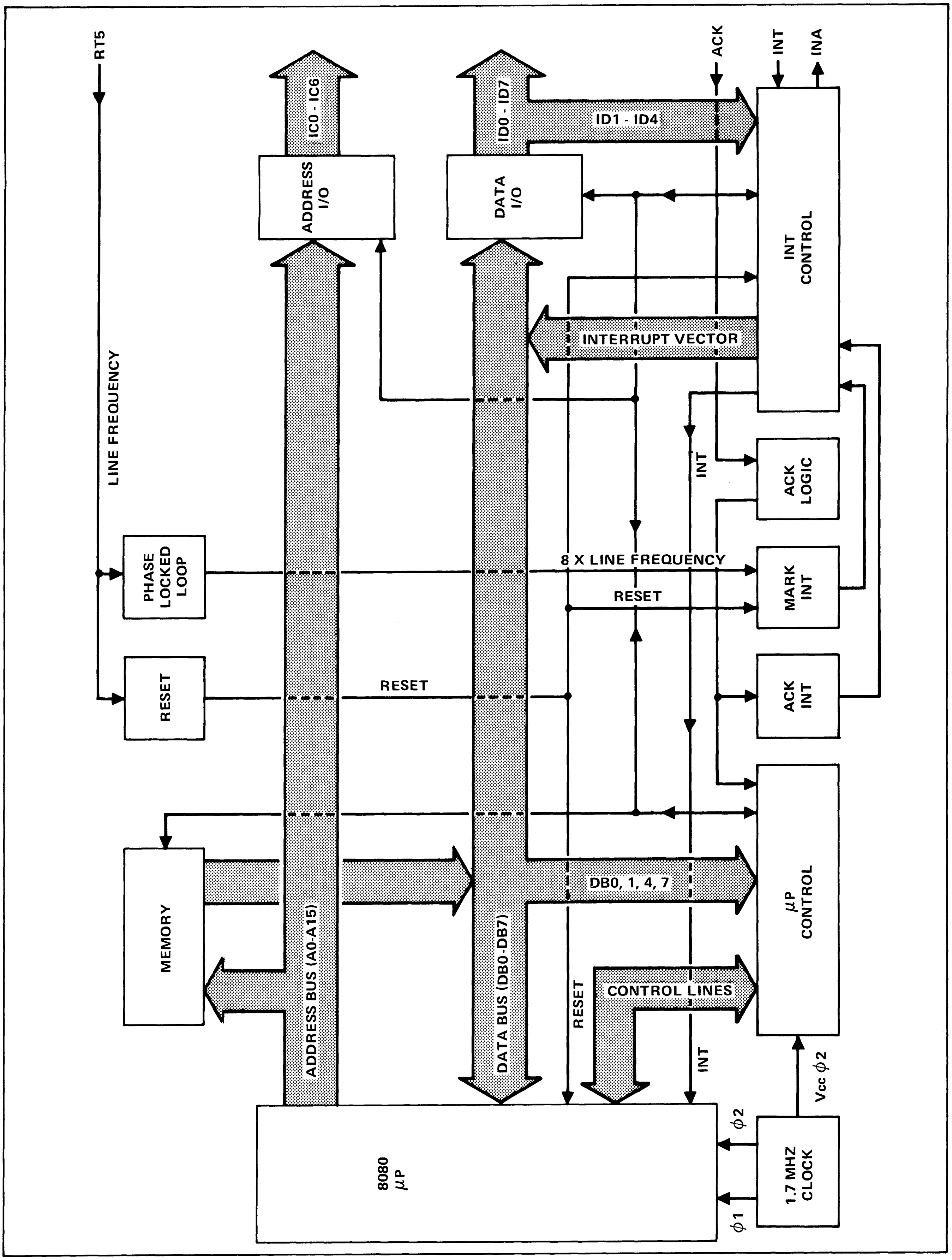


Figure 3-5. Controller Block Diagram

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 (± 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

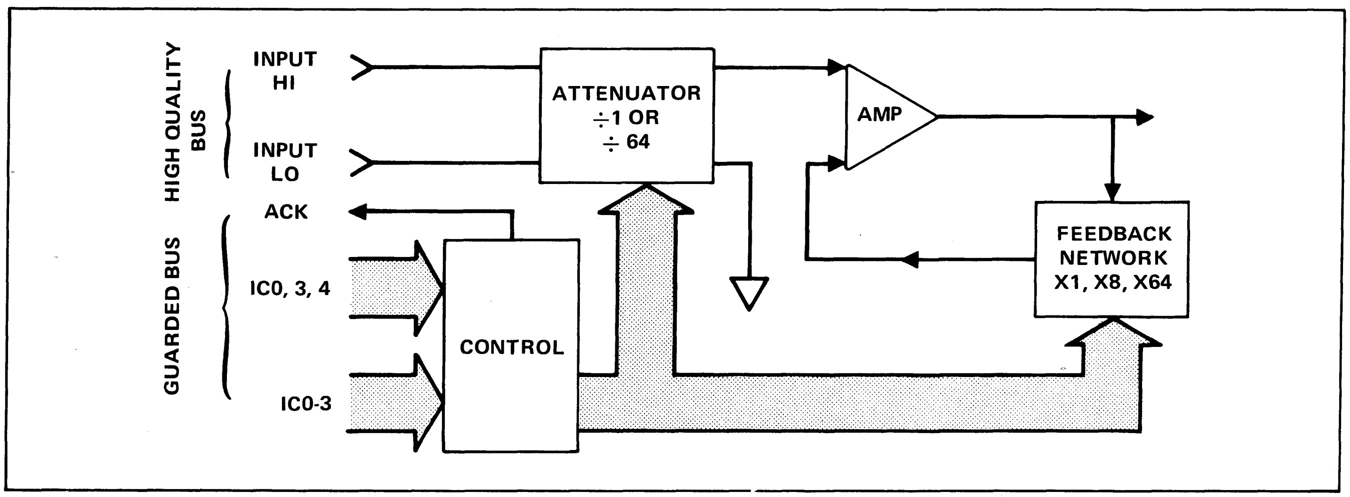


Figure 3-6. DC Signal Conditioner Block Diagram

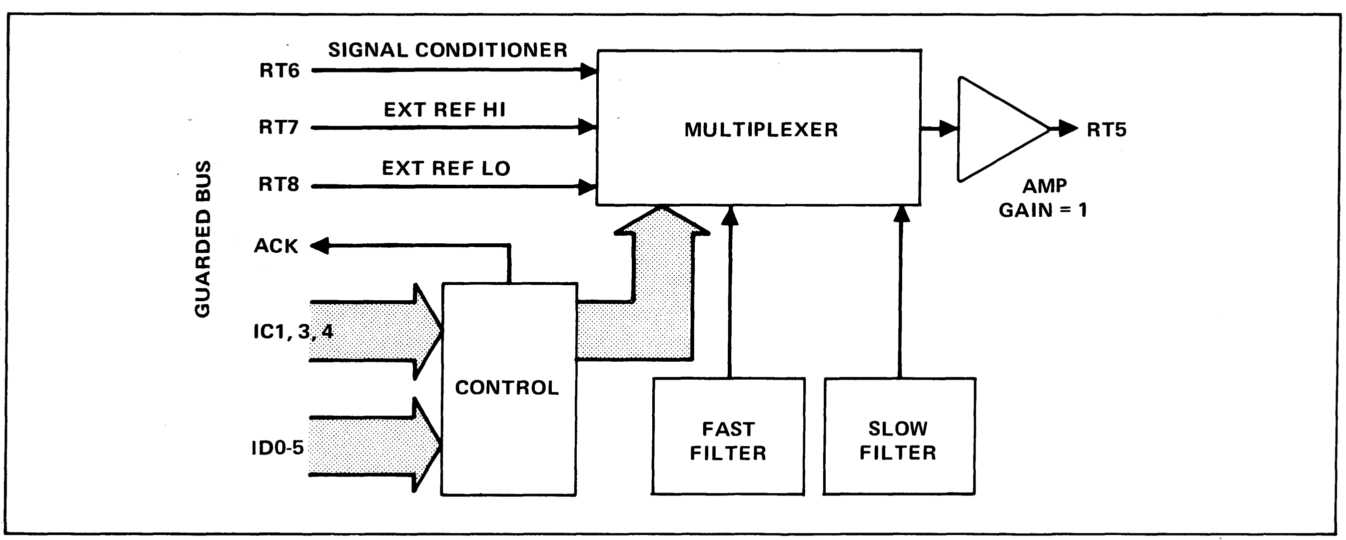


Figure 3-7. Active Filter Block Diagram

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^2 A/D Converter

3-27. The Fast R^2 A/D Converter employs Fluke's patented recirculating remainder (R^2) technique for converting a dc input signal into a binary, bit-serial data stream. The R^2 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^2 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

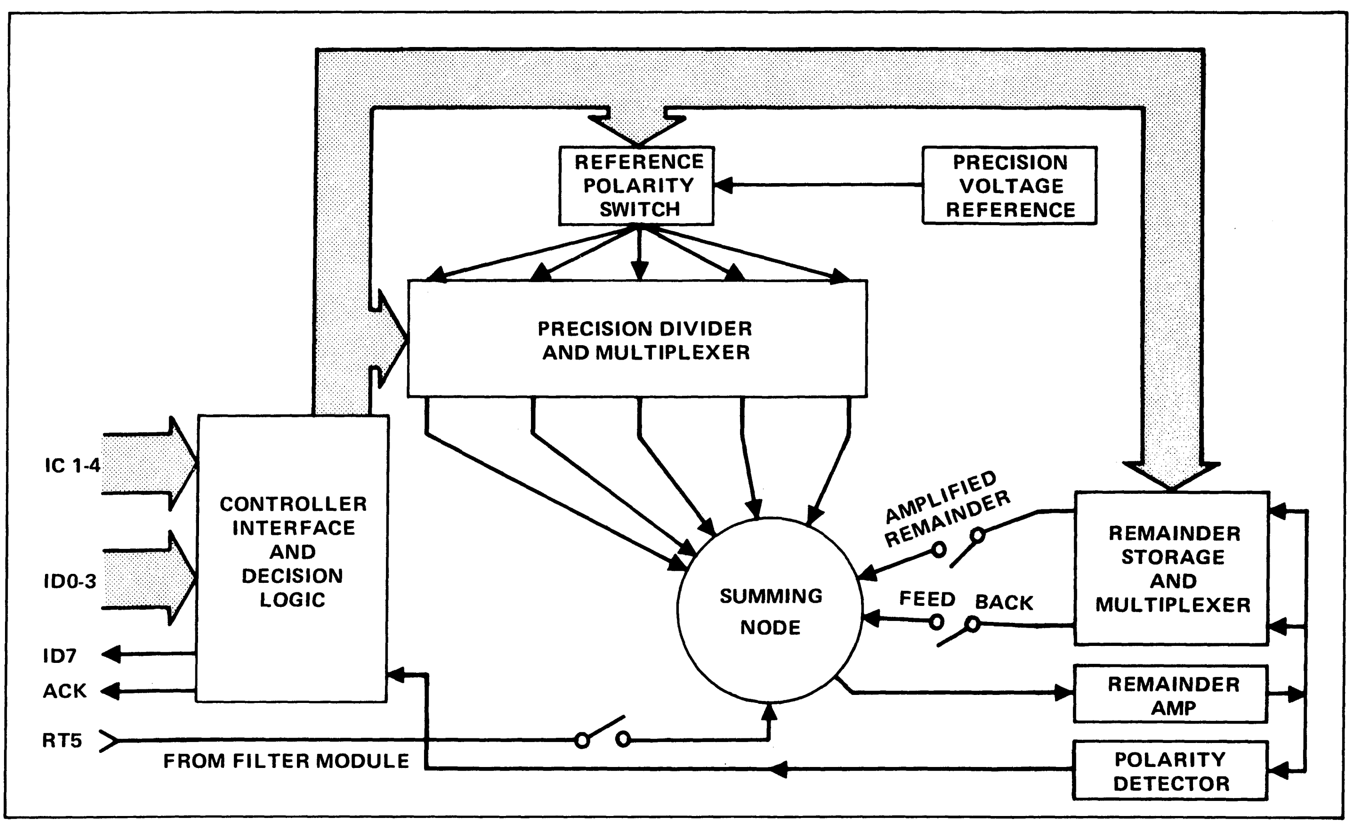


Figure 3-8. R^2 A/D Converter Block Diagram

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 μP)
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 μP)
INTE	– interrupt enable (from μP)
MEM RD	– memory read
MS ADDR BYTE	– memory select address byte
$\phi 1$	– clock pulse
$\phi 2$	– clock pulse
ϕLL	– phase-locked loop
RAM	– random access memory
ROM	– read only memory
RRDY	– reset ready
RST	– reset
RT	– real time
R/$\overline{W}$	– read/$\overline{\text{write}}$
μP	– 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 Vcc 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 IINT and INTA

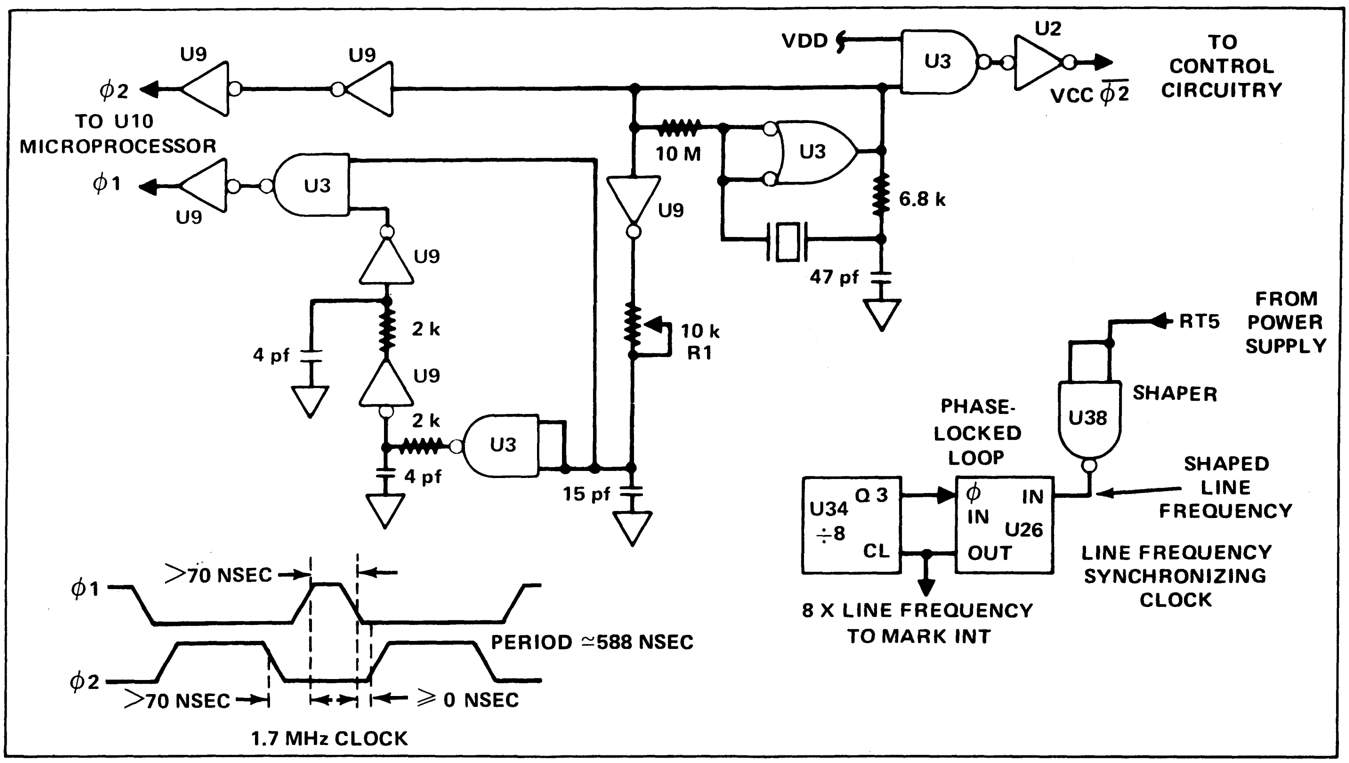


Figure 3-9. Timing Circuits

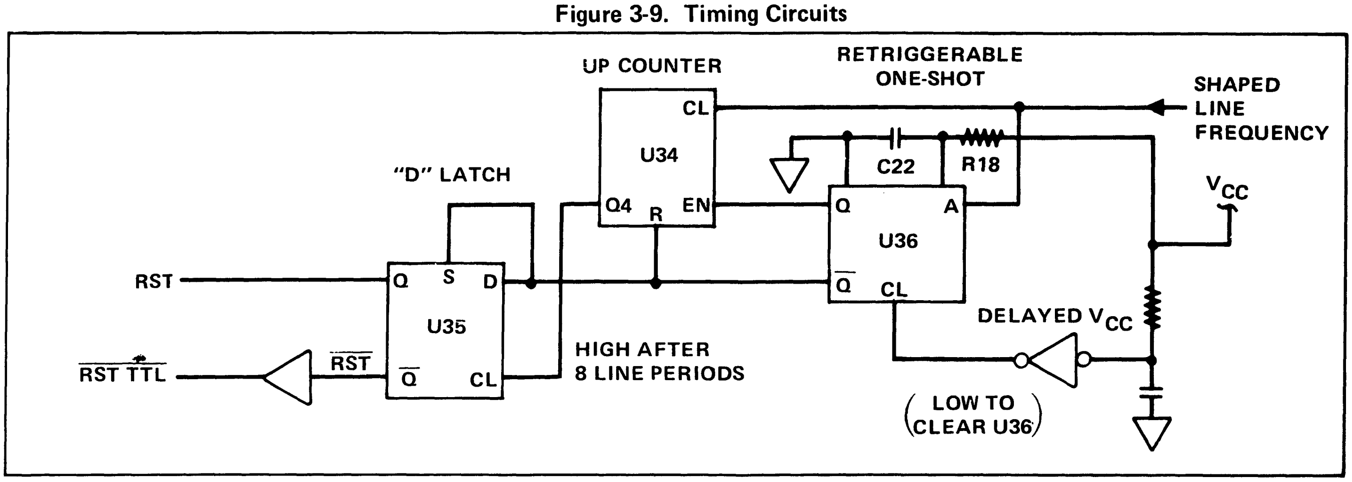


Figure 3-10. Reset Logic

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

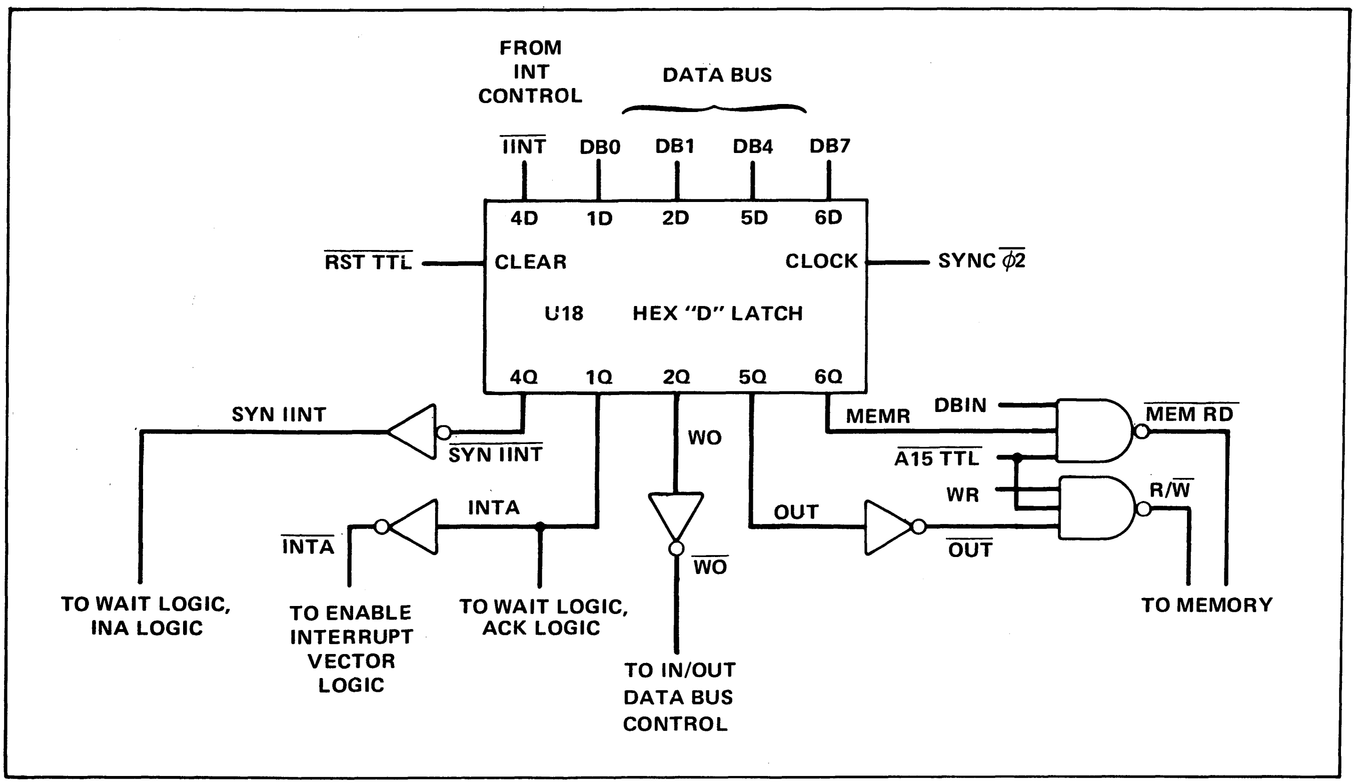


Figure 3-11. Status Latch

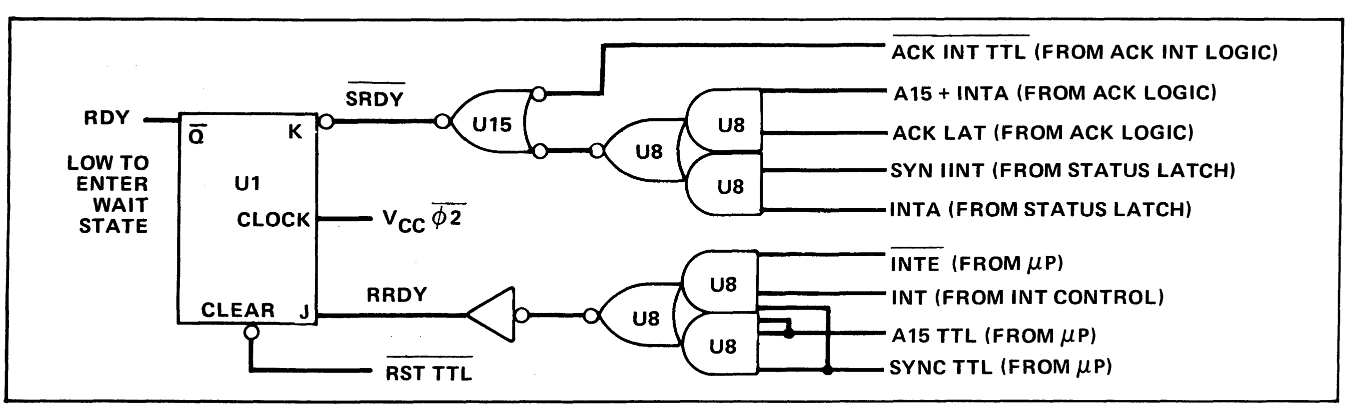


Figure 3-12. Wait Logic

monostable multivibrator, U36, and a "D" type flip-flop, U14. U36 is triggered by A15 TTL and SYNC $\overline{\phi 2}$. If $\overline{\text{DLD ACK}}$ does not occur within the time constant of U36, U36 will clock U14 to generate ACK INT. $\overline{\text{ACK INT TTL}}$ 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 $\overline{\phi 2}$ clock U1 through U31-12. $\overline{\text{A14}}$ 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/$\overline{\text{W}}$) is disabled by OUT from the STATUS LATCH. $\overline{\text{MEM RD}}$ (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. $\overline{\text{DBIN}}$ and $\overline{\text{INTA}}$ 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, $\overline{\text{IINT}}$ 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 $\overline{\text{EN INT}}$ low, INA is generated on the interbus. The interrupting module must respond with an

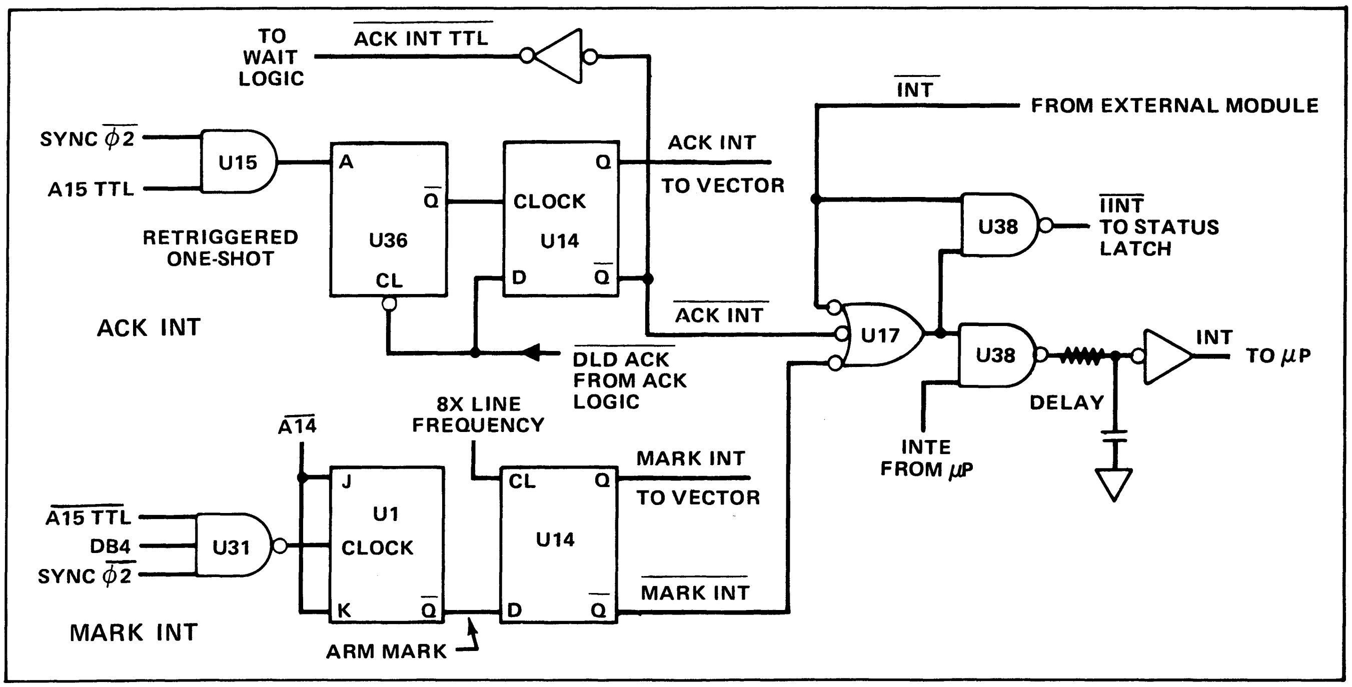


Figure 3-13. Internal Interrupts and INT Control

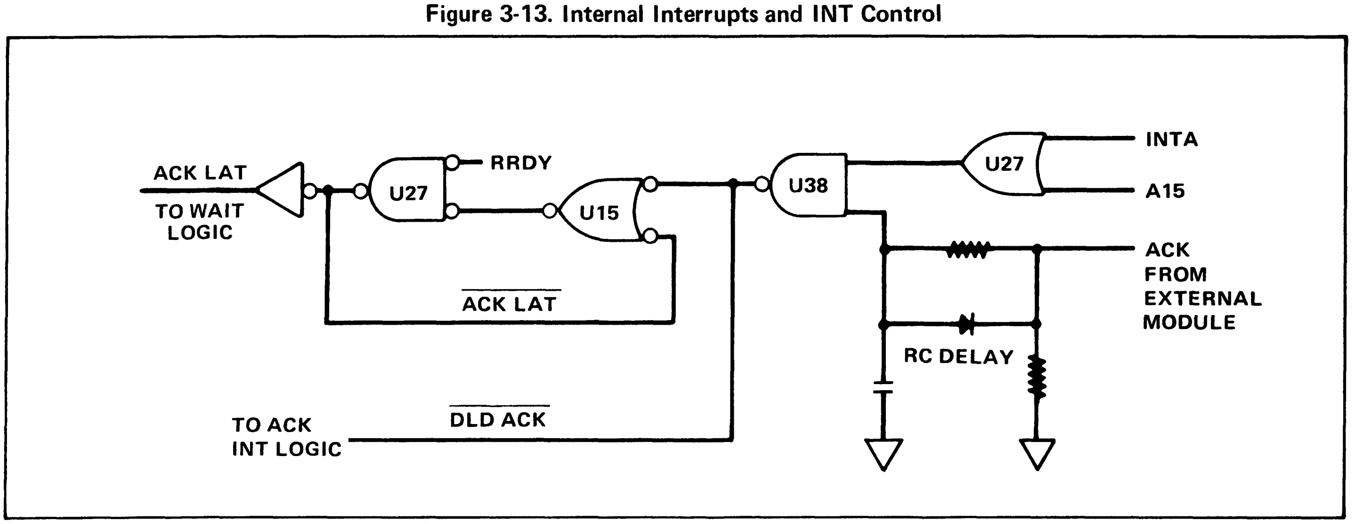


Figure 3-14. ACK Logic

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/Ω input terminals with ÷ 64 attenuation. If just K1 is energized, the input is from the Volt/Ω 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 ±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.

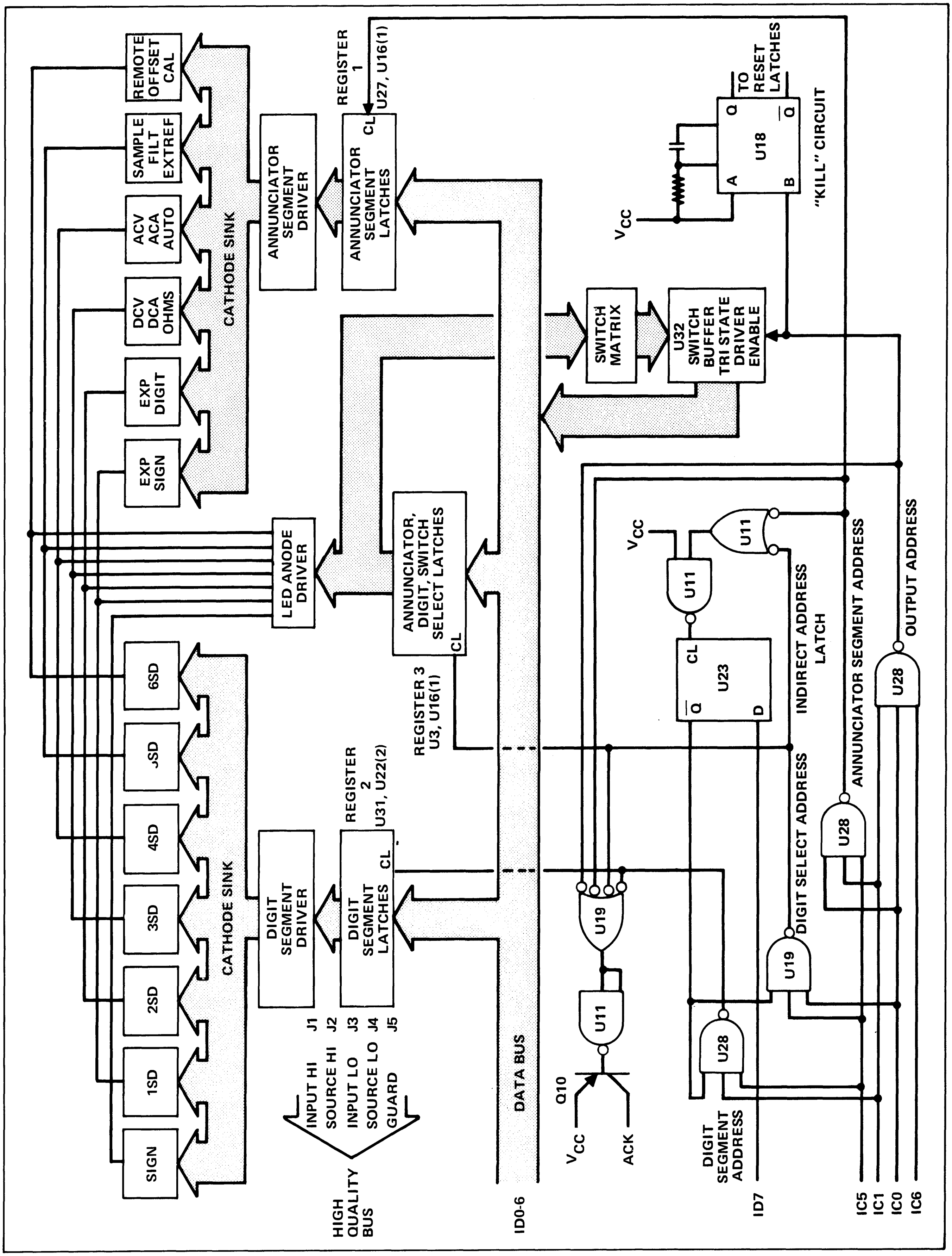


Figure 3-15. Front Panel

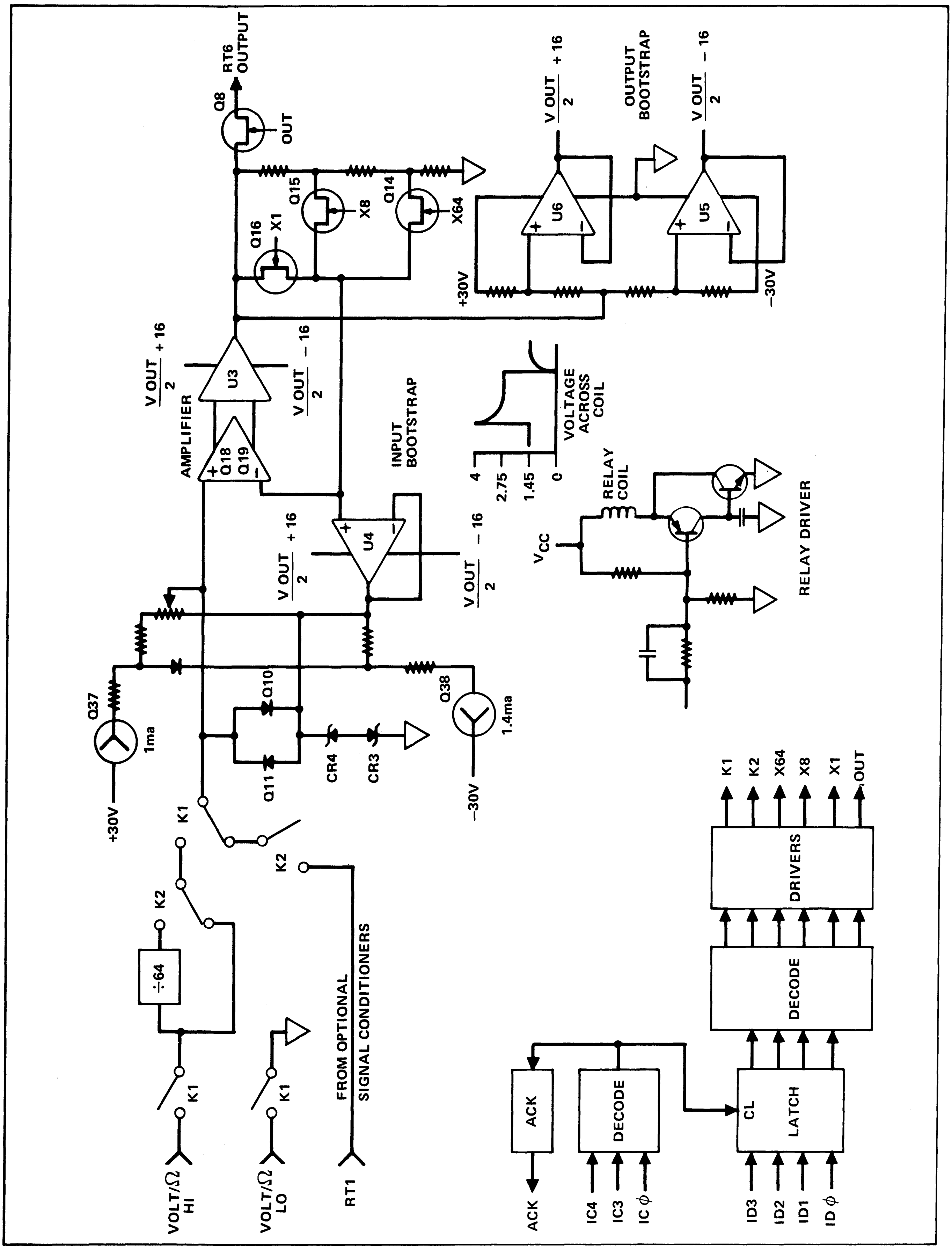


Figure 3-16. DC Signal Conditioner

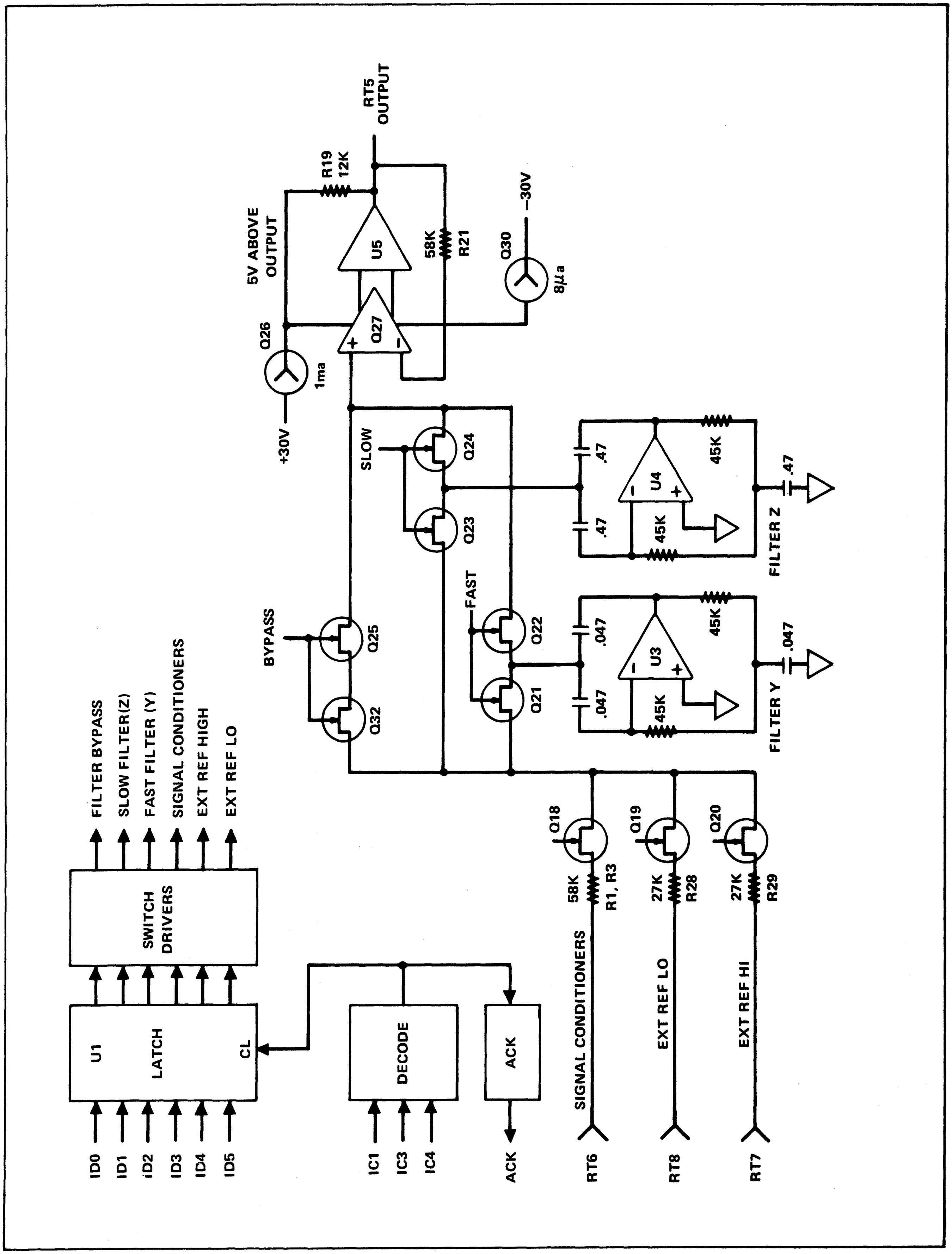


Figure 3-17. Filter/External Reference

3-65. Fast R^2 A/D Converter

3-66. The Fast R^2 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 isa 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 autozeroed. 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^2 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.

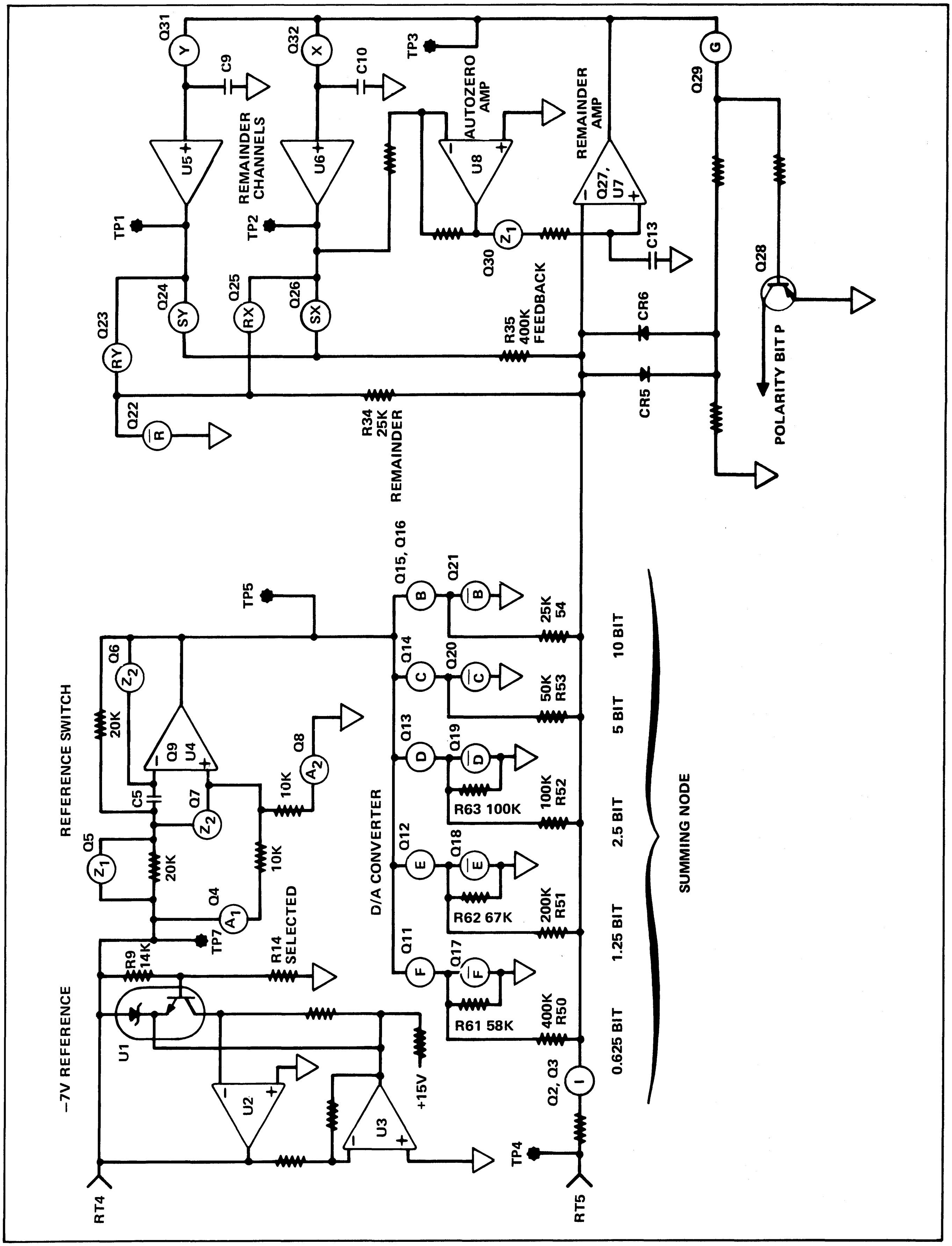


Figure 3-18. Fast R^2 A/D Converter (Analog)

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 Section 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 μV Full-Scale Resolution	Fluke Model 335A
Reference Divider	±.001% Division Accuracy	Fluke Model 750A
Kelvin-Varley Divider	Linearity: ±.1 PPM of Input	Fluke Model 720A
Standard Cell Enclosure	Guildline 91	Guildline 9152 (R)
Oscilloscope	General Purpose with 10MΩ Probe	Tektronix 465
Digital Multimeter	Voltage Accuracy: .01% Input Impedance: 1000 MΩ	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
AS REQUIRED BY INSTALLED OPTIONS		
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 kΩ Resistor	Accuracy: ±.02% ±.01 %	Fluke Model 382A
Standard Resistors	10Ω at 30 ppm; 100Ω, 1.9kΩ, 10kΩ, 100 kΩ, 250kΩ, 1 MΩ, 4 MΩ at 10 ppm; 10 MΩ at 50 ppm; 100 MΩ at 100 ppm	ESI SR-1010 ESI SR-1050
Terminating Load	1 MΩ ± 10%/0.22 μf 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 permissable 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 togather, 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.

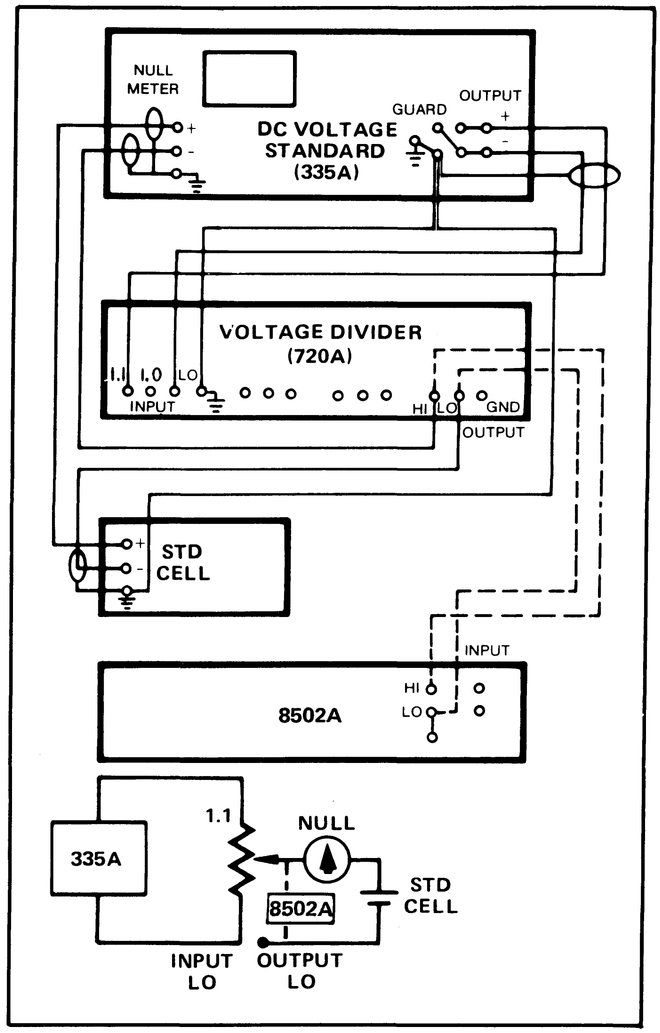


Figure 4-1. Connections For Low Range DC Voltage Tests

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.

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.

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.

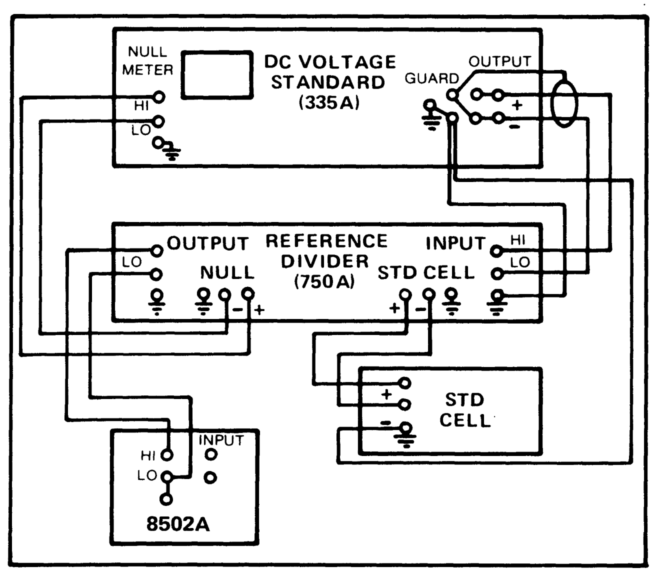


Figure 4-2. Connections For High Range DC Voltage Tests

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.

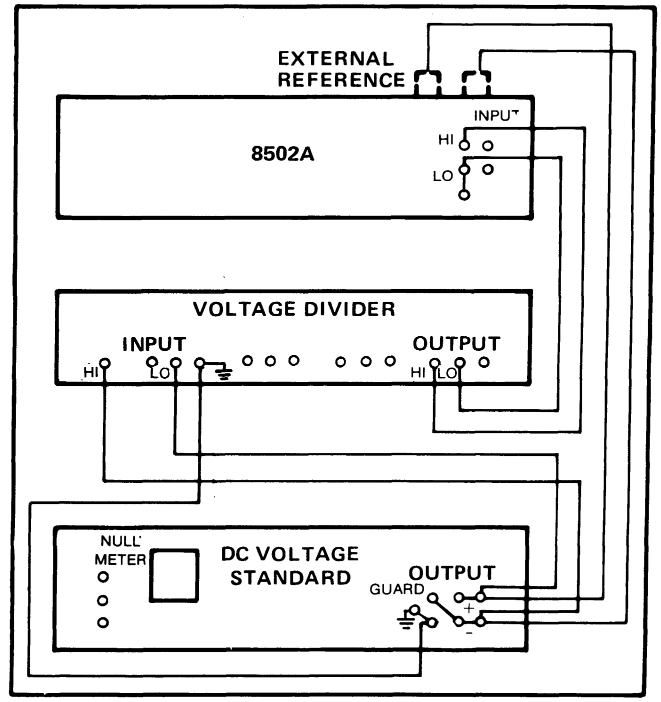


Figure 4-3. DC External Reference Test

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°C ± 2°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.

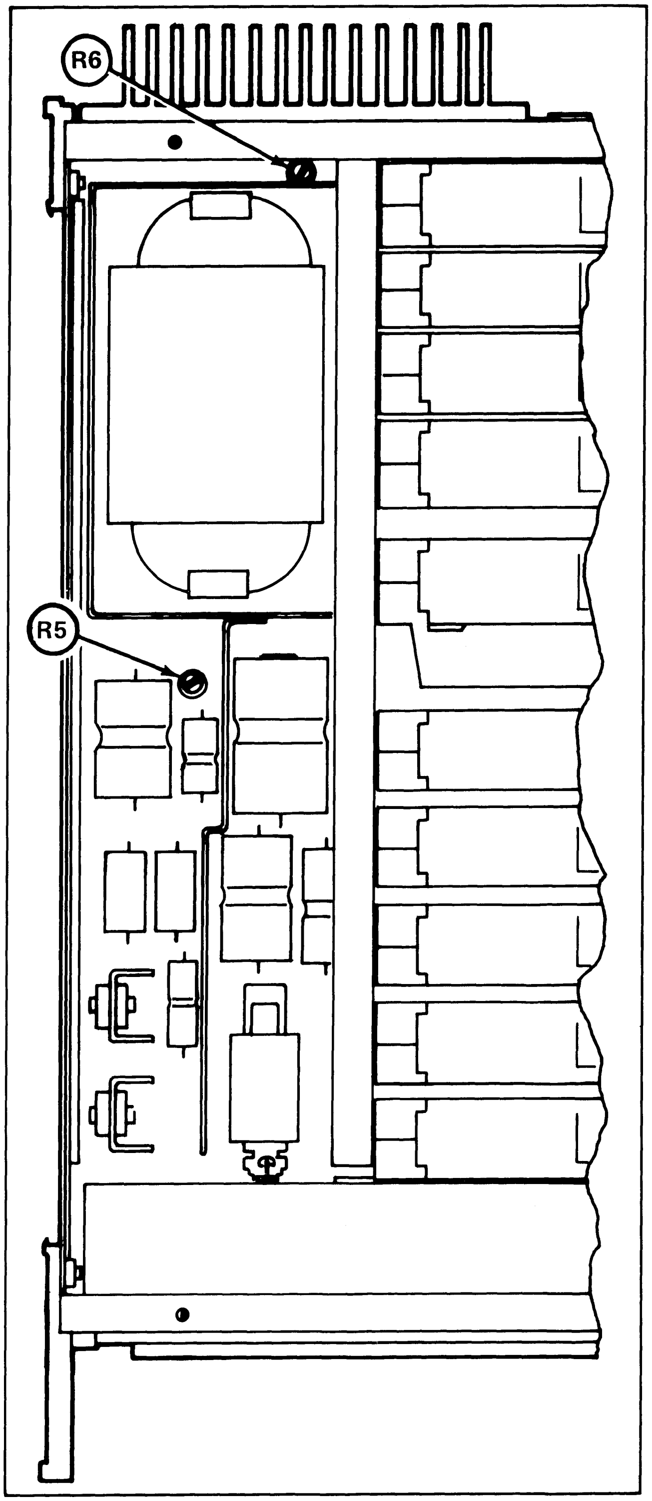


Figure 4-4. Power Supply Adjustments

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_{DD}	V_{SS}	+ 11.4	+ 12.6	Logic
V_{GG}	V_{SS}	− 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 μV.
4. Remove the short from the input terminals and apply a 1 MΩ/0.22 μF parallel load.
5. Adjust R52 for a reading between -0.002 and +0.002V dc (0 ±2 μV).
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 ±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 ±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 x 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 ±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 ±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 ±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 ±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 ±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 ±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 ±1 cal digit).

18. Repeat steps 2 through 17 until all steps are within the stated tolerance.

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.

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 ±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 ±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 ±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

4-63. 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±0 μV.
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 ±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 ±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 ±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 ±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 ±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 ±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 multilayer 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 ±0.25V 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±0.75V and +15±0.75V. 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_{DD} = +11.4 to +12.6 V_{CC} = +5.15 to 5.25 V_{GG} = –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_{CC} = −15V VA3 = +29 to +32V V_{SS} = −20V (V_{CC}, V_{SS}) Difference must equal 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_{CC} = –15V) Difference = 4.9 to 5.2V VA3 = +29 to +32V V_{SS} = –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.	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: 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
GUARDED SUPPLY	
VA1 – BAD	U3, BR2, or Transformer
(+15V). Noisy	C3, BR2
VA2 – BAD	U4, BR2, or Transformer
(–15V) Noisy	C4, BR2
VA3 – BAD	U2, CR4, BR1, Transformer
(+30V) Noisy	C2, BR1
VA4 – BAD	U1, CR3, BR1, Transformer
(–30V) Noisy	C1, BR2
V_{CC} (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.

UNGUARDED SUPPLY	
V_{DD} (+12V)	U6, C6, C9, C12, BR3, Transformer
V_{GG} (–12V)	U7, C13, C10, C7, BR3, Transformer
V_{CC} (+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.

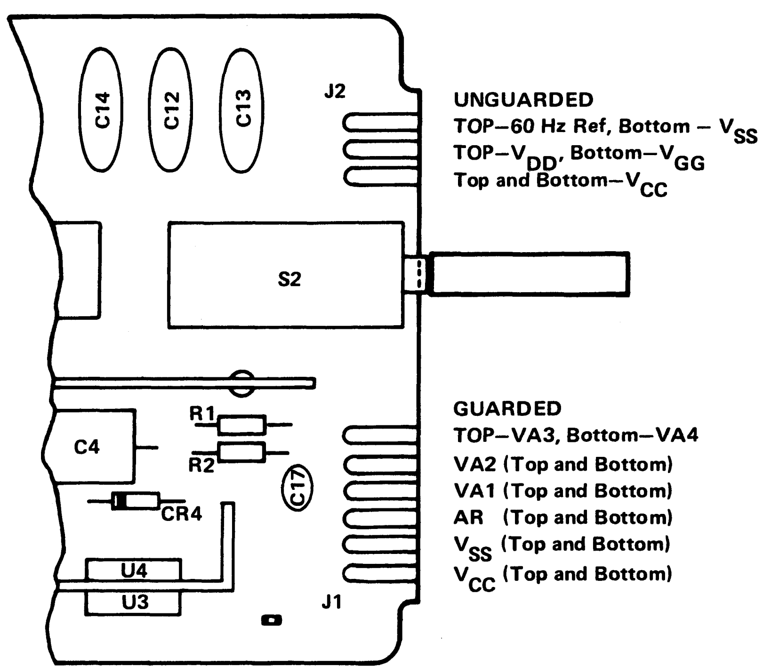


Figure 4-5. Power Supply Troubleshooting

NOTE

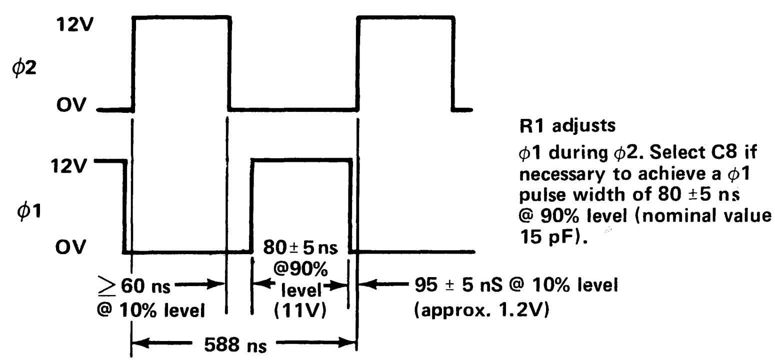
Due to the speed and complexity of the controller, it is recommended that, when a problem is isolated to the controller, the unit be sent to the nearest Service Center for repair. The following information will assist in troubleshooting simpler problems. Many problems require the use of a Trendar or 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 μsec delay on +5V at U36-13

   Stuck Low? U35, U34, U36, U38

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

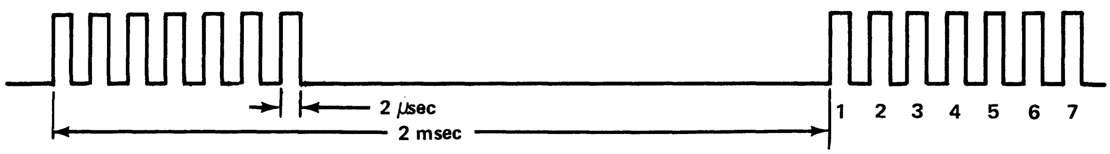
   Pulsing – OK

   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.	
OTHER PROBLEMS	
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 = ÷8 (÷64 x 8)
	1	1	0	0	100V Range G = ÷64

ID3 - ID4 = Control Amplifier Gain

0 1 = x 64
1 0 = x 8
1 1 = z 1

RT1 inputs controlled as follows for OHMS & ADC

ADDRESS	DATA				
	ID3	**ID2**	**ID1**	**ID0**	
IC4, IC3, IC0 = 1	0	1	0	1	G = x 64
	1	0	0	1	G = x 8
	1	1	0	1	G = x 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

Adjustment of R14

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.)

Selection of R15 or R16.

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 μV.)

OFFSET (μV)	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 μsec.
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/μsec. 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^2 A/D Converter Troubleshooting

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

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 deviations 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 CODE	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 R^2 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				1		
	BLUE	383265	89536	383265	REF		
	PUTTY GREY	522722	89536	522722	REF		
MP14	COVER PLATE, INPUT	420679	89536	420679	1		
MP15	DECAL, REAR PANEL	473413	89536	473413	1		
MP16	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	STANDOFF, 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.

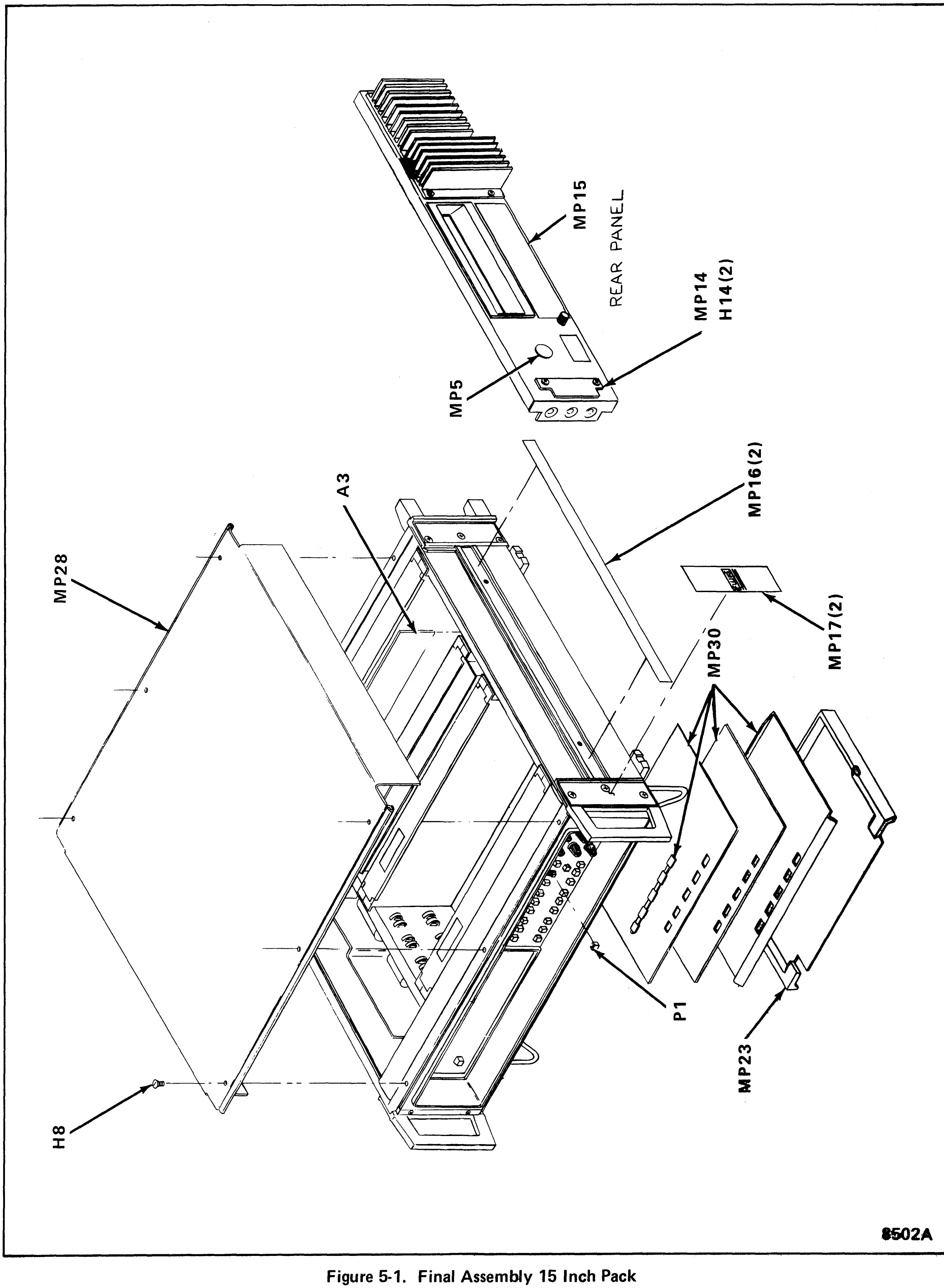


Figure 5-1. Final Assembly 15 Inch Pack

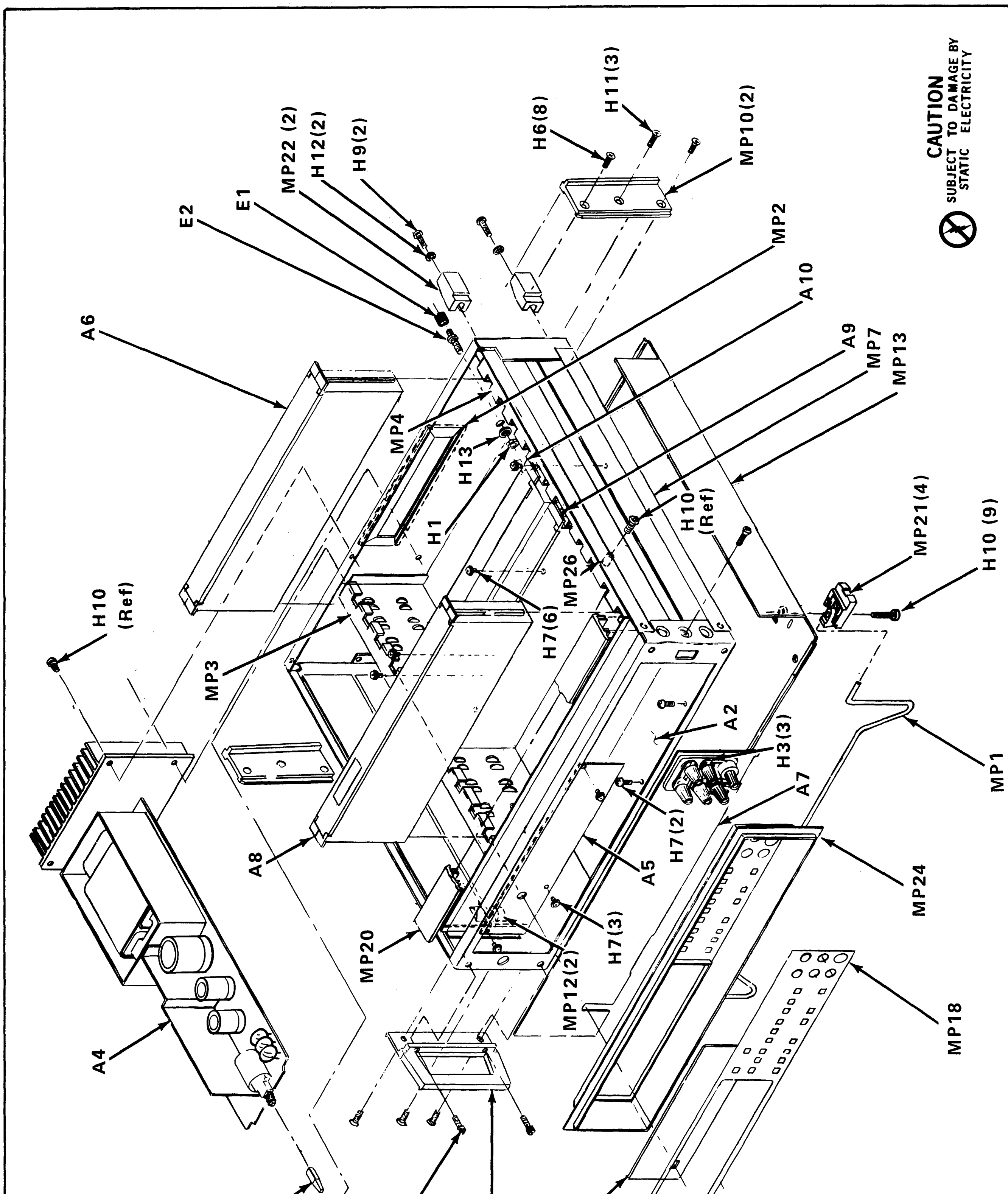
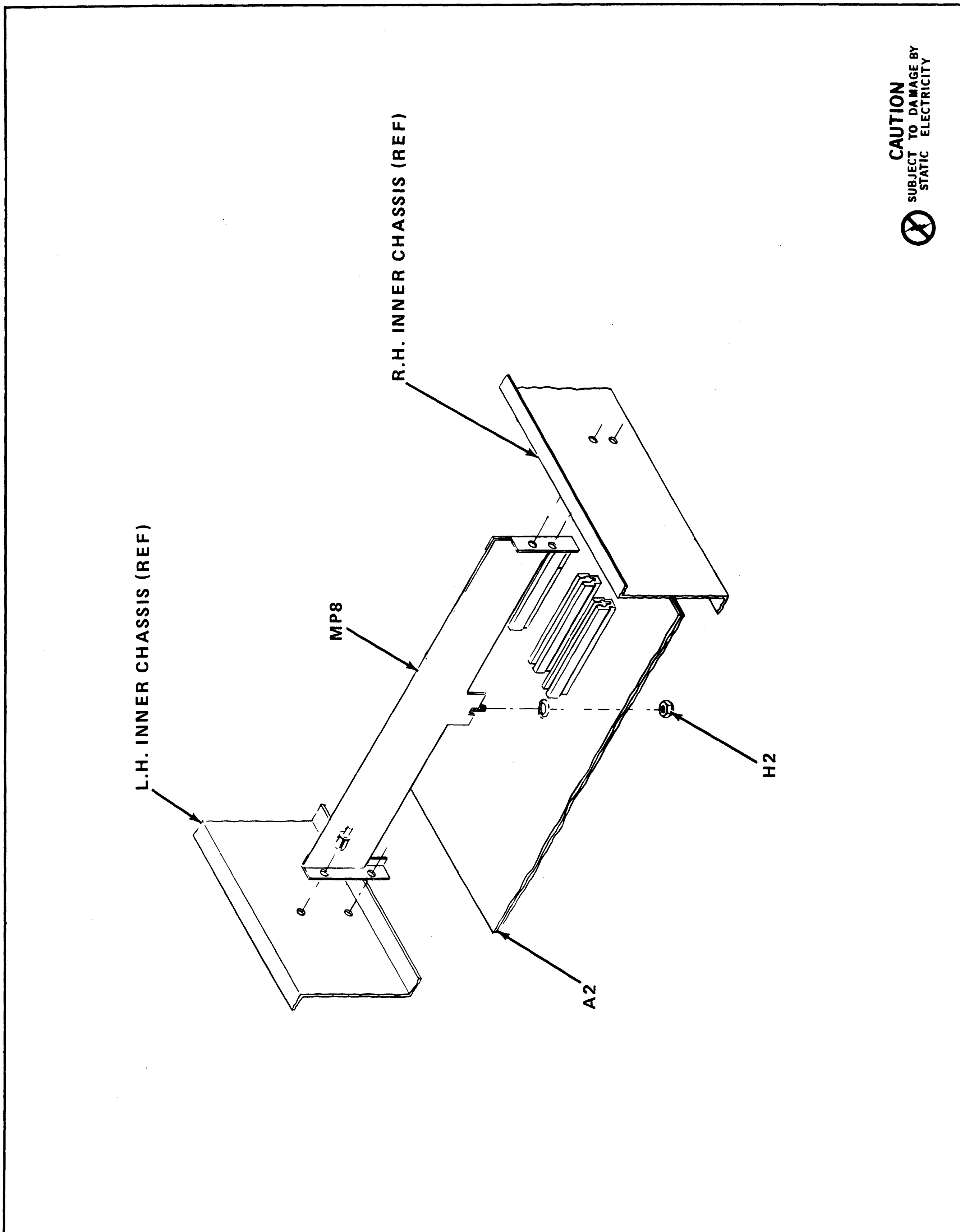


Figure 5-1. Final Assembly 15 Inch Pack (cont)



8502A-5001

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	NOTE
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		

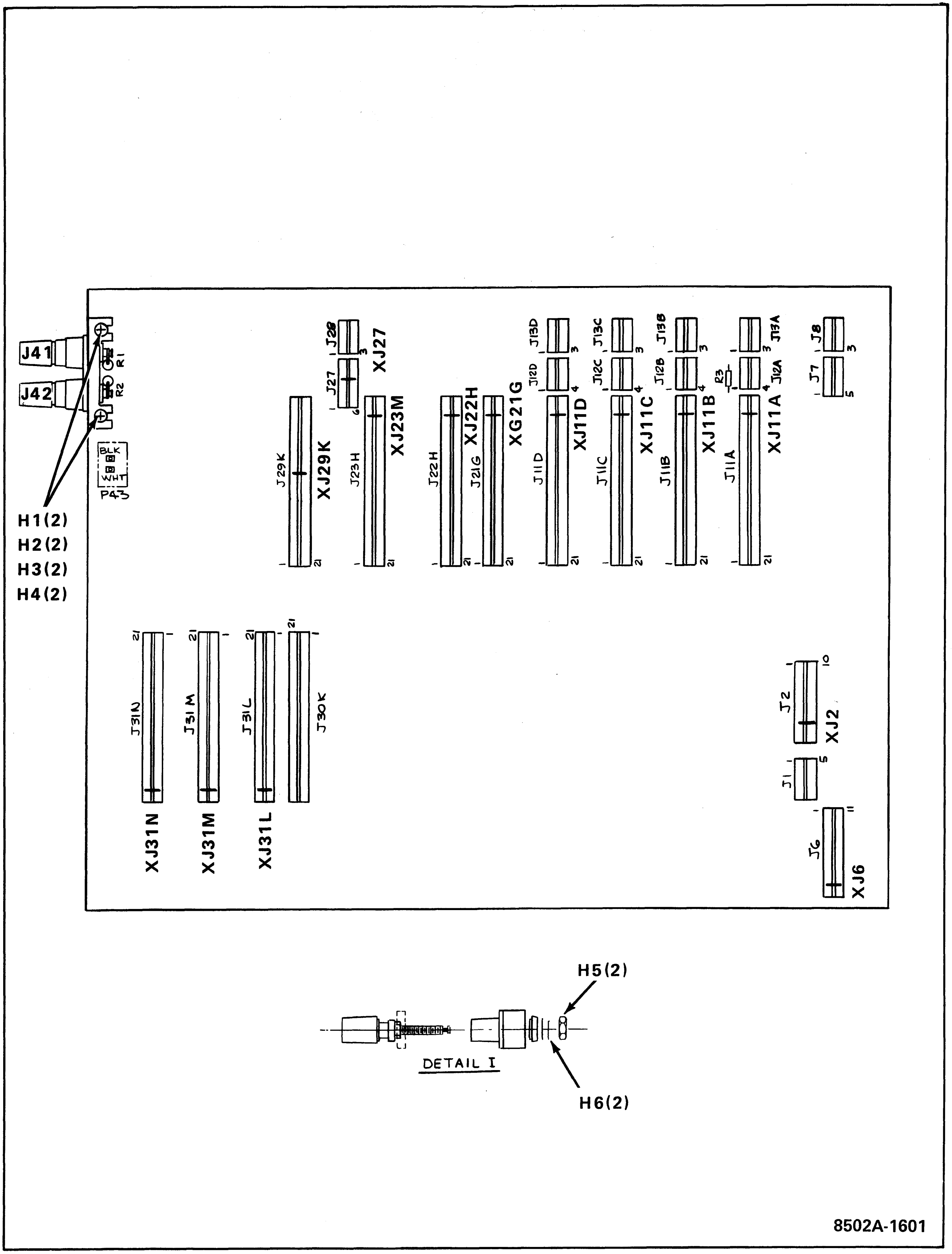


Figure 5-2. A2 Motherboard PCB Assembly

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	

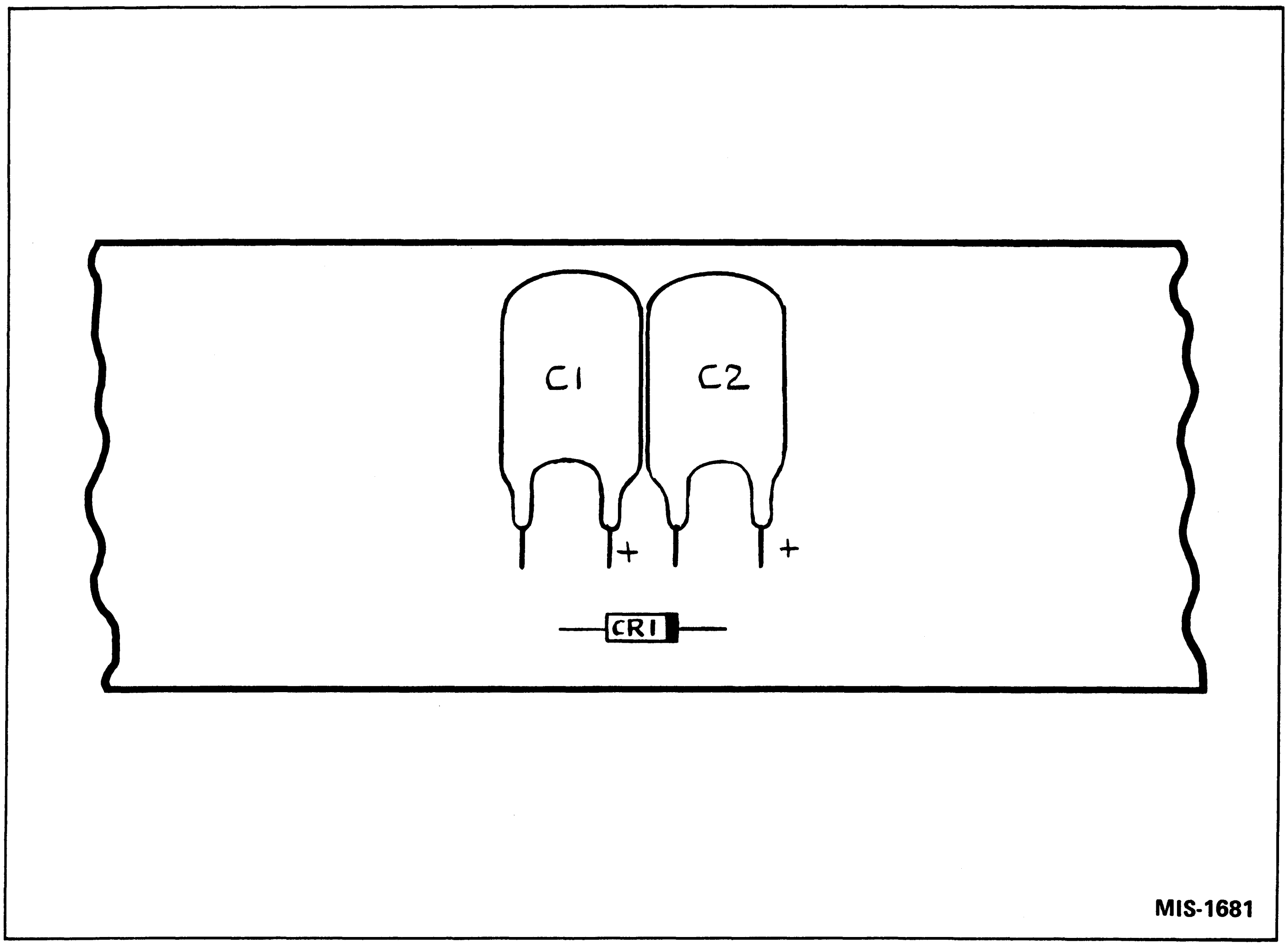


Figure 5-3. A3 Bus Interconnect PCB Assembly

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	NOTE
A4	POWER SUPPLY PCB ASSEMBLY	ORDER	FOR	APPROPRIATE SOURCE	REF		1
	POWER SUPPLY ASSY, 115/230V	448886	89536	448886			
	POWER SUPPLY ASSY, 100V	456996	89536	456996			
	FIGURE 5-4 (8500A-4041T)						
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	ORDER	FOR	APPROPRIATE SOURCE	1		
	115/230V	450403	89536	450403			
	100V	456350	89536	456350			
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.

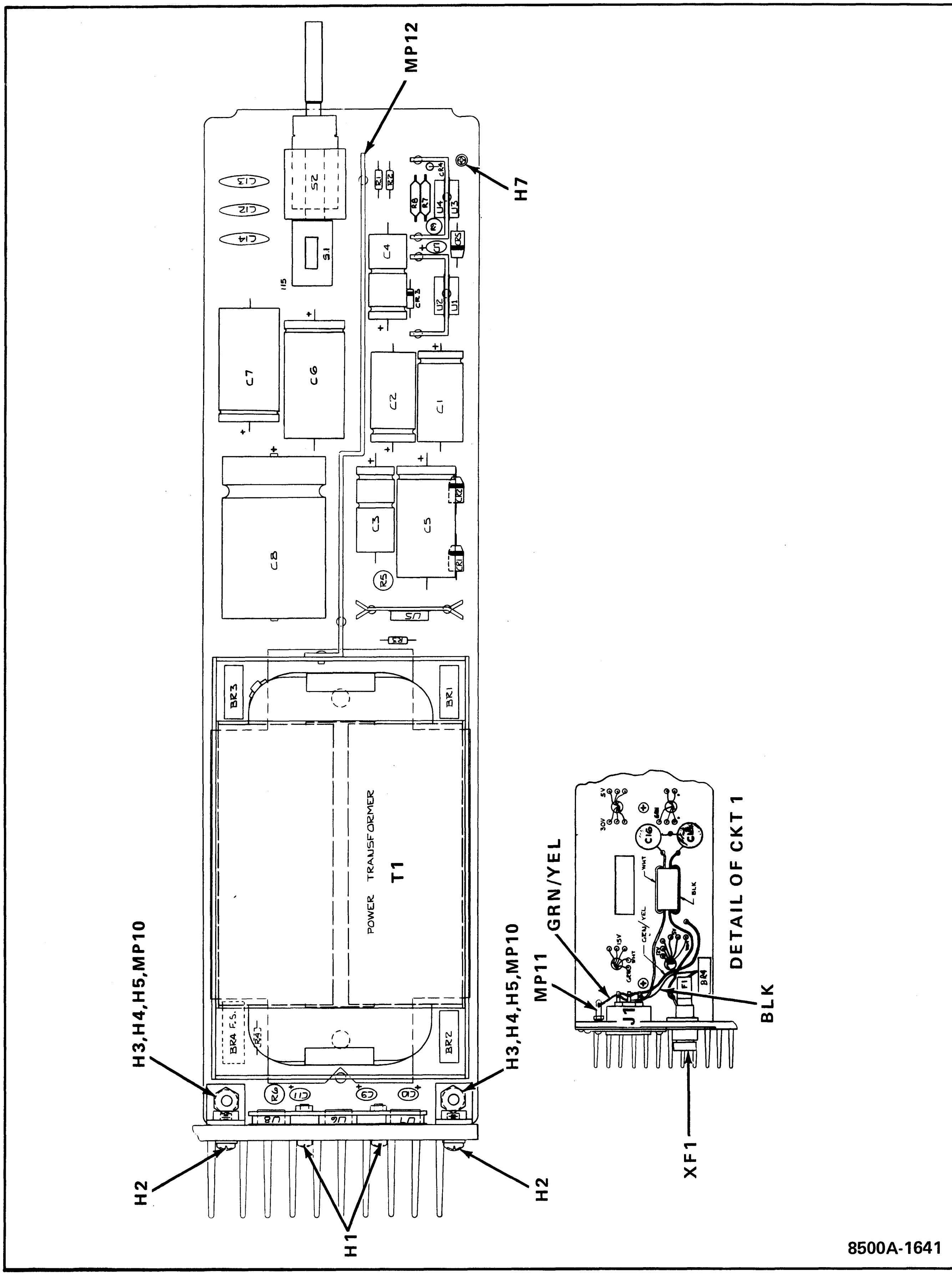


Figure 5-4. A4 Power Supply PCB Assembly

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	ORDER	FOR	APPROPRIATE SOURCE	REF		1
	POWER SUPPLY ASSY, 115/230V MODEL	608638	89536	608638			
	POWER SUPPLY ASSY, 100V MODEL	456988	89536	456988			
	FIGURE 5-5 (8500A-4051T)						
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	NOTE
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	ORDER	FOR	APPROPRIATE SOURCE	1		
	115/230V	450403	89536	450403			
	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.

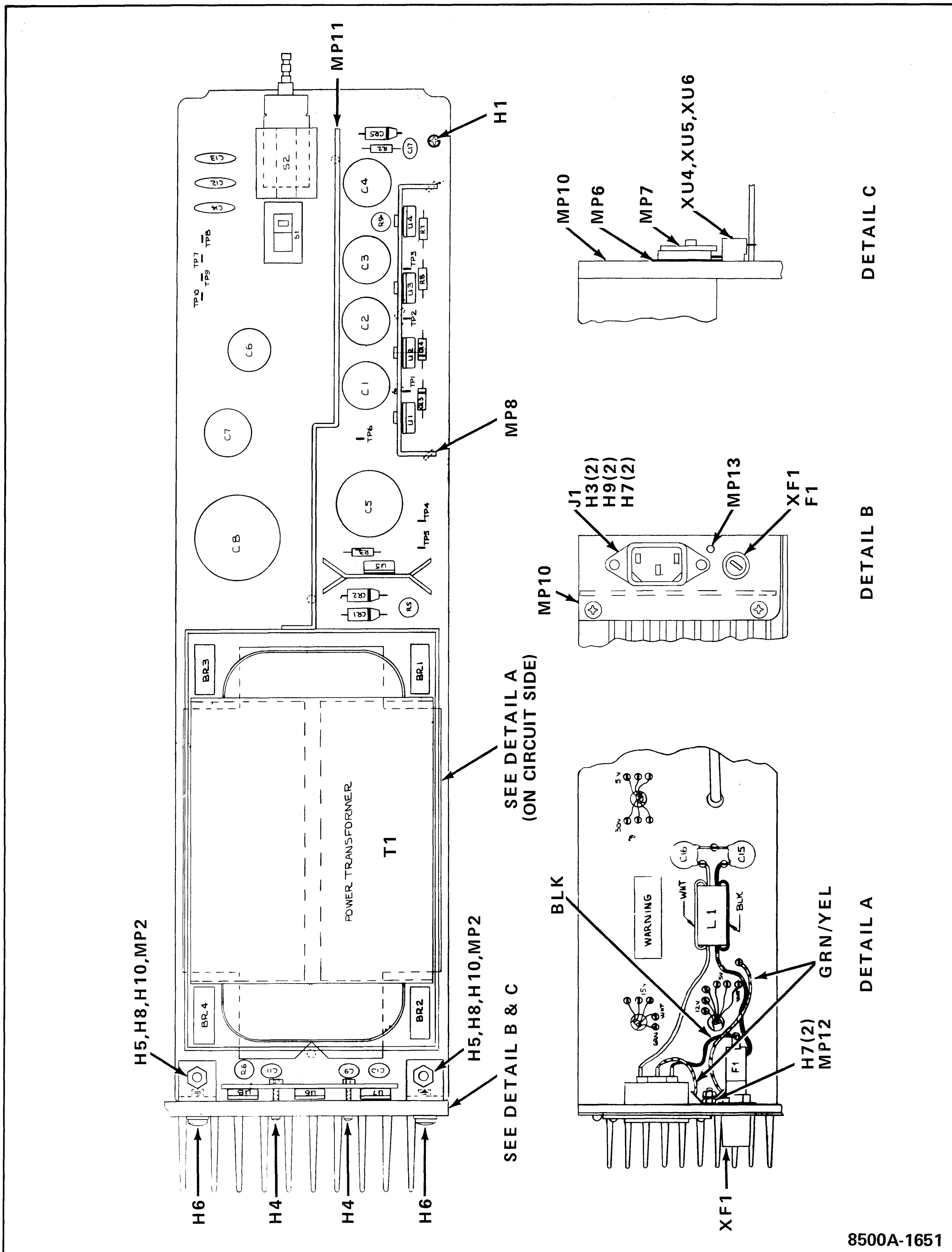


Figure 5-5. A4 Power Supply Assembly

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		

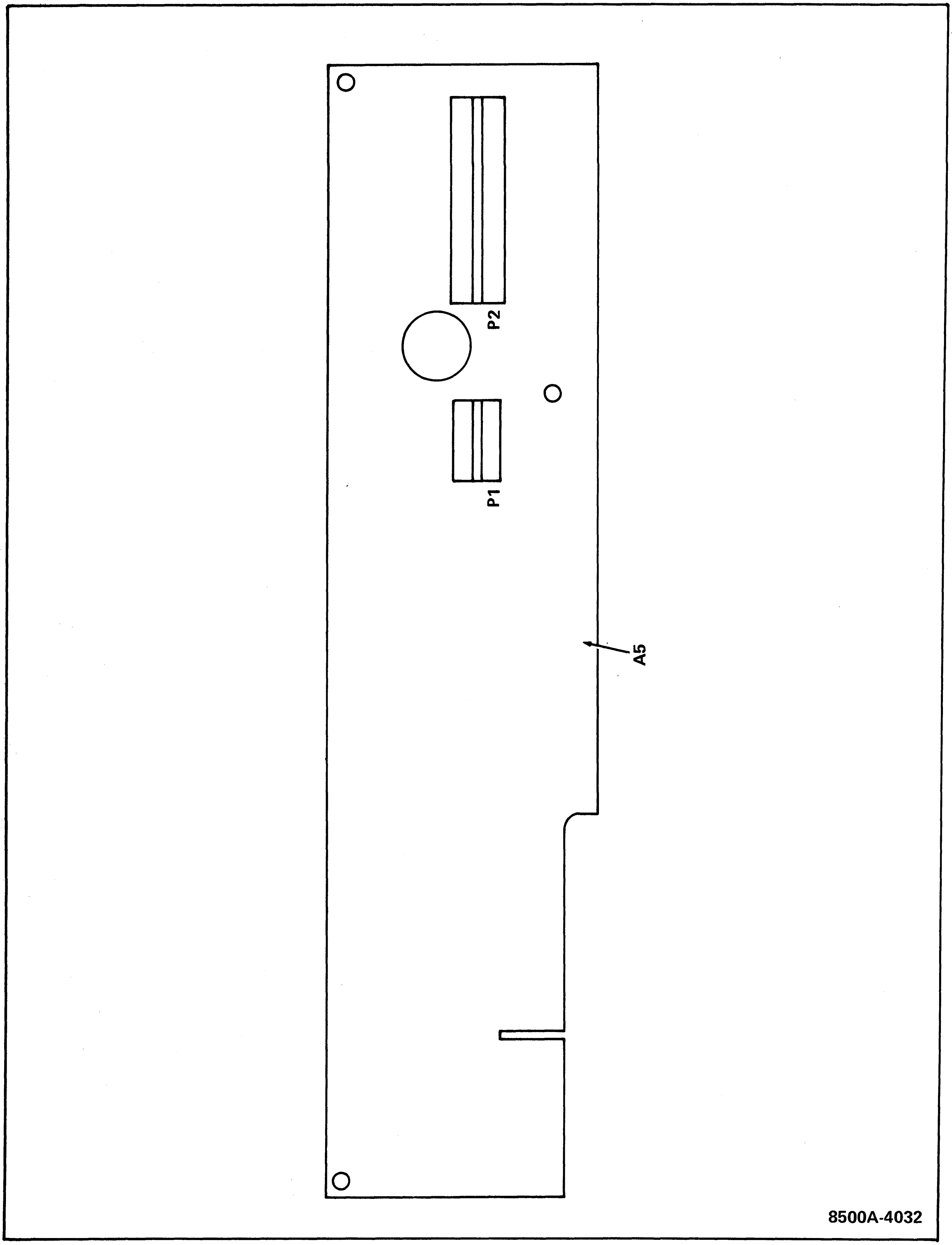


Figure 5-6. A5 Power Supply Interconnect Assembly

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	ⓢ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	ⓢIC, MOS, CPU	404541	01295	TMS8080	1	1	

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

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

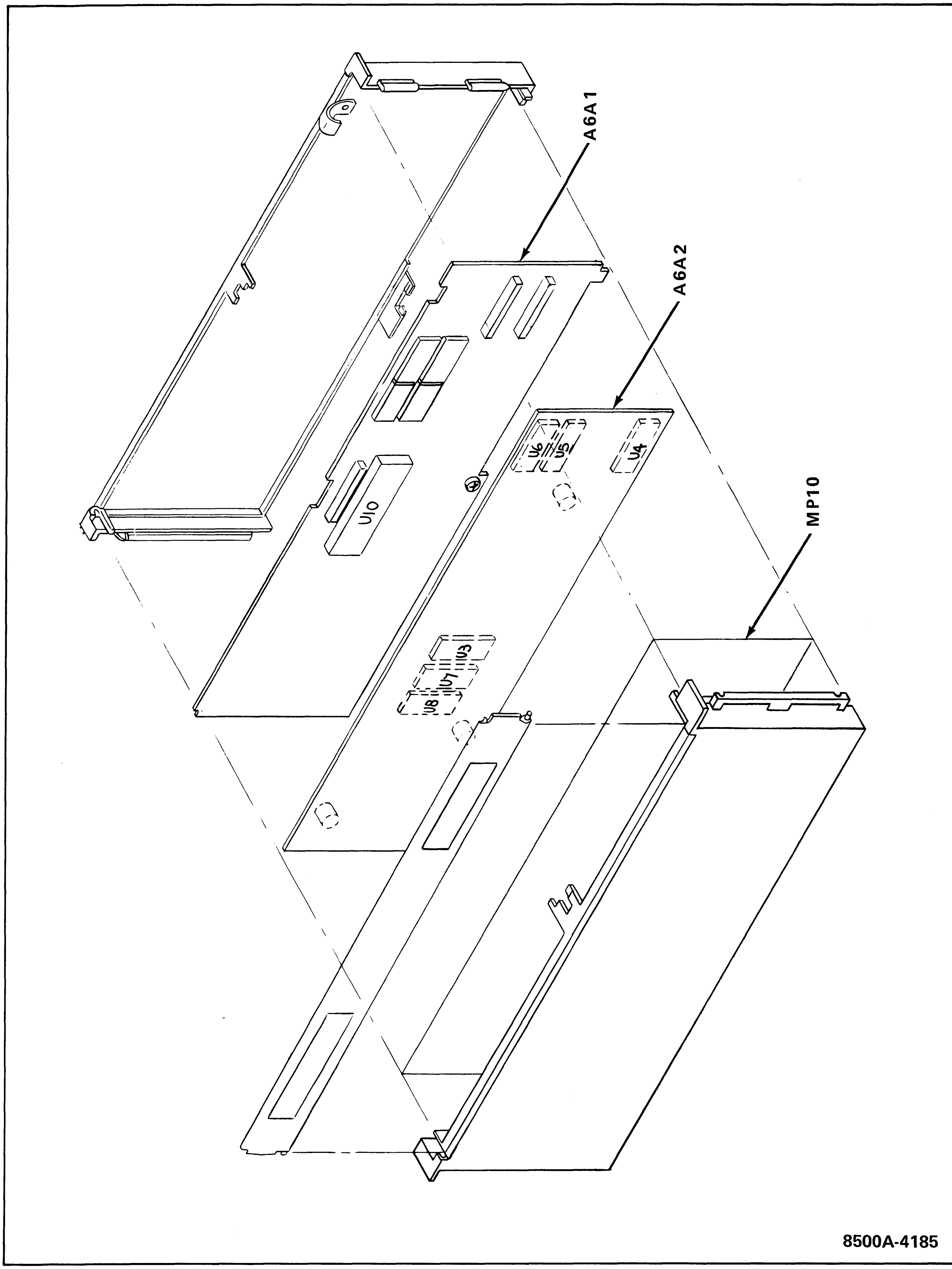


Figure 5-7. A6 Controller Assembly

Table 5-8. A6A1 Controller PCB Assembly

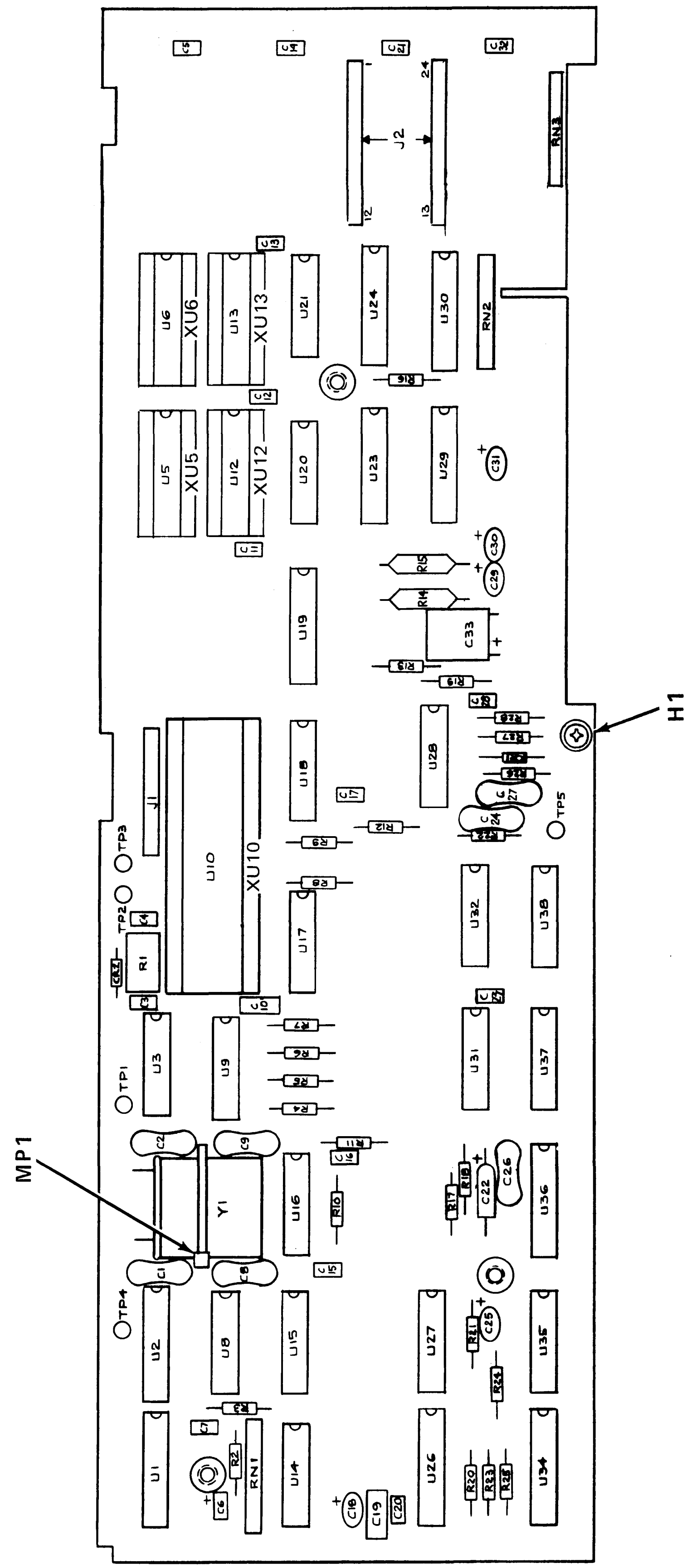
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A6A1	⊗ CONTROLLER PCB ASSEMBLY FIGURE 5-8 (8502A-4185)	471318	89536	471318	REF		
C1	CAP, MICA, 22 PF +/-5%, 500V	148551	72136	DM15E220J	1		
C2	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J	1		
C3	CAP, CER, 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-Z5R-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	⊗IC, C-MOS, HEX BUFFER/INVERTERS	381830	02735	CD4050AE	1	1	
U3	⊗IC, C-MOS, FAST QUAD 2-INPUT NAND GATE	413211	07263	34011PC4011PC	1	1	
U5	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	4	1	
U6	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U8	IC, TTL, AND-OR INVERT GATES	412981	01295	SN74LS51	1	1	
U9	⊗IC, C-MOS, HEX INVERTER	404699	12040	MM74C04N	1	1	
U12	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U13	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111-1	REF		
U14	⊗IC, 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	⊗IC, 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	⊗IC, 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	⊗IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	3	1	
U24	⊗IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	REF		
U26	IC, LIN, C-MOS, PLL	403584	02735	CD4046AE	1	1	
U27	⊗IC, C-MOS, QUAD 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	
U28	⊗IC, C-MOS, 8-BIT PRIORITY ENCODER	412973	02735	CD4523BE	1	1	
U29	⊗IC, C-MOS, STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	REF		
U30	⊗IC, 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 DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U32	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U34	⊗IC, C-MOS, DUAL UP COUNTER	355164	04713	MC14520CL/CP	1	1	
U35	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	REF		
U36	⊗IC, C-MOS, NONOSTABLE MV	454017	04713	MC14538BCP	1	1	
U37	⊗IC, C-MOS, QUAD 2-INPUT NOR GATES	429944	02735	CD4001BE	1	1	
U38	⊗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		



8502A-1785

Figure 5-8. A6A1 Controller PCB Assembly

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	NOTE
A6A2	⊗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	⊗IC, C-MOS TRISTATE HEX NON INV BUFFER	407759	04713	MC14503CP	3		
U18	⊗IC, C-MOS TRISTATE HEX NON INV BUFFER	407759	04713	MC14503CP	REF		
U19	⊗IC, 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	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		

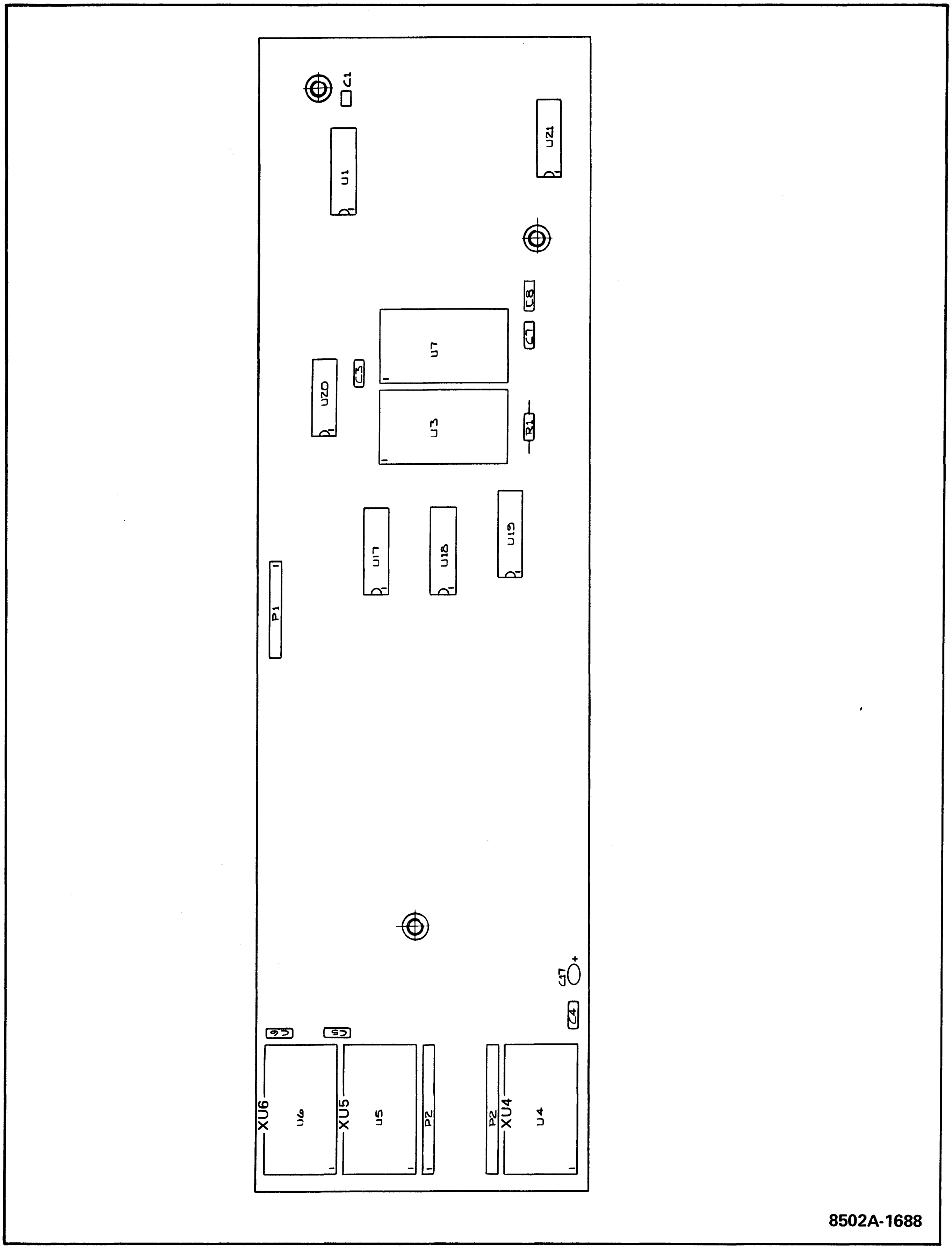


Figure 5-9. A6A2 Prom Rom PCB Assembly

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	SSTIM	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	⊗IC, C-MOS, HEX BUFFER/INVERTERS	381830	02735	CD4040BCN	1	1	
U3	⊗IC, C-MOS, FAST QUAD 2 INPUT NAND GATE	413211	07263	34011PC/4011PC	1	1	
U5	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	4	1	
U6	⊗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	⊗IC, C-MOS, HEX INVERTER	404699	12040	MM74C04N	1	1	
U10	⊗IC, MOS, CPU	404541	01295	TMS8080	1	1	
U12	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	REF		
U13	⊗IC, MOS 1024 BIT STATIC RAM	404558	34649	P2111A-4	REF		
U14	⊗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	⊗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	⊗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	⊗IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	3	1	
U24	⊗IC, 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	⊗IC, C-MOS, QUAD 2 INPUT OR GATE	408393	02735	CD4071BE	1	1	
U28	⊗IC, C-MOS 8-BIT PRIORITY ENCODER	412973	02735	CD4523BE	1	1	
U29	⊗IC, C-MOS STROBED HEX INVERTER/BUFFER	408211	04713	MC14502CP	REF		
U30	⊗IC, C-MOS TRISTATE NON INVERT BUFFERS	407759	12040	MM80C97N	REF		
U31	IC, TTL POS NAND GATES/INVERTERS	393074	01295	SN74LS10N	1	1	
U32	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069UBE	1	1	
U33	ROM	604124	89536	604124	1		
U34	⊗IC, C-MOS DUAL UP COUNTER	355164	04713	MC14520BCP	1	1	
U35	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	04713	MC14013CP	REF		
U36	⊗IC, C-MOS, MONOSTABLE MV	454017	04713	MC14538BCP	1	1	
U37	⊗IC, C-MOS QUAD 2 INPUT NOR GATES	429944	02735	CD4001BE	1	1	
U38	⊗IC, C-MOS QUAD 2 INPUT NAND	404632	02735	CD4093BE	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.

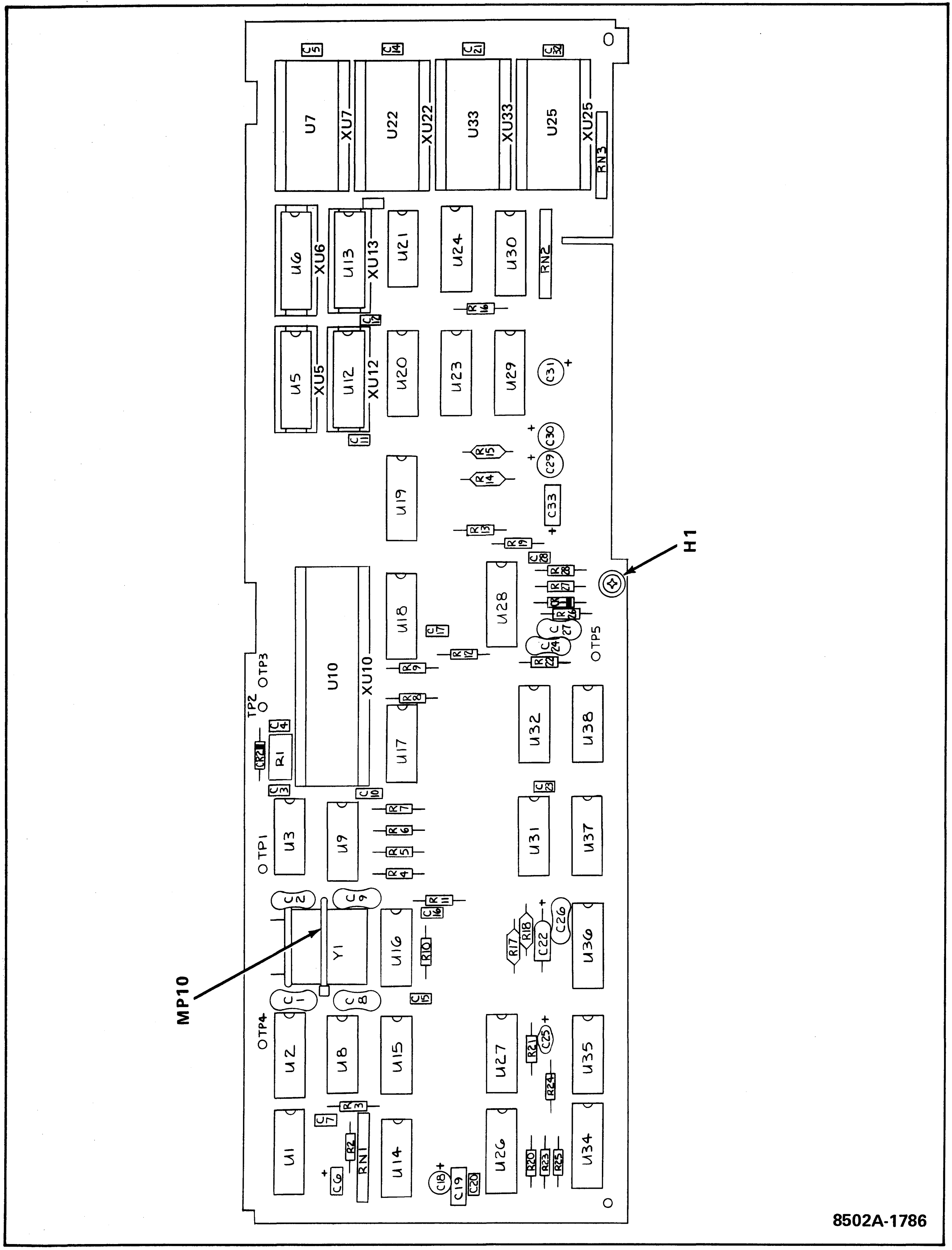


Figure 5-10. A6 Controller PCB Assembly

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	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	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		
S3	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		
S4	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		
S5	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		
S6	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, DK PUTTY GREY	406728	89536	406728	6		
S7	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, DK PUTTY GREY	406728	89536	406728	REF		
S8	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, DK PUTTY GREY	406728	89536	406728	REF		
S9	SWITCH, SLIDE, SPDT	417287	95146	MSS-104D-1	1		
S10	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, MED YELLOW	419937	89536	419937	2		
S11	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		
	SWITCH, PUSHBUTTON, DK PUTTY GREY	406728	89536	406728	REF		
S13	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, DK PUTTY GREY	406728	89536	406728	REF		
S14	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, DK PUTTY GREY	406728	89536	406728	REF		
S15	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		
S16	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		
	SWITCH, PUSHBUTTON, LT PUTTY GREY	401307	89536	401307	REF		
S18	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, BLUE	406736	89536	406736	1		
S19	SWITCH ASSEMBLY				REF		
	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
	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		
S20	SWITCH ASSEMBLY				REF		
	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		
S21	SWITCH ASSEMBLY				REF		
	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		
S25	SWITCH ASSEMBLY				REF		
	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		
S26	SWITCH ASSEMBLY				REF		
	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		
S27	SWITCH ASSEMBLY				REF		
	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		
U1	IC, LIN, NPN, TRANSISTOR ARRAY	407866	02735	CA3081	3	1	
U2	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U3	⊗IC, 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	⊗IC, 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	⊗IC, 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	NOTE
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		

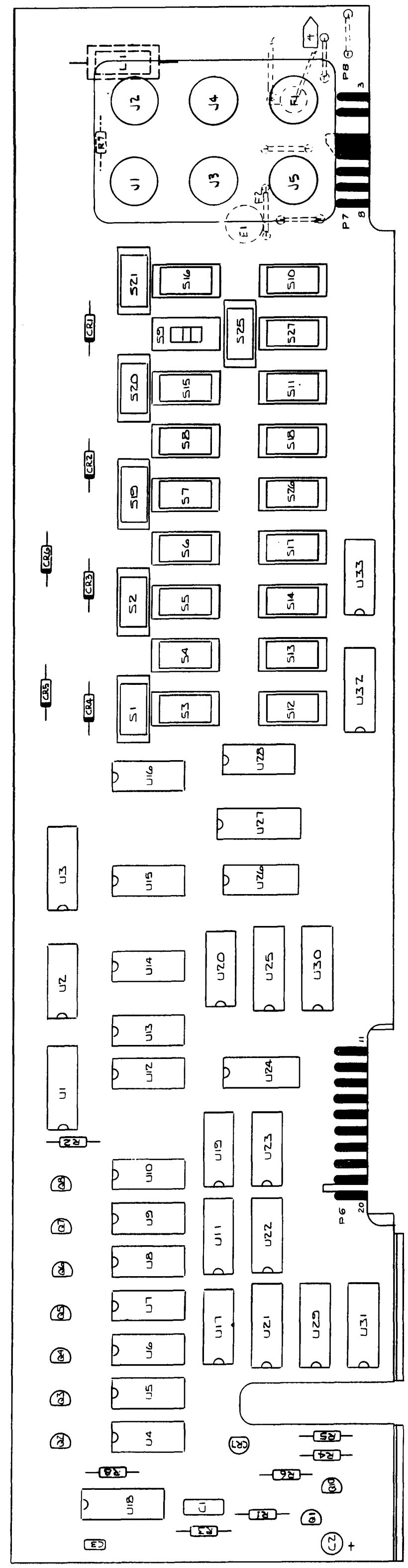


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Figure 5-11. A7 Display PCB Assembly

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	⊛DC 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)						
R23	(PART OF R21 SET)				REF		
					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	290320	89536	290320	1	1	
R59	(PART OF R58 SET)				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.

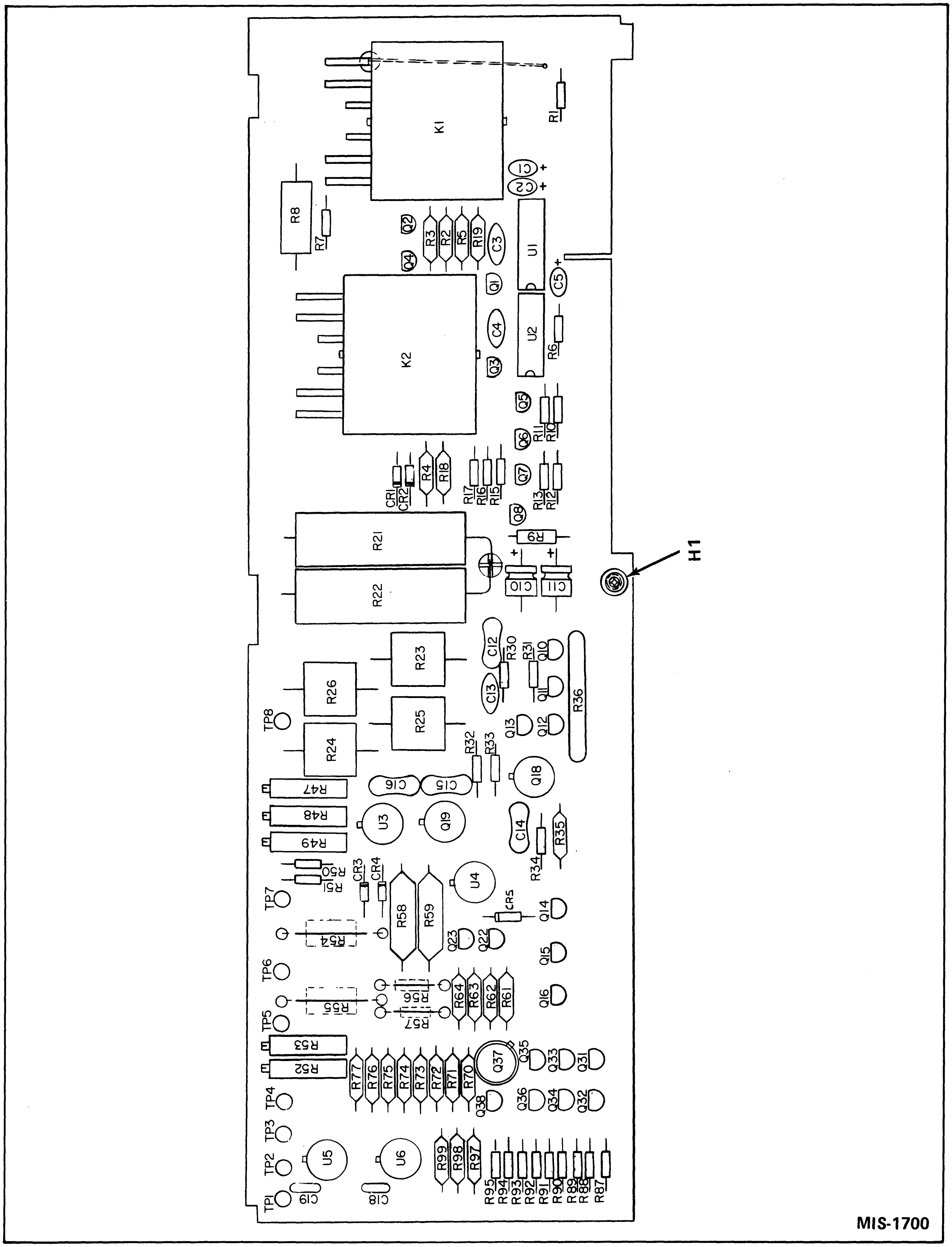


Figure 5-12. A8 DC Signal Conditioner PCB Assembly

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	⊗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		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.

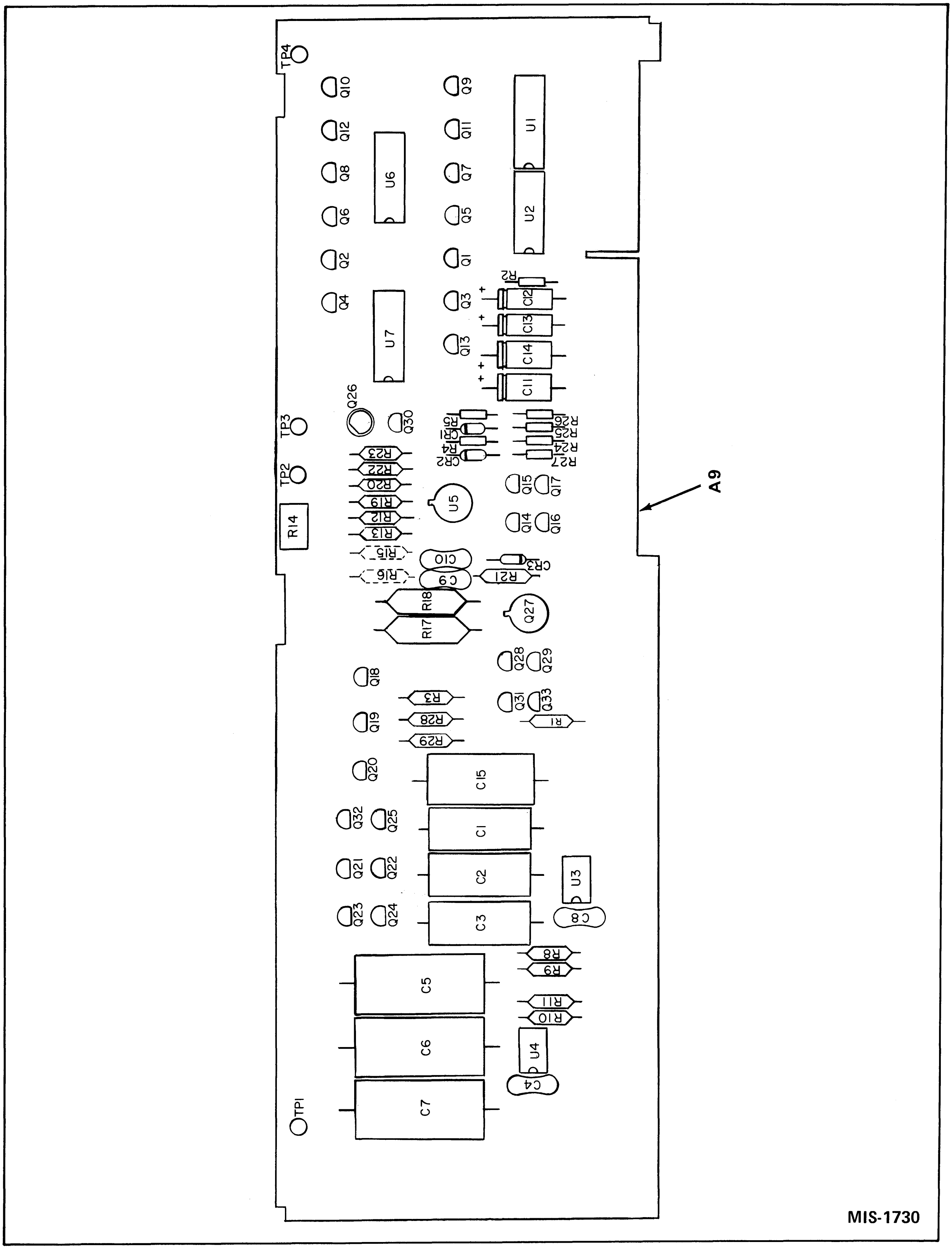


Figure 5-13. A9 Active Filter PCB Assembly

Table 5-14. A10 Fast R^2 A/D Converter Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A10	FAST R^2 A/D CONVERTER ASSEMBLY FIGURE 5-14 (MIS-4140T)	383984	89536	383984	REF		
A10A1	A/D ANANLOG 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		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.

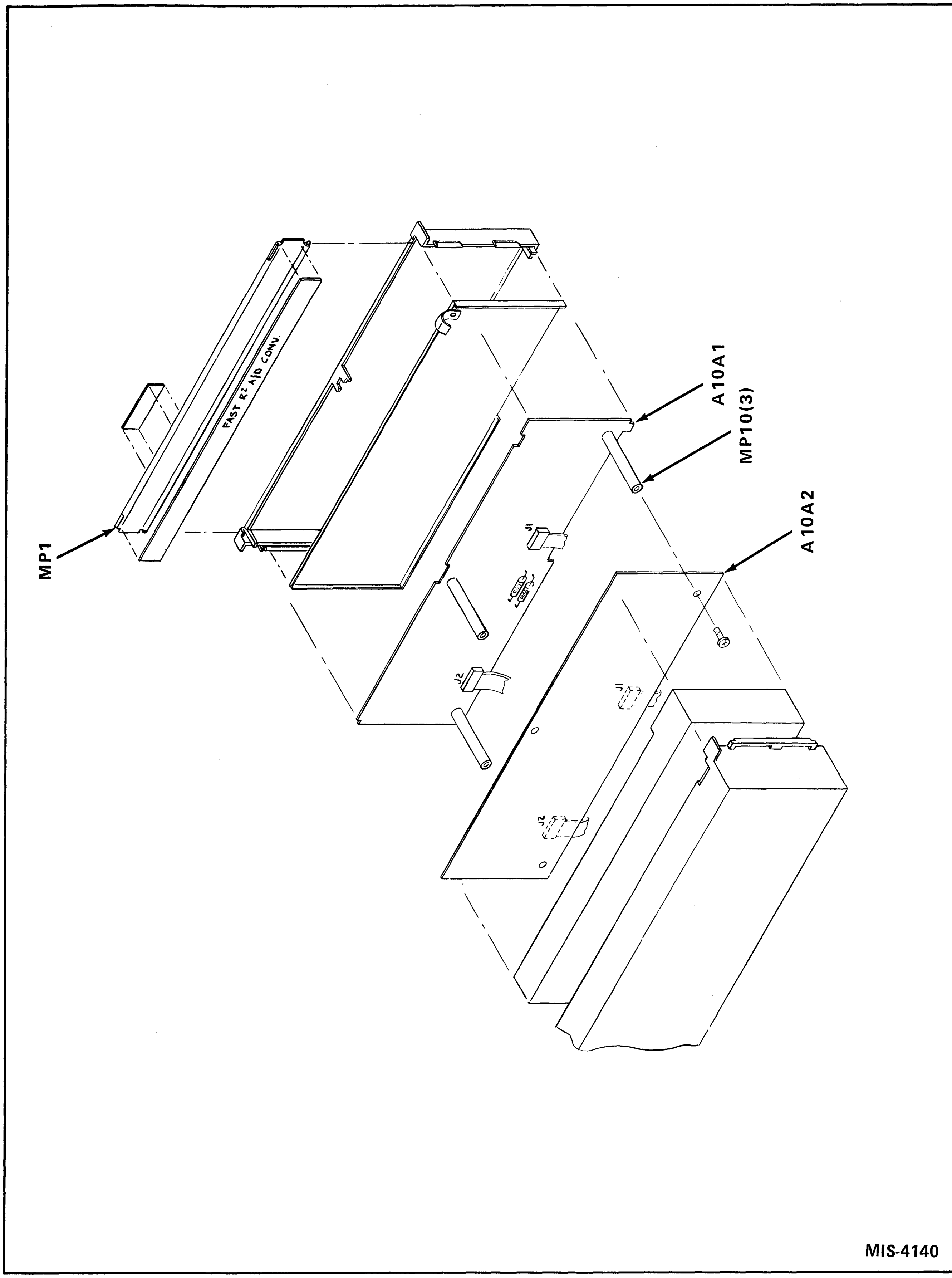


Figure 5-14. A10 Fast R^2 A/D Converter Assembly

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	417683	56289	196D106X0035KA1	2		
C2	CAP, TA, 10 UF +/-20%, 35V	417683	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	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	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, 24.3 +/-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	

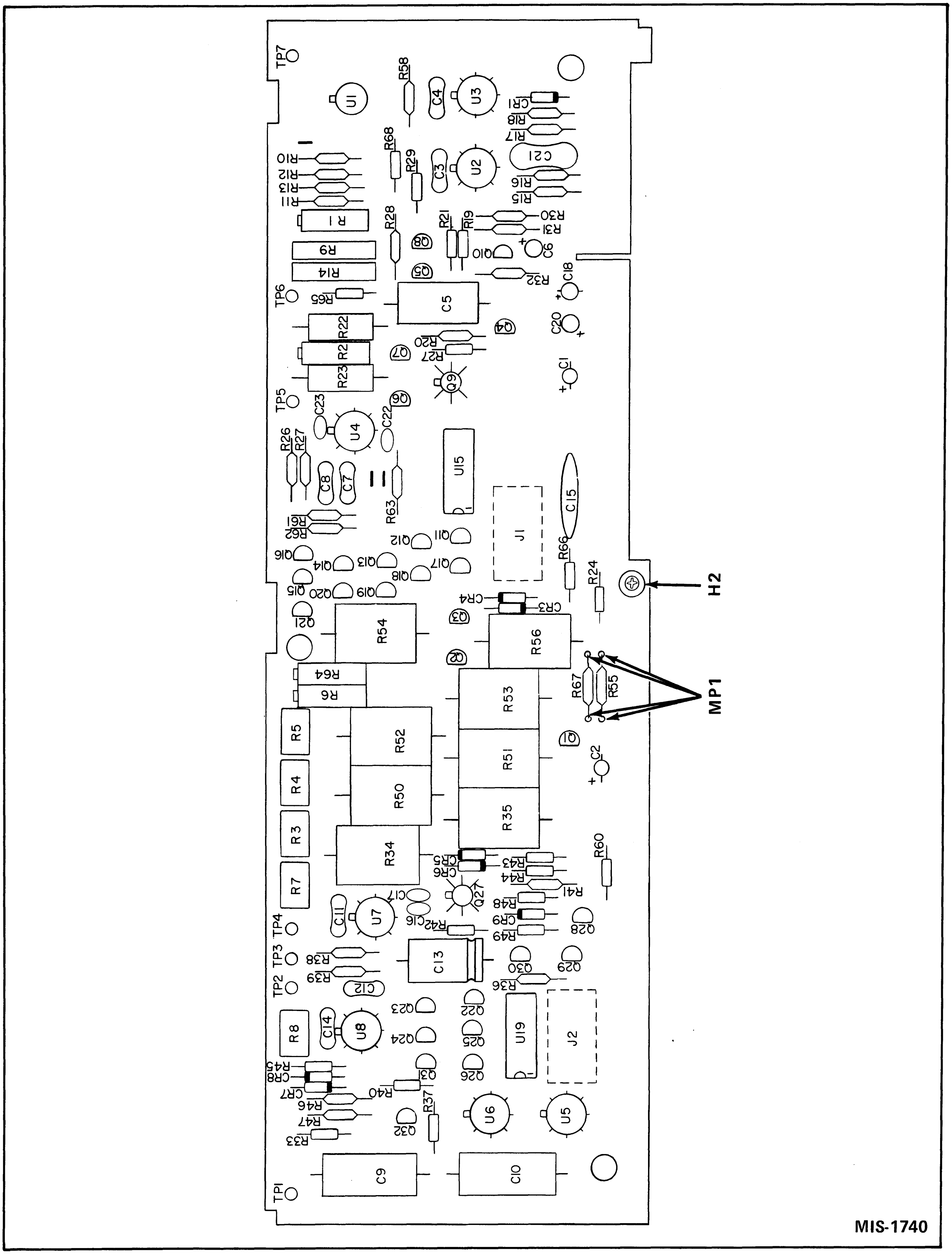


Figure 5-15. A10A1 A/D Analog PCB Assembly

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

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
A10A2	⊗FAST R^2 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	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	9	2	
U2	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U3	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	3	1	
U4	RES NETWORK	380618	89536	380618	3	1	
U5	⊗IC, C-MOS, DUAL, COMPLEMENTARY	408013	02735	CD4007AE	1	1	
U6	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U7	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	⊗IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	2	1	
U11	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U12	⊗IC, 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	⊗IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	2	1	
U17	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		
U21	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U22	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U23	IC, LINEAR, 5 XSTR ARRAY	477778	89536	477778	2	1	
U25	⊗IC, 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	⊗IC, C-MOS, DIV BY -8, COUNTER/DIV	403360	02735	CD4022AE	1	1	
U32	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U33	⊗IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U34	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U35	⊗IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U36	⊗IC, 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		

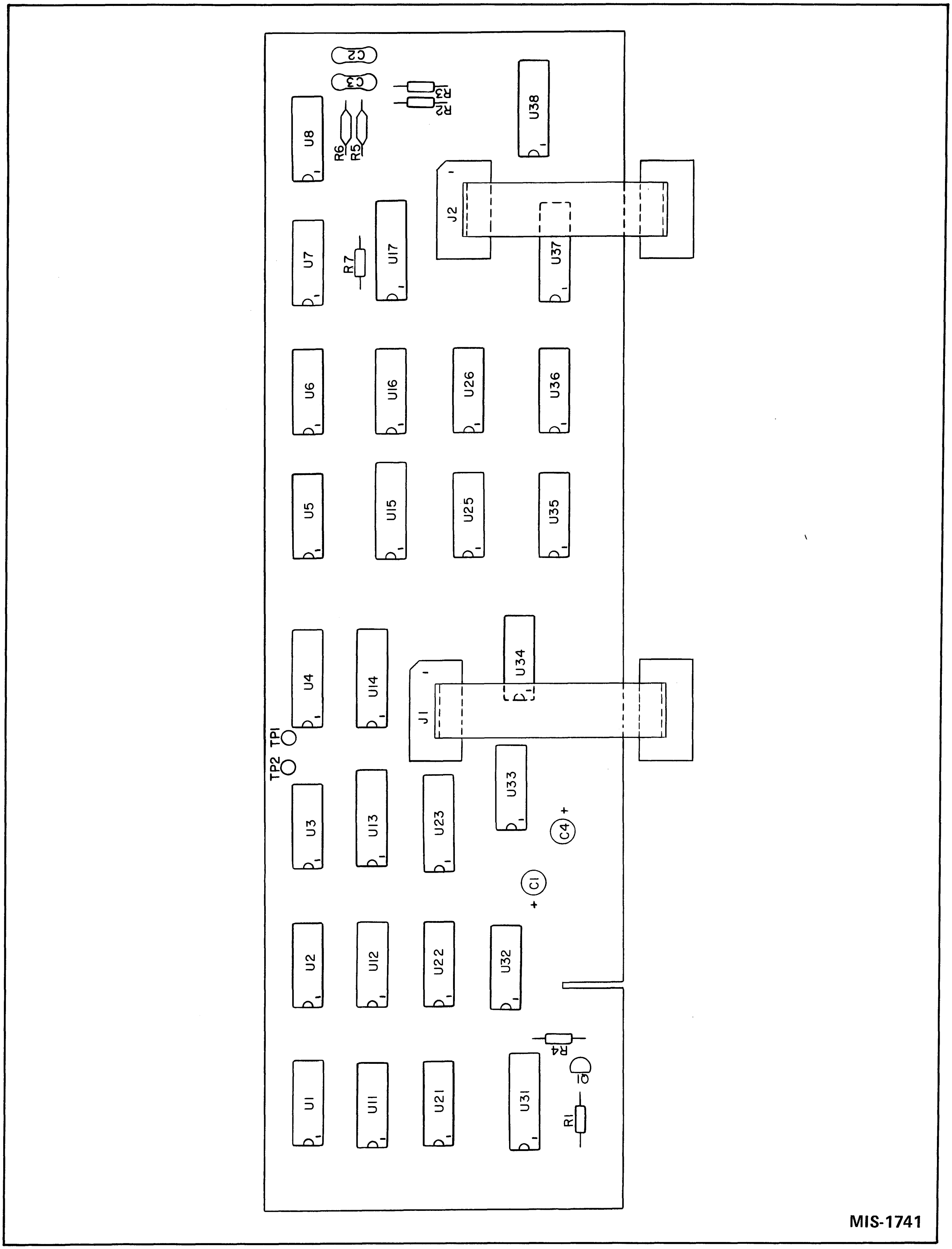


Figure 5-16. A10A2 Fast R^2 A/D Converter Digital PCB Assembly

Table 5-17. Module Case Assembly

PCB ASSY	CASE ASSY	CASE HALF MODULE	CASE HALF MODF'D	COVER MODULE CASE	SHIELD, COVER	DECAL ASSY	DECAL CAUTION	GUARD REAR	GUARD FRONT
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

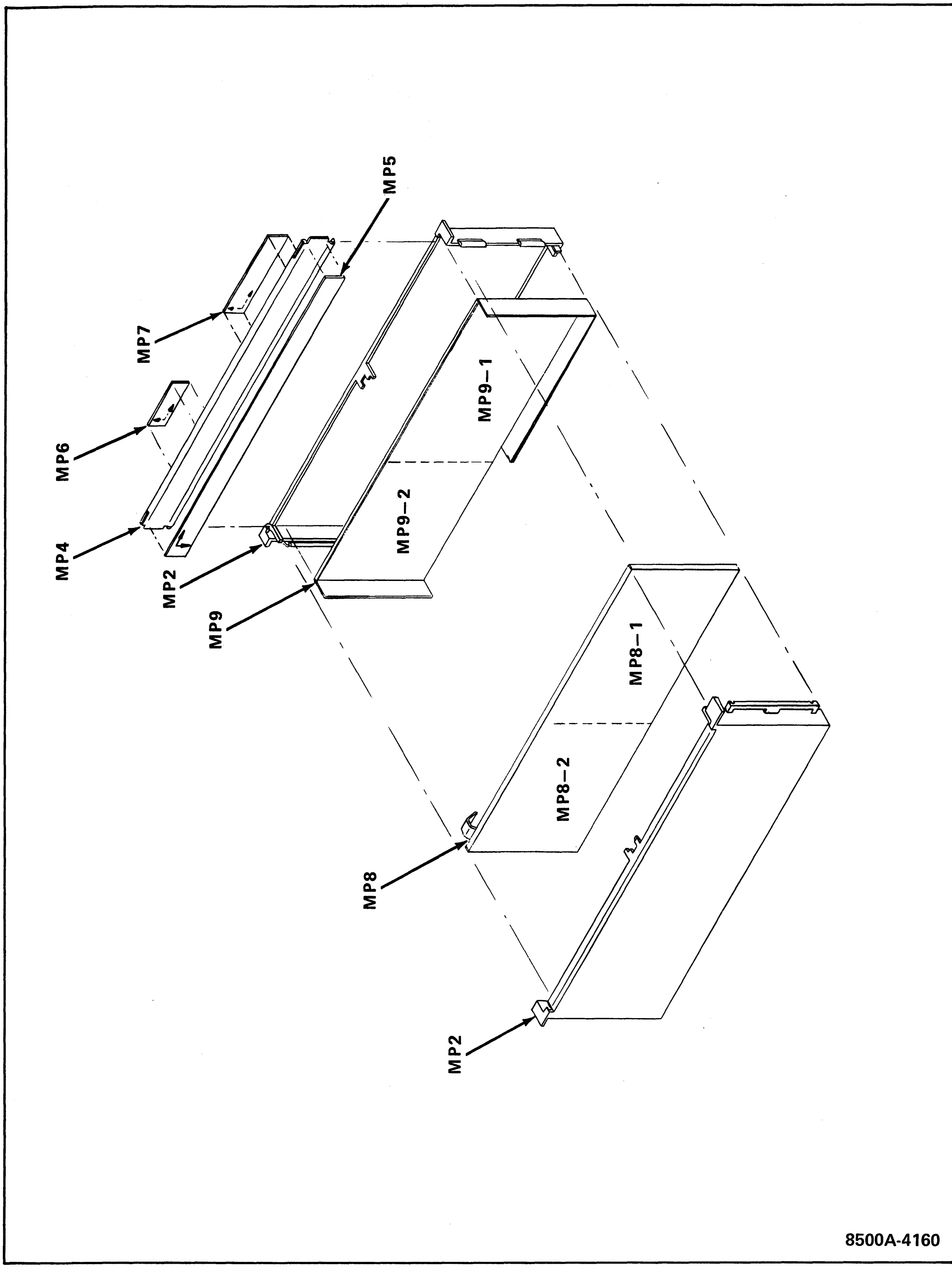


Figure 5-17. MP1 Module Case Assembly

Section 6
Option & Accessory Information

TABLE OF CONTENTS

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).

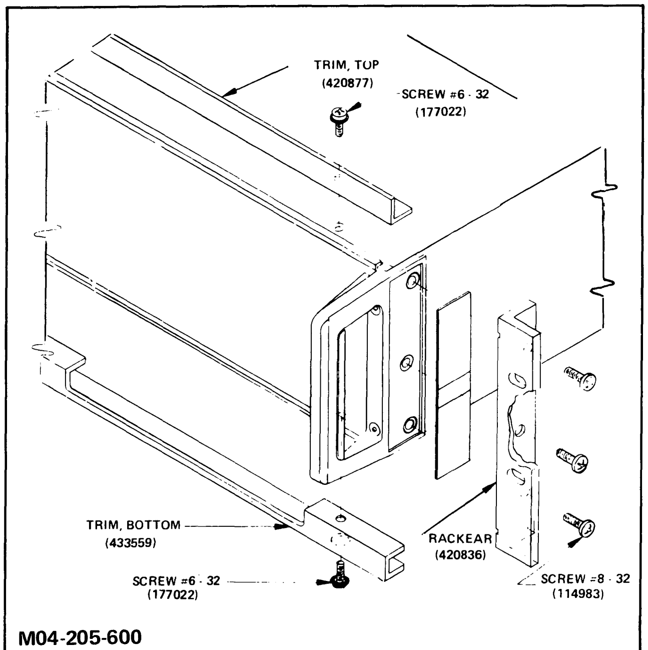


Figure 600-1. Rack Ear Mounting Installation

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.

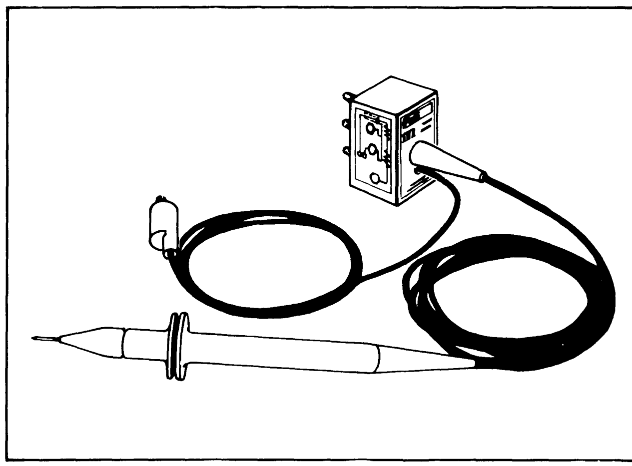


Figure 600-2. 80F5 Voltage Divider

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.

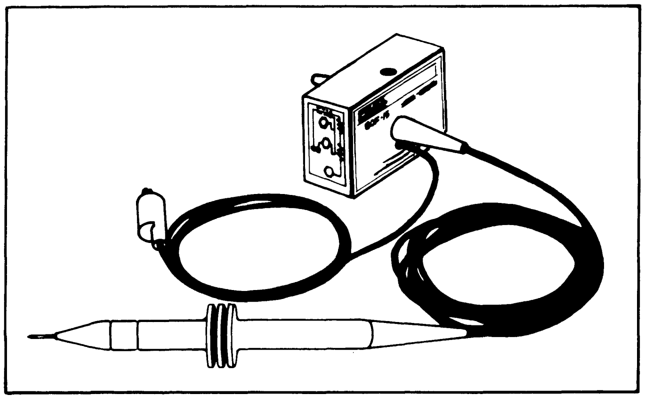


Figure 600-3. 80F15 Voltage Divider

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.

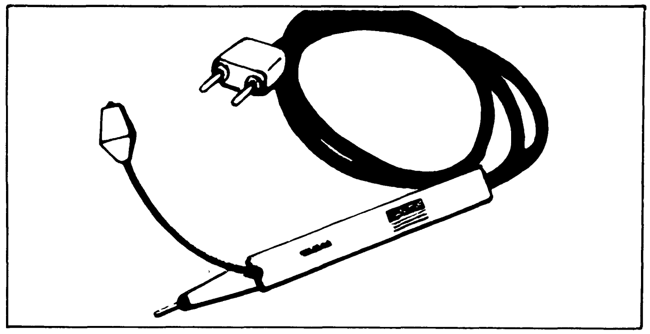


Figure 600-4. 81RF High Frequency Probe

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 + 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.

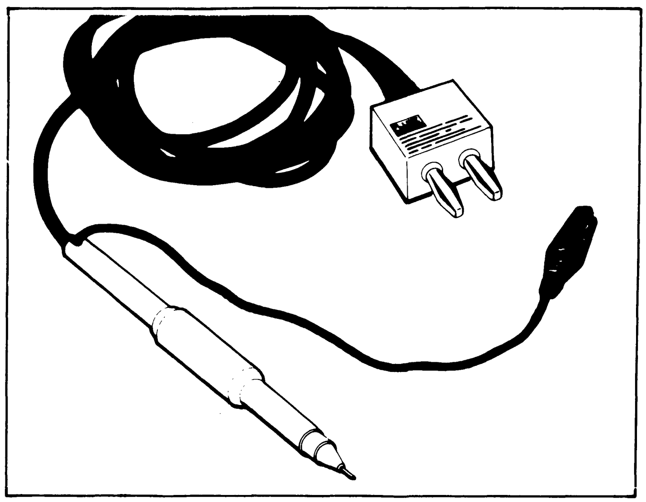


Figure 600-5. 82RF High Frequency Probe

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 2×10^7 Volt-hertz product, whichever is less) may be applied with resolutions available to one microvolt. Input impedance is 1 MΩ 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 MΩ 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) ± (% 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 x 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

Range	Full Scale	Resolution		Impedance
		Normal	High	
1V	2.5V	10 uV	1 uV	1 MΩ, $<$100 pF
10V	20V	100 uV	10 uV	
100V	160V	1 mV	100 uV	
1000V	1000V	10 mV	1 mV	

Maximum Input—1000V rms or 2 x 10^7 volt-hertz product, whichever is less.

COMMON MODE NOISE REJECTION (100Ω Unbalance)

$>$ 120 dB, dc to 60 Hz

TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)

30 Hz to 50 kHz ± (30 ppm/reading ± 0.5 digit)/°C
50 kHz to 100 kHz ± (100 ppm/reading ± 1 digit)/°C

SETTLING TIME (To Within 0.05%)

100 ms, Fast Filter
500 ms, Slow Filter

DIGITIZING TIME

Same as dc volts

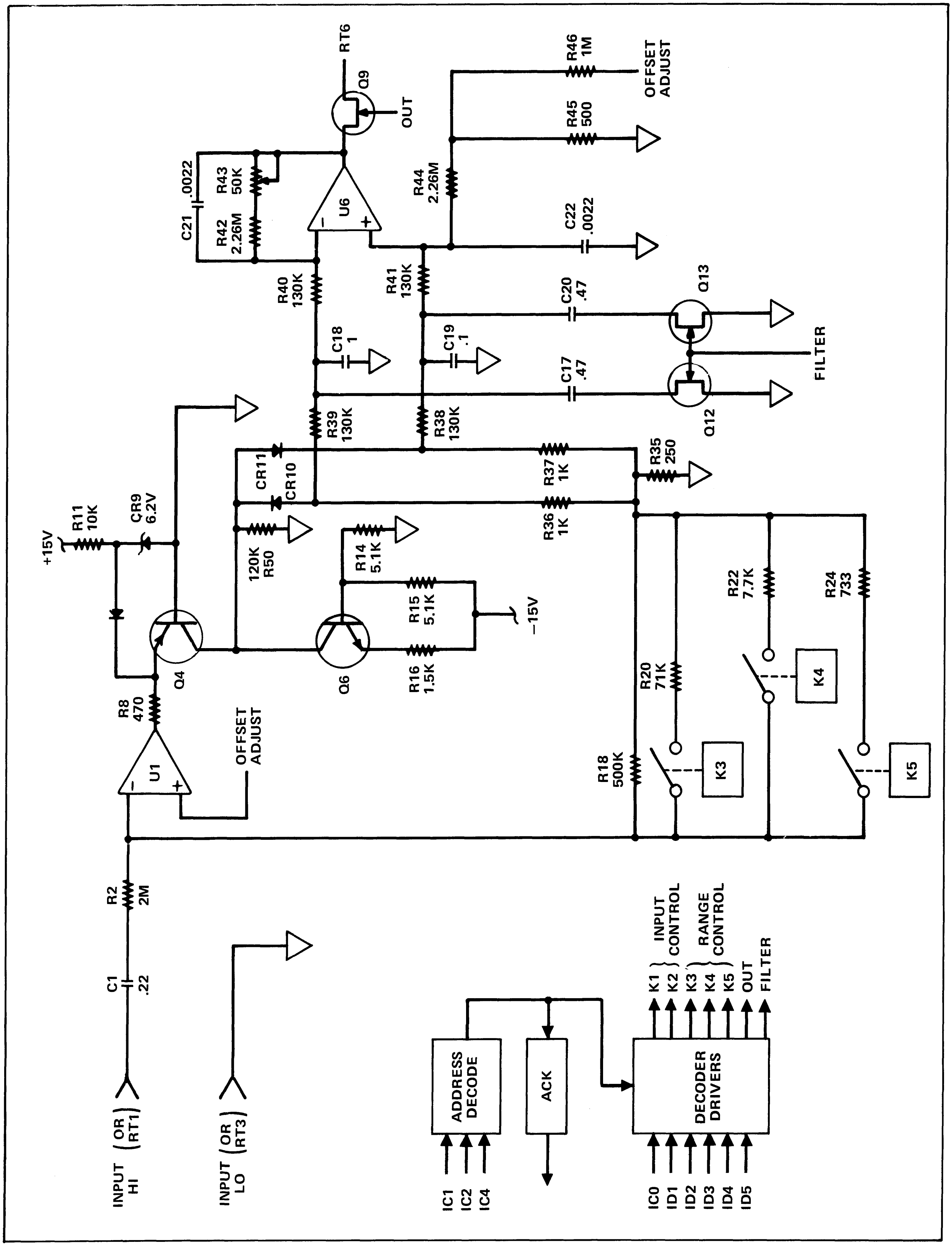


Figure 601-1. AC/DC Converter (Averaging)

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 ± 20 μV.
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 amking 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).		
2	Is DC Volts within tolerance?	3	Section 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, Vss = −20V } Difference = 4.9 to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 601-2.		

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

Address: IC 4, 2, 1 high

Data:	
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 μV.
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 MΩ	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	NOTE
-01	®AC/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	272070	71707	UD-6P	2		
	FOIL	313833	89536	313833	2		
	SWITCH, DRY REED	284091	95348	MR138	2		
	SWITCH, DRY REED	414300	95348	MR5830-7	2		
K2	RELAY ASSY				REF		
	RELAY, COIL, 6V	272070	71707	UD-6P	REF		
	FOIL	313833	89536	313833	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	SWITCH, DRY REED	414300	95348	MR5830-7	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.

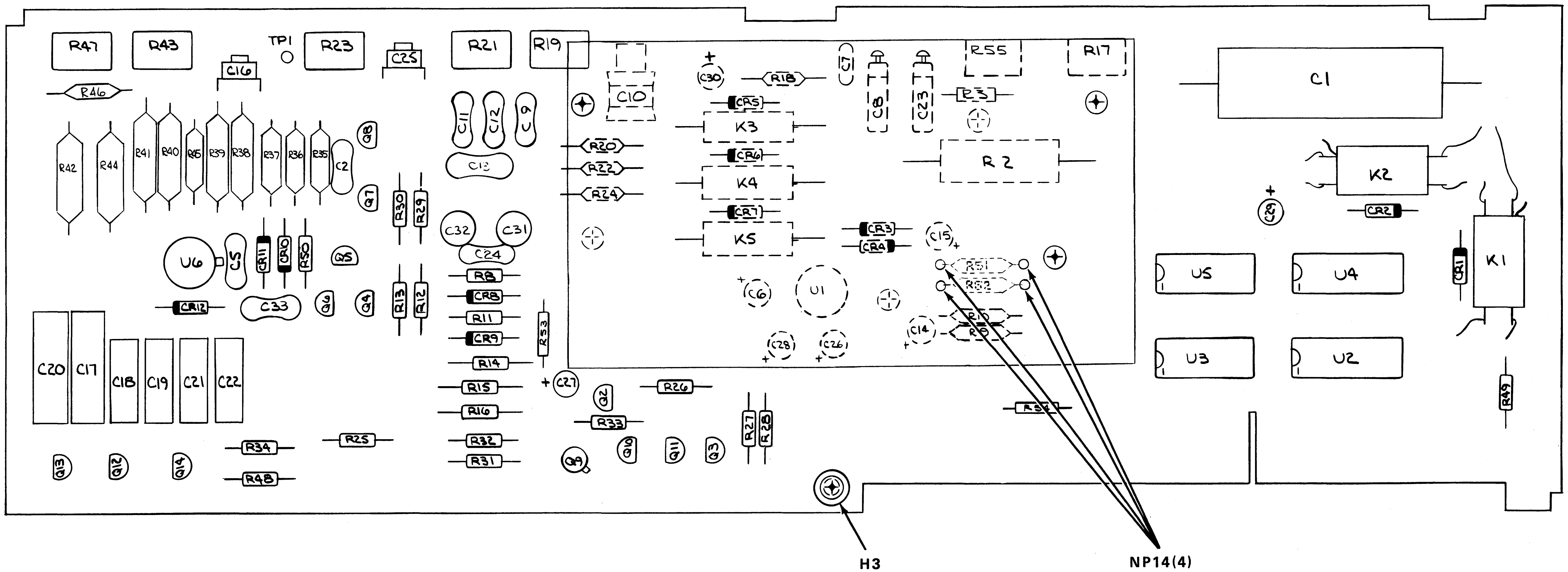
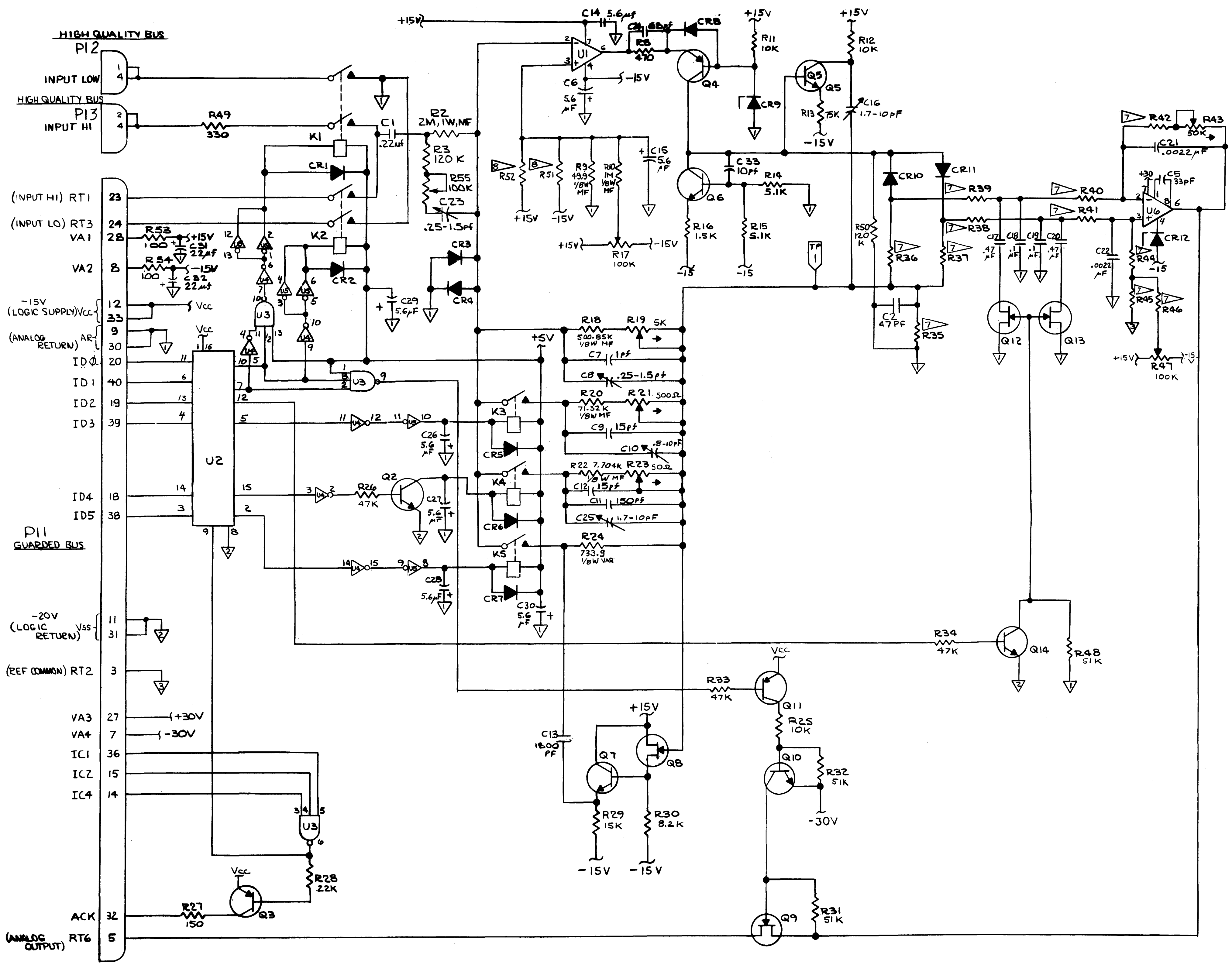


Figure 601-3. AC/DC Converter (Averaging) PCB Assembly



I.C. NO'S	TYP	VSS	VCC
U2	74C174	8	16
U3	4023	7	14
U4	4050	8	1
U5	7416	7	14

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS 1/4W CC, ALL RESISTANCE IN OHMS.
2. FOR REF. DESIGNATION SEE MIS-1701

7 MATCHED RESISTOR SET.

8 FACTORY SELECTED PARTS.

MIS-1101

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 μΩ to 262 MΩ. 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

ACCURACY

(Refer to the specifications table in section 1 for required environmental conditions)

Range	NORMAL RESOLUTION Accuracy ± (% of Input + No. of Digits)			HIGH RESOLUTION Accuracy ± (% of Input + No. of Digits		
	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
10Ω	0.003 + 20	0.005 + 20	0.01 + 20	–	–	–
100Ω	0.002 + 2	0.003 + 2	0.006 + 2	0.002 + 14	0.003 + 14	0.006 + 14
1 kΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10kΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
100 kΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
1 MΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10 MΩ	0.01 + 1	0.02 + 1	0.04 + 1	0.01 + 8	0. 02 + 8	0.004 + 8
100 MΩ	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: Resolution	Normal Resolution: Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C	High Resolution: Resolution	High 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

$0^\circ C$ to $18^\circ C$ and $28^\circ C$ to $50^\circ C$

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

Range	Voltage	Configuration
10Ω to 100 kΩ	7 volts max	4 Terminal
1 MΩ to 100 MΩ	25 volts max	2 Terminal

OVERLOAD

± 400V dc to 60 Hz, or 560 volts peak ac above 60 Hz maximum continuous on any range with no damage.

SETTLING TIME – (To Rated Accuracy)

80 ms, Fast Filter
800 ms, Slow Filter

DIGITIZING TIME

Mode of Operation	Filter	60 Hz: Approx. Rdg. Rate	60 Hz: Digitizing Time	50 Hz: Approx. Rdg. Rate	50 Hz: 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	–	–

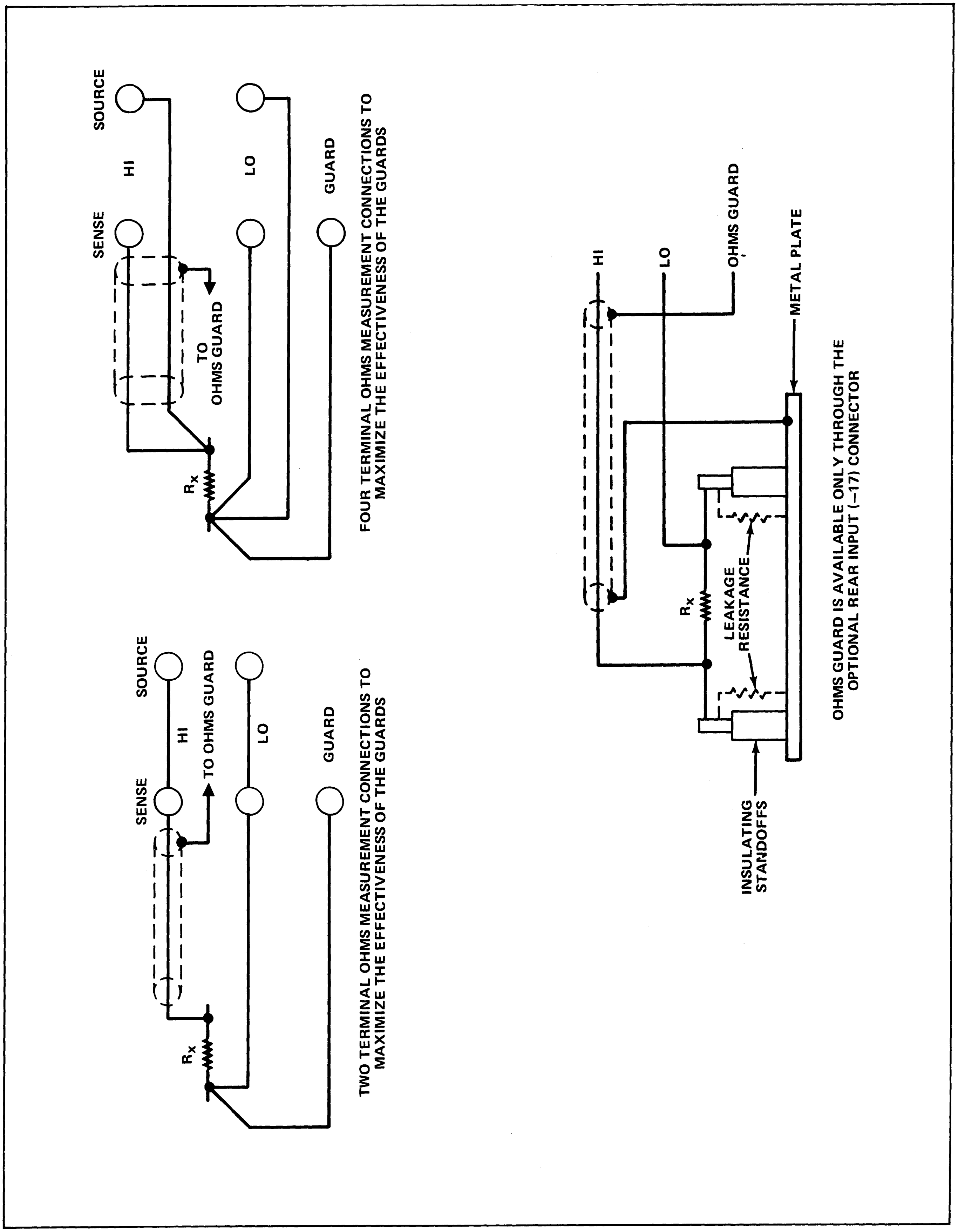


Figure 602-1. Ohms Measurement Connections And Guarding

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 10Ω range manually. Depress the STORE switch. Depress the V DC/Ω 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/Ω 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 x R41 (32.768 MΩ) 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.

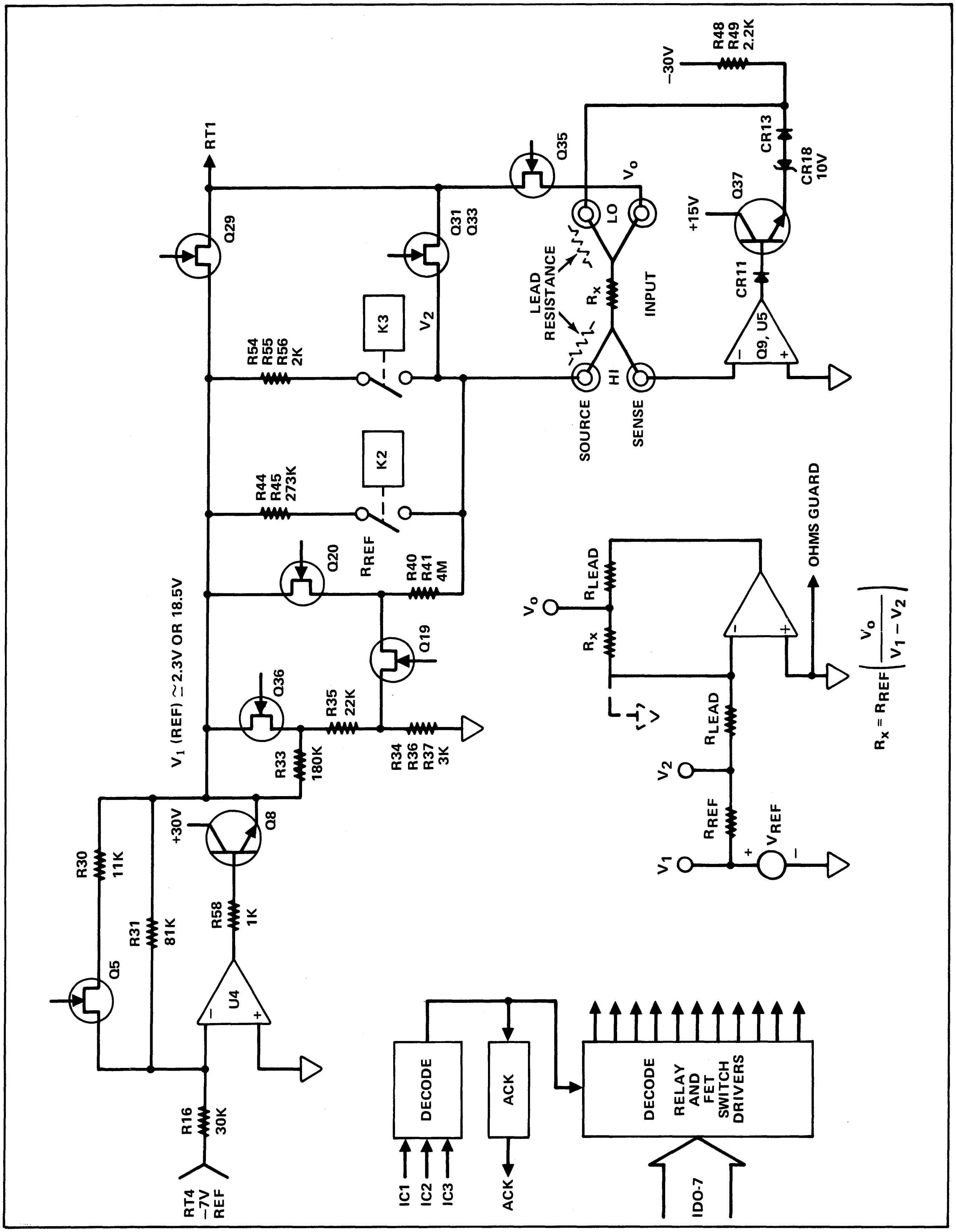


Figure 602-2. Ohms Converter

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 Ω 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/Ω 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 two hour warm-up.
3. Ensure that the dc Volts accuracy is within tolerance.
4. Short the HI and LO AMPS/Ω SOURCE terminals, short the HI, LO and GUARD VOLTS/Ω SENSE terminals, then short the two HI terminals. Use the terminal shorting links provided with the instrument and/or equivalents.
5. Use manual range selection to prevent range changes while testing at the range extremities.
6. Select the 10Ω range on the DMM.
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 ± 1 digit on all seven ranges.
9. Remove the shorting links and make four-wire ohms measurement connections to the INPUT terminals. Select the 1MΩ range and connect the input leads to a 4 MΩ standard resistor.

NOTE
Refer to Table 4-1 of the Instruction Manual for specifications on the Standard Resistors.

10. Adjust R40 for a reading between 3.99998 (+6) and 4.00002 (+6).
11. Select the 100 MΩ range and connect the input leads to a 100 MΩ standard resistor.
12. Adjust R37 for a reading between 99.995 (+6) and 100.005 (+6).
13. Select the 100 kΩ range and connect the input leads to a 250 kΩ standard resistor.
14. Adjust R44 for a reading between 249.998 (+3) and 250.002 (+3).
15. Select the 1 kΩ range and connect the input leads to a 1.9 kΩ standard resistor.
16. Adjust R54 for a reading between 1.89998 (+3) and 1.90002 (+3).
17. Select the 10Ω 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 ± 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

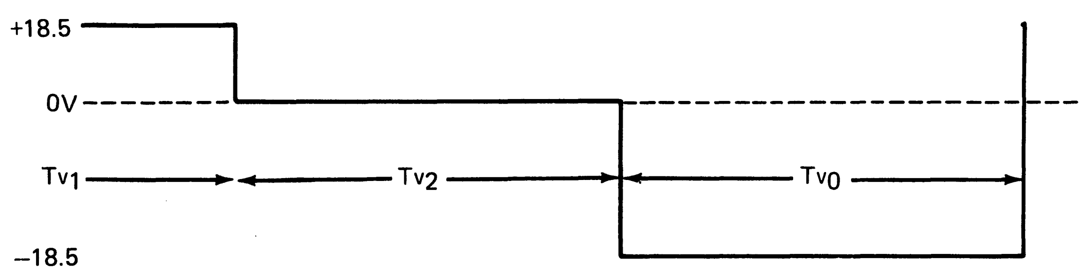
STEP NO.	ACTION	Go to the step number given for correct response: YES	NO
1	Perform DC Volts test (Section 4). Is DC Volts within tolerance?	2	Section 4
2	Perform Ohms test. Is Ohms within tolerance?	Section 4	3
3	Remove all optional modules except Isolator and Ohms converter.		
4	Is Ohms now within tolerance?	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, Vss = –20V: Difference = 4.9 to 5.2 VA3 = +29 to 32V 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)	U5, Q9, Q35, Digital Logic
(V_1)	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
DC SIGNAL CONDITIONER	
Slew Rates Bad	Q37, Q38, Q19, U3, U5, U6

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.

Voltages shown are at RT6, (DC Signal Conditioner Output).



Vo is proportional to Rx, Vo for full scale Rx is shown.

Sample Rate	Filter	Tv1	Tv2 *	Tv0
Fast	No	30ms	30ms	200 ms
Fast	Yes	30ms	30ms	650ms
Slow	No	30ms	30ms	600ms
Slow	Yes	30ms	30ms	1060ms

These are approximate times.

*Except Tv_2 for ranges 1M, 10M, 100M is zero. No V_2 is measured for these ranges.

The first reading after a range change or overrange is modified with longer V_1 and V_2 periods.

Figure 602-3. Timing

Table 602-6. Voltage Measurements

Range	Full Scale	V* TP2	R ref	I ref* (Source HI)	V_0* (Range Value)	V_1* (TP2)	V_2 (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 (± 5%)

TP1 is always −7.0V
TP3 Ref common (use for low side of measurements)
TP4 amplifier offset (<10μv properly adjusted)
V_0 is proportional to RX
V_2 will vary some with range change

SCANNER: Voltages will appear on RT1 in order. $V_0 - V_1 - V_2$

Table 602-7. Range Switch Closures

0 = Switch Open

1 = Switch Closed

Chart applies for time the particular voltage is SCANNED. All other times "0" applies.

	K1	K2	K3	Q5	Q19	Q20	V_0 Q29	V_{2a} Q31	V_{2b} Q33	V_1 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	IDϕ	ID1	ID2	ID3	ID4	ID5	ID6	ID7
10	V_ϕ	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_ϕ	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
1K	V_ϕ	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_ϕ	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_ϕ	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_ϕ	0	1	1	0	0	1	1	1
	V_1	1	0	1	0	0	1	1	1
10M	V_ϕ	0	1	1	0	1	1	1	1
	V_1	1	0	1	0	1	1	1	1
100M	V_ϕ	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. Ohms Converter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-02	⊗OHMS CONVERTER PCB ASSEMBLY FIGURE 602-4 (MIS-4110T)	ORDER	BY	OPTION -02			
C1	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	4		
C2	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C3	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C4	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	REF		
C5	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	1		
C6	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	2		
C7	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	REF		
C8	CAP, POLYSTRYRN, 100 PF +/-10%, 500V	446609	89536	446609	1		
C9	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
C10	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C11	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	1		
C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C13	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C14	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C15	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C16	CAP, TA, 5.6 UF +/-20%, 25V	368869	56289	196D565X0025KA1	1		
C17	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	3		
C18	CAP, TA, 0.47 UF +/-20%, 35V	161349	56289	196D474X0035HA1	1		
C19	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C20	CAP, CER, 0.0022 UF +/-10%, 500V	268425	32897	851000Z5R222K	1		
C21	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C22	CAP, TA, 0.33 UF +/-20%, 35V	408690	56289	196D334X0035HA1	1		
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	6	2	
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, RECT	428144	01295	1N4006	7	2	
CR7	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR8	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR9	DIODE, ZENER, UNCOMP	113324	07910	1N961A	2	1	
CR10	DIODE, SI, MULTIPELLET	375485	09214	MPD300	2	1	
CR11	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR12	DIODE, SI, MULTIPELLET	375485	09214	MPD300	REF		
CR13	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR14	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR15	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR16	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR17	DIODE, SI, RECT	428144	01295	1N4006	REF		
CR18	DIODE, ZENER, UNCOMP	113324	07910	1N961A	REF		
CR19	DIODE, 2-PELLET	375477	09214	MPD200	1	1	
CR20	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
E1	SURGE PROTECTOR, VOL	442723	25088	B1-C145	1		
H1	SCREW, PHP, 4-40 X 5/8	413062	89536	413062	1		
K1	RELAY, ARMATURE	515429	89536	515429	1		
K2	RELAY, DRY REED	357582	71707	UF40070	2		
K3	RELAY, DRY REED	357582	71707	UF40070	REF		
L1	CHOKE, RF	111542	99800	1537-76	1		

Table 602-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP1	CASE ASSY (INCLUDES MP2-MP9)	458927	89536	458927	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	411942	89536	411942	REF		
MP6	DECAL, OHMS CONVERTER	413435	89536	413435	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP11	SPACER, XSTR	152207	07047	10123-DAP	5		
MP12	SOCKET, COMPONENT LEAD (NOT SHOWN) (W/R20,R21,R23,R26)	343285	00779	2-331272-6	8		
MP13	LUG, SOLDER	103531	77963	501	1		
MP14	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
Q1	XSTR, SI, NPN	226290	04713	MPS3640	1	1	
Q2	XSTR, SI, NPN	218396	04713	2N3904	14	3	
Q3	XSTR, SI, PNP	195974	04713	2N3906	7	2	
Q4	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q5	XSTR, FET, N-CHANNEL	261578	89536	261578	4	1	
Q6	XSTR, SI, PNP	168716	07263	S19254	3	1	
Q7	XSTR, SI, PNP	168716	07263	S19254	REF		
Q8	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q9	XSTR, FET, DUAL, N-CHANNEL	476309	89536	476309	1	1	
Q10	XSTR, SI, NPN	203489	09214	11C2322	5	1	
Q11	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q12	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q13	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q14	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q15	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q16	XSTR, SI, NPN	203489	09214	11C2322	REF		
Q17	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q18	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q19	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q20	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q22	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q23	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q24	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q25	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q26	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q27	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q28	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q29	XSTR, FET, N-CHANNEL	393314	89536	393314	4	1	
Q30	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q31	XSTR, FET, N-CHANNEL	393314	89536	393314	REF		
Q32	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q33	XSTR, FET, N-CHANNEL	393314	89536	393314	REF		
Q34	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q35	XSTR, FET, N-CHANNEL	393314	89536	393314	REF		
Q36	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		

Table 602-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
Q38	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q39	XSTR, SI, PNP	168716	07263	S19254	REF		
Q40	XSTR, FET JUNCTION, N-CHANNEL	288324	89536	288324	1	1	
R1	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	7		
R2	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	6		
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	REF		
R5	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R6	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R7	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R8	RES, COMP, 220K +/-5%, 1/2W	109025	01121	EB2245	1		
R9	RES, COMP, 1.8K +/-5%, 1W	180331	01121	GB1825	2		
R10	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R11	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R12	RES, COMP, 100K +/-5%, 1W	109397	01121	GB1041	1		
R14	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R16	RES, MTL. FILM, 30.1K +/-1%, 1/8W	293431	91637	MFF1-83012F	1		
R17	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	6		
R18	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R19	RES, WW, 40K +/-0.1%	271403	89536	271403	2		
R20	RES, SELECTED				1		
R21	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	2		
R23	RES, SELECTED				REF		
R24	RES, VAR, CERMET, 100 +/-20%, 1/2W	267823	11236	190PC101B	1		
R25	RES, WW, 40K +/-0.1%	271403	89536	271403	REF		
R26	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	REF		
R27	RES, MTL. FILM, 20K +/-1%, 1/8W	291872	91637	MFF1-82002F	1		
R28	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	2		
R29	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	REF		
R30	RES, MTL. FILM, 11.3K +/-1%, 1/8W	335414	91637	MFF1-81132F	1		
R31	RES, MTL. FILM, 80.6K +/-1%, 1/8W	312710	91637	MFF1-88062F	1		
R32	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R33	RES, DEP. CAR, 180K +/-5%, 1/4W	348946	80031	CR251-4-5P180K	1		
R34	RES, MTL. FILM, 3.16K +/-0.1%, 1/8W	340588	91637	MFF1-83161B	1		
R35	RES, MTL. FILM, 21.5K +/-0.1%, 1/8W	344440	91637	MFF1-82152B	1		
R36	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	1		
R37	RES, VAR, CERMET, 50K +/-10%, 1/2W	330688	11236	190PC503B	1		
R39	RES, DEP. CAR, 1.6K +/-5%, 1/4W	348805	80031	CR251-4-5P1K6	1		
R40	RES, VAR, CERMET, 10K +/-10%, 1/2W	267880	11236	190PC103B	1		
R41	RES, WW, 4.091M +/-0.1%, 2W	412205	89536	412205	1		
R42	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R43	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R44	RES, VAR, CERMET, 500 +/-20%, 1/2W	267849	11236	190PC501B	1		
R45	RES, WW, 272.84K +/-0.08%, 1/2W	412197	89536	412197	1		
R46	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	1		
R47	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	4		
R48	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	2		
R49	RES, COMP, 1.8K +/-5%, 1W	180331	01121	GB1825	REF		
R50	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	2		
R51	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	REF		

Table 602-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R52	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R53	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R54	RES, VAR, CERMET, 200K +/-20%, 1/2W	381509	11236	190PC204B	1		
R55	RES, MTL. FILM, 332K +/-1%, 1/8W	289504	91637	MFF1-83323F	1		
R56	RES, WW, 2.01K +/-0.1%, 1/2W	412189	89536	412189	1		
R57	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R58	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R59	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R60	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	1		
R61	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R62	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R63	RES, MTL. FILM, 15.8K +/-1%, 1/8W	293688	91637	MFF1-81582F	1		
R64	RES, MTL. FILM, 73.2K +/-1%, 1/8W	237222	91637	MFF1-87322D	1		
R65	RES, MTL. FILM, 30.1K +/-1%, 1/8W	168286	91637	MFF1-83012F	1		
R66	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R67	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R68	RES, DEP. CAR, 560K +/-5%, 1/4W	342642	80031	CR251-4-5P560K	1		
R69	RES, DEP. CAR, 300 +/-5%, 1/4W	441519	80031	CR251-4-5P300E	1		
R70	RES, DEP. CAR, 200K +/-5%, 1/4W	441485	80031	CR251-4-5P200K	1		
R71	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
U1	⊗IC, C-MOS, NAND GATES	375147	02735	CD4023AE	1	1	
U2	⊗IC, C-MOS, QUAD, CLOCKED "D" LATCH	355149	02735	CD4042AE	2	1	
U3	⊗IC, C-MOS, QUAD, CLOCKED "D" LATCH	355149	02735	CD4042AE	REF		
U4	IC, LIN, OPNL AMPL	363515	34333	SG301A	1	1	
U5	IC, LIN, OPNL AMPL	418566	12040	LM358N	1	1	
U6	IC, RES NETWORK	380618	89536	380618	2	1	
U7	IC, RES NETWORK	380618	89536	380618	REF		

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

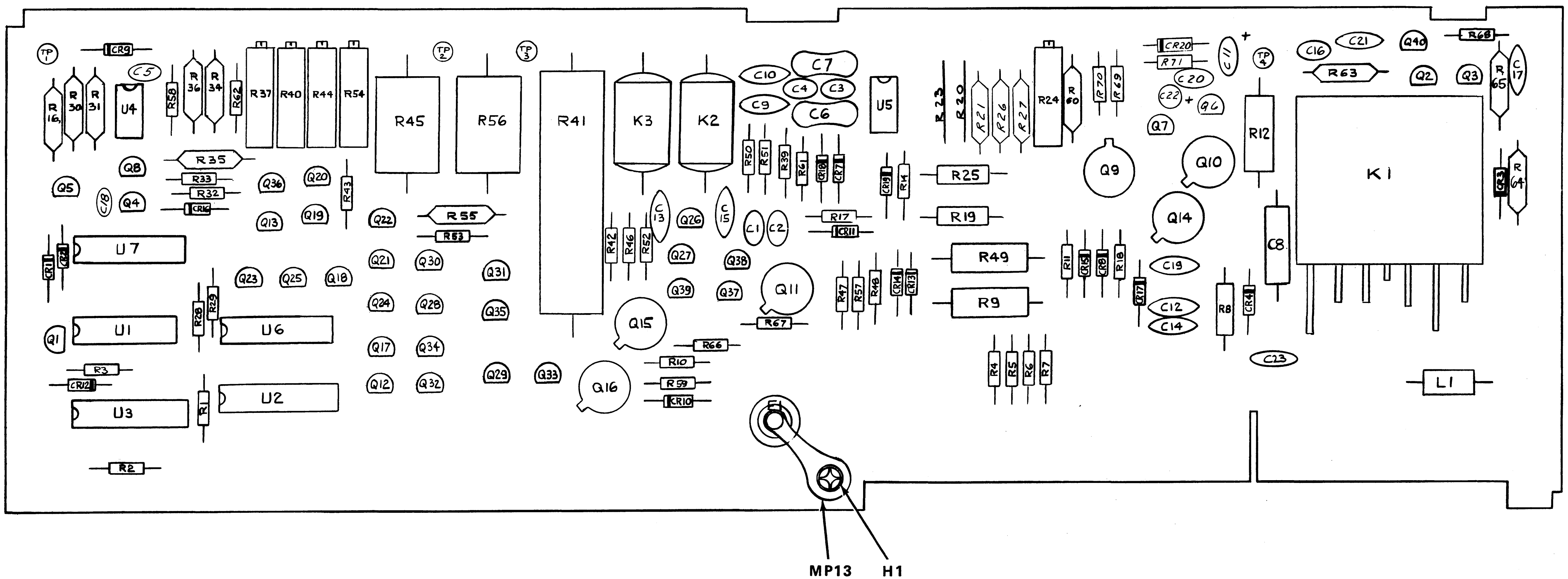


Figure 602-4. Ohms Converter PCB Assembly

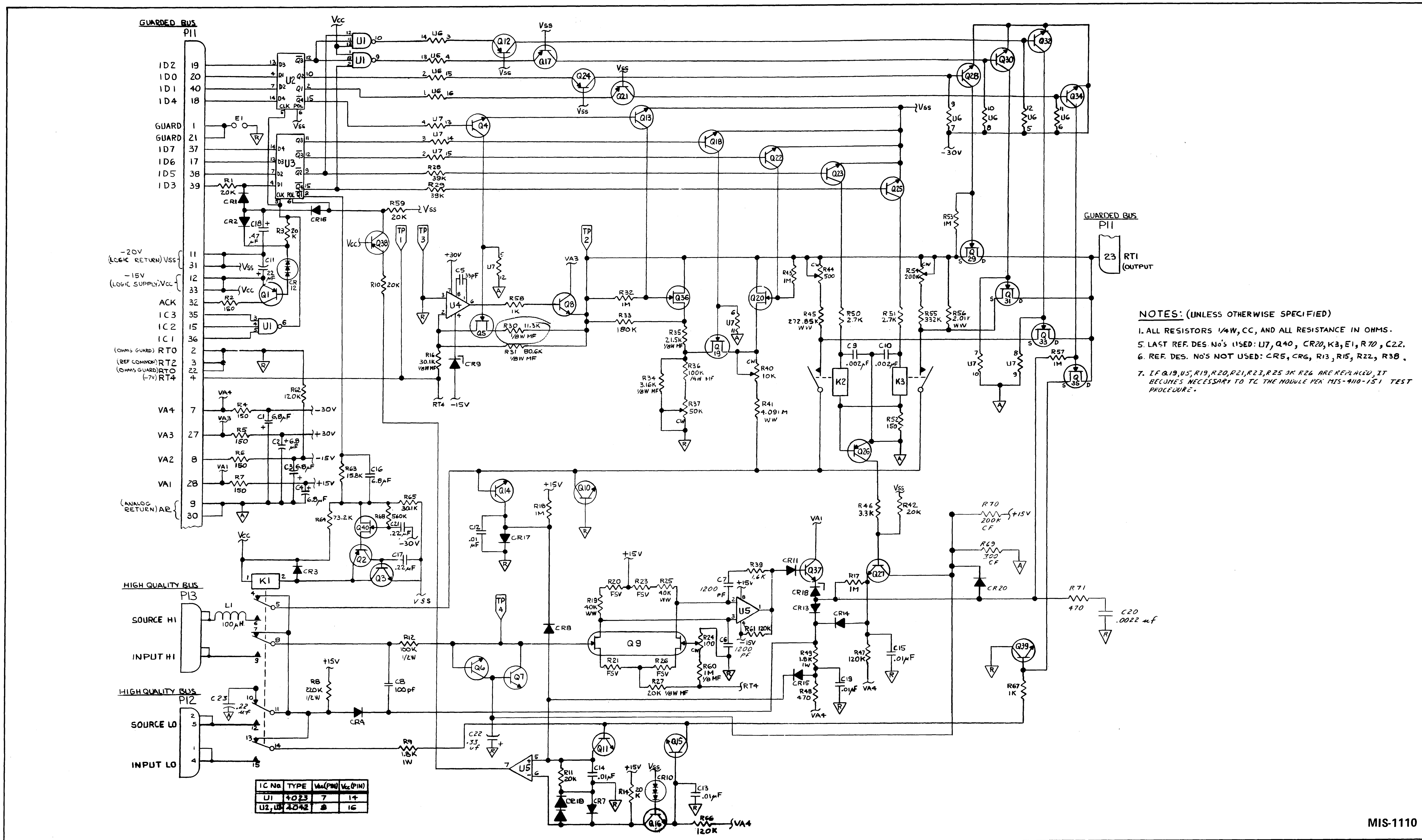


Figure 602-4. Ohms Converter PCB Assembly (cont)

Option —03
Current Shunts

603-1. INTRODUCTION

603-2. Installation of the Current Shunts module allows current measurement in five ranges: 100 μA, 1mA, 10 mA, 100 mA, and 1 A. Range selection can be done in either the manual or autorange mode. Either dc or ac current measurements may be made, but ac measurements require installation of one of the optional ac converters.

CAUTION

Selection of the autorange mode when using a constant current power source, e.g. the Fluke 3330B Constant Current Mode, can result in excessive voltage overloads. The overload results from the momentary open circuit at the 8500A/8502A input terminals when ranging into or out of the 100 μA and 1A current ranges. Constant voltage power sources are not effected.

603-3. SPECIFICATIONS

603-4. Table 603-1 lists the specifications for the Current Shunts module. Accuracy specifications for the lower current ranges (100 μA, 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.

NOTE

Position sensitivity of switches requires that the instrument be operated within 30° of its horizontal position.

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 measured. 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 μA, 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 x $R_{FEEDBACK}$, 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 $R_{FEEDBACK}$.

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[1] RES. (R_s)	ACCURACY ±(% OF INPUT + NO. OF DIGITS[2]) 24 HOURS	90 DAYS	1 YEAR
100 uA	312 uA	80 kΩ	0.02 + 10	0.03 + 10	0.05 + 10
1 mA	2.5 mA	10 kΩ	0.02 + 10	0.03 + 10	0.05 + 10
10 mA	20 mA	1.25 kΩ	0.02 + 10	0.03 + 10	0.05 + 10
100 mA	160 mA	40Ω	0.03 + 20	0.05 + 20	0.1 + 20
1 A	1.28A	10Ω	0.03 + 20	0.05 + 20	0.1 + 20

[1] *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)*

[2] *For high resolution multiply the number of digits by 10.*

ALTERNATING CURRENT

Accuracy ±(% of Input + No. of Digits) from 0.1% of full scale to full scale:

Range	Full Scale	Frequency	24 Hours Average Current	24 Hours True RMS Current	90 Days Average Current	90 Days True RMS Current	1 Year Average Current	1 Year True RMS Current
100 uA*	312.5 uA	10 Hz–20 Hz	–	0.7 + 110	–	1.0 + 110	–	2.0 + 110
		20 Hz–50 Hz	0.55 + 9	0.55 + 35	0.8 + 9	0.8 + 35	1.6 + 10	1.6 + 35
		50 Hz–10 kHz	0.3 + 9	0.28 + 35	0.4 + 9	0.4 + 35	0.8 + 10	0.8 + 35
		10 kHz–20 kHz	0.5 + 9	0.7 + 110	0.7 + 9	1.0 + 110	1.5 + 10	2.0 + 110
		20 kHz–50 kHz	1.0 + 9	1.0 + 260	1.5 + 9	1.5 + 260	3.0 + 10	3.0 + 260
		50 kHz–100 kHz	2.0 + 9	2.8 + 760	3.0 + 9	4.0 + 760	6.0 + 10	8.0 + 760
1 mA* and 10 mA*	2.5 mA 20 mA	10 Hz–20 Hz	–	0.7 + 110	–	1.0 + 110	–	2.0 + 110
		20 Hz–50 Hz	0.35 + 9	0.35 + 35	0.5 + 9	0.5 + 35	1.0 + 9	1.0 + 35
		50 Hz–10 kHz	0.05 + 9	0.08 + 35	0.06 + 9	0.11 + 35	0.12 + 9	0.22 + 35
		10 kHz–20 kHz	0.08 + 9	0.14 + 110	0.11 + 9	0.2 + 110	0.22 + 9	0.4 + 110
		20 kHz–50 kHz	0.08 + 9	0.2 + 260	0.12 + 9	0.3 + 260	0.24 + 9	0.6 + 260
		50 kHz–100 kHz	0.35 + 9	0.7 + 760	0.51 + 9	1.0 + 760	1.0 + 9	2.0 + 760
100 mA	160 mA	10 Hz–20 Hz	–	0.7 + 150	–	1.0 + 150	–	2.0 + 150
		20 Hz–50 Hz	0.34 + 55	0.35 + 80	0.5 + 55	0.5 + 80	1.0 + 55	1.0 + 80
		50 Hz–10 kHz	–	0.18 + 80	–	0.26 + 80	–	0.52 + 80
		50 Hz–100 kHz	0.16 + 55	–	0.24 + 55	–	0.5 + 55	–
1A	1.28A	10 Hz–20 Hz	–	0.7 + 150	–	1.0 + 160	–	2.0 + 160
		20 Hz–50 Hz	0.34 + 65	0.35 + 90	0.5 + 65	0.5 + 90	1.0 + 65	0.5 + 90
		50 Hz–10 kHz	0.16 + 65	0.18 + 90	0.24 + 65	0.26 + 90	0.5 + 65	0.52 + 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 Res. (R_S) [1]	Temperature Coefficient [2]: Voltage Burden	Temperature Coefficient [2]: ±(ppm/rdg + No. of Digits)/°C [3]
100 uA	312 uA	80 kΩ	≤100 mV	25 + 0.6
1 mA	2.5 mA	10 kΩ	≤100 mV	25 + 0.6
10 mA	20 mA	1.25 kΩ	≤200 mV	25 + 0.6
100 mA	160 mA	–	≤200 mV	35 + 0.6
1A	1.28A	–	≤500 mV	35 + 0.6

1 For Source Resistance less than specified, replace Temperature Coefficient with the following:

Temperature Coefficient: Range	+ No. of Digits/°C
100 uA	0.5 (1 + 8k/R_S)
1 mA	0.5 (1 + 1k/R_S)
10 mA	0.5 (1 + 125/R_S)

2 0°C to 18°C and 28°C to 50°C.

3 For high resolution multiply No. of digits by 10

OVERLOAD

1.5A maximum, ± 140V dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.

PROTECTION

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)

RANGE	TEMPERATURE COEFFICIENT: RMS AC	TEMPERATURE COEFFICIENT: AVG. AC
100 uA*	(50 ppm + 3.5 digits)/°C	(40 ppm + 1.5 digits)/°C
1 mA*	(50 ppm + 3.5 digits)/°C	(40 ppm + 1.5 digits)/°C
10 mA*	(50 ppm + 3 digits)/°C	(40 ppm + 1 digit)/°C
100 mA	(50 ppm + 9 digits)/°C	(40 ppm + 7 digits)/°C
1A	(50 ppm + 9 digits)/°C	(40 ppm + 7 digits)/°C

VOLTAGE BURDEN

Same as dc current

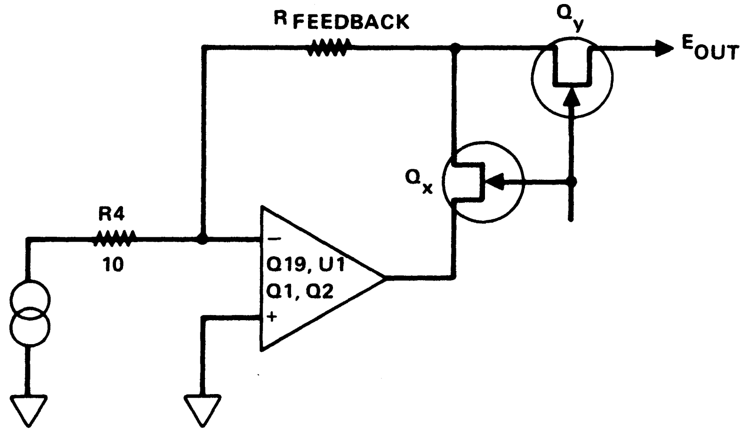
OVERLOAD

1.5A maximum current (1-1/2A fuse protected)
± 140V dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.

CREST FACTOR (RMS only)

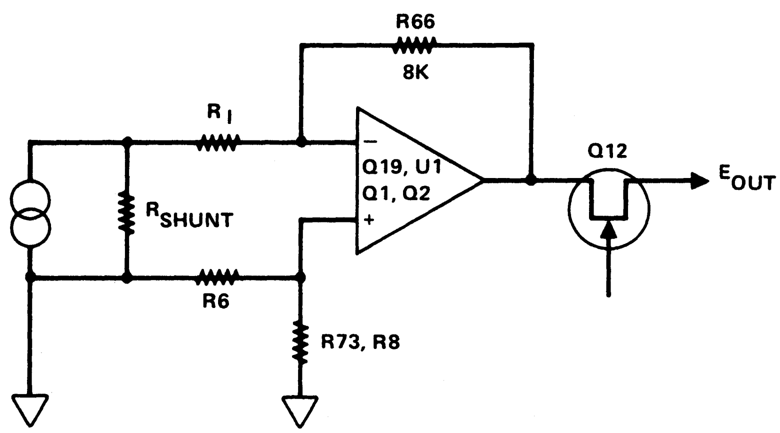
≤4.5 full scale, increasing down scale by:

$$4.5\sqrt{\frac{I_{Range}}{I_{Input}}}$$



MODE A — 100 μA, 1 mA, 10 mA

RANGE	$R_{FEEDBACK}$	Q_X	Q_Y	RELAYS	FULL SCALE E_{OUT}
100 μA 1 mA 10 mA	R30, R31 R33, R34 R36, R37	Q30 Q7 Q9	Q31 Q10 Q8	K3, K4 K3, K4 K3, K4	.8 V 1.0 V 1.25 V



MODE B 100 mA, 1A

RANGE	R_{SHUNT}	R_I	RELAYS	FET SWITCHES	FULL SCALE E_{OUT}
100 mA 1 A	R2, R1 R1	R7, R70, R71 R7, R68, R69	K1, K3 K2, K3	Q20, Q32, Q29, Q12 Q20, Q29, Q28, Q12	1.6V 2.0V

Q11 and either Q3 or Q4 will be conducting in all ranges

Figure 603-1. Current Shunt Configurations And Range Information

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 [$R66/R_I$ = (R8 + R73)/R6].

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 10Ω). 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.

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 ± 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 μA, 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 ± 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 uA	10 uA	9.987 (−6)	10.013 (−6)
100 uA	100 uA	99.960 (−6)	100.040 (−6)
100 uA	250 uA	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 two 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 ± 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 kΩ ± 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 μA 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 R71 for a reading between +99.999-0 and +100.001-0.

17. Select a current source output of 1.00000A.

18. Adjust R68 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.		

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
100μA, 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 μA 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

Q19 DC Readings with Zero Input

Drains (10Ω resistors) ≃ –0.6 V dc
Sources (40 KΩ resistors) ≃ 8.0 V dc
U1 pin 6 ≃ 0V dc

Differences between ADC and AAC

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.

Figure 603-2. Symptom Analysis

Table 603-4. Address and Data Field

Address — IC0, 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
100μA Range	X	1	1	0	1	1
1 mA Range	X	1	1	0	0	1
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 DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-03	⊗CURRENT SHUNTS PCB ASSEMBLY FIGURE 603-3 (MIS-4104T)	ORDER	BY	OPTION -03			
C1	CAP, TA, 0.47 UF +/-20%, 35V	161349	56349	196D474X0035HA1	2		
C2	CAP, TA, 0.47 UF +/-20%, 35V	161349	56349	196D474X0035HA1	REF		
C3	CAP, MICA, 47 PF +/-1%, 500V	284802	72136	DM15E470F	1		
C4	CAP, MICA, 150 PF +/-5%, 500V	148478	72136	DM15F151J	1		
C5	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	2		
C6	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	REF		
C7	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	1		
C8	CAP, MICA, 39 PF +/-5%, 500V	148544	72136	DM15E390J	2		
C9	CAP, MICA, 39 PF +/-5%, 500V	148544	72136	DM15E390J	REF		
C10	CAP, TA, 4.7 UF +/-20%, 25V	161943	56289	196D475X0025KA1	1		
C11	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	1		
C12	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	2		
C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C14	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C15	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015A1	3		
C16	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015A1	REF		
C17	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015A1	REF		
CR1	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	14	4	
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, SI, 1A, 600 PIV	112383	05277	1N4822	6	2	
CR6	DIODE, SI, 1A, 600 PIV	112383	05277	1N4822	REF		
CR7	DIODE, SI, 1A, 600 PIV	112383	05277	1N4822	REF		
CR8	DIODE, SI, 1A, 600 PIV	112383	05277	1N4822	REF		
CR9	DIODE, SI, 1A, 600 PIV	112383	05277	1N4822	REF		
CR10	DIODE, SI, 1A, 600 PIV	112383	05277	1N4822	REF		
CR11	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR12	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR14	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR15	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR16	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR17	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR18	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR19	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR20	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR21	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR22	DIODE, ZENER	325803	07910	TD333408	1	1	
H1	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	5		
	SWITCH, DRY REED	602714	15636	V1101	5		
K2	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	REF		
	SWITCH, DRY REED	602714	15636	V1101	REF		
K3	RELAY ASSY						
	COIL REED RELAY	269019	71707	U-6-P	REF		

Table 603-5. Current Shunts Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	SWITCH, DRY REED	602714	15636	V1101	REF		
K4	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	REF		
	SWITCH, DRY REED	602714	15636	V1101	REF		
K5	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	REF		
	SWITCH, DRY REED	602714	15636	V1101	REF		
MP1	CASE ASSY (INCLUDES MP2-MP9)	459008	89536	459008	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	412015	89536	412015	REF		
MP6	DECAL, CURRENT SHUNTS ASSY	413419	89536	413419	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	SOCKET, COMP. LEAD (NOT SHOWN)	343285	27264	02-09-2133	10		
MP11	SPACER, COMPONENT (NOT SHOWN)	296319	32559	T0806	10		
MP12	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	13	3	
Q2	XSTR, SI, PNP	195974	04713	2N3906	3	1	
Q3	XSTR, FET, N-CHANNEL	261578	89536	261578	13	3	
Q4	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q5	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q6	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q7	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q8	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q9	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q10	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q11	XSTR, FET, N-CHANNEL	393314	89536	393314	1	1	
Q12	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q13	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q14	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q15	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q16	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q17	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q18	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
Q19	XSTR, FET, DUAL, N-CHANNEL (SELECTED)	267963	89536	267963	1	1	
Q20	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q22	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q23	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q25	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q26	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q27	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q28	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q29	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q30	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q31	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q32	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		

Table 603-5. Current Shunts Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
Q33	XSTR, SI, PNP	195974	04713	2N3906	REF		
R1	RES, WW, 0.1 +/-0.05%, 1/2W	374611	89536	374611	1		
R2	RES, WW, 0.7 +/-0.1%, 1/4W	440404	89536	440404	1		
R3	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	23		
R4	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	4		
R5	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R6	RES, MTL. FILM, 383 +/-1%, 1/8W	375899	91637	MFF1-88380F	1		
R7	RES, WW, 419 +/-0.1%, 2W	440883	89536	440883	1		
R8	RES, MTL. FILM, 7.87K +/-1%, 1/8W	294934	91637	MFF1-87871F	1		
R9	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R10	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R11	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R12	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R13	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R14	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R15	RES, WW, 40K +/-0.1%	271403	89536	271403	2		
R16	RES, WW, 40K +/-0.1%	271403	89536	271403	REF		
R17	RES, VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	1		
R18	RES, MTL. FILM, 19.1K +/-1%, 1/8W	234963	91637	MFF1-81912F	1		
R19	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R20	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	2		
R21	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R22	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	REF		
R23	RES, DEP. CAR, 39 +/-5%, 1/4W	340836	80031	CR251-4-5P39E	2		
R24	RES, DEP. CAR, 39 +/-5%, 1/4W	340836	80031	CR251-4-5P39E	REF		
R25	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R26	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R27	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R28	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R29	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R30	RES, WW, 7975	440909	89536	440909	2		
R31	RES, VAR, CERMET, 50 +/-20%, 1/2W	267815	75378	190PC500B	1		
R32	RES, WW, 1020 +/-0.05%, 0.2W	440891	89536	440891	1		
R33	RES, MTL. FILM, 47.5K +/-1%, 1/8W	289546	91637	MFF1-84752F	1		
R34	RES, VAR, CERMET, 10K +/-20%, 1/2W	267880	75378	190PC103B	1		
R35	RES, WW, 128 +/-0.05%, 0.2W	440875	89536	440875	1		
R36	RES, MTL. FILM, 4.99K +/-1%, 1/8W	168252	91637	MFF1-84991	1		
R37	RES, VAR, CERMET, 1K +/-20%, 1/2W	267856	75378	190PC102B	1		
R38	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R39	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	5		
R40	RES, MTL. FILM, 49.9K +/-1%, 1/8W	268821	91637	MFF1-84992F	1		
R41	RES, MTL. FILM, 100K +/-0.5%, 1/8W	291054	91637	MFF1-81003D	2		
R42	RES, MTL. FILM, 100K +/-0.5%, 1/8W	291054	91637	MFF1-81003D	REF		
R43	RES, COMP, 10M +/-10%, 1/2W	108142	01121	EB1061	2		
R44	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R45	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R46	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R47	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R48	RES, MTL. FILM, 150K +/-1%, 1/8W	241083	91637	MFF1-81503F	1		
R49	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		

Table 603-5. Current Shunts 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, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R51	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R52	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R53	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R54	RES, MTL. FILM, 13K +/-1%, 1/8W	335539	91637	MFF1-81302F	1		
R55	RES, SELECTED						
R56	RES, SELECTED						
R57	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	REF		
R58	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	REF		
R59	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	REF		
R60	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	1		
R61	RES, COMP, 10M +/-10%, 1/2W	108142	01121	EB1061	REF		
R62	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R63	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R64	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R65	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R66	RES, WW, 7975	440909	89536	440909	REF		
R67	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R68	RES, VAR, CERMET, 5K +/-20%, 1/2W	267872	75378	190PC502B	2	1	
R69	RES, MTL. FILM, 12.4K +/-1%, 1/8W	261644	91637	MFF1-81242F	1		
R70	RES, MTL. FILM, 13.3K +/-1%, 1/8W	296566	91637	MFF1-81332F	1		
R71	RES, VAR, CERMET, 5K +/-20%, 1/2W	267872	75378	190PC502B	REF		
R72	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R73	RES, MTL. FILM, 100 +/-1%, 1/8W	168195	91637	MFF1-81000F	1		
R74	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	1		
U1	IC, LIN, OP AMP	483495	12040	LM318H	1	1	
U2	⊗IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U3	⊗IC, C-MOS, HEX, INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U4	IC, TTL, HEX INVERTER, BUFFER/DRIVER	327775	01295	SN7416J	1	1	
U5	⊗IC, 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, C-MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	1	1	

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

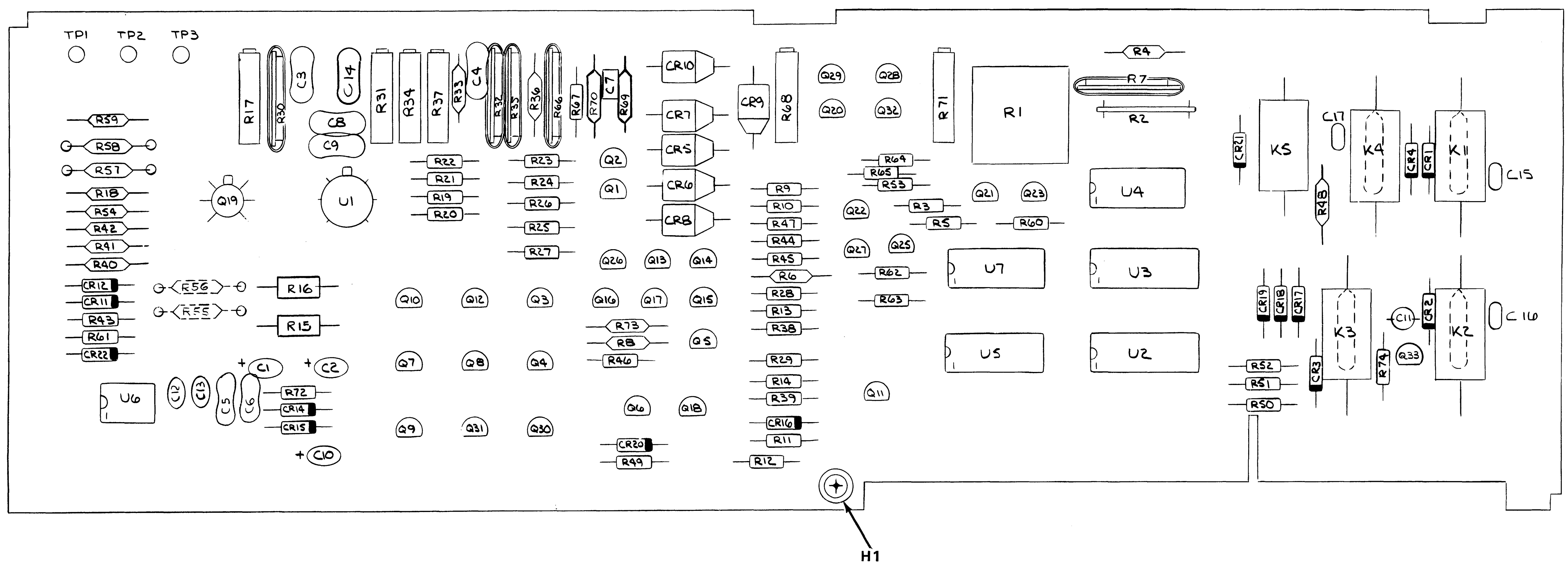
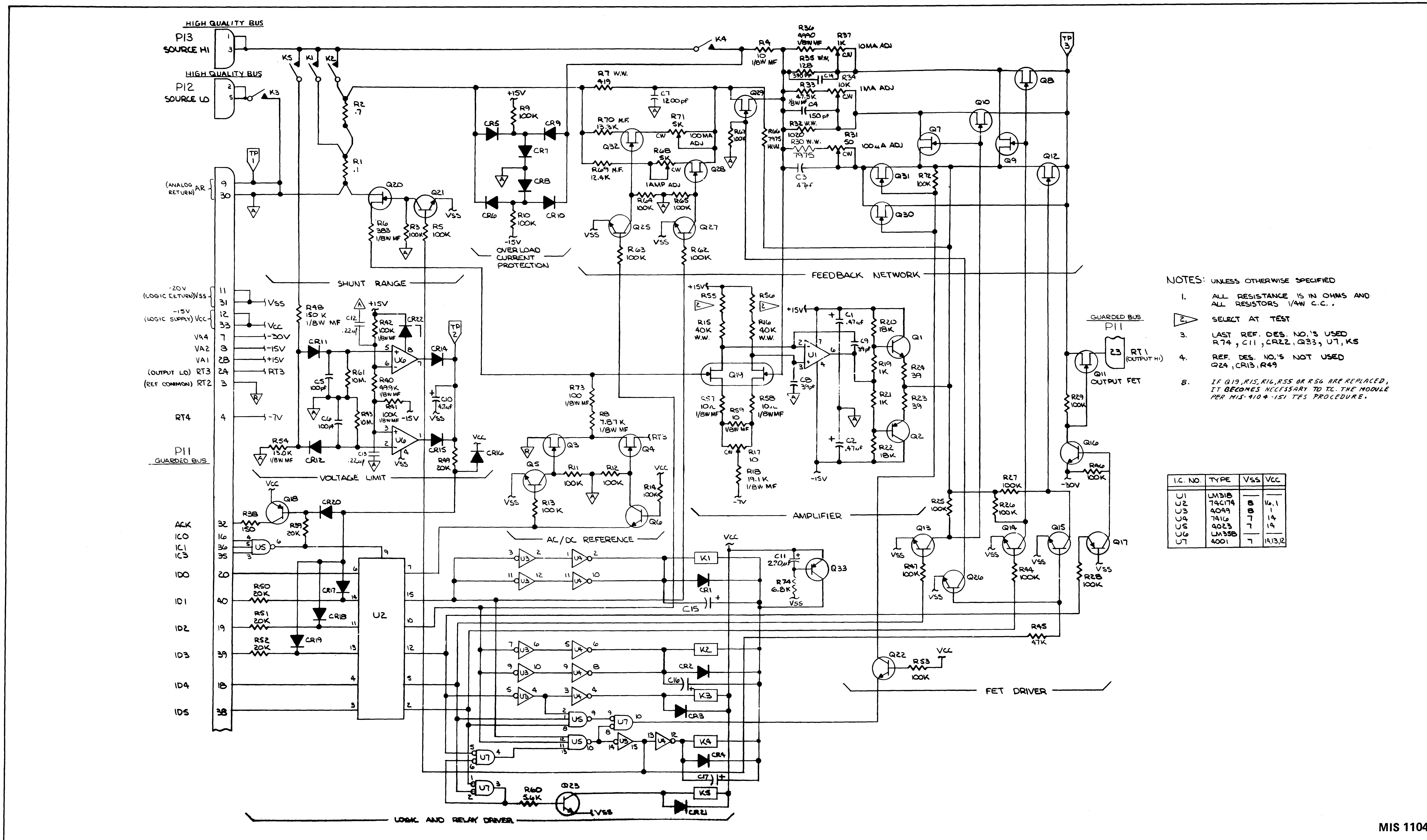


Figure 603-3. Current Shunts Assembly



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

8. IF Q19, R15, R16, R55 OR R56 ARE REPLACED, IT BECOMES NECESSARY TO T.C. THE MODULE PER MIS-4104-151 TES PROCEDURE.

I.C. NO.	TYPE	VSS	VCC
U1	LM318	—	—
U2	74C174	8	16, 1
U3	4049	8	1
U4	7416	7	14
U5	4023	7	14
U6	LM358	—	—
U7	4001	7	14, 13, 12

Figure 603-3. Current Shunts Assembly (cont)

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 permissable 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 place 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

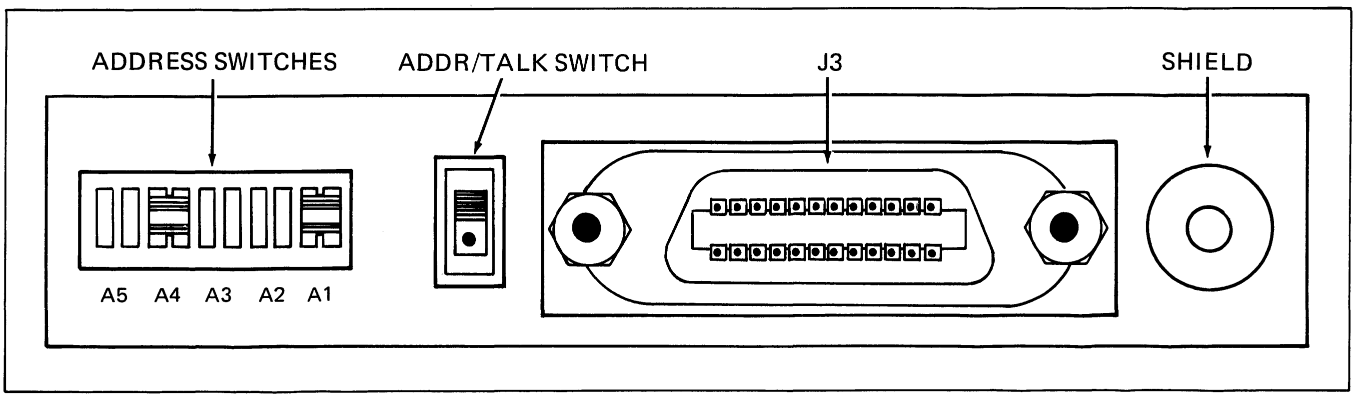


Figure 605-1. Rear Panel Access

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
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	;	[
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	>	^
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 000000000) 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	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.
13	DIO 5	Data	
14	DIO 6	Data	
15	DIO 7	Data	
16	DIO 8	Data	
5	EOI	End Or Identify	Used to indicate the end of a nultiple 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 T	077	3F	X			
UNT	Untalk	X T F T T T T T	137	5F	X		X	
OTA	Other Talk Address	X 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
	NOTE *Due to the speed and complexity of the data on the bus system, it is recommeded 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, manu 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.*		
1	This test is based on the assumption that the DMM was checked and found opeational 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 and "SRQ" from an Interrupt Ready or Error?	12	11
11	Check the SRQ line inand 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)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 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. V A R 2 S 5 F ?
   - ? — Execute, trigger and transmit
   - F — Slow filter, no time out
   - S 5 — 2^5 samples/reading
   - R 2 — 10 volt range
   - V A — AC voltage

2. T D Y ?
   - ? — Execute, trigger and transmit
   - Y — Echo characters
   - D — Turn display off
   - T — Continuous line synchronized readings

3. K N U 6 . 3
   - K N U 6 . 3 — Upper limit

   K N L 6 . 2 U ,
   - , — Execute
   - U — Enter limits mode
   - K N L 6 . 2 — Lower limit

4. Z R , S 5 $
   - $ — Clears command string to preceeding "," "?" or "@"
   - S 5 — 2^5 samples/reading
   - , — Execute
   - R — Auto range
   - Z — Ohms

5. % G 1 ?
   - ? — Execute, trigger and transmit
   - G 1 — 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)

#	**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 2^7 (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 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.

BYTE 1	BYTE 2	BYTE 3
1 1 1 1 0 1 1 1	1 0 1 1 1 1 1 1	1 1 1 1 1 1 1 1

Implied Binary Point
Error Bit
Sign Bits

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.

0 0 0 0 1 0 0 0	+	0 1 0 0 0 0 0 0	+	0 0 0 0 0 0 0 1
– (0 . 5	+	.015625 0	+	0 .000001)

= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$[R_t = R_{AD}$ X 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 immmediate 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
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.

V **DC Volts**

V A **AC Volts**

C **DC Coupled AC Volts**

I **DC Current**

I A **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: $Rx = Rr \frac{V0}{V1-V2}$ Fast Ohms mode differs in that the value of $\frac{Rr}{(V1-V2)}$ is stored as a constant. The instrument will the 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
R	Auto	Auto	Auto	Auto
R 0	312 mV	Auto	312 μA	31.25Ω
R 1	2.5V	2.5V	2.5 mA	250Ω
R 2	20V	20V	20 mA	2 kΩ
R 3	160V	160V	160 mA	32 kΩ
R 4	1200V	1000V	1.28A	256 kΩ
R 5	Auto	Auto	Auto	4.096 MΩ
R 6	Auto	Auto	Auto	32.768 MΩ
R 7	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.

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

F **Slow filter, time-out disabled.**

F 0 **Fast filter, time-out disabled.**

F 1 **Bypass filter.**

F 2 **Slow filter, time-out enabled (approximately 500 ms).**

F 3 **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.

T **Continuous reading mode/line synchronized.**

T 0 **Single reading mode/line synchronized.**

T 1 **Continuous reading mode/line asynchronous.**

T 2 **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).

[P] **Offset subtracted (ON).**

[P][0] **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.

[X] **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 = ±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 = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 605-6. Programming Instructions (cont)

X 0 — **External Reference Off, Scaling Off**

X 1 — **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 valued may not be used as a scaling factor.

NOTE

The 8502A can store the external reference voltage and the numerical scale factor separately. The 8500A can only store one or the other, not both.

◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A.

◆ For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor.

Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor $<10^{-9}$ (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.

U — **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).

U 0 — **Disable Limits and Peak Mode(s)**

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

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 0 **Single Byte ASCII Format**

● **B 1** **Binary 16-Bit Parallel**

● **B 2** **16-Bit Parallel**

"B1","B2" used with Paralled 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.

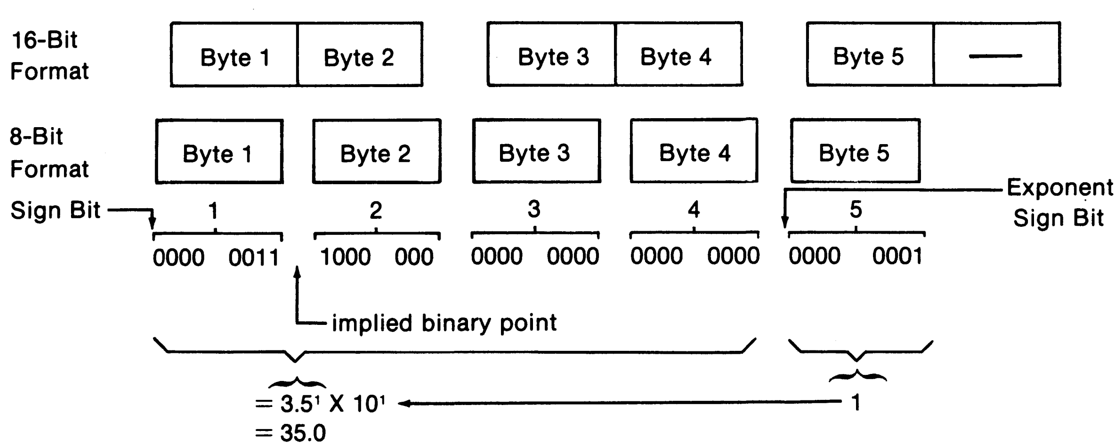


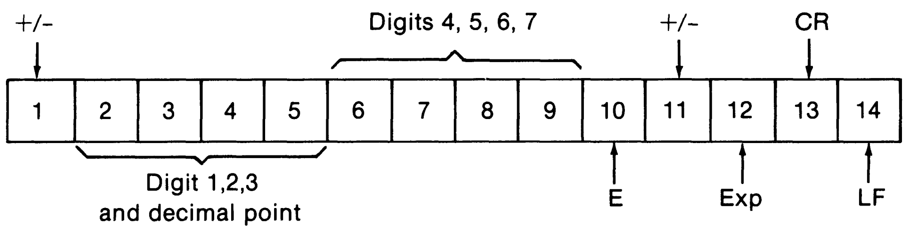
Table 605-6. Programming Instructions (cont)

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.

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 605-6. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings** ◆	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.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

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

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	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.

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

Table 605-6. Programming Instructions (cont)

MEMORY COMMAND CHARACTERS

STORE

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

Keys	Command	Remarks
K	**Store Last Reading as Offset**	◆ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.
K 0	**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 10.3×10^{-1} or 1.03

K N U 7 . 6 E 4

Keep numeric upper limit of 7.6×10^{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:

K N X 2 . 0 E - 1 3

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 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/Underrange
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 μA, 10Ω
1 1V dc, 1V ac, 1 mA, 100Ω
2 10V dc, 10V ac, 10 mA, 1kΩ
3 100V dc, 100V ac, 100 mA, 10 kΩ
4 1000V dc, 1000V ac, 1A, 100 kΩ
5 1 MΩ
6 10 MΩ
7 100 MΩ

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-488-1975 Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-05	®IEEE 488-1975 INTERFACE PCB ASSEMBLY FIGURE 605-2 (MIS-4172T)	ORDER	BY	OPTION -05			
	IEEE 488-1975 PIGGYBACK PCB ASSEMBLY FIGURE 605-3 (MIS-4074)						2
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	1	
H1	LOCKWASHER, SPLIT, 8-32	111070	89536	111070	2		
H2	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H3	SCREW, CONN MTG, (USE ON J3)	429472	89536	429472	2		
J2	POST, CONTACT	447813	22526	65501-136	3		
J3	CONN, CABLE, 24-PIN, MODIFIED	534107	89536	534107	1		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458935	89536	458935	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE, MODIFIED	456079	89536	456079	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	441022	89536	441022	REF		
MP6	DECAL, IEEE INTERFACE ASSY	413518	89536	413518	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	COIL, SPRING (NOT SHOWN)	424465	83553	C0120-014-0380	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	1		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
R3	RES, DEP CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R4	RES, DEP CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	1		
R5	RES, DEP CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	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	®IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U2	®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	®IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	2	1	
U5	®IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	3	1	
U6	®IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U7	®IC, COS/MOS, TRIPLE, 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U8	®IC, COS/MOS, QUAD, 2-INPUT, NOR GATES	355172	02735	CD4001AE	REF		
U9	®IC, C-MOS, DCDR/MULTIPLEXER	408369	04713	MC14556CP	1	1	
U10	®IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	
U11	®IC, COS/MOS, DUAL, JK MASTER FLIP FLOP	355230	02735	CD4027AE	2	1	
U12	®IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	

Table 605-7. IEEE-488-1975 Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U13	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U14	⊗IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U15	⊗IC, COS/MOS, DUAL, JK MASTER FLIP FLOP	355230	02735	CD4027AE	REF		
U16	⊗IC, C-MOS, QUAD, 2-INPUT, NAND	404632	02735	CD4093BE	1	1	
U17	⊗IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	REF		
U18	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U19	⊗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	⊗IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	2	1	
U24	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U25	⊗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	⊗IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	3	1	
U29	⊗IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	REF		
U30	⊗IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U31	⊗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		

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

2 ONE OR THE OTHER WILL BE INSTALLED.

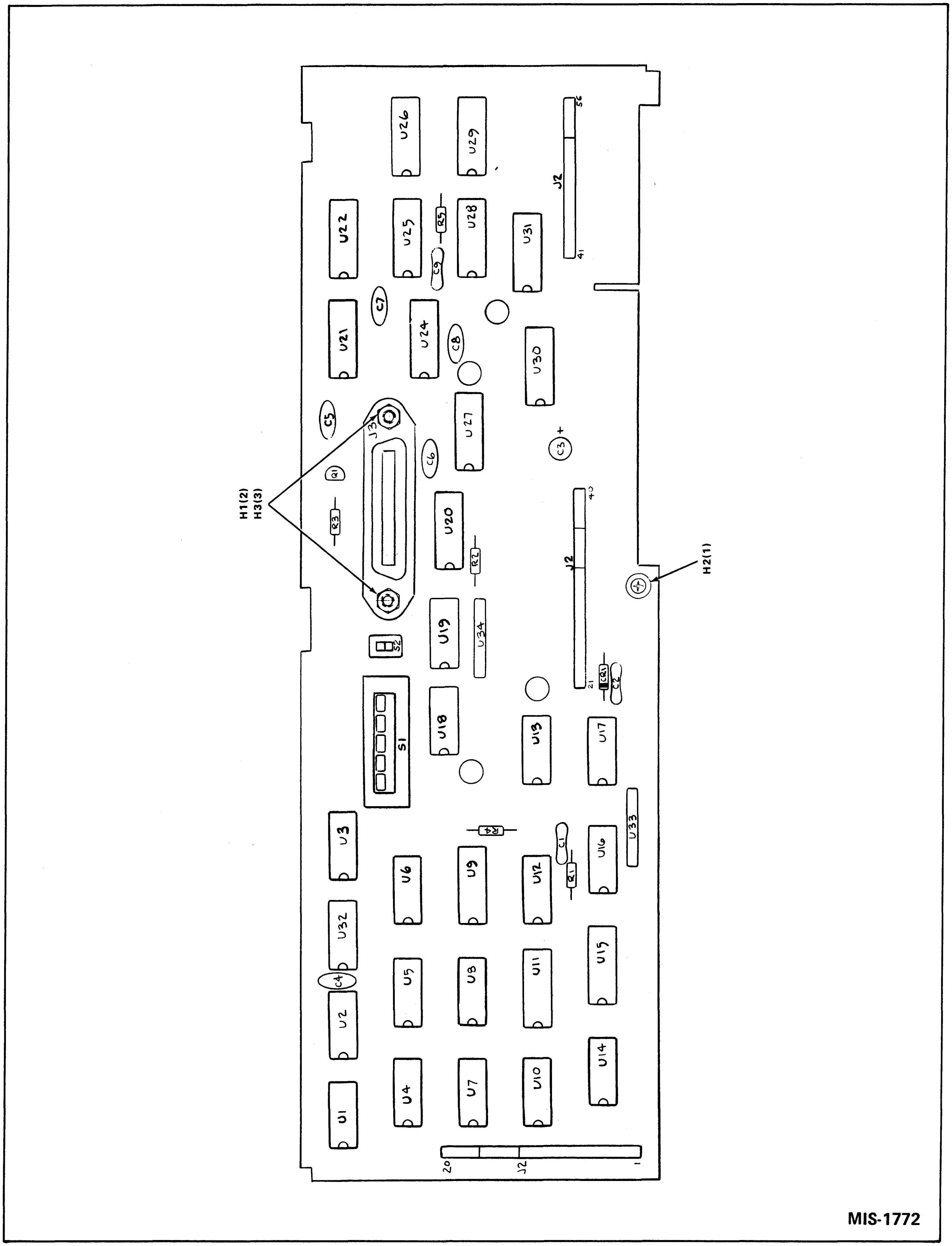
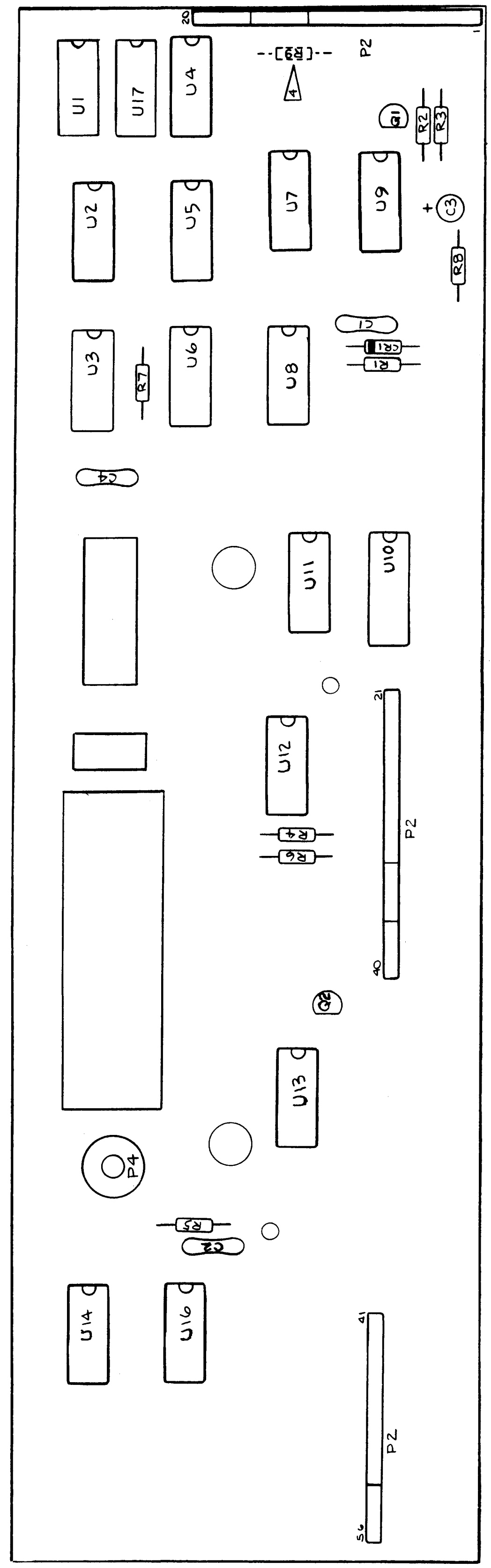


Figure 605-2. IEEE-488-1975 Interface PCB Assembly

Table 605-8.. IEEE-488-1975 Piggyback PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-05P	IEEE-488-1975 PIGGY BACK PCB ASSEMBLY FIGURE 605-3 (MIS-4074)	PART	OF	OPTION -05			
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 (W/P4)	200980	86928	5710-65-16	1		
H2	WASHER, INT LOCK, 1/4 INCH (W/P4)	110817	73734	1308	1		
P2	CONNECTOR, SOCKET, 20 PIN	447110	30035	SK-109-1-20	2		
	CONNECTOR, SOCKET, 16 PIN	447102	20447	SS-109-1-16	1		
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, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R2	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	2		
R3	RES, DEP CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R4	RES, DEP CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R5	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R6	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	REF		
R7	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R9	RES, SELECTED AT TEST						
U1	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	4	1	
U2	⊗IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	2	1	
U3	⊗IC, C-MOS, QUAD, 2-INPUT NAND GATE	404632	02735	CD4093BE	1	1	
U4	⊗IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U5	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U6	⊗IC, COS/MOS, DUAL, 4-INPUT NOR GATES	363820	02735	CD4002AE	1	1	
U7	⊗IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	⊗IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	2	1	
U9	⊗IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	REF		
U10	⊗IC, C-MOS, HEX INVERTER BUFFERS	381848	02735	CD4049AE	1	1	
U11	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U12	⊗IC, C-MOS, TRIPLE 3-INPUT AND GATES	408807	02735	CD4073BE	1	1	
U13	⊗IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U14	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U16	⊗IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U17	⊗IC, C-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	



MIS-1674

Figure 605-3. IEEE-488-1975 Piggyback PCB Assembly

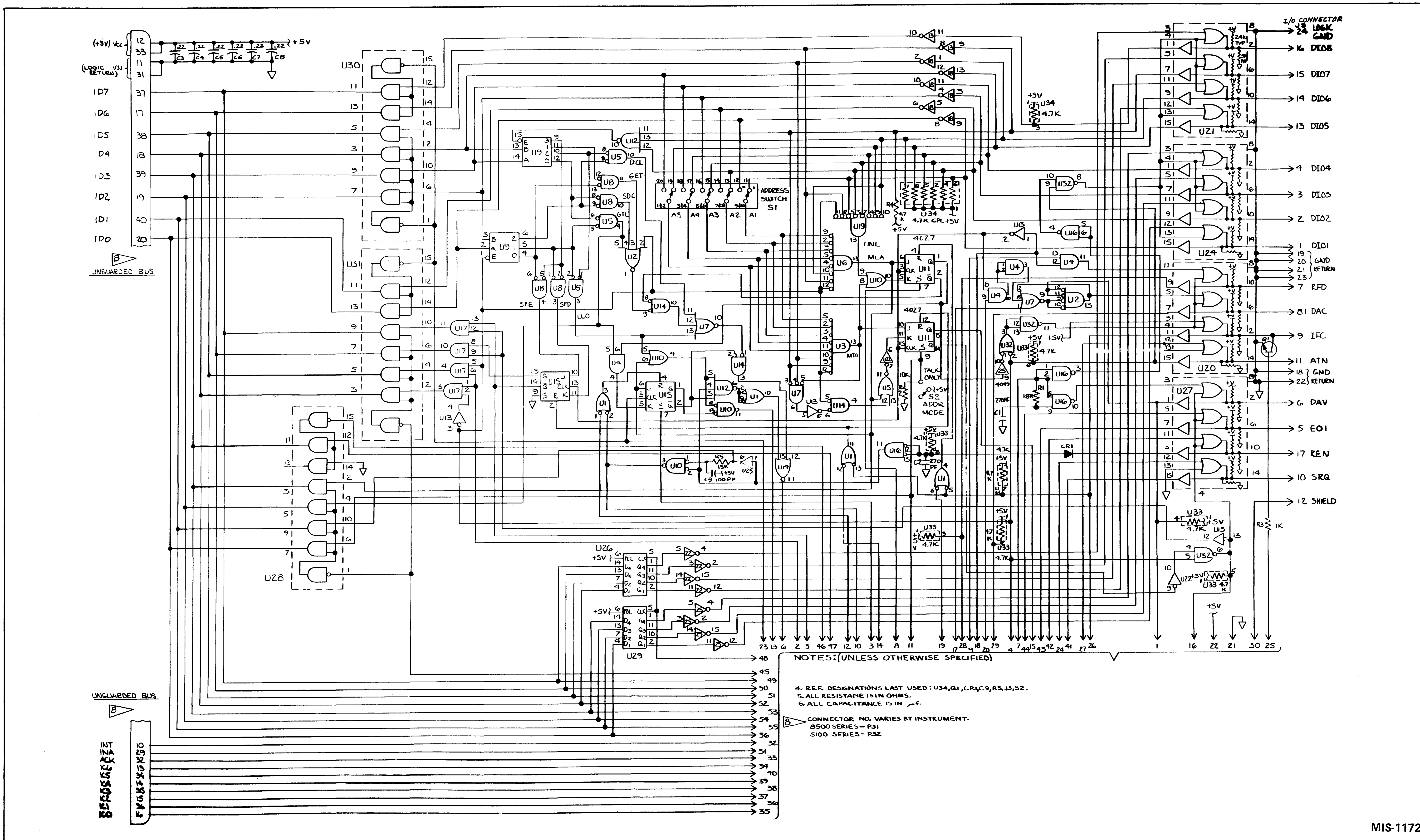
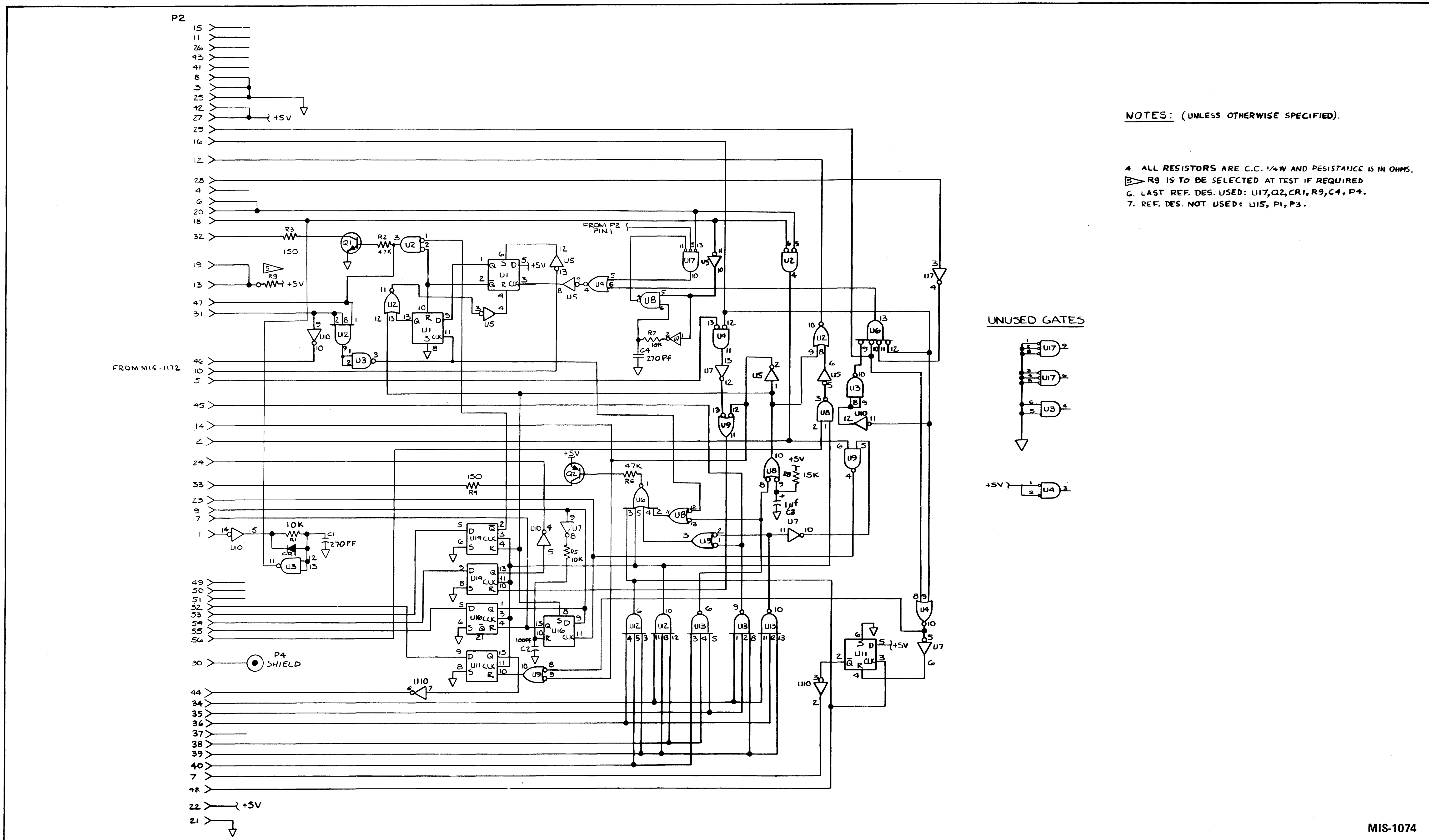


Figure 605-4. IEEE-488-1975 Interface
PCB Assembly



NOTES: (UNLESS OTHERWISE SPECIFIED).

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: U17, Q2, CR1, R9, C4, P4.
7. REF. DES. NOT USED: U15, P1, P3.

Figure 605-5. IEEE-488-1975 Piggyback PCB Assembly

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.

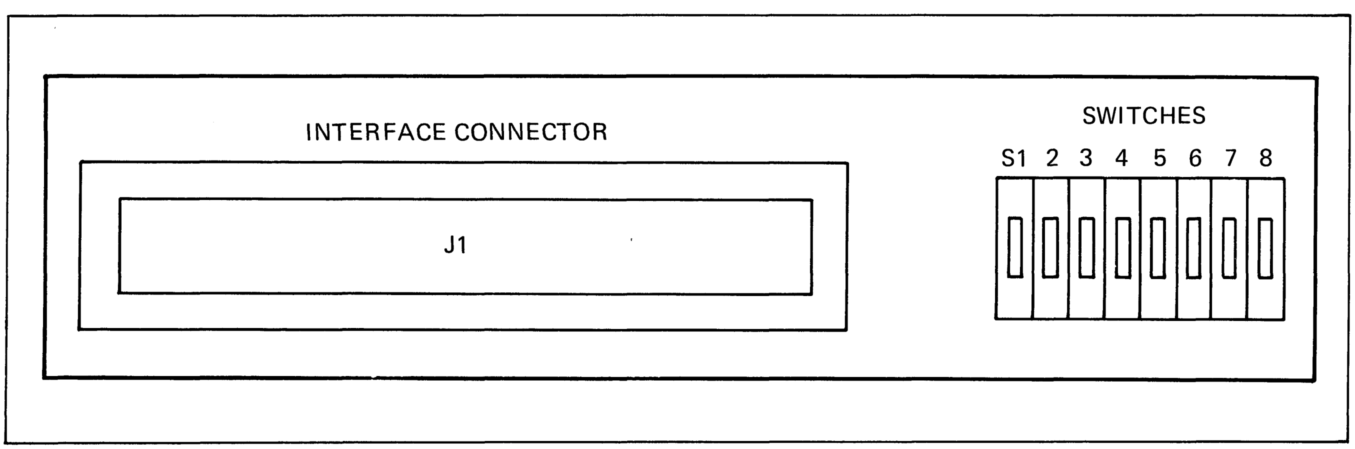


Figure 606-1. Rear Panel Access

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 progammable 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
	NOTE *The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.*		
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:

	REMOTE CODE	COMMAND
	V	Volts DC
	R4	1000V range
◆	S5 (8500A)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 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

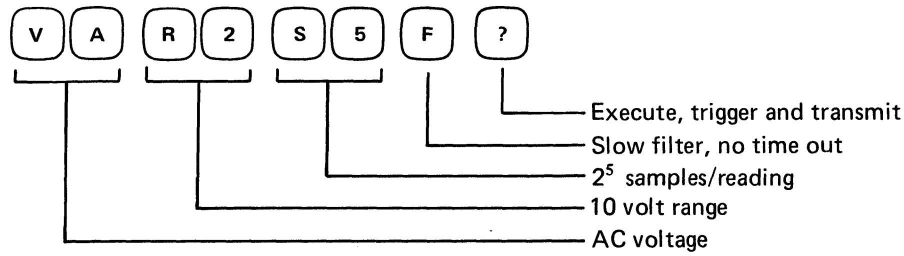
*Retained if Cal Memory Option -04 installed

Table 606-5. Programming Instructions (cont)

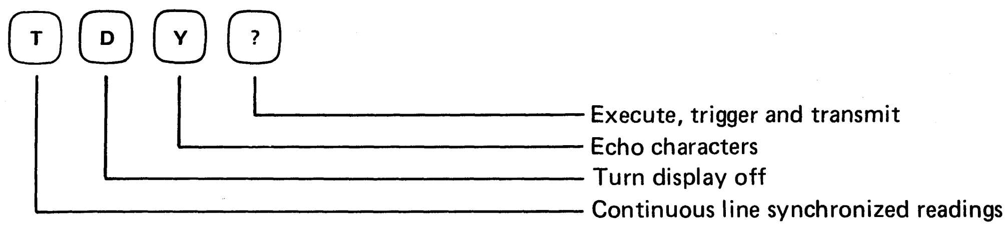
PROGRAM SEQUENCE

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:

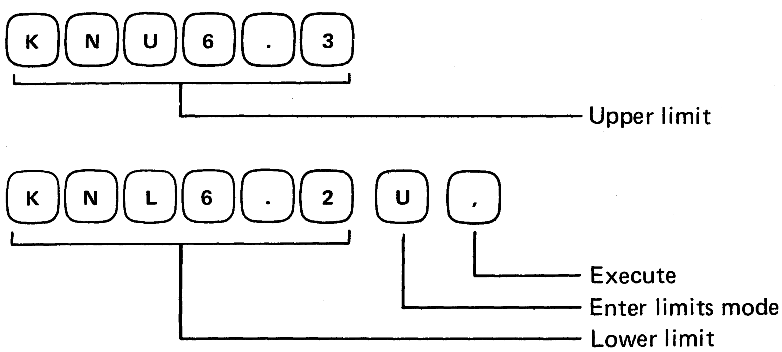
1.



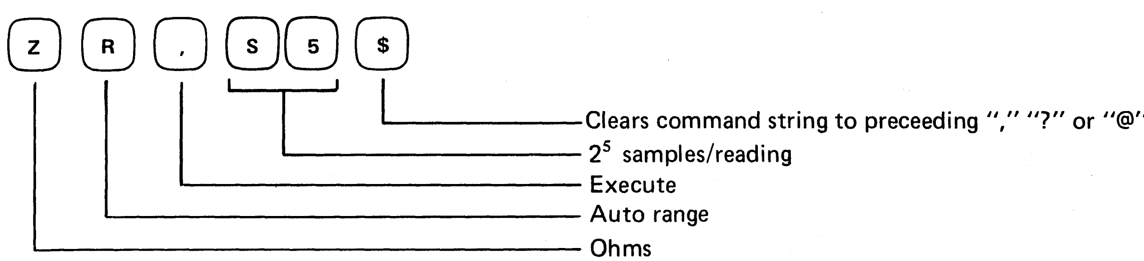
2.



3.



4.



5.

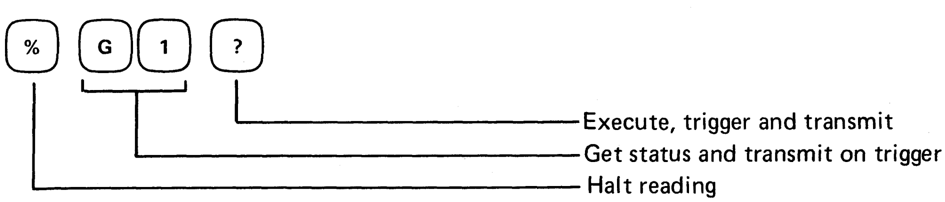


Table 606-5. Programming Instructions (cont)

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 2^7 (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.

BYTE 1	BYTE 2	BYTE 3
1 1 1 1 0 1 1 1	1 0 1 1 1 1 1 1	1 1 1 1 1 1 1 1

Implied Binary Point
Error Bit
Sign Bits

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.

0 0 0 0 1 0 0 0	+	0 1 0 0 0 0 0 0	+	0 0 0 0 0 0 0 1
− (0 . 5	+	.015625 0	+	0 .000001)

= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$[R_t = R_{AD}$ X 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 immmediate 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.

V **DC Volts**

V **A** **AC Volts**

C **DC Coupled AC Volts**

I **DC Current**

I **A** **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:

$$Rx = Rr \frac{V0}{V1\text{-}V2}$$

Fast Ohms mode differs in that the value of $\frac{Rr}{(V1\text{-}V2)}$ is stored as a constant. The instrument will the 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
R	Auto	Auto	Auto	Auto
R 0	312 mV	Auto	312 μA	31.25Ω
R 1	2.5V	2.5V	2.5 mA	250Ω
R 2	20V	20V	20 mA	2 kΩ
R 3	160V	160V	160 mA	32 kΩ
R 4	1200V	1000V	1.28A	256 kΩ
R 5	Auto	Auto	Auto	4.096 MΩ
R 6	Auto	Auto	Auto	32.768 MΩ
R 7	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.

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

F	**Slow filter, time-out disabled.**
F 0	**Fast filter, time-out disabled.**
F 1	**Bypass filter.**
F 2	**Slow filter, time-out enabled (approximately 500 ms).**
F 3	**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.

T	**Continuous reading mode/line synchronized.**
T 0	**Single reading mode/line synchronized.**
T 1	**Continuous reading mode/line asynchronous.**
T 2	**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).

P **Offset subtracted (ON).**

P 0 **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.

X **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 = ±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 = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 606-5. Programming Instructions (cont)

X 0	**External Reference Off, Scaling Off**	
X 1	**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 valued may not be used as a scaling factor. NOTE *The 8502A can store the external reference voltage and the numerical scale factor separately. The 8500A can only store one or the other, not both.* ◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A. ◆ For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor. Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor <10^{-9} (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.

U	**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).
U 0	**Disable Limits and Peak Mode(s)**	
U 1	**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 0 **Single Byte ASCII Format**

● B 1 **Binary 16-Bit Parallel**

● B 2 **16-Bit Parallel**

"B1","B2" used with Paralled 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.

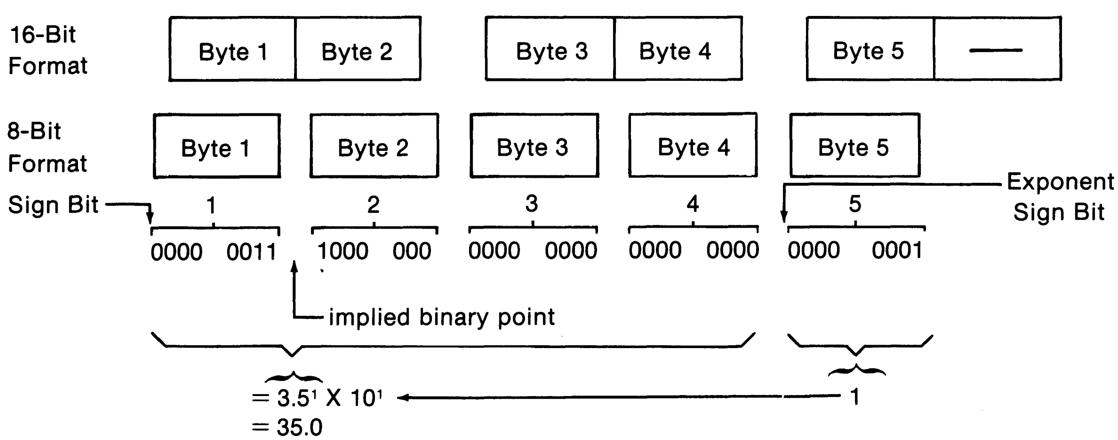


Table 606-5. Programming Instructions (cont)

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

+/-	Digit 1,2,3 and decimal point				Digits 4, 5, 6, 7				E	+/-	Exp	CR	LF
1	2	3	4	5	6	7	8	9	10	11	12	13	14

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 0 **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 0 **Local Lockout Off**

ECHO COMMAND CHARACTERS

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

Y **ECHO ON (Full-Duplex)**

Y 0 **ECHO OFF (Half-Duplex)**

Table 606-5. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings**	◆ 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.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

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

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	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.

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

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 0	**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 X 10^{-1} or 1.03

K N U 7 . 6 E 4

Keep numeric upper limit of 7.6 X 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:

K N X 2 . 0 E - 1 3

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 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 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 μA, 10Ω
1 1V dc, 1V ac, 1 mA, 100Ω
2 10V dc, 10V ac, 10 mA, 1kΩ
3 100V dc, 100V ac, 100 mA, 10 kΩ
4 1000V dc, 1000V ac, 1A, 100 kΩ
5 1 MΩ
6 10 MΩ
7 100 MΩ

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 PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-06	⊗BIT SERIAL ASYNCHRONOUS INTERFACE ASSY FIGURE 606-2 (MIS-4170T)	ORDER	BY	OPTION -06			
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	3		
C2	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP, TA, 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, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	SCREW, FHP, U/C, 6-32 X 1/4 (NOT SHOWN)	320093	89536	320093	2		
H2	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H3	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
J1	CONNECTOR, D, SUB-MINI	413898	71785	DB25PV	1		
MP1	CASE ASSY (INCLUDES MP2-MP9)	458943	89536	458943	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE, MODIFIED	412031	89536	412031	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411983	89536	411983	REF		
MP6	DECAL, BIT SERIAL INTERFACE	413492	89536	413492	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	SHIELD, FRONT	383372	89536	383372	1		
MP10	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
MP11	SPRING CLIP ASSY KIT	330134	02660	17-529	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, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R2	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R5	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
R6	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	1		
R7	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R8	RES, DEP. CAR, 2.2K +/-5%, 1/4	343400	80031	CR251-4-5P2K2	1		
R9	RES, DEP. CAR, 47 +/-5%, 1/4W	441592	80031	CR251-4-5P47E	1		
R10	RES, DEP. CAR, 750 +/-5%, 1/4W	441659	80031	CR251-4-5P750E	1		
R11	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	3		
R12	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R13	RES, DEP. CAR, 620 +/-5%, 1/4W	442319	80031	CR251-4-5P620E	1		
R14	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R15	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	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 BUFFER INVERTER	381848	02735	CD4049UBE	1	1	
U3	⊗IC, C-MOS, PRGMBLE BIT RATE GEN	418731	07263	F4702/34702	1	1	

Table 606-6. Bit Serial Asynchronous Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U4	IC, TTL, MSI, DUAL EIA/MTL	354696	18324	N8T15A	1	1	
U5	⊗ IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U6	⊗ IC, C-MOS, NAND GATES, TRIPLE, 3-INPUT	375147	02735	CD4023AE	2	1	
U7	⊗ IC, C-MOS, NAND GATES, TRIPLE, 3-INPUT	375147	02735	CD4023AE	REF		
U8	⊗ 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	⊗ IC, C-MOS, TRIPLE, 3-INPUT AND GATE	408807	02735	CD4073BE	1	1	
U11	⊗ IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U12	⊗ IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	1	1	
U13	⊗ 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		

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

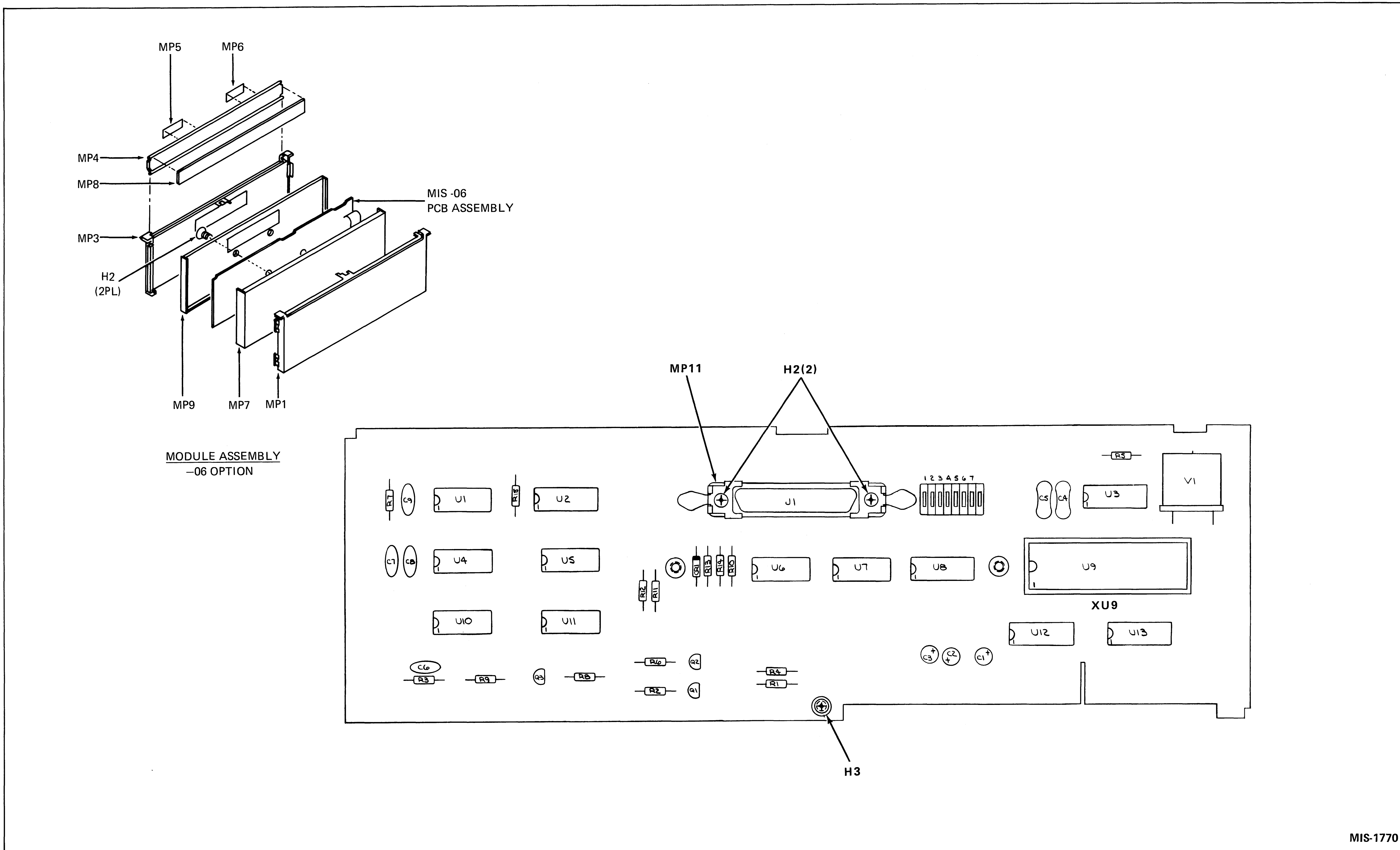


Figure 606-2. Bit Serial Asynchronous Interface PCB Assembly

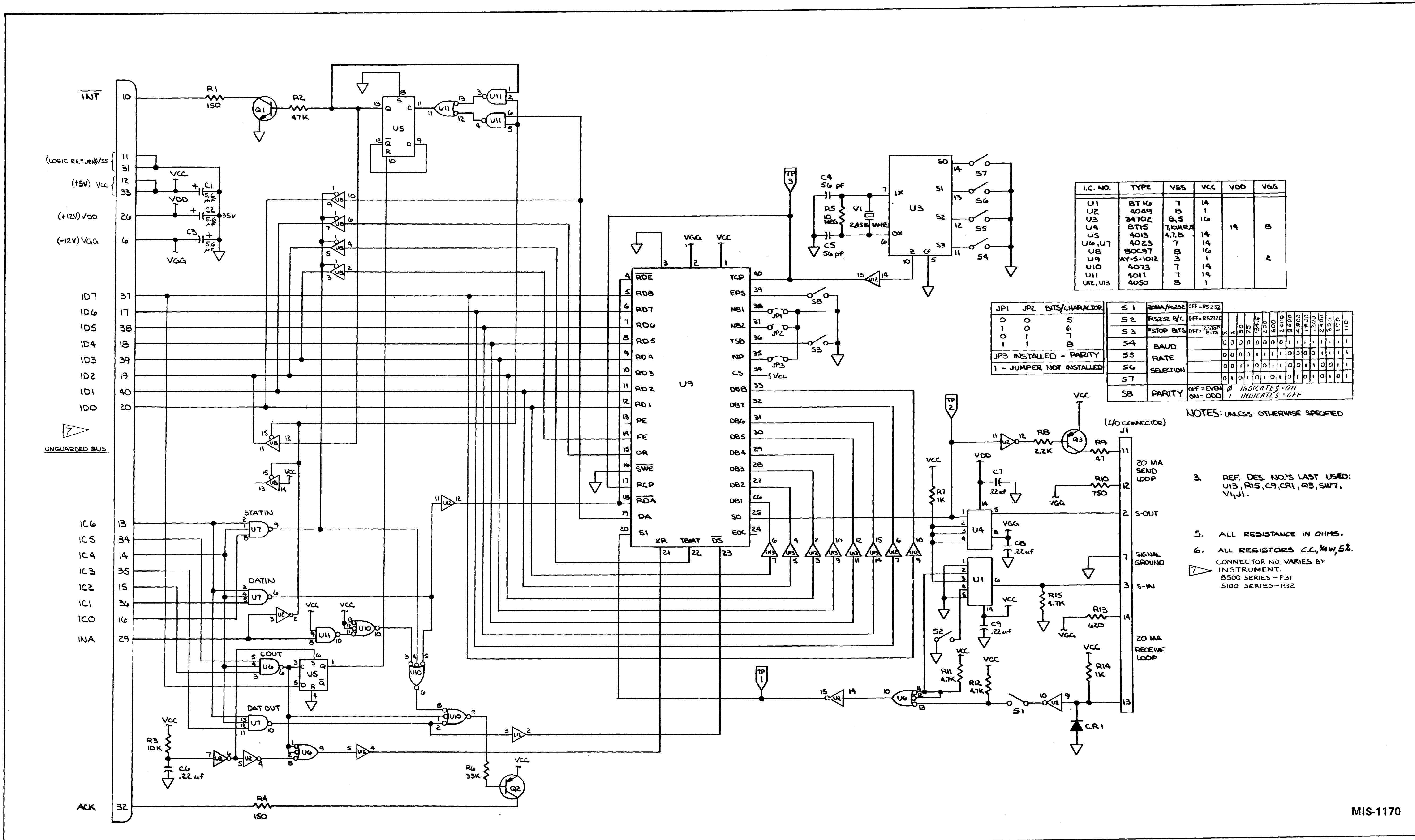


Figure 606-2. Bit Serial Asynchronous Interface PCB Assembly (cont)

Option -07
Parallel Interface

607-1. INTRODUCTION

607-2. Installation of the Parallel Interface provides external programming capability in mini- and microcomputer systems. Program inputs must be in ASCII code. Outputs are remotely selectable between ASCII or binary (2's complement) and 8 or 16 bit characters.

607-3. Interfacing to a wide variety of devices is accomplished with a plug-in header termed a "personality card". By defining the pins, this card can be tailored to perform control of the DMM through the external device. Table 607-1 lists pins and definitions for the personality card. The personality card plugs into J2, as seen in Figure 607-1. Available personality cards are listed in Table 607-2.

607-4. Descriptions unique to the Parallel Interface will be provided separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Fluke Application Bulletin #25 contains useful information concerning the use of the Parallel Interface.

Table 607-1. Personality Card Pin Definition

PIN NO.	INTERFACE MNEMONIC	BOARD - PIN DEFINITION
1	COS-B	= Control Output Strobe Buffered
2	$\overline{\text{COS-B}}$	= Control Output Strobe Inverted Buffered
3	COS	= Control Output Strobe
4	OR2A	= OR Gate 2 Input A
5	OR2B	= OR Gate 2 Input B
6	OR2A + OR2B	= OR Gate 2 Output
7	$\overline{\text{COS-B}}$	= Control Output Strobe Inverted Buffered
8	COEN	= LSB Output Enable
9	DOEN	= MSB Output Enable
10	OSLE	= Output Strobe Latch Enable
11	ILAT	= Data Input MSB Latch
12	SLAT	= Control Input LSB Latch
13	ISLE	= Input Strobe Latch Enable
14	ILS	= Data Input Latch Strobe

Table 607-1. Personality Card Pin Definition (cont)

PIN NO.	INTERFACE MNEMONIC	BOARD-PIN DEFINITION
15	SLS	= Control Input Latch Strobe
16	DLR	= Data Output Latch Reset
17	CLR	= Control Output Latch Reset
18	QP	= High Output Delay Pulse
19	GND	= Ground
20	VCC	= +5V dc
21	$\overline{\text{INT}}$	= Interrupt Clock
22	$\overline{\text{CIS}}$	= Control Input Strobe Clock Inverted
23	$\overline{\text{QP}}$	= Low Output Delay Pulse
24	$\overline{\text{CIS-B}}$	= Control Input Strobe Inverted Buffered
25	$\overline{\text{IQ}}$	= Data Input Ready Low
26	IQ	= Data Input Ready High
27	$\overline{\text{DQ}}$	= Data Output Ready Low
28	DQ	= Data Output Ready High
29	TTL PU	= TTL Pull Up
30	OR1A	= OR Gate 1 Input A
31	OR1B	= OR Gate 1 Input B
32	OR1A + OR1B	= OR Gate 1 Output
33	$\overline{\text{CIS B}}$	= Control Input Strobe Inverted Buffered
34	CIS B	= Control Input Strobe Buffered
35	CIS	= Control Input Strobe
36	NC	= No Connection
37	HT	= High Trigger Delay Pulse
38	$\overline{\text{COR}}$	= Control Output Ready Inverted
39	LT	= Low Trigger Delay Pulse
40	$\overline{\text{CIR}}$	= Control Input Ready Inverted

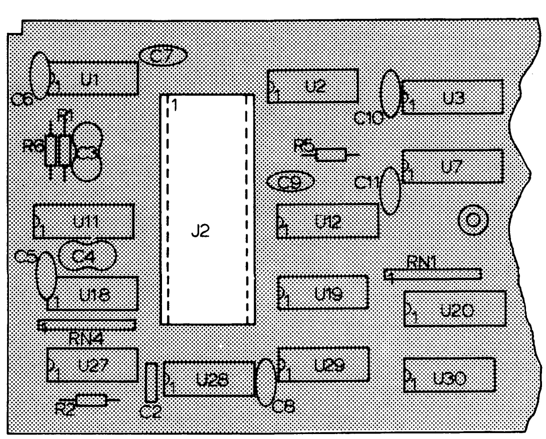


Figure 607-1. Personality Card Location

Table 607-2. Personality Cards

DESIGNATION	DESCRIPTION
-07A	Duplex Parallel Interface for PDP-11, DR11C, DRV-11.
-07B	Duplex Parallel Interface for PDP-11, PC11.
-07D	Duplex Parallel Interface (wiring completed by user).
-07H	Duplex Parallel Interface for HP12566B, 9825A.
-07L	Similar to the 07A, but used in noisier systems.

607-5. INSTALLATION

607-6. The Parallel 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. Ensure that the desired personality card is installed on the Interface PCB. If necessary, refer to "Module Disassembly" in Section 4 of the Instruction Manual when accessing the Interface PCB.

NOTE

If the -07L Personality Card is used remove jumpers W1 and W2 from the Interface PCB.

4. Plug the personality card into J2 on the Parallel Interface PCB. The location of J2 is illustrated in Figure 607-1.

5. Reassemble the module (PCB and shield covers).

6. The Interface module fits in the rearmost slot, bus connector and address switches facing 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.

7. Remove the Interconnect PCB, if installed, from slot K. This slot can be identified as the only one 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. 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.

8. Replace the DMM's top cover.

9. Energize the DMM.

607-7. OPERATING DIRECTIONS

607-8. The normal power-up condition of the Parallel Interface is eight-bit ASCII input and output. Command codes can change this to 16-bit ASCII input (two characters per transfer), 16-bit ASCII output, 8-bit Binary output, or 16-bit Binary output in character serial format.

607-9. When the front panel remote switch is pressed on the 8500A, the DMM stops measurements and waits for stimulation from the external device. On the 8502A, pressing the front panel remote switch results in the Parallel Interface trying to output data (ASCII 8-bit) in a continuous talk only mode.

607-10. THEORY OF OPERATION

607-11. Block Diagram Analysis

607-12. Data transfer through the Parallel Interface involves handshake processes between the interface and either the system controller or the instrument controller. Refer to the Block Diagram, Figure 607-2, during the following descriptions.

607-13. At power on, a reset circuit in the interface holds the control latches in the proper state until Vcc stabilizes. The instrument controller sends a software reset and an interrupt enable signal to the interface during its power on routine. This enables I/O operations to proceed.

607-14. This paragraph describes a typical two-wire handshake process for transferring commands through the interface to the DMM. Before the system controller attempts to send data to the instrument it verifies that the DMM is ready to accept the data. If the Control Input Ready (CIR) handshake signal indicates the DMM is ready, the system controller can strobe the Control Input Strobe (CIS) handshake signal line. The CIS has three functions. One clocks the input data placed by system controller on the input lines into the data input latches of the -07 interface. The second generates an interrupt request to the instrument controller. The last toggles the CIR handshake signal to indicate that the DMM is not ready and cannot accept additional input data. The CIS interrupts the DMM which responds by accepting the input data from the -07 interface data input latches and toggling the CIR handshake signal to indicate that the -07 interface is now ready to accept additional data from the system controller. This process is repeated for each input operation

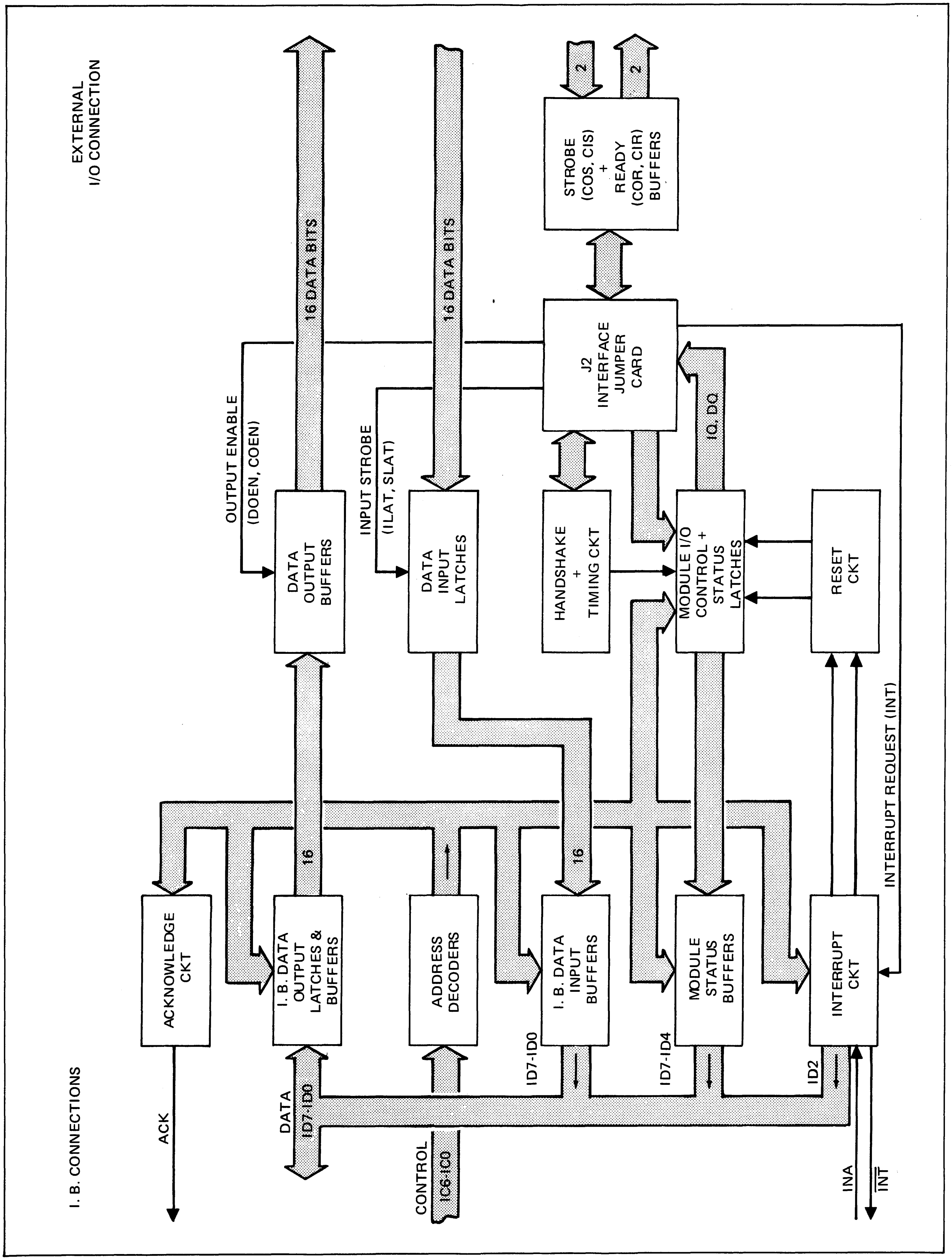


Figure 607-2. Parallel Interface Block Diagram

607-15. A typical two-wire data output transaction from the DMM is handled in a similar manner to the command input operation described above. When a data output transaction is initiated the instrument loads the data into the data output latches of the -07 interface and toggles the Control Output Ready (COR) handshake signal. This indicates that the -07 interface contains data to be transferred to the receiving device. The receiving device may accept the output data via the Data Out/Control Out Signal lines while enabling the Data Output Buffers. The receiving device strobes the Control Output Strobe (COS) handshake signal line either while or after it accepts the data. This toggles the COR handshake signal to indicate acceptance of the previously output data and to permit subsequent data output operations to occur. This process is repeated for each output operation.

607-16. Due to the wide variety of handshaking protocols, a personality card is used to match the logical and electrical characteristics of the system interface handshake signals to the -07 interface circuitry. The personality card connects the handshake lines to interface control and status signals. However, if the handshake protocol warrants additional circuitry may be used in the personality card connection configuration. The additional circuitry may be from either logic and timing circuitry existing on the -07 interface PCB, or additional circuitry on the personality card. Typical personality card connections have I-LAT, S-LAT, $\overline{\text{INT}}$, and SLS stimulated through the CIS handshake signal and CIR stimulated by IQ for input operations. I-LAT and S-LAT are used to store input data over the Data In and Control In signal lines. $\overline{\text{INT}}$ is used to generate the interrupt request to the instrument controller. SLS toggles the CIR signal. For output operations, COR is stimulated through DQ and COS stimulated by CLR. CLR toggles the COS signal.

607-17. Circuit Analysis

607-18. The following circuit analysis is accurate for Parallel Interface with Personality Card DR11C (4062) installed; control signals COS, CIS, COR, and CIR are therefore positive true logic. Refer to the Schematic Diagram during the following circuit descriptions. Table 607-3 defines interface connections.

607-19. RESETS

607-20. Power up resets are controlled by the RC network connected to U19-13. The reset signal is applied through U1-11 and U8-4 to the control latches (U29-8 and U28-8 are reset, while U29-5 and U28-5 are set). Address IC5, 3, 2, decoded by U25-10, provides software resets.

607-21. ADDRESSES

607-22. For all addresses, an ACK response is returned to the instrument controller through U31-10 and Q1. Upon termination of the address, U30-12 is clocked. If ID7 is high, the interface is reset through U23-10, U23-11 and U19-12 and interrrupts are disabled. If ID7 is low at address IC5, 3, and 2, interrupts are enabled, U30-12 goes high. Since U30-2 was reset, U19-6 is high; U19-4 places a high on U30-5. When U30-2 is clocked, an interrupt will be generated from U20-11. When triggered by U19-10, U11-12 goes low to clear U29-5 and U28-5. The signal from U28-5, routed through the personality card to generate CIR, indicates to the system controller that the instrument is ready to receive data.

607-23. DATA INPUTS

607-24. The system controller strobes the CIS line to make U2-2 low and applies it through the personality card to I-LAT, S-LAT, and LT. U2-4 also goes high and is applied to SLS through the personality card. I-LAT and S-LAT from the personality card clock the input data on the Data In and Control In lines into the data latches U3, U7, U13, and U14 at the termination of the CIS strobe. The termination of CIS also triggers a pulse (QP) at U11-2 through the LT signal at U11-1 which connects through the personality card to $\overline{\text{INT}}$. $\overline{\text{INT}}$, through U19-10, clocks U30-2 which enables the tri-state U20-11 to interrupt the instrument controller. SLS, through U18-8 and U27-4 clocks U28-5 (IQ) high. IQ, through the personality card and U2-6, drives CIR to indicate to the system controller that the -07 interface is not ready to accept additional data. The instrument controller responds to $\overline{\text{INT}}$ with an $\overline{\text{INA}}$ which drives U8-2 low to enable tri-state U12-13 to place a high (from U30-1) on ID2 for use as the interrupt vector in the instrument controller. INA is also applied directly to U23-2 which drives U23-3 and U19-10 low to cause an ACK response. Termination of INA clocks U30-1 low, ending the interrupt signal.

607-25. The interrupt vector tells the instrument controller to read data out of the interface. Address IC1, 4, 6 is decoded by U24-10 to enable tri-state buffers U12, U21 and U22. The low from U24-10 is applied through U27-4 to the clock input of U28-5. Termination of the address clocks IQ (U28-4) low. This state, transferred through the personality card and U2-6, causes CIR to go high and signals the system controller that the instrument is ready for more data.

607-26. In the double character mode, data of the most significant byte (DATA IN) is read first and the least significant byte (CONTROL IN) is read second. In the data output mode the MSB is loaded first. All termination and immediate command characters must use the CONTROL IN data lines.

607-27. DATA OUTPUTS

607-28. Data bytes are loaded into data latches U15, U16, U17, and U26 by addresses IC0, 3, 5 (decoded by U25-9) and IC1, 3, 5 (decoded by U25-6). Termination of the addresses also clock DQ (U28-8) low. Applied through the personality card to U2-8, this low sets COR high. The receiving device now sees that data is ready to be read from the interface.

607-29. The COS strobe is used by the receiving device to complete the output handshake. Since data output buffers U4, U5, and U6 are enabled by DOEN and COEN low through personality card connections, output data is available on Data Out and Control Out lines. The COS strobe is generated, either while or after, the receiving device accepts the data. A high on U2-10 from COS is applied through the personality card to the CLR line (U18-4) and eventually to the clock input of DQ (U28-11). Termination of COS clocks DQ high which toggles COR and informs the instrument controller that more data may be transferred to the receiving device via the -07 interface.

607-30. One complete reading in the 16-bit mode consists of seven transfers in ASCII (six with line feed suppression), or three transfers in binary code. Each reading in the eight bit mode consists of fourteen transfers in ASCII (thirteen with line feed suppression) or five transfers in binary code. When a complete reading has been sent in either mode, the instrument controller resets the interface and enables interrupts. CIR goes high to indicate that the instrument is ready to receive data.

607-31. Detailed Input Processes Description

607-32. For a graphical representation of the signal timing relationships, refer to Figure 607-3 and Table 607-4. Before inputting any information to the DMM, the -07 interface must indicate that it is ready to accept input data. This is

Table 607-3. Parallel Interface Connections

TITLE	MNEMONIC	J1 PIN NO.	SIGNAL FLOW
Input Strobe	CIS	31	From Control Device
Output Strobe	COS	37	From Control Device
MSD Bit 15 Input	I7	14	From Control Device
MSD Bit 14 Input	I6	15	From Control Device
MSD Bit 13 Input	I5	16	From Control Device
MSD Bit 12 Input	I4	17	From Control Device
MSD Bit 11 Input	I3	18	From Control Device
MSD Bit 10 Input	I2	19	From Control Device
MSD Bit 9 Input	I1	20	From Control Device
MSD Bit 8 Input	I0	21	From Control Device
LSD Bit 7 Input	S7	6	From Control Device
LSD Bit 6 Input	S6	7	From Control Device
LSD Bit 5 Input	S5	8	From Control Device
LSD Bit 4 Input	S4	9	From Control Device
LSD Bit 3 Input	S3	10	From Control Device
LSD Bit 2 Input	S2	11	From Control Device
LSD Bit 1 Input	S1	12	From Control Device
LSD Bit 0 Input	S0	13	From Control Device
Output Ready	COR	1	To Control Device
Input Ready	CIR	29	To Control Device
MSD Bit 15 Output	D7	46	To Control Device
MSD Bit 14 Output	D6	45	To Control Device
MSD Bit 13 Output	D5	44	To Control Device
MSD Bit 12 Output	D4	43	To Control Device
MSD Bit 11 Output	D3	42	To Control Device
MSD Bit 10 Output	D2	41	To Control Device
MSD Bit 9 Output	D1	40	To Control Device
MSD Bit 8 Output	D0	39	To Control Device
LSD Bit 7 Output	C7	22	To Control Device
LSD Bit 6 Output	C6	23	To Control Device
LSD Bit 5 Output	C5	24	To Control Device
LSD Bit 4 Output	C4	25	To Control Device
LSD Bit 3 Output	C3	50	To Control Device
LSD Bit 2 Output	C2	49	To Control Device
LSD Bit 1 Output	C1	48	To Control Device
LSD Bit 0 Output	C0	47	To Control Device

reflected by Data Input Ready Indicator, IQ or $\overline{IQ}$. The Data Ready Indicator, DQ, is at a low level when the DMM is ready to accept data (prior to T9). (Conversely, $\overline{DQ}$ is at a high level to reflect this condition.) With this indicating ready, data on data lines I0-I7 and S0-S7 if appropriate, can be strobed into the data latches. This is done by a low to high transition on ILAT and SLAT as appropriate (T4). (S0-S7 and SLAT are only used for 16 bit mode input operations.)

607-33. The Data Input Ready Indicator must be toggled to reflect that the interface is no longer able to accept data. ISLE and SLS are used to toggle Data Input Ready. The logical NAND of ISLE and SLS is formed. This signal is termed $\overline{CIS}$. With both ISLE and SLS in a high state, the high to low transition of SLS toggles the Indicator (T7). $\overline{CIS}$ is low with both ISLE and SLS high. The high to low transition of SLS causes a low to high transition on $\overline{CIS}$ (T8), toggling the Data Input Ready Indicator (T9). $\overline{CIS}$ must remain high until the input cycle is complete. This means that both ISLE and SLS must not be high simultaneously again until the completion of the input cycle (T12).

607-34. To initiate processing of the data from the interface into the DMM, a low going pulse must be placed on $\overline{INT}$. Its trailing edge initiates the activity (T13). $\overline{INT}$ must not again make a low to high transition until the subsequent input transaction.

607-35. Following the $\overline{INT}$ signal, the DMM is processing the data from its interface. When it has completed this processing, it will toggle the Data Input Ready Indicator (T12). When this has occurred, the DMM input operation is complete. Additional data may now be transferred to the interface from the external device as necessary.

607-36. Detailed Output Processes Description

607-37. For a graphical representation of the signal timing relationships, refer to Figure 607-4 and Table 607-5. An output cycle is started by the DMM indicating that its interface contains data to be transferred to the external device. This is shown by the Data Output Ready Indicator, DQ or $\overline{DQ}$. DQ is at a low level and $\overline{DQ}$ is at a high level when output data is available from the DMM (prior to T2).

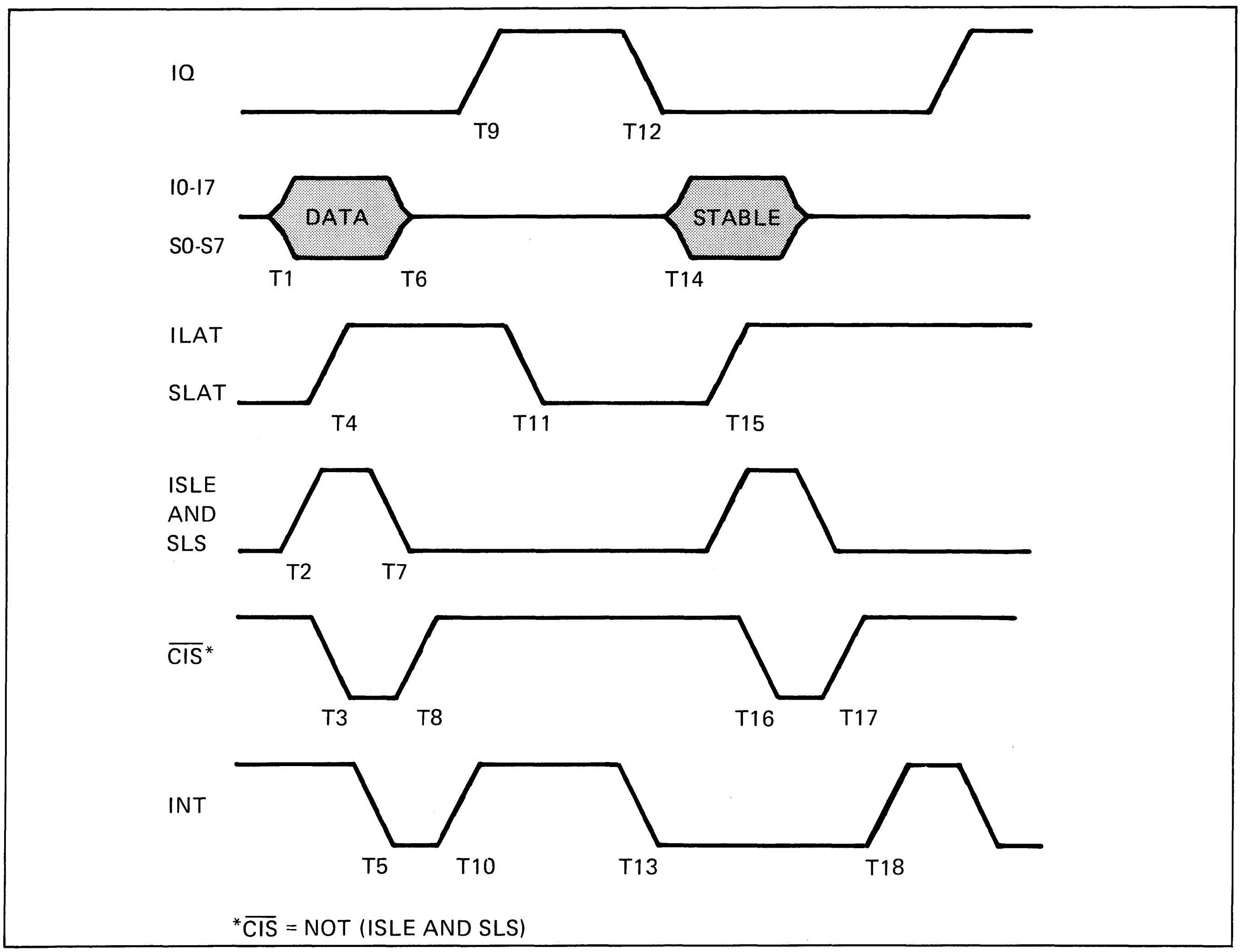


Figure 607-3. Interface Input Control Signal Timing Diagram

Table 607-4. Input Timing Parameters

T_1-T_4	5 ns	Data set up time preceding SLAT or ILAT low to high transition
T_4-T_6	3 ns	Data hold time following SLAT or ILAT low to high transition
T_{12}-T_{14}	0 ns	Minimum wait time following the ready transition of IQ or $\overline{\text{IQ}}$ before new data can be placed on data lines
T_4-T_{11}	10 ns	Minimum time SLAT or ILAT can be high
T_{11}-T_{15}	3 ns	Minimum time SLAT or ILAT can be low
T_3-T_8	250 ns	Maximum time from when ISLE and SLS both become high to the high to low transition of $\overline{\text{CIS}}$
T_7-T_8	250 ns	Maximum time from when either ISLE or SLS become low to when $\overline{\text{CIS}}$ becomes high
T_8-T_9	300 ns	Time for the low to high transition of CIS to toggle IQ or $\overline{\text{IQ}}$
T_{16}-T_{17}	15 ns	Minimum time $\overline{\text{CIS}}$ may be low
T_{12}-T_{16}	0 ns	Minimum wait time following the ready transition of IQ until $\overline{\text{CIS}}$ may enter a low condition
T_5-T_{10}	500 ns	Minimum time for $\overline{\text{INT}}$ to remain low preceding the low to high transition
T_{10}-T_{12}	500 ns	Typical time for IQ or $\overline{\text{IQ}}$ to respond to $\overline{\text{INT}}$ transition (8 bit mode)
	920 ns	Typical time for IQ or $\overline{\text{IQ}}$ to respond to $\overline{\text{INT}}$ transition (16 bit mode)
T_{10}-T_{13}	500 ns	Minimum time $\overline{\text{INT}}$ must remain high
T_{17}-T_{18}	0 ns	Minimum wait time following the $\overline{\text{CIS}}$ transition before the $\overline{\text{INT}}$ transition

607-38. At this point, data is stored in latches on the -07 interface (T3). For this data to be on data lines C0-C7 and D0-D7 if appropriate, the output driver circuitry must be enabled. A low level on COEN enables the data line drivers on C0-C7. Similarly, a low level on DOEN enables data line drivers on D0-D7. D0-D7 need only to be enabled when data is transferred in the two byte, 16 bit format. A high level on either of these enable lines disables the tri-state drive circuitry and presents a high impedance to the appropriate data lines from the interface.

Table 607-5. Output Timing Parameters

T_1-T_3	40 ns	Minimum enabling time for data line driving circuitry
T_{10}-T_{11}	30 ns	Minimum disabling time for data line driving circuitry
T_2-T_3	1170 ns	Minimum time from data ready transition until valid data
T_2-T_4	0 ns	Minimum time following ready transition until start of ready toggle pulse
T_4-T_5	250 ns	Maximum time from when both CLR and OSLE become high until $\overline{\text{DQTGL}}$ makes a high to low transition
T_6-T_7	250 ns	Maximum time for $\overline{\text{DQTGL}}$ to make a low to high transition following either CLR or OSLE becoming high
T_5-T_7	15 ns	Minimum ready toggle pulse time
T_7-T_8	315 ns	Time to toggle the ready indicator following the toggle pulse
T_8-T_9	1 us	Time following ready indicator toggle before data is not valid

607-39. With the acceptance of the data from the interface, the external device must toggle the Data Output Ready Indicator. This indicates that the output cycle is complete. Subsequent operations may then proceed (such as another output cycle, another measurement, subsequent command processing, etc.). To toggle the Data Output Ready Indicator, OSLE and CLR are used. OSLE and CLR are NANDed together to generate the signal which toggles the Data Output Ready Indicator. (This combined signal is termed $\overline{\text{DQTGL}}$ in the timing diagram.) A rising edge on this signal toggles the indicator (T7). From the completion of the previous output cycle, OSLE and CLR cannot both be at a high level simultaneously. One or the other or both must be low at all times. To toggle the indicator, both OSLE and CLR should be at or change to a high state (T4), and then CLR should make a high to low transition (T6). The Output Data Ready Indicator toggles (T8) and completes the output cycle.

607-40. TROUBLESHOOTING

607-41. Troubleshooting the Parallel Interface requires an external control device with a parallel I/O, such as a PDP 11 with the DR11C Interface. When a problem is isolated to the Parallel Interface, it is recommended that the faulty unit be sent to the nearest service center for repair. Table 607-6 additionally provides a tabular flow chart approach to troubleshooting. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step in sequence.

607-42. PROGRAMMING INSTRUCTIONS

607-43. Programming command instructions are provided in Table 607-7.

607-44. PARTS LIST

607-45. Table 607-8 gives a parts breakdown for the Parallel Interface. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

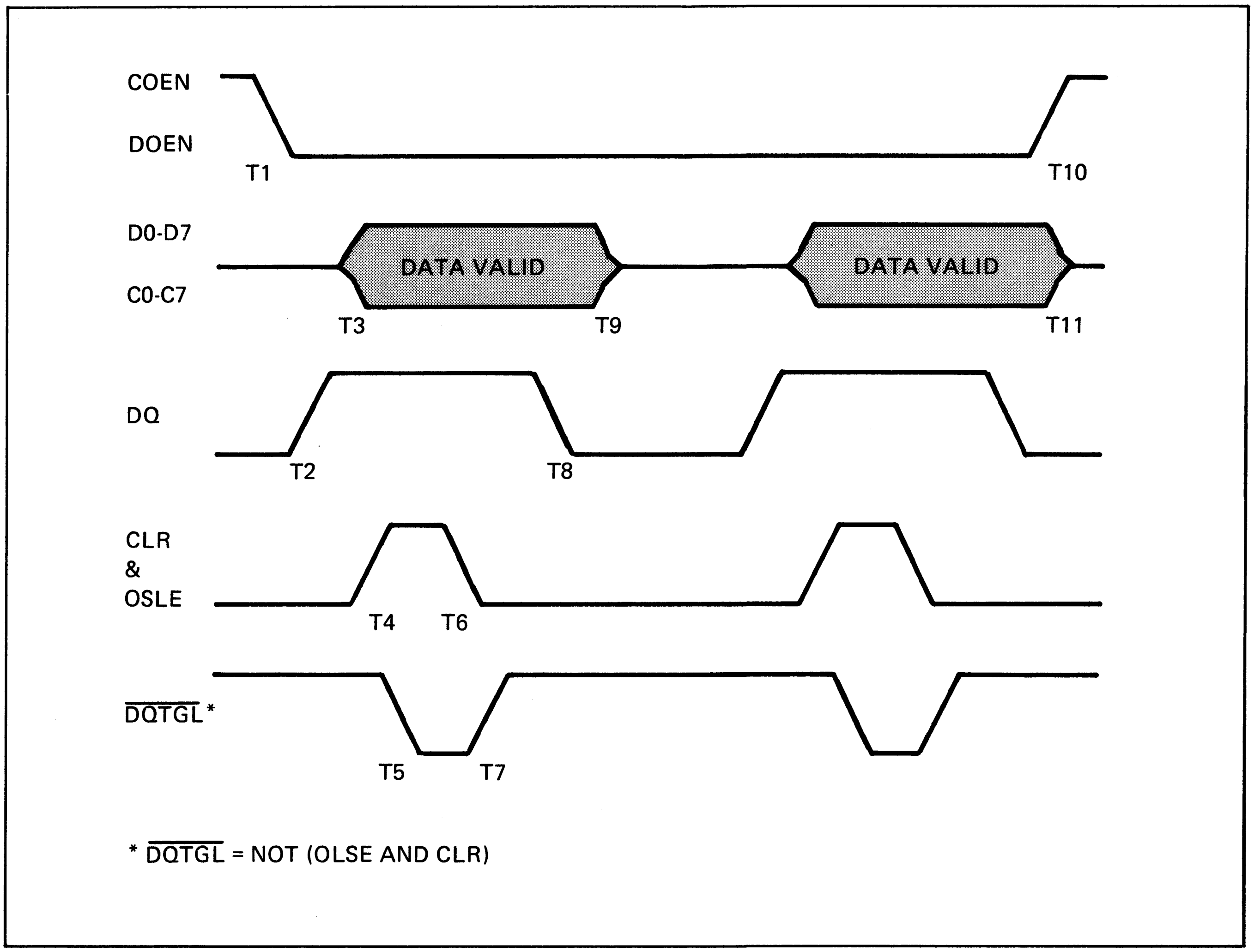


Figure 607-4. Interface Output Control Signal Timing Diagram

Table 607-6. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
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 Parallel Interface.		
2	Install the Parallel Interface in the instrument and apply power from the front panel switch.		
3	Is the display blank?	4	6
4	Check for an address (IC) line held low. Check the address decoders.		
5	Check for the ACK line held high. Check the ACK circuitry. Repair as required and return to step 2.		
6	Is the wrong option configuration displayed at power on or reset?	7	8
7	Check for an address (IC) line held high. Check the address decoder. Repair as required and return to step 2.		
8	Is the display incorrect or garbled?	9	10
9	Check for an ID line held high or low. Check the input latch, output buffer, and INT set flip-flop.		
10	Instruct the instrument to go to remote by inputting a valid program character. Does the instrument go to remote?	12	11
11	Check the input strobe (CIS) J2-34; check for the INT circuit not being set (U30,19); check for the INT from the input strobe (J2-21).		
12	Select a mode from remote. Is the right mode selected?	14	13
13	Check the input data latches or buffers. Check the data strobe at J2-22, -12.		
14	Check the response data. Is there any, or is it correct?	16	15
15	Check the ready (COR) line. Check the output strobe (COS). Check the output latches or buffer.		
16	Is the response only a single byte of data?	17	18
17	Check the status flip-flops (U28, U29) for reset.		
18	Is the ready line hung?	18	19
19	Check for incorrect data out or bad input data.		
20	If there is no input, check for a bad input ready (CIR).		
21	Troubleshooting of the Parallel Interface as applicable at this level, is complete.		

Table 607-7. 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)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 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 607-7. 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. V A R 2 S 5 F ?
   - ? — Execute, trigger and transmit
   - F — Slow filter, no time out
   - S 5 — 2^5 samples/reading
   - R 2 — 10 volt range
   - V A — AC voltage

2. T D Y ?
   - ? — Execute, trigger and transmit
   - Y — Echo characters
   - D — Turn display off
   - T — Continuous line synchronized readings

3. K N U 6 . 3
   - K N U 6 . 3 — Upper limit

   K N L 6 . 2 U ,
   - , — Execute
   - U — Enter limits mode
   - K N L 6 . 2 — Lower limit

4. Z R , S 5 $
   - $ — Clears command string to preceeding "," "?" or "@"
   - S 5 — 2^5 samples/reading
   - , — Execute
   - R — Auto range
   - Z — Ohms

5. % G 1 ?
   - ? — Execute, trigger and transmit
   - G 1 — Get status and transmit on trigger
   - % — Halt reading

Table 607-7. 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 607-7. Programming Instructions (cont)

Key	Instruction	Description
#	**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 2^7 (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 607-7. 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.

BYTE 1	BYTE 2	BYTE 3
1 1 1 1 0 1 1 1	1 0 1 1 1 1 1 1	1 1 1 1 1 1 1 1

Implied Binary Point
Error Bit
Sign Bits

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.

$$\underbrace{0\,0\,0\,0 \quad 1\,0\,0\,0}_{-(0 \quad . \quad 5} + \underbrace{0\,1\,0\,0 \quad 0\,0\,0\,0}_{+ \quad .015625 \quad 0} + \underbrace{0\,0\,0\,0 \quad 0\,0\,0\,1}_{+ \quad 0 \quad .000001)}$$

= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

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

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 immmediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 607-7. 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 607-7. 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.

V **DC Volts**

V **A** **AC Volts**

C **DC Coupled AC Volts**

I **DC Current**

I **A** **AC Current**

Table 607-7. 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:

$$Rx = Rr \frac{V0}{V1\text{-}V2}$$

Fast Ohms mode differs in that the value of $\frac{Rr}{(V1\text{-}V2)}$ is stored as a constant. The instrument will the 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
R	Auto	Auto	Auto	Auto
R 0	312 mV	Auto	312 μA	31.25Ω
R 1	2.5V	2.5V	2.5 mA	250Ω
R 2	20V	20V	20 mA	2 kΩ
R 3	160V	160V	160 mA	32 kΩ
R 4	1200V	1000V	1.28A	256 kΩ
R 5	Auto	Auto	Auto	4.096 MΩ
R 6	Auto	Auto	Auto	32.768 MΩ
R 7	Auto	Auto	Auto	262.144 MΩ

Table 607-7. 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.

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

Table 607-7. 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:

F	**Slow filter, time-out disabled.**
F 0	**Fast filter, time-out disabled.**
F 1	**Bypass filter.**
F 2	**Slow filter, time-out enabled (approximately 500 ms).**
F 3	**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.

T	**Continuous reading mode/line synchronized.**
T 0	**Single reading mode/line synchronized.**
T 1	**Continuous reading mode/line asynchronous.**
T 2	**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 607-7. 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).

[P] **Offset subtracted (ON).**

[P][0] **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.

[X] **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 = ±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 = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 607-7. Programming Instructions (cont)

X 0 **External Reference Off, Scaling Off**

X 1 **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 valued may not be used as a scaling factor.

NOTE

The 8502A can store the external reference voltage and the numerical scale factor separately. The 8500A can only store one or the other, not both.

- ◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A.
- ◆ For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor.

Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor $<10^{-9}$ (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.

U **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).

U 0 **Disable Limits and Peak Mode(s)**

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

Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 607-7. 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 0 **Single Byte ASCII Format**

● **B 1** **Binary 16-Bit Parallel**

● **B 2** **16-Bit Parallel**

"B1","B2" used with Paralled 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.

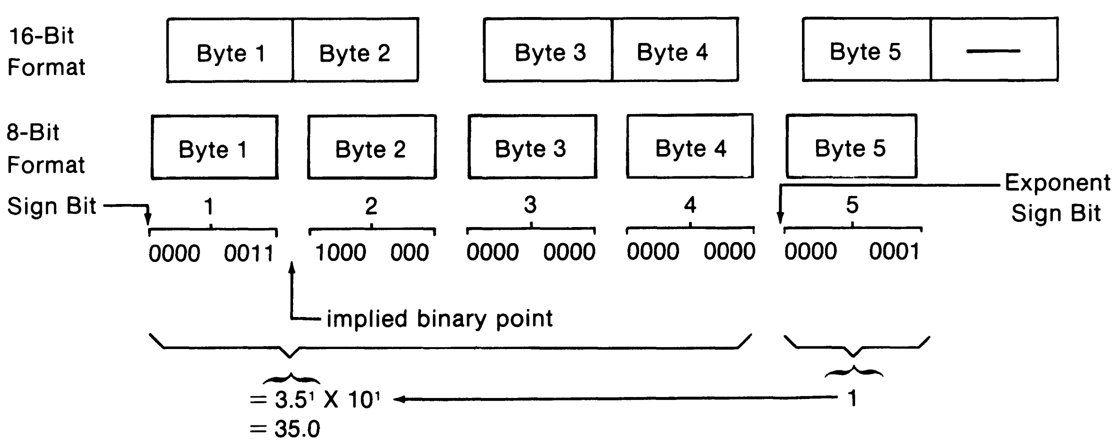


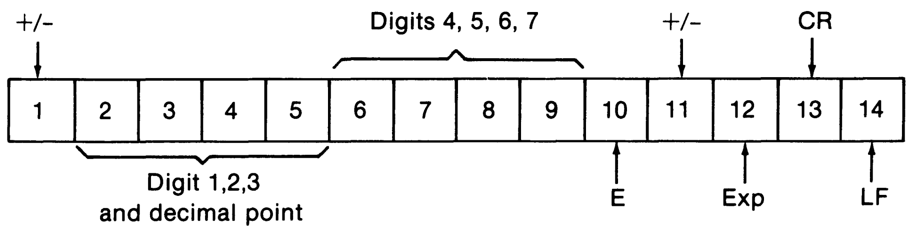
Table 607-7. Programming Instructions (cont)

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 607-7. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings** ◆	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.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

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

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	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 607-7. 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.

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

Table 607-7. 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 0 **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 X 10^{-1} or 1.03

K N U 7 . 6 E 4

Keep numeric upper limit of 7.6 X 10^{4}

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

Keep numeric lower limit of −123.456

Table 607-7. Programming Instructions (cont)

An example of an illegal numeric string is:

K N X 2 . 0 E - 1 3

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 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 607-7. 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 μA, 10Ω
1 1V dc, 1V ac, 1 mA, 100Ω
2 10V dc, 10V ac, 10 mA, 1kΩ
3 100V dc, 100V ac, 100 mA, 10 kΩ
4 1000V dc, 1000V ac, 1A, 100 kΩ
5 1 MΩ
6 10 MΩ
7 100 MΩ

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 607-7. 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 607-8. Parallel Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-07	⊗ PARALLEL INTERFACE PCB ASSEMBLY FIGURE 607-5 (MIS-4175T)	ORDER	BY	OPTION -07			1
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
C2	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
C3	CAP, MICA, 100 PF +/-1%, 500V	226126	72136	DM15F101F	1		
C4	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C5	CAP, CER, 560 PF +/-10%, 600V	106203	72982	801-00-X5R0-561K	1		
C6	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
C7	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C8	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C9	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C10	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C11	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
H1	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H2	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H3	WASHER, INT/LK #4	110403	73734	99402	2		
J2	CONNECTOR, SOCKET, 12 PIN	425744	89536	425744	2		
	CONNECTOR, SOCKET, 4 PIN	417311	30035	SS-109-1-04	4		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458950	89536	458950	1		2
MP2	CASE HALF	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	427625	89536	427625	REF		
MP4	COVER, MODULE CASE	411991	89536	411991	REF		
MP5	SHIELD, COVER	411991	89536	411991	REF		
MP6	DECAL. PARALLEL INTERFACE	413500	89536	413500	REF		
MP7	DECAL. CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	LATCH	412700	13511	57-1001	2		
MP10	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
MP11	SPRING, CONNECTOR	412718	71785	436-99-22-205	2		
P1	CONNECTOR, CABLE, 50-PIN, MODIFIED	413138	13511	57-20500-31	1		
Q1	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	2		
R2	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R5	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R6	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	1		
R7	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
RN1	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	4		
RN2	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
RN3	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
RN4	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
U1	IC, TTL, 2-INPUT POS OR GATE	393108	01295	SN74LS32N	1	1	
U2	IC, TTL, POS NAND GATES	292979	01295	SN7404N	1	1	
U3	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	4	1	
U4	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	3	1	
U5	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SA74367N	REF		
U6	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	REF		

Table 607-8. Parallel Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U7	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U8	⊗ IC, C-MOS, HEX INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U9	⊗ IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	2	1	
U10	⊗ IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	REF		
U11	IC, LO-PWR SCHOTTKY	404186	01295	SN74LS123N	1	1	
U12	⊗ IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	4	1	
U13	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U14	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U15	⊗ IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	4	1	
U16	⊗ IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U17	⊗ IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U18	IC, TTL, QUAD, 2-INPUT POS NAND GATE	393033	01295	SN74LSOON	1	1	
U19	⊗ IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	2	1	
U20	⊗ IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U21	IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U22	⊗ IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U23	⊗ IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	1	1	
U24	⊗ IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	2	1	
U25	⊗ IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	REF		
U26	⊗ IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U27	⊗ IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	REF		
U28	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	2	1	
U29	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	REF		
U30	⊗ IC, C-MOS, DUAL TYPE "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U31	⊗ IC, C-MOS, TRIPLE 3-INPUT, AND GATE	408807	02735	CD4073B	1	1	
	DR11-C, LN1 PERSONALITY CARD PCB ASSY (MIS-4062) (NOT SHOWN)	523043	89536	523043			
CR1	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
R1	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	1		
	DR11-C, HN1 PERSONALITY CARD PCB ASSY (MIS-4063) (NOT SHOWN)	523068	00779	87022-1	40		
	PC11 PERSONALITY CARD PCB ASSY (MIS-4069) (NOT SHOWN)	449447	89536	449447			
	SFH PERSONALITY CARD PCB ASSY (MIS-4070) (NOT SHOWN)	449454	89536	449454			
	GP PERSONALITY CARD PCB ASSY (MIS-4071) (NOT SHOWN)	449462	89536	449462			
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
MP2							
MP3							

Table 607-8. Parallel Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
	HP PERSONALITY CARD PCB ASSEMBLY (MIS-4067T)	476218	89536	476218	1		
C1	CAP, CER, 0.01 UF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
R1	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	2		
R2	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	2		
R3	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R4	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
U1	IC, TTL, QUAD, 2-INPUT, POS AND GATES	393066	01295	SN74LS08	1	1	
U2	IC, TTL, LO-PWR SCHTKY MNSTB MULTVBRS	404186	01295	SN74LS123N	1	1	
U3							
U4							
U5	THE DR11-C/HN1, PC11, SFH, AND						
U6	GP PERSONALITY CARDS HAVE THE SAME COMPONENT PARTS.						

1 EITHER OF THE -07 OPTION BOARDS MAY BE INSTALLED.

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

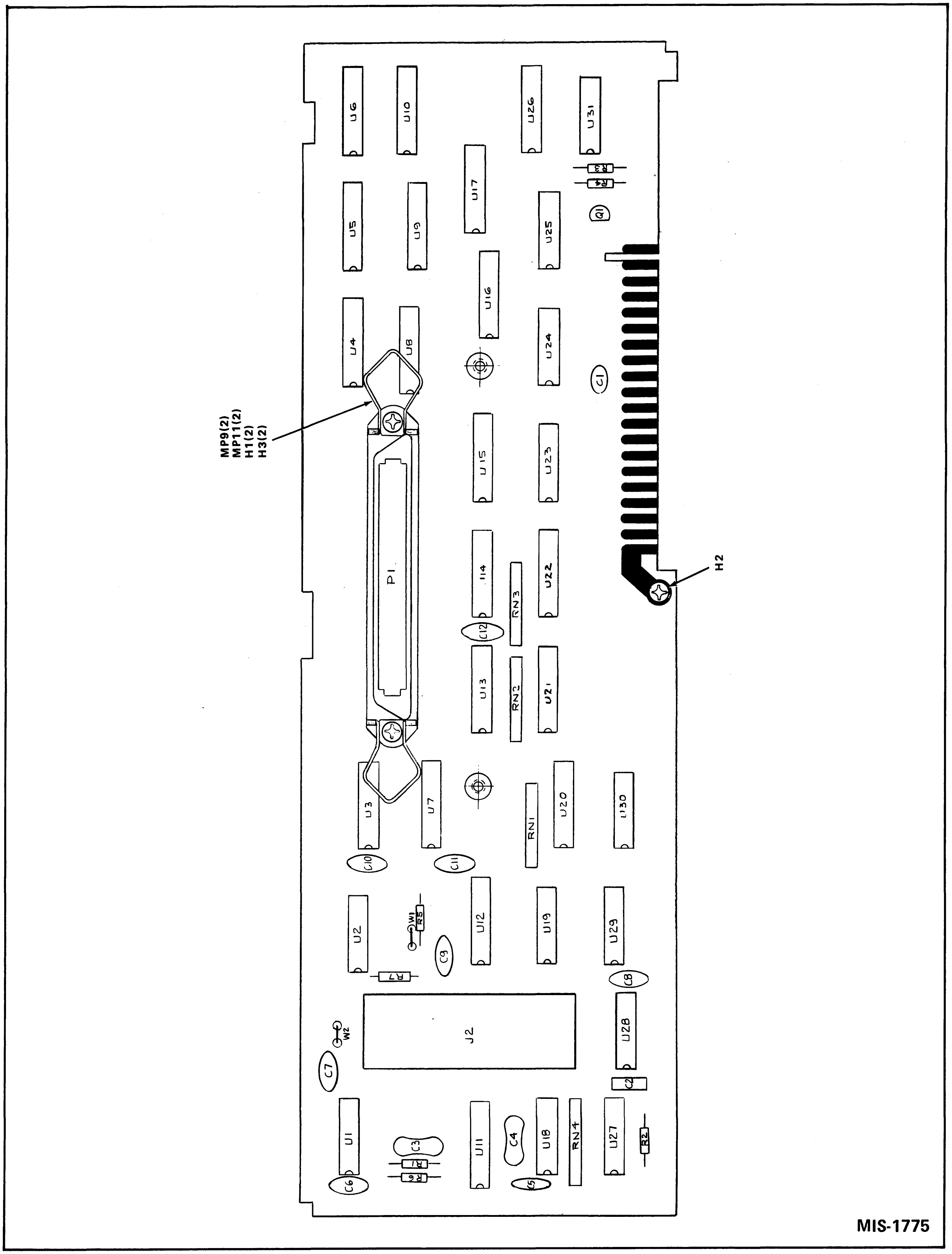


Figure 607-5. Parallel Interface PCB Assembly

Table 607-9. Parallel Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-07	⊗PARALLEL INTERFACE PCB ASSEMBLY FIGURE 607-6 (MIS-4171T)	ORDER	BY	OPTION -07			1
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
C2	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
C3	CAP, MICA, 100 PF +/-1%, 500V	226126	72136	DM15F101F	1		
C4	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C5	CAP, CER, 560 PF +/-10%, 600V	106203	72982	801-00-X5R0-561K	1		
C6	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
C7	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C8	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C9	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C10	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C11	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
H1	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H2	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H3	WASHER, INT/LK #4	110403	73734	99402	2		
J2	CONNECTOR, SOCKET, 20 PIN	447110	30035	SK-109-1-20	2		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458950	89536	458950	1		2
MP2	CASE HALF	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	427625	89536	427625	REF		
MP4	COVER, MODULE CASE	411991	89536	411991	REF		
MP5	SHIELD, COVER	411991	89536	411991	REF		
MP6	DECAL. PARALLEL INTERFACE	413500	89536	413500	REF		
MP7	DECAL. CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	LATCH	412700	13511	57-1001	2		
MP10	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
MP11	SPRING, CONNECTOR	412718	71785	436-99-22-205	2		
P1	CONNECTOR, CABLE, 50-PIN, MODIFIED	413138	13511	57-20500-31	1		
Q1	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	2		
R2	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	2		
R3	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	1		
R5	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	REF		
R6	RES, COMP, 2K +/-5%, 1/4W	202879	01121	CB2025	1		
R7	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
RN1	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	4		
RN2	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
RN3	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
RN4	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
U1	IC, TTL, 2-INPUT POS OR GATE	393108	01295	SN74LS32N	1	1	
U2	IC, TTL, POS NAND GATES	292979	01295	SN7404N	1	1	
U3	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	4	1	
U4	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	3	1	
U5	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SA74367N	REF		
U6	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	REF		
U7	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		

Table 607-9. Parallel Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U8	⊗IC, C-MOS, HEX INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U9	⊗IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	2	1	
U10	⊗IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	REF		
U11	IC, LO-PWR SCHOTTKY	404186	01295	SN74LS123N	1	1	
U12	⊗IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	4	1	
U13	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U14	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U15	⊗IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	4	1	
U16	⊗IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U17	⊗IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U18	IC, TTL, QUAD, 2-INPUT POS NAND GATE	393033	01295	SN74LSOON	1	1	
U19	⊗IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	2	1	
U20	⊗IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U21	⊗IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U22	⊗IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U23	⊗IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	1	1	
U24	⊗IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	2	1	
U25	⊗IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	REF		
U26	⊗IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U27	⊗IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	REF		
U28	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	2	1	
U29	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	REF		
U30	⊗IC, C-MOS, DUAL TYPE "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U31	⊗IC, C-MOS, TRIPLE 3-INPUT, AND GATE	408807	02735	CD4073B	1	1	
	DR11-C, LN1 PERSONALITY CARD PCB ASSY	523043	89536	523043			
	(MIS-4062) (NOT SHOWN)						
CR1	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
R1	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	1		
	DR11-C, HN1 PERSONALITY CARD PCB ASSY	523068	00779	87022-1	40		
	(MIS-4063) (NOT SHOWN)						
	PC11 PERSONALITY CARD PCB ASSY	449447	89536	449447			
	(MIS-4069) (NOT SHOWN)						
	SFH PERSONALITY CARD PCB ASSY	449454	89536	449454			
	(MIS-4070) (NOT SHOWN)						
	GP PERSONALITY CARD PCB ASSY	449462	89536	449462			
	(MIS-4071) (NOT SHOWN)						
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
MP2							
MP3							
	HP PERSONALITY CARD PCB ASSEMBLY	476218	89536	476218	1		
	(MIS-4067T)						

Table 607-9. Parallel Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
C1	CAP, CER, 0.01 UF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
R1	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	2		
R2	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	2		
R3	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R4	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
U1	IC, TTL, QUAD, 2-INPUT, POS AND GATES	393066	01295	SN74LS08	1	1	
U2	IC, TTL, LO-PWR SCHTKY MNSTB MULTVBRS	404186	01295	SN74LS123N	1	1	
ZZZU5U5 ZZZU5U6 ZZZU5U7	THE DR11-C/HN1, PC11, SFH, AND GP PERSONALITY CARDS HAVE THE SAME COMPONENT PARTS.						

1 EITHER OF THE -07 OPTION BOARDS MAY BE INSTALLED.

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

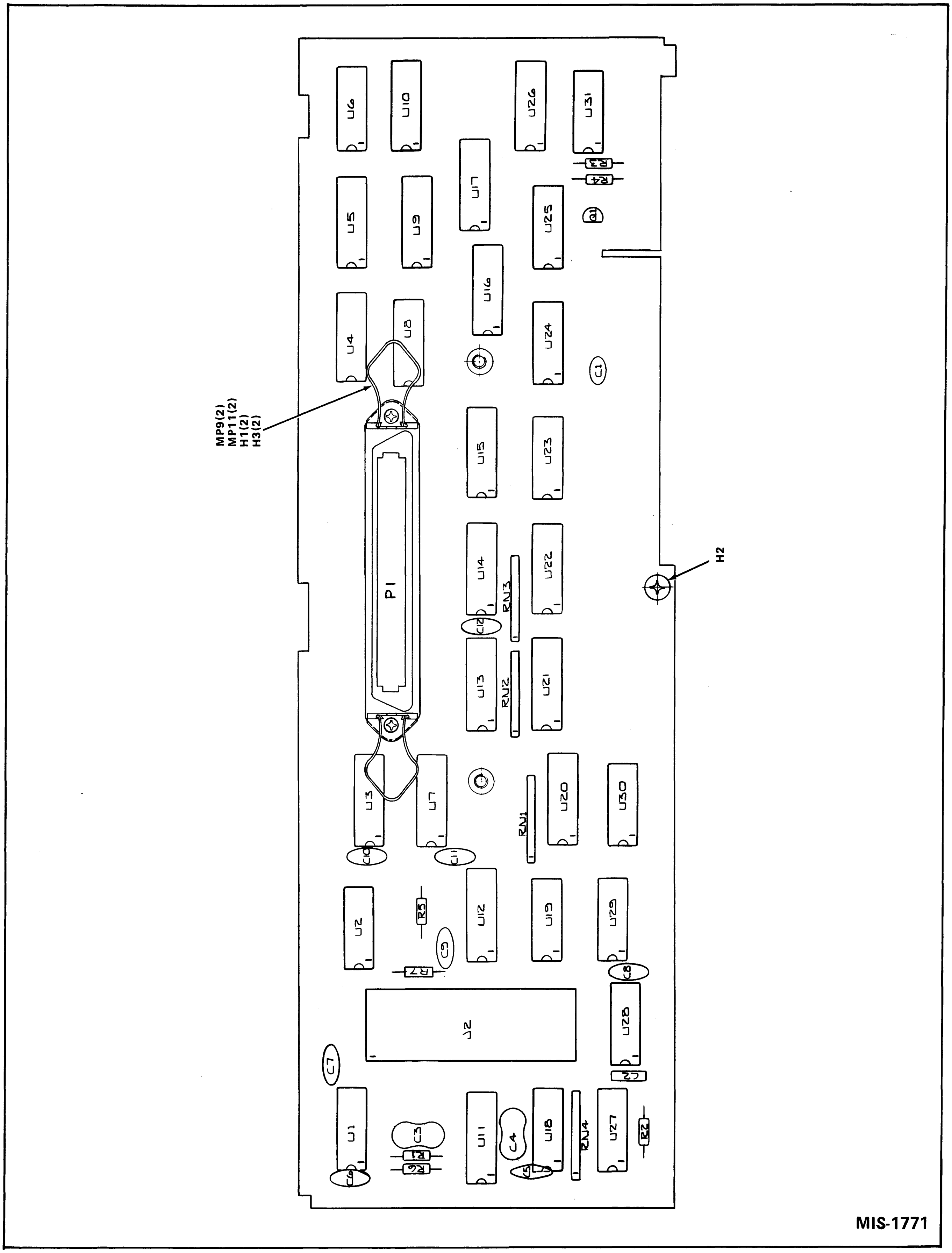


Figure 607-6. Parallel Interface PCB Assembly

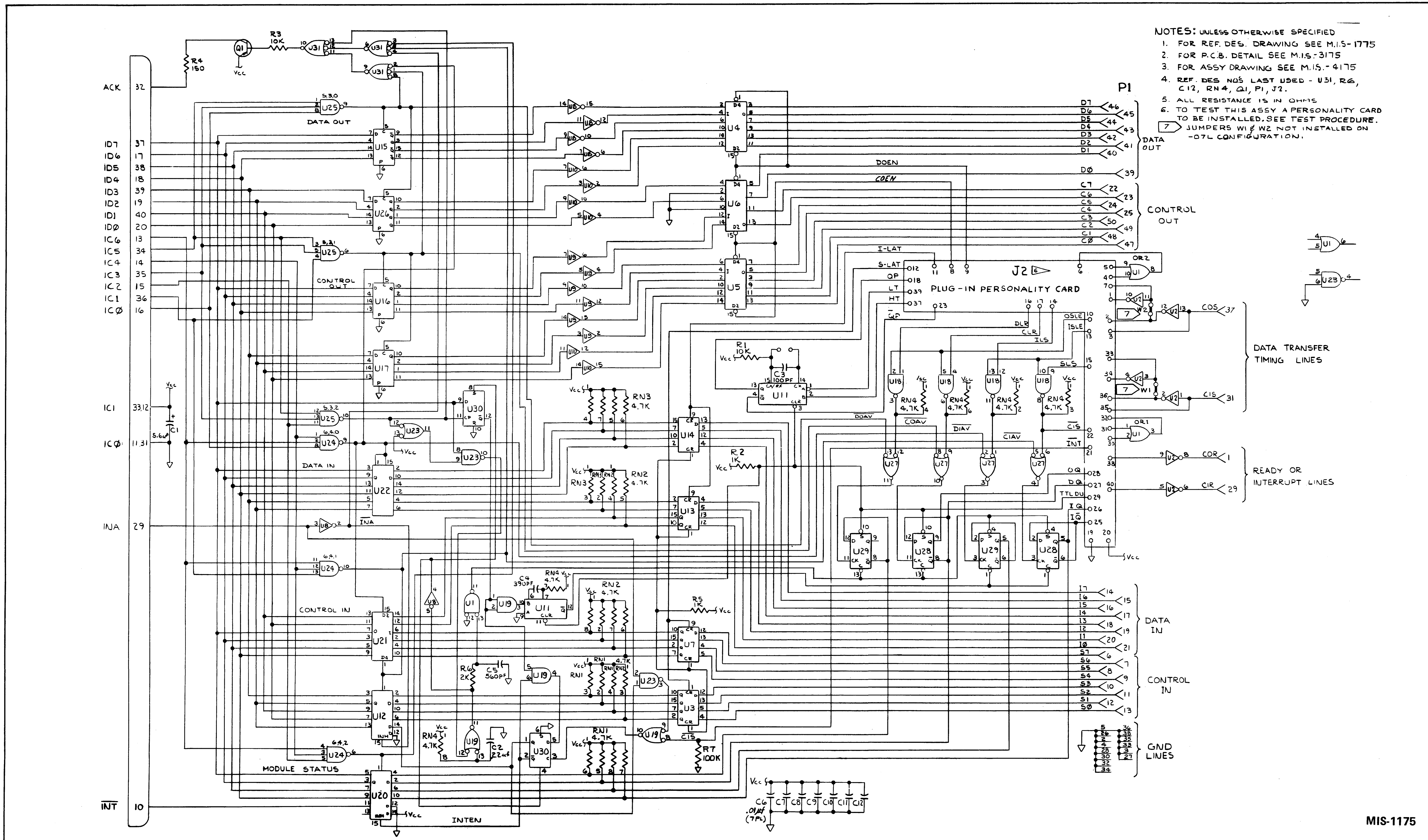


Figure 607-7. Parallel Interface PCB Assembly (cont)

NOTES: UNLESS OTHERWISE SPECIFIED
1. FOR REF. DES. DRAWING SEE M.I.S-1771
2. FOR P.C.B. DETAIL SEE M.I.S-3171
3. FOR ASSY DRAWING SEE M.I.S.-4171
4. REF. DES. NOS. LAST USED - U31, R7, C12, RN4, Q1, P1, J2.
5. ALL RESISTANCE IS IN OHMS.
6. FOUR TYPES OF PERSONALITY CARDS ARE AVAILABLE. THESE ARE: 1.) MIS-4068, 2.) MIS-4069, 3.) MIS-4070 4. MIS-4071, (AN UNLOADED PCB, AVAILABLE FOR CUSTOMER TO WIRE TO SUIT HIS OWN APPLICATION AND INTERFACE).
7. TO TEST THIS ASSY A PERSONALITY CARD HAS TO BE INSTALLED. SEE TEST PROCEDURE.

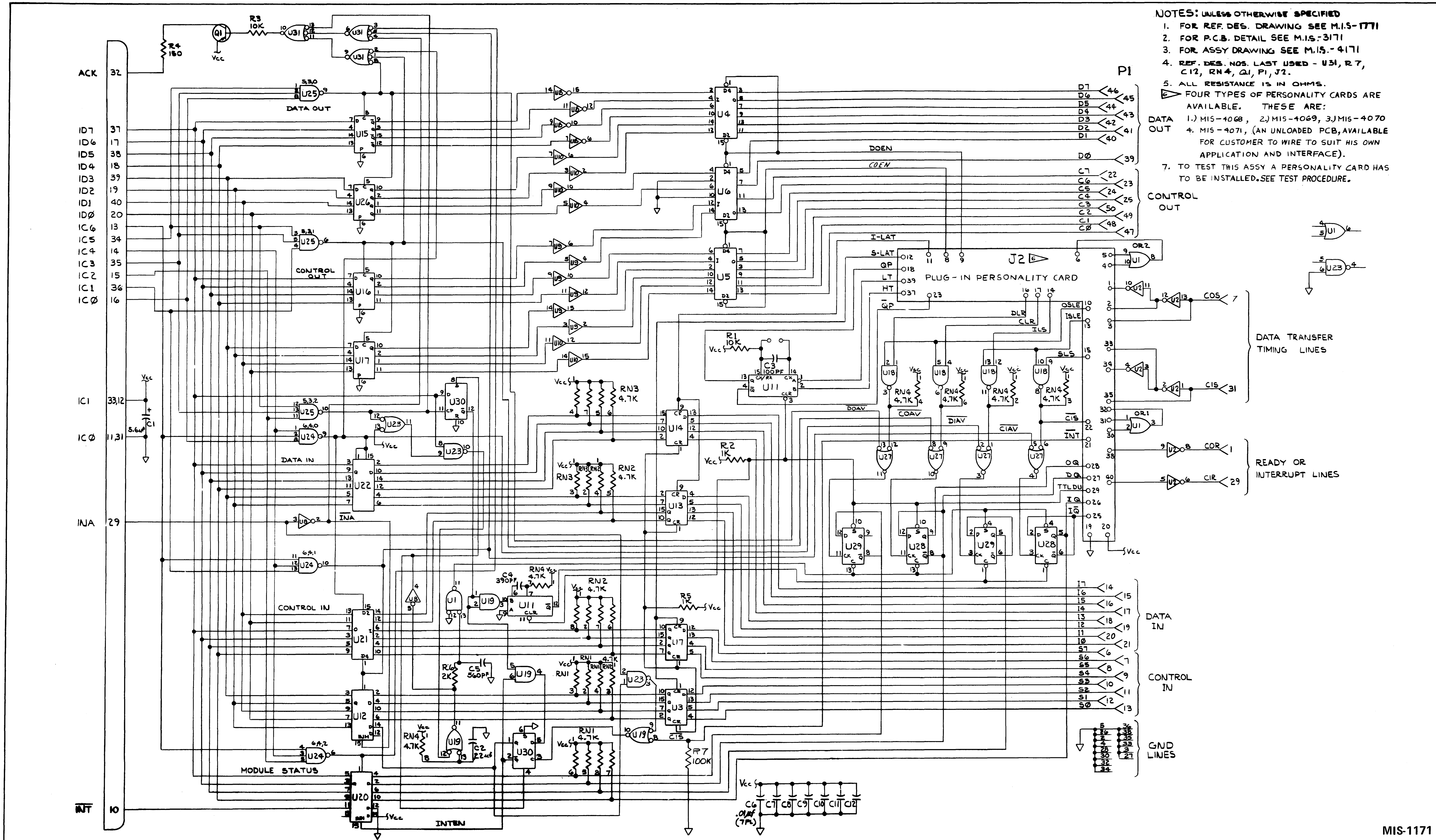


Figure 607-8. Parallel Interface PCB Assembly (cont)

Option -08A
Isolator (External Trigger)

608A-1. INTRODUCTION

608A-2. The Isolator module maintains the guarded nature of the analog bus by isolating the analog signal processing and converting circuitry from the digital processing, control, display and input/output circuits. An isolator module (either Option -08 or -08A) must be installed whenever a remote interface (Option -05, -06, -07) is used in the 8500 series DMM. The following description pertains to the Isolator Option -08A only. Option -08A provides the capability for external triggering of the DMM. This mode may not be used in instruments which do not have mainframe and motherboard (A2) provisions for external triggering. Digital Multimeter Model 8502A will accept only the -08A Option; Model 8500A will accept the -08, or the -08A without external triggering capability.

608A-3. INSTALLATION

608A-4. Refer to Section 4 of the Instruction Manual for general module installation procedures. The Isolator module (Option -08A) replaces the Interconnect pcb in slot K; slot K can be identified as the only module slot with connectors on both the analog and digital bus lines. The Interconnect Diagram in Section 8 contains a table of slot locations.

608A-5. SPECIFICATIONS

608A-6. Input

608A-7. The trigger input is factory-wired for a high level of 4.3V (minimum) and a low level of 0.7V (maximum); pulse width should be greater than 10 μs. Common will be the same as interface logic common.

608A-8. The outer connector for external triggering is at interface common. There should be no more than 10V between the outer connector and earth ground.

608A-9. Trigger Processing Time

608A-10. The time between trigger edge and first A/D conversion (not including filter timeouts or programmed delays) is:

1. Non-line synchronous mode, .8 to .9 ms
2. Line synchronous mode, 1 to 6 ms
3. High speed mode (Option -05 or -07 installed), 114 $\pm$.5 μs

608A-11. OPERATING NOTES

608A-12. Installation of the Isolator (Option -08A) will not affect standard operation of the instrument. The External Triggering mode may, however, be activated locally from the front panel or through remote interfacing commands.

608A-13. Local Operation

608A-14. The External Triggering mode may be enabled from the DMM's front panel (Option -08A must be installed). To activate this mode, press TRIGGER. The SAMPLE LED will now stop flashing to denote that both External Triggering and Manual Triggering modes are in effect. Apply a negative going TTL level pulse to the external trigger input connector located on the rear panel. The SAMPLE LED will now flash once for each trigger received.

608A-15. The following considerations apply when External Triggering mode is in use:

1. A manual trigger attempted from the front panel will take precedence over an external trigger. If manual TRIGGER is pressed while a reading is in progress, the reading will be aborted and a new one started.

2. All other front panel switch applications will abort the reading in progress. A new reading

will not start until another trigger is received; the numeric display will not update until the new reading is complete.

608A-16. Remote Operation

608A-17. External Triggering can be enabled and controlled remotely when a remote interface (Option -05, -06, or -07) and the Isolator (Option -08A) are installed. The command characters in Table 608A-1 can be used from the remote.

608A-18. Trigger Polarity

608A-19. Either positive or negative going external triggers may be accepted by the Isolator (Option -08A); factory settings will be for negative triggers. Separate jumper wire arrangements are employed for negative and positive triggers. Refer to Figure 608A-1 for the location of jumper terminals on the Isolator PCB. To change the jumper arrangement, use the following procedure:

1. On the Digital Multimeter (8500 series), press POWER OFF and disconnect the line cord.

Table 608A-1. Remote Commands

	Ext. Trigger Commands
Q	Ext. Trigger—interrupt when ready
Q1	Ext. Trigger and Transmit Reading
Q0	Disable Ext. Trigger
	External Trigger Delay Commands
W	No Delay
W0	2.083 ms
W1	4.166 ms
W2	8.332 ms
W3	16.66 ms
W4	33.33 ms
W5	66.66 ms
W6	133.3 ms
W7	266.6 ms
W8	533.2 ms
W9	1,066s
W10	2.133s
W11	4.266s
W12	8.532s
W13	17.06s
W14	34.13s
W15	68.26s

2. Remove the Isolator module.

3. Observe Static Sensitive device precautions listed in Section 4 of the Instruction Manual. Avoid touching connector terminals on the Isolator PCB.

4. Remove the Guard Covers from the Isolator PCB using techniques outlined in Section 4 of the Instruction Manual (Module Assembly and Disassembly).

5. For negative going triggers, there will be a jumper between pin 1 and pin 4 on Schmitt Trigger U35.

6. For positive going triggers, remove the jumper between pins 1 and 4 and jumper pin 1 to 2 and 3 to 4 on U35.

7. Reassemble module, replace in Digital Multimeter.

608A-20. THEORY OF OPERATION

608A-21. 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 (ID) and eight data (ID) lines are used. Lines IC5 and IC6 are always low. The

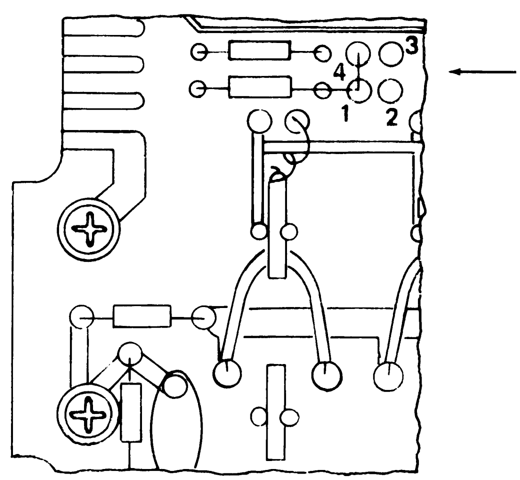


Figure 608A-1. Trigger Polarity Connections

Controller can send data to any addressed module; the A/D Converter will be the only analog module that sends data back to the Controller (bit serial data stream on ID7). Refer to the Isolator Schematic (Figure 608A-3) and the Functional Block Diagram (Figure 608A-2) for the following circuit descriptions.

NOTE

When the Isolator is Installed, Vcc and Vss in the unguarded digital bus are isolated from analog common.

608A-22. The description given in this paragraph will detail how data (ID0-ID7) and address (IC0-IC4) levels on the unguarded digital bus are loaded into shift registers (U3 and U7) in the Isolator. Inputs on address lines IC0-4 for either direct or indirect addresses are applied through inverters to shift register U7. Inputs on data lines (ID0-7) are applied to U7 (ID0, ID1) and U3 (ID2-7). A low on U14-12 will clock both address and data levels into the shift registers; the relaxation oscillator made up of U9-6 and U9-8 will be disabled by this same low during the load time. Monostable multivibrator U14-12 is clocked by a low going signal on U10-12. Two inputs to U10-12 will always be high (IC5, IC6 will always be low and are inverted). The third input will be a high from U10-8, which is enabled with any direct address on IC0-4 (IC0, 3, or 4 will have at least one high). The length of the load time will be determined by R2 and C2.

608A-23. At the end of the load time, relaxation oscillator U9-6 and U9-8 will be enabled, and data will be serially shifted out of registers U3 and U7, across isolation transformers T1 and T2, and into registers U20 and U6. Oscillator pulses from U11-10 and U11-13 clock serial data out of U3 and U7, and into U20 and U16. When this data transfer is complete, U16-11 will go high to enable address gates U22 and U26-4 and disable loading clock pulses to U20 and U16. Parallel data will then be applied through output buffers to ID0-7 on the guarded analog bus. Parallel address levels will be applied through the enabled address gates to address lines IC0-4 on the guarded analog bus.

608A-24. The clock pulse for U9-6 and U9-8 is disabled during the load period (U14-12 low). When clock pulses cease from U24-4, retriggerable monostable multivibrator U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

608A-25. An acknowledge (ACK) signal is transferred from the guarded analog bus to the unguarded digital bus by way of an isolation transformer. A low at U23-12 will enable U19-1 whenever an ACK is returned. With U19-1 high, a clock pulse from U24-4 and U24-12 is applied through U15-3, U15-6, T8 and T7. This pulse then clocks U8-2, resulting in an ACK signal out on U8-13.

608A-26. In order to obtain a data bit return on ID7, the indirect address is used in three ways. First, the address (IC1, IC2 high) is sent to the A/D Converter

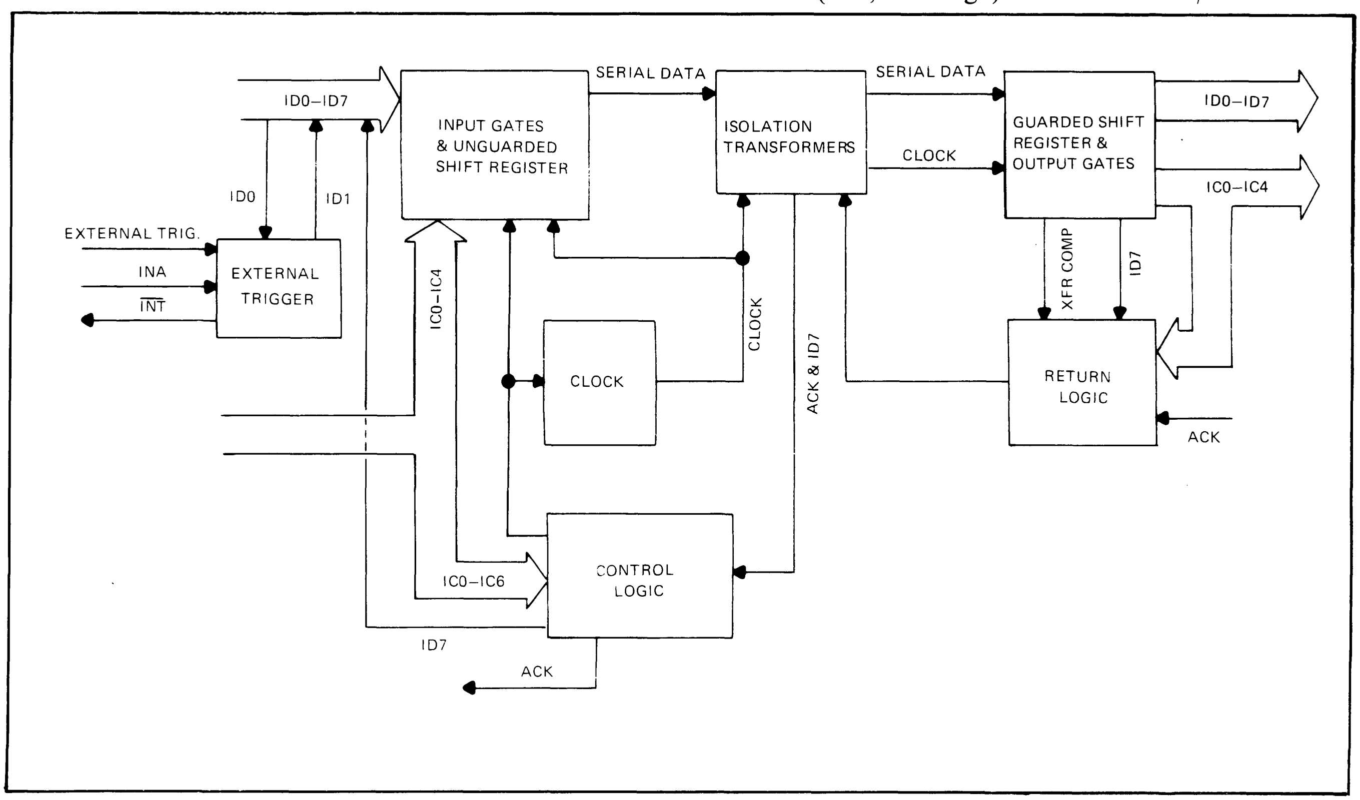


Figure 608A-2. Isolator Block Diagram

through the Isolator's shift register system. The address will also be used to enable U9-11 on the unguarded side of the Isolator. Thirdly, on the Isolator's guarded side, IC1 and IC2 high will enable address decoders U18-4 and U25-9. With U18-3 consequently high, tri-state device U21-13 is placed in the high impedance mode. A path is now enabled for ID7 levels from the guarded analog bus to be transferred back to the unguarded digital bus. For instance, with a high on U19-5, ID7 high will enable U19-4. Clock pulses from U24-4 and U19-4 high enable U15-11 and U15-8. While U9-11 enables U13-9, U8-5 clocked high places ID7 high on the unguarded digital bus.

608A-27. The following sequence of events takes place in the Isolator during external triggering. Dual D flip-flop U31 will be enabled by a low on ID0 and high at U33-9. Address lines IC4, IC5, and IC6 must all be high for U33-9 to go low. With Vcc applied to U31-5, a positive going external trigger from U35-10 will clock U31-1 high. The network of R24 and C6 will detect Vcc at power on and disable the module's interrupt capability. The high at U31-1 sets INT low and places a high at pin 12 of tri-state buffer U13. A returned high on INA then gates U13-11 high onto ID1. The controller will react to this high on ID1 by taking a reading. When data from the reading is accepted, ID0 will again go low, resetting U31 ready for the next external trigger. Triggers received prior to ID0 going low will be ignored.

608A-28. TROUBLESHOOTING

608A-29. Table 608A-2 gives a symptom analysis routine for troubleshooting the Isolator module.

608A-30. PARTS LIST

608A-31. Table 608A-3 gives a detailed parts breakdown of the Isolator (Option -08A). Refer to Section 5 of the Instruction Manual for ordering information.

Table 608A-2. Isolator Troubleshooting

SYMPTOM	POSSIBLE FAILURE
No display at Power On	IC line held low U5, U12, U35
Display Bad	IC line held high U5, U12, U35
	ID line held high or low U1, U2, U13
UNGUARDED SECTION	
Error 9 at Power On	Oscillator check U11-10 Shift Register U31-1, U7 Not transferring pulses U4, core windings ACK bad U9, U12, Q1, U6, U7, U2, U8
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U8, U13, core winding U12, U10, U9, U35, U6.
GUARDED SECTION	
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 608A-3. Isolator PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-08A	⊗ ISOLATOR PCB ASSEMBLY FIGURE 608A-3 (8502A-4181T)	ORDER	BY	OPTION -08A			
C1	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	2		
C2	CAP, MICA, 18 PF +/-5%, 500V	266585	72136	DM15C180J	1		
C3	CAP, MICA, 180 PF +/-5%, 500V	148460	72136	DM15F181J	1		
C4	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	REF		
C5	CAP, MICA, 68 PF +/-5%, 500V	148510	72136	DM15F680J	1		
C6	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	1		
C7	CAP, ELECT, 150 UF -10/+50%, 16V	186296	73445	ET151X016A5	1		
C8	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15E270J	2		
C9	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15E270J	REF		
C10	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	3		
C11	CAP, CER, 0.0047 UF +/-10%, 500V	106724	71590	CF-472	1		
C12	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C16	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
H1	SCREW, PHP, 4-40 X 5/8	145813	73734	19027	2		
L1	INDUCTOR, COIL 6-TURN	320911	89536	320911	1		
MP1	CASE ASSY (INCLUDES MP2-MP9)	459024	89536	459024	1		1
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	437939	89536	437939	REF		
MP6	DECAL, ISOLATOR/EXT TRIGGER	477570	89536	477570	REF		
MP7	DECAL CAUTION	454504	89536	454504	REF		
MP8-1	GUARD, REAR LEFT	437947	89536	437947	REF		
MP8-2	GUARD, REAR RIGHT	383349	89536	383349	REF		
MP9-1	GUARD, FRONT LEFT	487298	89536	487298	REF		
MP9-2	GUARD, FRONT RIGHT	487280	89536	487280	REF		
MP10	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	2		
P43	CABLE ASSY, TRIGGER (NOT SHOWN)	486332	89536	486332	1		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	1		
R1	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P 220ET	1		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	9		
R3	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R4	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	1		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R6	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R7	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	1		
R8	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R9	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R10	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R13	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R14	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R15	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P 470ET	1		
R17	RES, DEP. CAR, 10K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		

Table 608A-3. Isolator PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R18	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R20	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R21	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R24	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
T1	INDUCTOR	437608	89536	437608	4		
T2	INDUCTOR	437590	89536	437590	4		
T3	INDUCTOR	437608	89536	437608	REF		
T4	INDUCTOR	437590	89536	437590	REF		
T5	INDUCTOR	437590	89536	437590	REF		
T6	INDUCTOR	437608	89536	437608	REF		
T7	INDUCTOR	437590	89536	437590	REF		
T8	INDUCTOR	437608	89536	437608	REF		
U1	⊗ IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	3	1	
U2	⊗ IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U3	IC, TTL, MSI 8 BIT SHIFT REGISTER	293118	01295	SN74165N	2	1	
U4	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	2	1	
U5	⊗ IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U6	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	2	1	
U7	IC, TTL, MSI 8-BIT SHIFT REGISTER	293118	01295	SN74165N	REF		
U8	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	3	1	
U9	IC, TTL, QUAD 2-INPUT NAND GATE	363580	01295	SN7400SN	1		
U10	IC, POS NAND GATES, TRIPLE 3 INPUT	393074	01295	SN74LS10N	1	1	
U11	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	2	1	
U12	⊗ IC, COS/MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	1		
U13	⊗ IC, C-MOS, TRI-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	2	1	
U14	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U15	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	REF		
U16	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	2	1	
U17	RES NETWORK, 10K +/-5%, 1/4W	355305	89536	355305	1	1	
U18	⊗ IC, C-MOS, QUAD 2-INPUT AND GATES	408401	02735	CD4081B1	1	1	
U19	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	REF		
U20	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	REF		
U21	⊗ IC, C-MOS, TRI-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	REF		
U22	⊗ IC, COS/MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U23	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U24	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	REF		
U25	⊗ IC, C-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U26	⊗ IC, COS/MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	1		
U31	⊗ IC, C-MOS, DUAL "D" FLIP FLOP	340117	04713	MC14013CP	1		
U32	⊗ IC, C-MOS, FAST QUAD 2-INPUT NAND GATE	413211	12040	34011PC/4011PC	1		
U33	⊗ IC, C-MOS, TRIPLE 3-INPUT NAND GAE	375147	04713	MC14023CP	1		
U35	⊗ IC, C-MOS, HEX SCHMITT TRIGGER	477810	12040	MM74C914N	1		

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

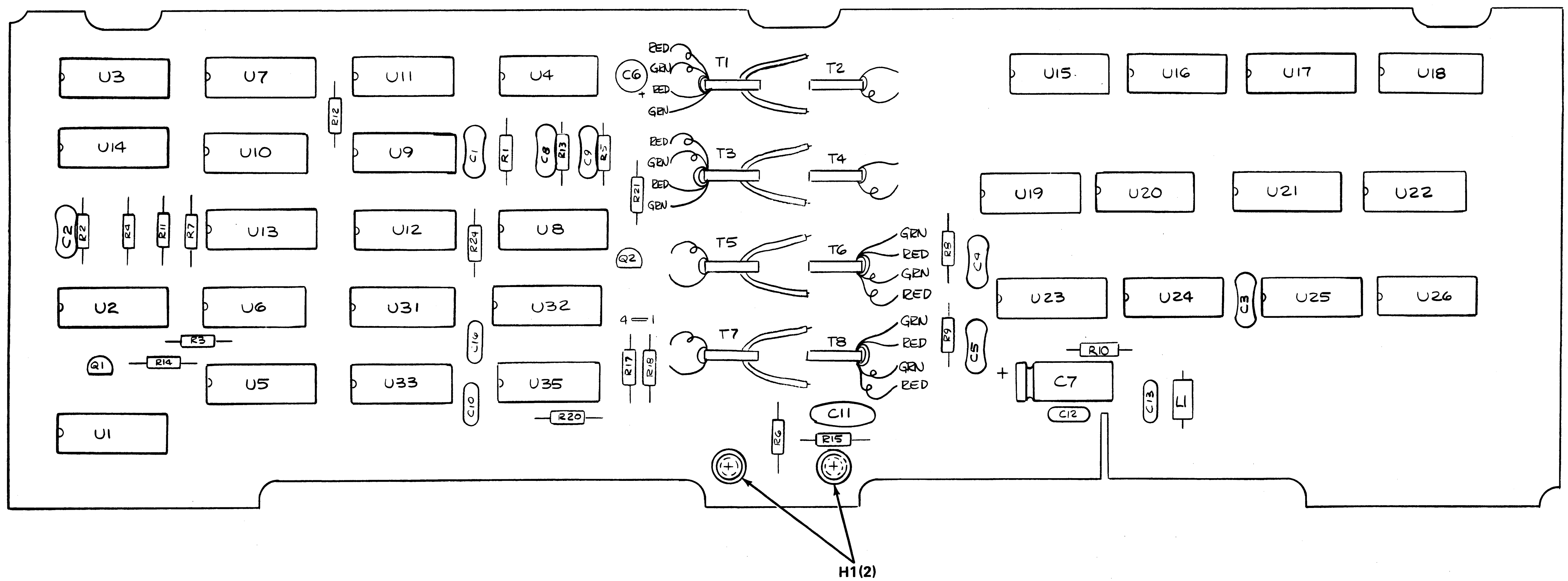
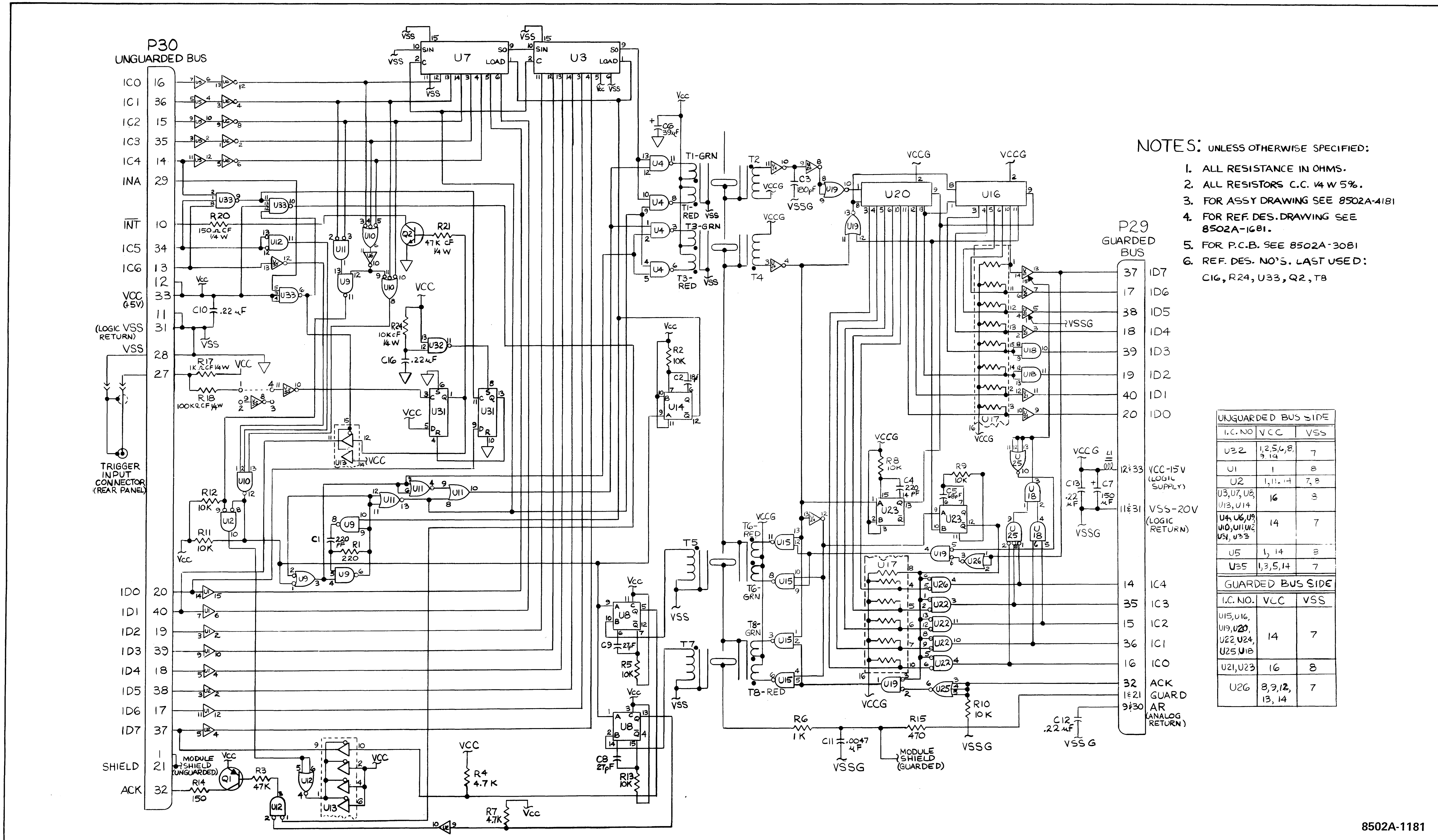


Figure 608A-3. Isolator PCB Assembly



NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C. 1/4 W 5%.
3. FOR ASSY DRAWING SEE 8502A-4181
4. FOR REF. DES. DRAWING SEE 8502A-1681.
5. FOR P.C.B. SEE 8502A-3081
6. REF. DES. NO'S. LAST USED: C16, R24, U33, Q2, T8

UNGUARDED BUS SIDE		
I.C. NO	VCC	VSS
U32	1,2,5,6,8, 9,14	7
U1	1	8
U2	1, 11, 14	7, 8
U3, U7, U8, U13, U14	16	8
U4, U6, U9, U10, U11, U12, U31, U33	14	7
U5	1, 14	8
U35	1,3,5,14	7

GUARDED BUS SIDE		
I.C. NO.	VCC	VSS
U15, U16, U19, U20, U22, U24, U25, U18	14	7
U21, U23	16	8
U26	8, 9, 12, 13, 14	7

Figure 608A-3. Isolator PCB Assembly (cont)

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 x 10^7). Input impedance is 1 MΩ 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 permissable 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 ($V_{rms} = \sqrt{\overline{Vin^2}}$). 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	2.8	1.0	1.0
300 kHz to 1 MHz	2.9	1.3	1.3	3.3	1.8	1.8	3.7	2.1	2.1

NOTES:

1. *Slow Filter must be used for full accuracy below 400 Hz.*
2. *Volt-Hertz product not to exceed 2 x 10^7 for 100V and 1000V ranges and 1 x 10^7 for for 1V and 10V ranges.*
3. *For inputs above 500V, multiply accuracy by:* $\left(\frac{2000V + V\,in}{2000V}\right)$

INSTRUMENT OPERATING CHARACTERISTICS

INPUT CHARACTERISTICS

Range	Full Scale	Resolution Normal	Resolution High	Impedance
1V	2.5V	10 uV	1 uV	1 MΩ, <100 pF
10V	20V	100 uV	10 uV	
100V	160V	1 mV	100 uV	
1000V	1000V	10 mV	1 mV	

MAXIMUM INPUT

1000V rms or 2 x 10^7 volt-hertz product, whichever is less.

TEMPERATURE COEFFICIENT

(0°C to 18°C and 28°C to 50°C)

AC* Only ±(40 ppm or Reading + 20 ppm f.s.)/ °C
AC* + DC ±(40 ppm of Reading + 40 ppm f.s.)/ °C

**Frequencies <10 kHz*

SETTLING TIME (To within 0.1%)

100 ms, Fast Filter
500 ms, Slow Filter

COMMON MODE REJECTION

(100Ω Unbalance)

120 dB, dc to 60 Hz

CREST FACTOR

>7 at full scale, increasing down scale by:

$$7 \times \sqrt{\frac{V_{Range}}{V_{Input}}}$$

(1400 V peak max)
1000 V range

DIGITIZING

Same as dc volts

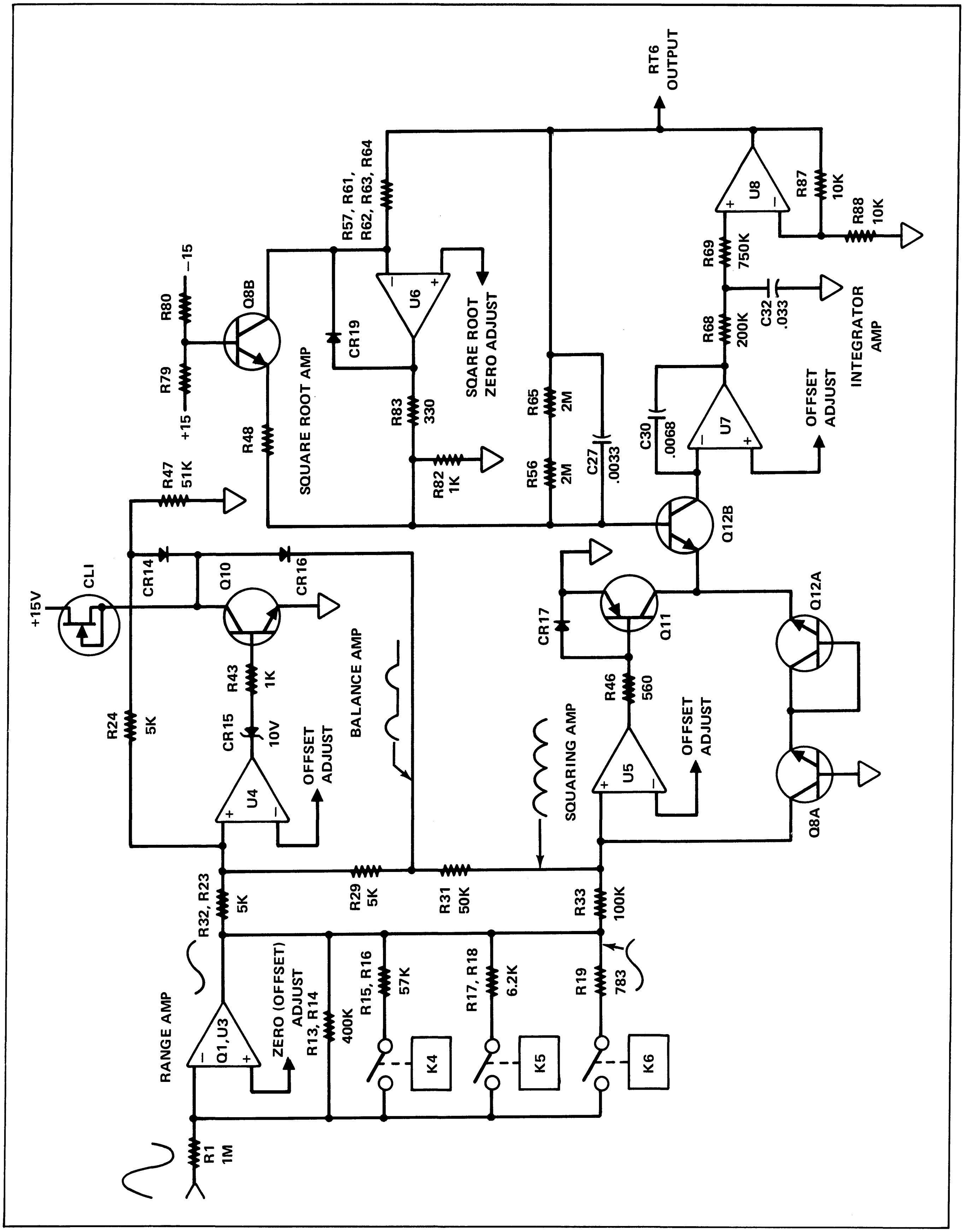


Figure 609A-1. AC/DC Converter (RMS)

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 two 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 μV.
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 μV 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 50Ω 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 sympton 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[1]	500 Hz	R64	499.90	500.10
2	1000V	500V[1]	50 kHz	C4	499.80	500.20
3	1000V	1000V[1]	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
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)[2]	9.8000	10.2000
9	1V	1V	1 MHz[3]	Check (R75)[2]	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[4]	Check	2.49900	2.50100
13	1V	2.5V	100 kHz	Check	2.49000	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[1]	500 Hz	R18	159.960	160.020
19	100V	160V[1]	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[3]	Check	0.07000	0.13000

1. Use CAUTION, Dangerous voltage.
2. If R75 is adjusted, repeat the previous steps.
3. Terminate cable in 50Ω; 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 (Section4).		
2	Is DC Volts within tolerance?	3	Section 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; 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?	15	Section 4
15	Go to Figure 609-2.		

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

Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.

Address IC 0, 2, 4 high

IDO =0, ID1 = 0 —DC Coupled AC
IDO = 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. Preliminary Calibration

609A-37. 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 OV $\pm 100\ \mu V$.
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 μV.
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 ± 5 digits.
19. Apply -0.02V DC and adjust R45, AC Zero, for a reading of 0.0200 ± 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 ± 20 digits.
26. Change the frequency to 50 kHz and adjust C4, 1000V HIGH FREQ ADJUST, for 500.000V ± 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 ± 10 digits.
29. Change the input frequency to 500 kHz and adjust C9, 1V HF-1, for 2.50000 ± 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 re-adjusting C9. Alternately adjust C9 as in step 29, than C24 @ 500 kHz until a reading of 2.50000V ± 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 ±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 ±20 digits.

34. Change the frequency to 50 kHz and adjust C11, 10V HF, for 20.0000 ±100 digits.

35. Apply 10V @ 1 MHz using four-wire sensing (without the 50Ω termination).

36. Adjust R75, 1 MHz, for a reading of 10.0000 ±100 digits.

37. Apply 1V @ 1 MHz using four-wire sensing with the 50Ω 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 ±.036V, adjust C24 until the reading is within ±.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 ±.018V.

39. Apply 500V @ 50 kHz. The reading should be 500.00 ±20 digits (adjust C4 if necessary).

40. Apply 2.5V @ 500 kHz and check reading for 2.50000 ±.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 ±.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 ±.001V.

43. Apply 20V @ 50 kHz and adjust C11 if necessary for a reading of 20.0000 ±.01V.

44. Apply 10V @ 1 MHz using a four-wire cable. The reading should be 10.0000 ±.02V.

45. Apply 1V @ 1 MHz using a four-wire cable with a 50Ω termination. The reading should be 1.00000 ±.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 ± 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 ± 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-38. PARTS LIST

609A-39. 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 PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-09A	⊗RMS CONVERTER PCB ASSEMBLY FIGURE 609A-3 (MIS-4103T)	ORDER	BY	OPTION -09A			
C1	CAP, MYLAR, 0.22 UF +/-20%, 1200V	268904	84411	JF-65	1		
C2	CAP, PORC, 1.5 PF +/-0.25 PF, 1.7V ACK	461004	95275	VY10CA1R5CA	1		
C3	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	1		
C4	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530-000	2		
C7	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	2		
C8	CAP, PORC, 5.6 PF +/-0.25 PF, 100V	460568	95275	VY10CA5R6CA	1		
C9	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530-000	REF		
C10	CAP, MICA, 43 PF +/-1%, 500V	277202	72136	DM15E430F	1		
C11	CAP, VAR, 0.8-10. PF, 250V	229930	91293	JM2951	1		
C12	CAP, POLY FILM, 0.047 UF +/-10%, 250V	162008	73445	C280MAE/A47K	1		
C13	CAP, MICA, 390 PF +/-1%, 500V	355339	72136	DM15F391F	1		
C14	CAP, VAR, 9-35 PF, 350V	289637	72982	538-006D9-35	1		
C15	CAP, MICA, 3600 PF +/-2%, 500V	176644	72136	DM19F362G	1		
C16	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	5		
C17	CAP, MICA, 8 PF +/-10%, 500V	216986	72136	DM15C080K	1		
C18	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	3		
C19	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	2		
C20	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C21	CAP, MICA, 2 PF +/-0.5%, 500V	175208	72136	DM15C020E	1		
C22	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	REF		
C23	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	4		
C24	CAP, VAR, 1.7-10 PF, 250V	321109	56289	GKB10000	1		
C25	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C26	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C27	CAP, MYLAR, 0.0033 UF +/-10%, 50V	402867	06001	75F1R5A-333	2		
C28	CAP, POLY FILM, 0.01 UF +/-10%, 400V	402818	73445	C280MAF/A10K	1		
C29	CAP, MYLAR, 0.022 UF +/-10%, 250V	234484	73445	C280MAE/A22K	2		
C30	CAP, MYLAR, 0.0068 UF +/-20%, 200V	106070	56289	192P68202	1		
C31	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C32	CAP, MYLAR, 0.033 UF +/-10%, 250V	234492	73445	C280MAE/A33K	2		
C33	CAP, MYLAR, 0.0047 UF +/-10%, 50V	260844	06001	75F1R5A347	1		
C34	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	REF		
C35	CAP, MYLAR, 0.033 UF +/-10%, 250V	234492	73445	C280MAE/A33K	REF		
C36	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C37	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C38	CAP, MICA, 4 PF +/-0.5%, 500V	190397	72136	DM15C040E	2		
C39	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C40	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	REF		
C41	CAP, MYLAR, 0.022 UF +/-10%, 250V	234484	73445	C280MAE/A22K	REF		
C42	CAP, MYLAR, 0.0033 UF +/-10%, 50V	402867	06001	75F1R5A-333	REF		
C43	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D68X0035HA1	1		
C44	CAP, MICA, 4 PF +/-0.5%, 500V	190397	72136	DM15C040E	REF		
C45	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C46	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	REF		
C47	CAP, MYLAR, 0.001 UF +/-10%, 200V	159582	56289	192P10292	1	1	
CL1	DIODE, FET, CURRENT REGULATOR	429373	89536	429373	1		
CR2	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	8	2	

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
CR3	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR5	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR6	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	4	1	
CR7	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
CR8	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR9	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR10	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR11	DIODE, ZENER	246611	07910	1N961B	4	1	
CR14	DIODE, SI, SM SIG	313247	28484	HP5082-6264	2	1	
CR15	DIODE, ZENER	246611	07910	1N961B	REF		
CR16	DIODE, SI, SM SIG	313247	28484	HP5082-6264	REF		
CR17	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR18	DIODE, ZENER	246611	07910	1N961B	REF		
CR19	DIODE, SI, 75 MA, 90 PIV	260554	07910	CD55105	1	1	
CR20	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
CR21	DIODE, ZENER	260695	07910	1N754A	2	1	
CR22	DIODE, ZENER	260695	07910	1N754A	REF		
CR24	DIODE, ZENER	246611	07910	1N961B	REF		
CR25	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
H1	SCREW, RH FILISTER, 6-32 X 1/2 (NOT SHOWN)	115006	89536	115006	3		
H2	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY ASSY						
	COIL, REED RELAY	272070	71707	UD-6-P	2		
	SWITCH, DRY REED	219097	95348	MR5972	2		
	SWITCH, DRY REED	284091	95348	MR138	3		
	FOIL WRAP	313833	89536	313833	5		
	FOIL WRAP	313833	89536	313833	REF		
K2	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	1		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	REF		
K4	RELAY, DRY REED	357566	71707	UF40069	4		
K5	RELAY, DRY REED	357566	71707	UF40069	REF		
K6	RELAY, DRY REED	357566	71707	UF40069	REF		
K7	RELAY ASSY						
	COIL, REED RELAY	272070	71707	UD-6-P	REF		
	SWITCH, DRY REED	219097	95348	MR5972	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	REF		
	FOIL WRAP	313833	89536	313833	REF		
K8	RELAY, DRY REED	357566	71707	UF40069	REF		
MP1	CASE ASSY (INCLUDES MP2-MP9)	425231	89536	425231	1		1
MP2	CASE HALF	402990	89536	402990	REF		
MP3	CASE HALF	402990	89536	402990	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	468462	89536	468462	REF		
MP6	DECAL, AC/DC CONVERTER (RMS)	413401	89536	413401	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	FEED-THRU, TEFLON (NOT SHOWN)	281865	12615	SL-841-777	4		
MP11	HEATSINK	347740	05820	260-18D	1		
MP12	INSULATOR, SHIELD (NOT SHOWN)	426932	89536	426932	1		
MP13	SHIELD (NOT SHOWN)	416214	89536	416214	1		
MP14	SHIELD, INPUT	468470	89536	468470	1		
MP15	SOCKET (NOT SHOWN)	343285	00779	2-331272-6	7		
MP16	SPRING, COIL (NOT SHOWN)	424465	83553	C0120-014-0380	1		
MP17	STAND-OFF, TEFLON (NOT SHOWN)	275719	15849	1497B	5		
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	XSTR, FET, N-CHANNEL	343103	89536	343103	REF		
Q7	XSTR, FET, N-CHANNEL	343103	89536	343103	REF		
Q8	XSTR, MATCHED SET (Q8 & Q12)	341057	89536	341057	1	1	2
Q10	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q11	XSTR, SI, PNP	195974	04713	2N3906	1	1	
Q12	XSTR, MATCHED SET (Q8 & Q12)	341057	89536	341057	REF		2
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	XSTR, FET, N-CHANNEL	288324	89536	288324	REF		
Q17	XSTR, FET, N-CHANNEL	288324	89536	288324	REF		
Q18	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q19	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q20	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, MTL. FILM, 1M +/-0.1%, 1W	340265	03888	PME75	1		
R2	RES, MTL. FILM, 16.9K +/-1%, 1/8W	267146	91637	CMF551692F	1		
R3	RES, DEP. CAR, 200 +/-5%, 1/4W	193482	80031	CR251-4-5P200E	1		
R4	THERMISTOR, TEMP SENS, NEG TC	501304	89536	501304	1		
R5	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	2		
R6	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	3		
R7	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	REF		
R8	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R9	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	6		
R10	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
R11	RES, DEP. CAR, 12K +/-5%, 1/4W	348847	80031	CR251-4-5P12K	1		
R12	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	3		
R13	RES, MTL. FILM, 399.0K +/-0.1%, 1/8W	417212	91637	CMF553993B	1		
R14	RES, VAR, CERMET, 5K +/-10%, 1/2W	288282	89536	288282	1		
R15	RES, MTL. FILM, 56.89K +/-0.1%, 1/8W	417220	91637	CMF5556891B	1		
R16	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1		
R17	RES, MTL. FILM, 6324 +/-0.1%, 1/8W	417238	91637	CMF556324B	1		
R18	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285100	2		
R19	RES, MTL. FILM, 782.8 +/-0.1%, 1/8W	417246	91637	CMF55782R8B	1		
R20	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	2		
R21	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	1		
R22	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	3		
R23	RES, MTL. FILM, 4.975K +/-0.1%, 1/8W	340232	91637	CMF554975B	1		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R24	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R25	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	1		
R26	RES, DEP. CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9	1		
R27	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	2		
R28	RES, MTL. FILM, 121 +/-1%, 1/8W	343160	91637	CMF551210F	1		
R29	RES, MTL. FILM, 5K +/-0.1%, 1/8W	340240	91637	CMF555001B	1		
R30	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	3		
R31	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	REF		
R32	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285100	REF		
R33	RES, MTL. FILM, 100K +/-0.1%, 1/8W	340166	91637	CMF551003B	1		
R34	RES, MTL. FILM, 35.7K +/-1%, 1/8W	288480	91637	CMF553572F	1		
R35	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R36	RES, DEP. CAR, 82 +/-5%, 1/4W	442277	80031	CR251-4-5P82E	1		
R37	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	REF		
R38	RES, VAR, CERMET, 3 +/-25%, 1/2W	347963	32997	3329H-J81-3R0	1		
R39	RESISTOR, SELECT						2
R40	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	REF		
R42	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	REF		
R43	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	3		
R44	RES, DEP. CAR, 9.1K +/-5%, 1/4W	441691	80031	CR251-4-5P9K1	1		
R45	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	REF		
R46	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	3		
R47	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	1		
R48	RES, SELECTED						2
R49	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R50	RES, CAR. DEP, 2.7 +/-5%, 1/4W	442061	80031	CR251-4-5P2E7	1		
R51	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R52	RES, MTL. FILM, 4.02M +/-1%, 1/4W	417253	91637	CMF604024F	1		
R53	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R54	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R55	RES, VAR, CERMET, 1M +/-10%, 1/2W	276691	89536	276691	2		
R56	RES, MTL. FILM, 2M +/-0.25%, 1/2W	327502	91637	CMF652004C	2		
R57	RES, MTL. FILM, 930K +/-0.25%, 1/4W	417345	91637	CMF609303C	1		
R58	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	REF		
R59	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R60	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R61	RES, MTL. FILM, 17.4K +/-1%, 1/8W	236802	91637	CMF551742F	1		
R62	RES, MTL. FIL, 34K +/-1%, 1/8W	261602	91637	CMF553402F	1		
R63	RES, MTL. FILM, 68.1K +/-1%, 1/8W	236828	91637	CMF556812F	1		
R64	RES, VAR, CERMET, 20K +/-10%, 1.2W	291609	89536	291609	1		
R65	RES, MTL. FILM, 2M +/-0.25%, 1/2W	327502	91637	CMF652004C	REF		
R66	RES, VAR, CERMET, 1M +/-10%, 1/2W	276691	89536	276691	REF		
R67	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R68	RES, DEP. CAR, 200K +/-5%, 1/4W	441485	80031	CR251-4-5P200K	1		
R69	RES, DEP. CAR, 750K +/-5%, 1/4W	442525	80031	CR251-4-5P750K	1		
R70	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R71	RES, DEP. CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P470K	1		
R72	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	1		
R73	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R74	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	2		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R75	RES, VAR, CERMET, 10K +/-10%, 1/2W	285171	89536	285171	1		
R76	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R77	RES, MTL. FILM, 23.2K +/-1%, 1/8W	291351	91637	CMF552322F	1		
R78	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	CMF55A100F	1		
R79	RES, SELECTED						2
R80	RES, SELECTED						2
R81	RES, THERMISTOR, TEMP SENSITIVE	104596	73168	JA41J1	1		
R82	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R83	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R84	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R85	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R86	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R87	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R88	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R89	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	CMF554222F	1		
R90	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R92	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	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	IC, LIN, OP AMP	284760	12040	LM308H	2	1	
U7	IC, LIN, OP AMP	284760	12040	LM308H	REF		
U8	IC, LIN, OP AMP	381889	12040	LM201AH	1	1	
U9	⊗IC, C-MOS, HEX BUFFER/INVERTER	381848	20735	CD4049AE	1	1	
U10	⊗IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U11	⊗IC, C-MOS, QUAD 2-INPUT NAND GATE	355198	04713	MC14011CD	1	1	
XQ15	SPACER, COMPONENT	152207	07047	10123DAP	1		
Z							

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

2 RESISTORS ARE TC COMPENSATED AND MUST BE RETURNED FOR RESELECTION IF ANY REQUIRE REPLACEMENT.

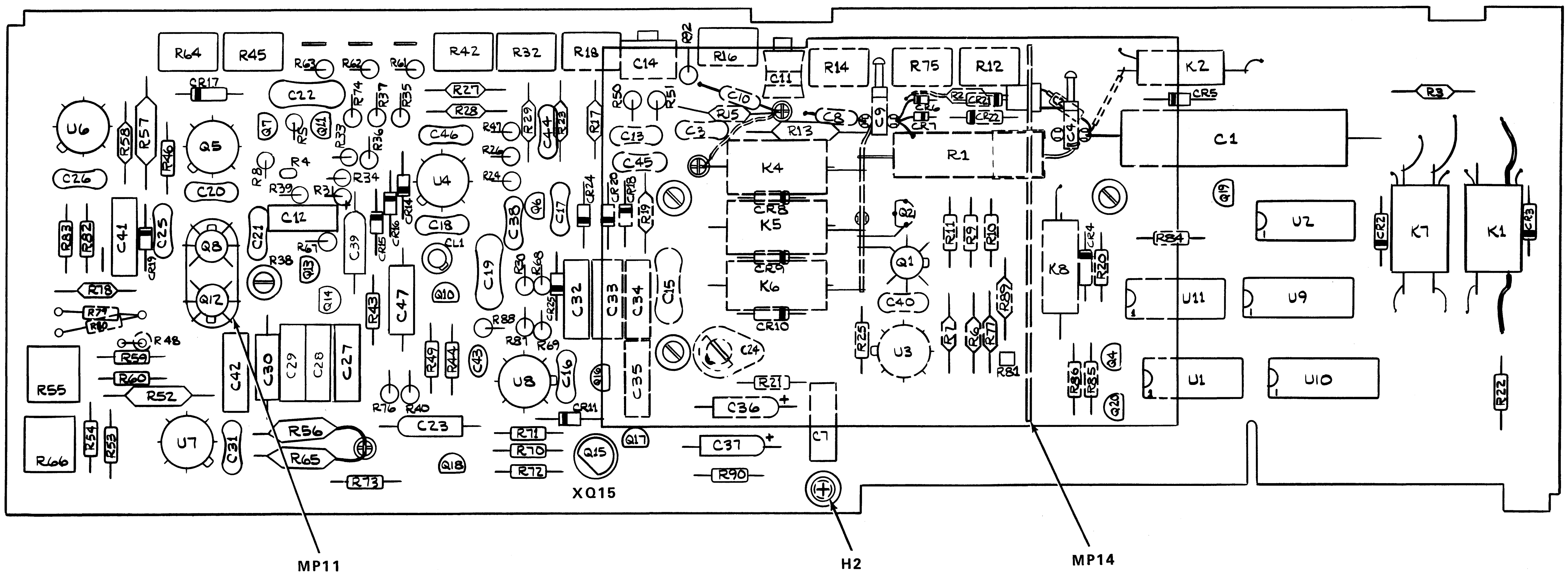
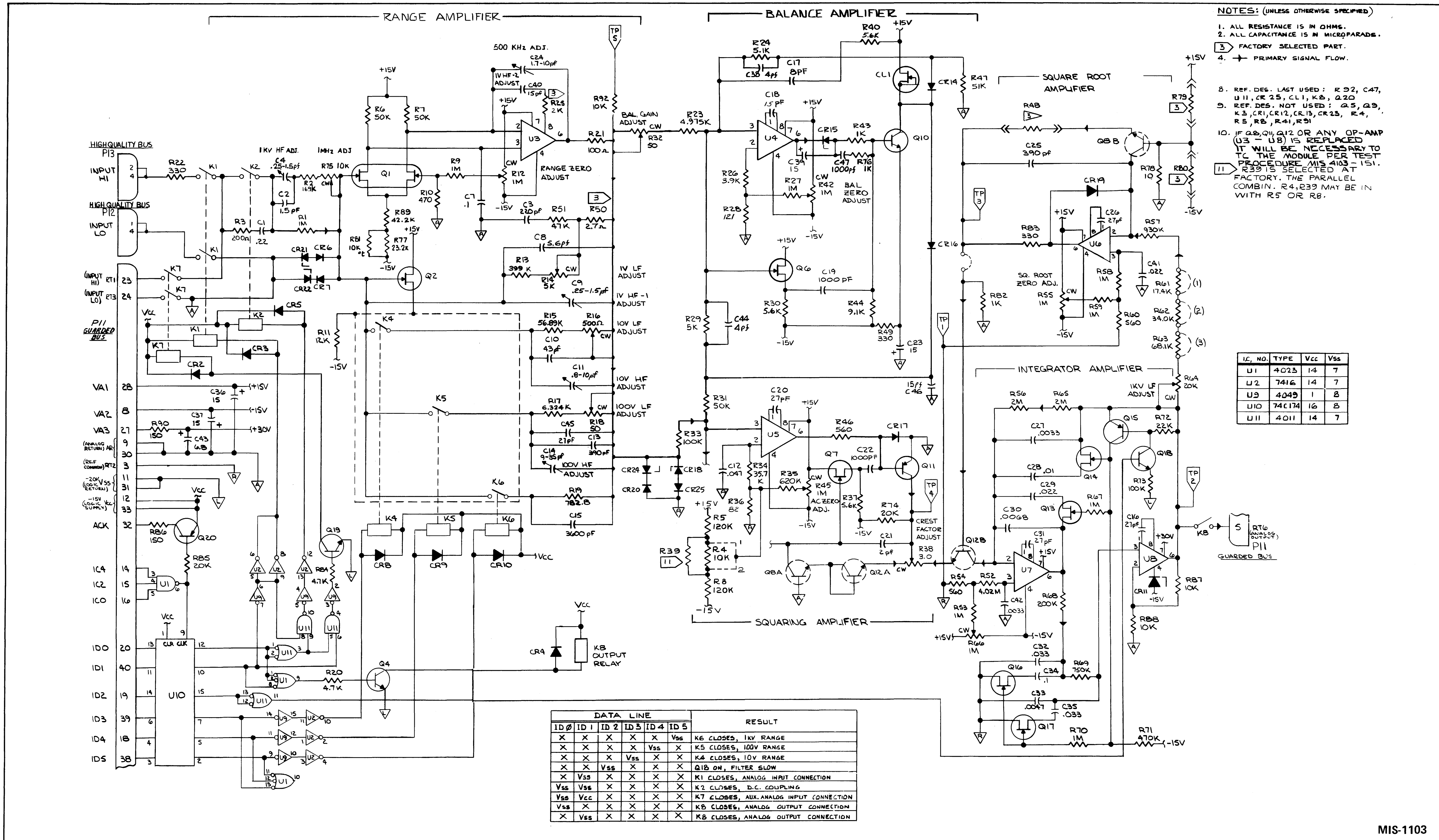


Figure 609A-3. RMS Converter PCB Assembly



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IS IN OHMS.
2. ALL CAPACITANCE IS IN MICROFARADS.
3. FACTORY SELECTED PART.
4. PRIMARY SIGNAL FLOW.
8. REF. DES. LAST USED: R92, C47, U11, CR25, CL1, K8, Q20
9. REF. DES. NOT USED: Q5, Q9, K3, CR1, CR12, CR13, CR23, R4, R5, R8, R41, R91
10. IF Q8, Q11, Q12 OR ANY OP-AMP (U3 – U8) IS REPLACED IT WILL BE NECESSARY TO TC THE MODULE PER TEST PROCEDURE MIS 4103-151.
11. R39 IS SELECTED AT FACTORY. THE PARALLEL COMBIN. R4, R39 MAY BE IN WITH R5 OR R8.

IC, NO.	TYPE	Vcc	Vss
U1	4023	14	7
U2	7416	14	7
U9	4049	1	8
U10	74C174	16	8
U11	4011	14	7

DATA LINE						RESULT
IDØ	ID1	ID2	ID3	ID4	ID5	
X	X	X	X	X	Vss	K6 CLOSES, 1KV RANGE
X	X	X	X	Vss	X	K5 CLOSES, 100V RANGE
X	X	X	Vss	X	X	K4 CLOSES, 10V RANGE
X	X	Vss	X	X	X	Q18 ON, FILTER SLOW
X	Vss	X	X	X	X	K1 CLOSES, ANALOG INPUT CONNECTION
Vss	Vss	X	X	X	X	K2 CLOSES, D.C. COUPLING
Vss	Vcc	X	X	X	X	K7 CLOSES, AUX. ANALOG INPUT CONNECTION
Vss	X	X	X	X	X	K8 CLOSES, ANALOG OUTPUT CONNECTION
X	Vss	X	X	X	X	K8 CLOSES, ANALOG OUTPUT CONNECTION

MIS-1103

Figure 609A-3. RMS Converter PCB Assembly (cont)

Option -16
Front/Rear Input Switching

616-1. INTRODUCTION

616-2. Installation of the switchable front-rear input (Option -16) provides alternate analog input terminals for use in systems type measurements. A single connector houses Input Sense, Input Source, Ohms Guard, Guard, and External Reference terminals on the instrument's rear panel. A push button on the front panel then allows the user to select either front or rear panel analog inputs. The REAR INPUT IN switch connects one set of inputs at a time to the High Quality Bus. The -16 Option is not compatible with the Model 8500A DMM.

616-3. SPECIFICATIONS

616-4. Due to input switch characteristics, there will be a slight alteration in the 8500 series DMM's specifications with Option -16 installed. Note the following changes to the listed option specifications:

1. AC AVG (-01), Table 601-1:
   Change "Input Characteristics - Impedance" from <100 pF to <110 pF (front) and add <100 pF (rear).

2. CURRENT SHUNTS (-03), Table 603-1:
   Change "Voltage Burden" on the following ranges:

   10 mA from ≤200 mV to ≤250 mV
   100 mA from ≤200 mV to ≤250 mV
   1A from ≤500 mV to ≤750 mV

3. AC RMS (-09), Table 609-1:
   Change "Input Characteristics - Impedance" from <100 pF to <120 pF (front) and add <110 pF (rear).

CAUTION

A difference in potential between front and rear input terminals of 1000V peak must not be exceeded. Damage to the front-rear switch could otherwise result.

616-5. INSTALLATION

616-6. The switchable front-rear input (Option -16) is factory installed only.

616-7. OPERATING NOTES

616-8. Before switching between analog input terminals, use the following procedure:

1. Remove inputs from the input terminals already in use.
2. Insure that the DMM's range and function are appropriate for the input terminals to be selected.
3. Check that proper terminal interconnections are made on the input terminals to be selected, (especially GUARD to LO). Refer to Table 616-1 for inter-terminal overload definitions.

616-9. Connect rear analog input terminals, and disconnect front terminals, by pressing REAR INPUT IN (push on, push off). Samplings will now be taken through the rear input connector. Since front panel terminal strapping is now irrelevant, separate interconnections must be made at the remote analog inputs. In addition, external reference inputs are disconnected from the rear panel terminal posts; these inputs must be applied through the rear input connector.

Table 616-1. Inter-Terminal Overloads

TERMINALS	OVERLOAD
LO to Guard	127V max
Guard to Chassis	1000V max
HI Sense to HI Source	127V max
LO Sense to LO Source	127V max
HI Sense to LO Sense	1000V max
HI Source to LO Source	280V max

616-10. Unlike the front inputs, the rear input connects to ohms guard. Use of ohms guard is detailed in the Ohms Converter (Option -02) information provided in Section 6 of the Instruction Manual.

NOTE

"Remote control" of the DMM does not provide switching of analog inputs. This function can only be performed manually by pressing REAR INPUT IN.

616-11. THEORY OF OPERATION

616-12. Refer to Figure 616-1 for the following circuit description. The high quality bus consists of lines connecting the front-rear input switch (Sense Hi and Lo, Source Hi and Lo, Guard, Ohms Guard, External Reference Hi and Lo) to the signal conditioning and converting modules in the DMM. Ohms Guard is available only through the rear input terminals. External Reference Hi and Lo are available through the rear input terminals or through separate rear panel binding posts for use in conjunction with the front input terminals. Table 616-2 defines rear input terminal usage.

Table 616-2. Rear Input Terminal Usage

PIN	SIGNAL
A	Guard
B	Source Lo
D	Chassis
E	Input Lo
K	Ext Ref Hi
L	Ext Ref Lo
R	Ohms Guard
S	Input Hi
X	Source Hi

616-13. MAINTENANCE

616-14. An additional current protection fuse is included for the rear input terminals. This fuse (1-1/2A AGC) can be accessed immediately above the rear input connector.

616-15. The rear input connector mounting plate is made of a special high resistance, low-leakage material to minimize leakage error in high resistance measurements. Periodically, and whenever leakage is suspected, clean the plate with a mild detergent; rinse well with hot water.

616-16. Care should also be exercised when cleaning the front/rear input switch. Avoid use of any degreasing agents when cleaning in or near the front/rear input switch.

616-17. PARTS LIST

616-18. Table 616-3 gives a detailed parts description for the front-rear switching option. Refer to Section 5 of the Instruction Manual for ordering information.

Table 616-3. Front/Rear Input Switching Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-16	FRONT/REAR INPUT SWITCHING ASSEMBLY FIGURE 616-1 (8502A-16)	ORDER	BY	OPTION -16			
-16A1	FRONT REAR SWITCH ASSEMBLY	486985	89536	486985	1		
-16A2	REAR INPUT ASSEMBLY	487553	89536	487553	1		
E1	SPARK GAP	442731	25088	B2-B470	1		
F1	MAGNET WIRE #36	160978	89536	160978	2		
F2	FUSE, 1.5 AMP	109330	71400	AGC-1.5A	1	5	
H1	LOCKWASHER, INT. TOOTH	110676	89536	110676	4		
H2	NUT, HEX	110668	73734	8000NP	4		
H3	NUT, HEX, 8-32	281113	89536	281113	1		
H4	NUT, HEX, 4-40	110635	89536	110635	1		
H5	SCREW, FH, 2-56 X 5/8	370270	89536	370270	4		
H6	SCREW, PHP, 4-40 X 3/16	129882	89536	129882	1		
H7	SCREW, PHP, 8-32 X 1/4	228890	89536	228890	1		
H8	SCREW, PHP, 8-32 X 1/4	320044	89536	320044	2		
H9	SCREW, SEMS, 6-32 X 3/8	177022	89536	177022	2		
J1	CONNECTOR MATING, REAR INPUT (NOT SHOWN)				1		
	CONNECTOR	369231	91662	00-8016-020-000-703	REF		
	PINS, CONNECTOR, SOLDER (IF USED)	369298	91662	217-60-8017-05-13	REF		
	PINS, CONNECTOR, CRIMP (IF USED)	369280	91662	000-60-8017-03-13	REF		
L2	RESISTOR COIL ASSEMBLY	438325	89536	438325	1		
MP1	BUSHING	102780	28520	SB-625-8	1		
MP2	BUSHING, SNAP	184620	28520	SB-500-6	1		
MP3	CABLE CLAMP	103796	95998	5/16-3NA	1		
MP4	CABLE TIE	172080	89536	172080	1		
MP5	FRONT PANEL INSERT, ALTERED	475103	89536	475103	1		
MP6	HOUSING, REAR INPUT	420828	89536	420828	1		
MP7	NYLON SPACER	158634	89536	158634	1		
MP8	PUSHBUTTON, STAMPED	473603	89536	473603	1		
MP9	STANDOFF, TERM, TEFLON	271650	12615	SL890823	1		
MP10	SWITCH EXTENSION	478057	89536	478057	1		
MP11	SWITCH, PCB	486324	89536	486324	1		
MP12	WEB	472654	89536	472654	1		
R1	RES, MTL. FILM, 30.9K +/-1%, 1/2W	247569	91637	CMF653092F	2		
R2	RES, MTL. FILM, 30.9K +/-1%, 1/2W	247569	91637	CMF653092F	REF		
R3	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	1		
S1	SWITCH	473538	89536	473538	1		
TM1	INSERT, MANUAL (NOT SHOWN)	486365	89536	486365	1		
W1	CABLE, PCB TO SWITCH	486993	89536	486993	1		
W2	CABLE, INPUT FRONT	486316	89536	486316	1		
W3	CABLE, INPUT REAR	487546	89536	487546	1		
W4	CABLE, EXTERNAL REFERENCE	472597	89536	472597	1		
XF1	FUSE HOLDER	435628	89536	435628	1		

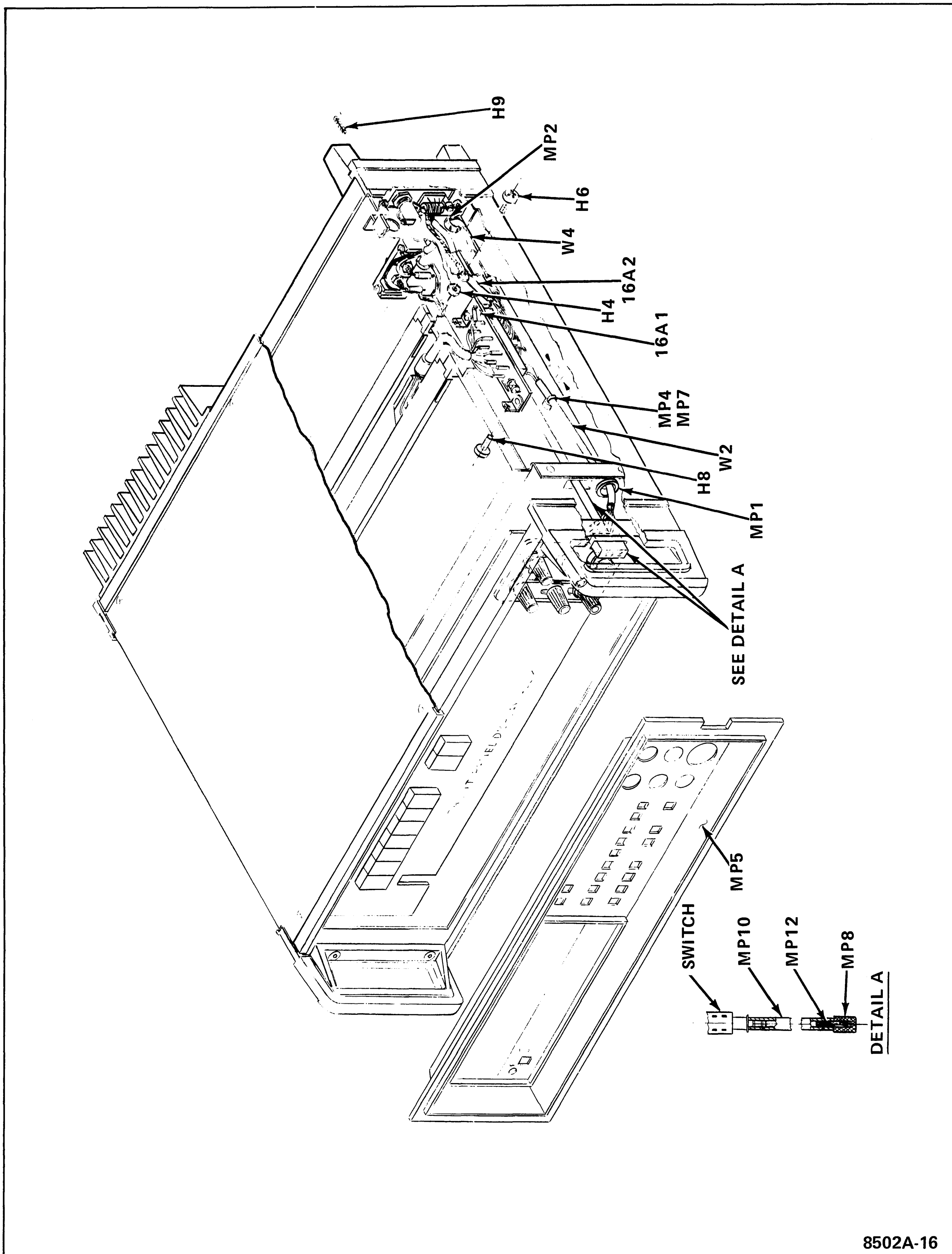
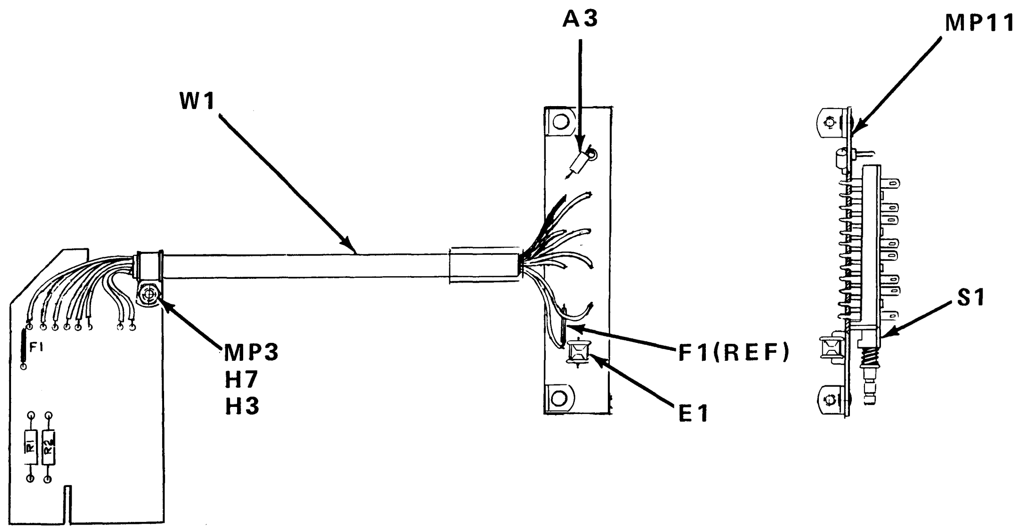
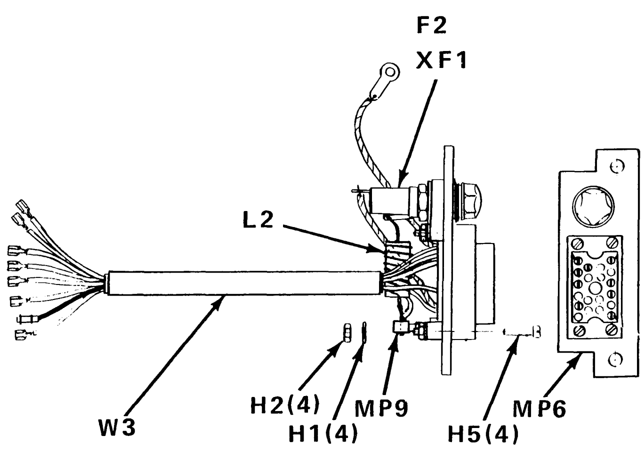


Figure 616-1. Front/Rear Input Switching Assembly



8502A-4414



8502A-4413

Figure 616-1. Front/Rear Input Switching Assembly (cont)

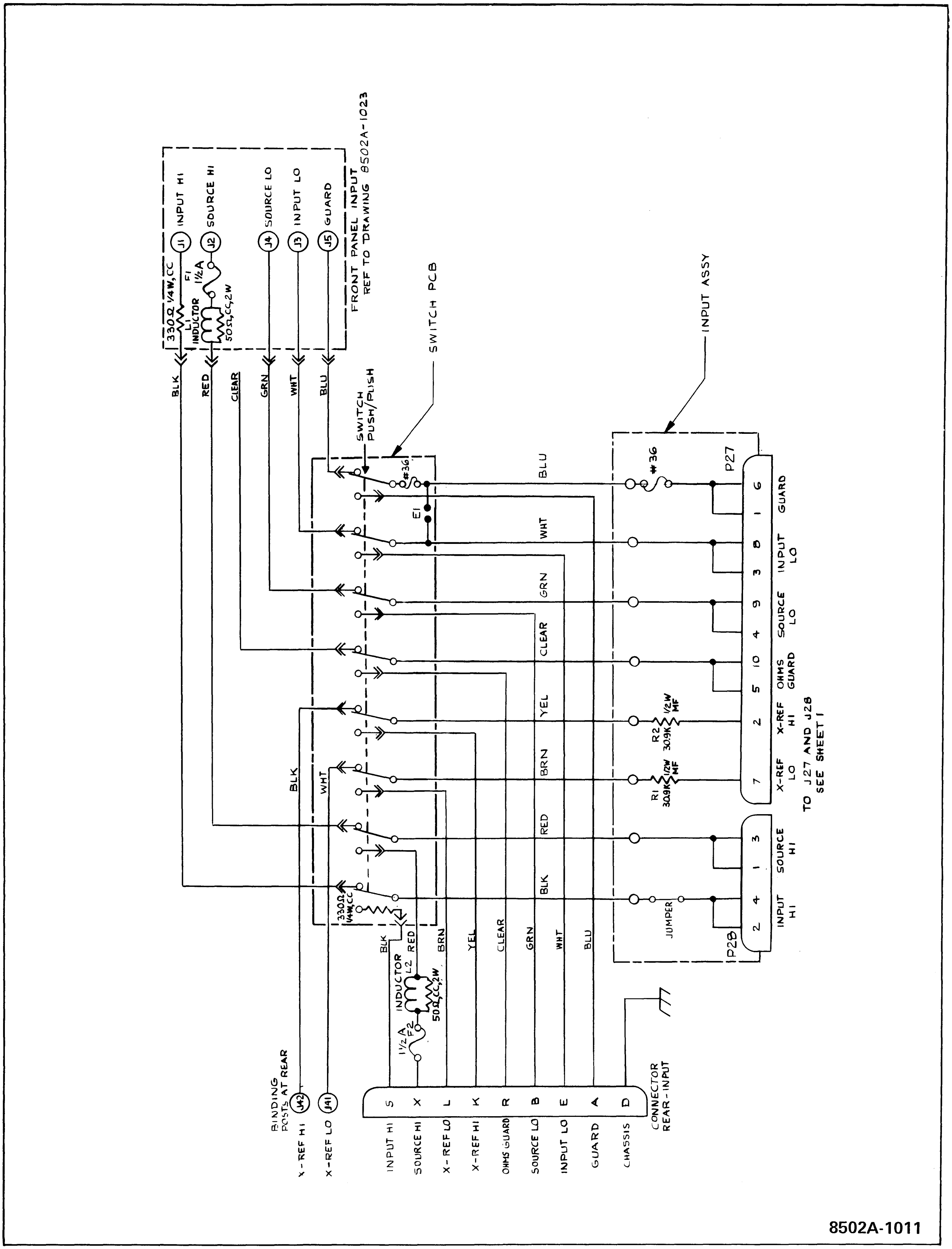


Figure 616-1. Front/Rear Input Switching Assembly (cont)

Option —17
Rear Input

617-1. INTRODUCTION

617-2. Installation of the Rear Input option allows single-connector access to the Input Sense and Source terminals, the Guard terminal, and the ohms guard for ease in systems type measurements. Refer to Section 602 for use of the ohms guard. All connections are directly to the High-Quality Bus. For an explanation of the bus structure, refer to Section 3. When making connections through the Rear Input connector, the shorting links should be removed from the front panel input terminals. Guard connections explained in Section 2 then must be made through the Rear Input.

617-3. INSTALLATION

617-4. To install the Rear Input option use the following procedure. Figure 617-1 illustrates proper installation. Table 617-1 lists the pin identification and associated signal line. Pin D of the cable connector should be connected to the metal shield or hood over the connector so that all metal surfaces will be grounded.

1. Remove the top cover from the instrument.

2. Remove the cover plate from the rear input entry port.

3. Install the rear input cable connector in the entry port using the screws that held the cover plate in place.

4. Attach the ground wire (grn/yel) to the chassis through the existing hole. Use the #4-40 screw and nut included in the kit.

5. Plug the pcb connector into the card edge connector located on the right side of the motherboard between the 4th (A/D Converter) and 5th (Isolator) module positions, from the rear panel.

6. Replace the top cover on the instrument.

Table 617-1. Rear Input Connections

PIN	SIGNAL
A	Guard
B	Source Lo
D	Chassis
E	Input Lo
K	Ext Ref Hi
L	Ext Ref Lo
R	Ohms Source Guard
S	Input Hi
X	Source Hi

617-5. MAINTENANCE

617-6. Fuse F1 is mounted on the same plate as the Rear Input Connector. It is the current overload protection in series with the Source HI terminal. Use a 1½A fast-blow fuse as a replacement.

617-7. The plate on which the connector is mounted is made of a special high-resistance, low-leakage material to minimize leakage error in high-resistance measurements. If leakage is suspected, clean the plate with a mild detergent. Rinse well with hot water.

617-8. PARTS LIST

617-9. Table 617-2 gives a parts breakdown for the Rear Input assembly. Refer to Section 5 for ordering information.

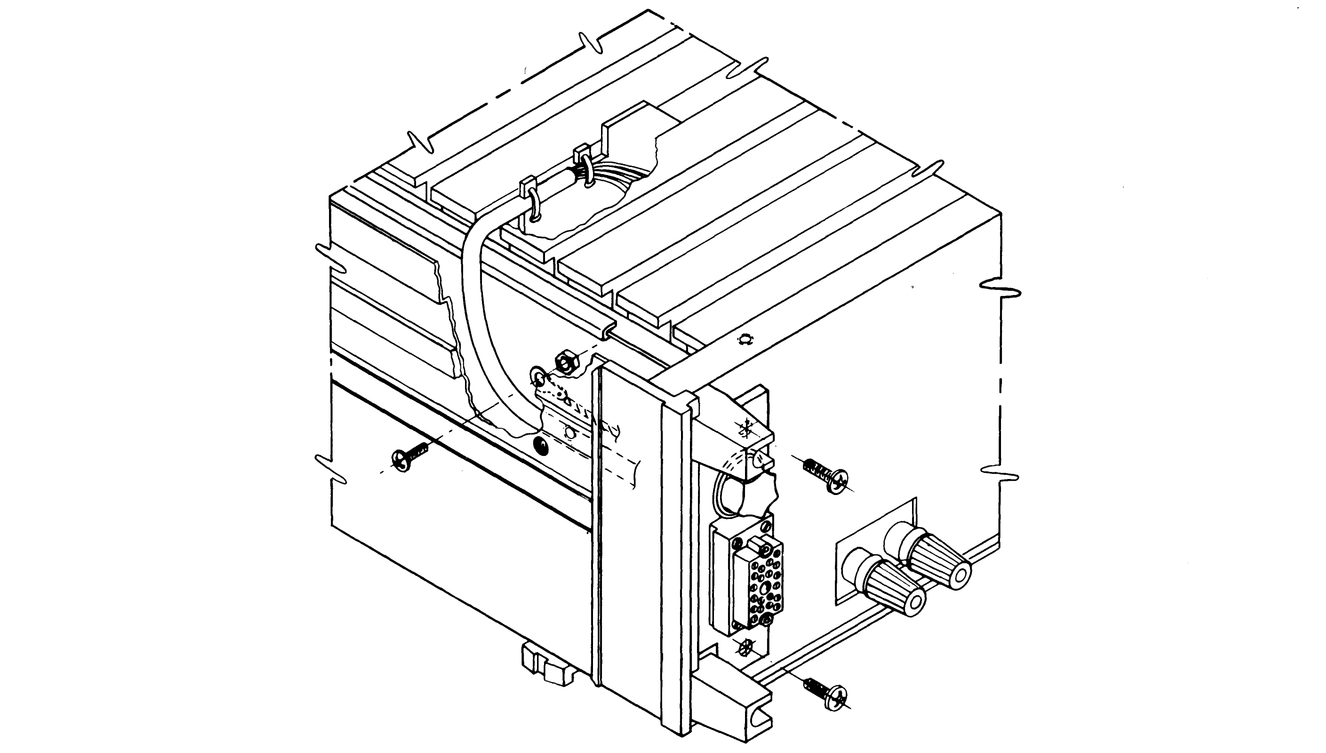


Figure 617-1. Rear Input Option —17 Installation

Table 617-2. Harness Rear Input Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-17	HARNESS REAR INPUT ASSEMBLY FIGURE 617-2 (8500A-4414)	ORDER	BY	OPTION -17			
F1	FUSE, FAST ACTING, 1-1/2 AMP	109330	71400	AGC 1-1/2	1	5	
F2	WIRE, MAGNET, #36	160978	89536	160978	1		
H1	NUT, HEX, 2-56	110668	89536	110668	4		
H2	NUT, HEX, 8-32	281113	89536	281113	1		
H3	SCREW, FH, 2-56 X 5/8	370270	89536	370270	4		
H4	SCREW, PHP, 8-32 X 1/4	228890	89536	228890	1		
H5	WASHER, LOCK, INT. TOOTH	110676	89536	110676	4		
J1	CONNECTOR MATING, REAR INPUT (NOT SHOWN)				1		
	CONNECTOR	369231	91662	00-8016-020-000-703	REF		
	PINS, CONNECTOR, SOLDER (IF USED)	369298	91662	217-60-8017-05-13	REF		
	PINS, CONNECTOR, CRIMP (IF USED)	369280	91662	000-60-8017-03-13	REF		
MP1	CLAMP, CABLE, NYLON	103796	95987	5/16-3NA	1		
MP2	HOUSING, REAR INPUT	420828	89536	420828	1		
MP3	STANDOFF, TERM, TEFLON	271650	12615	SL890823	1		
R1	RES, MTL. FILM, 30.9K +/-1%, 1/2W	247569	91637	MMFF1-23092F	2		
R2	RES, MTL. FILM, 30.9K +/-1%, 1/2W	247569	91637	MMFF1-23092F	REF		
R3	RES, COMP, 300 +/-5%, 1/4W	348276	01121	CB3015	1		
RL1	RESISTOR COIL ASSEMBLY	438325	89536	438325	1		
W1	CABLE	420851	89536	420851	1		
XF1	FUSE HOLDER	435628	89536	435628	1		

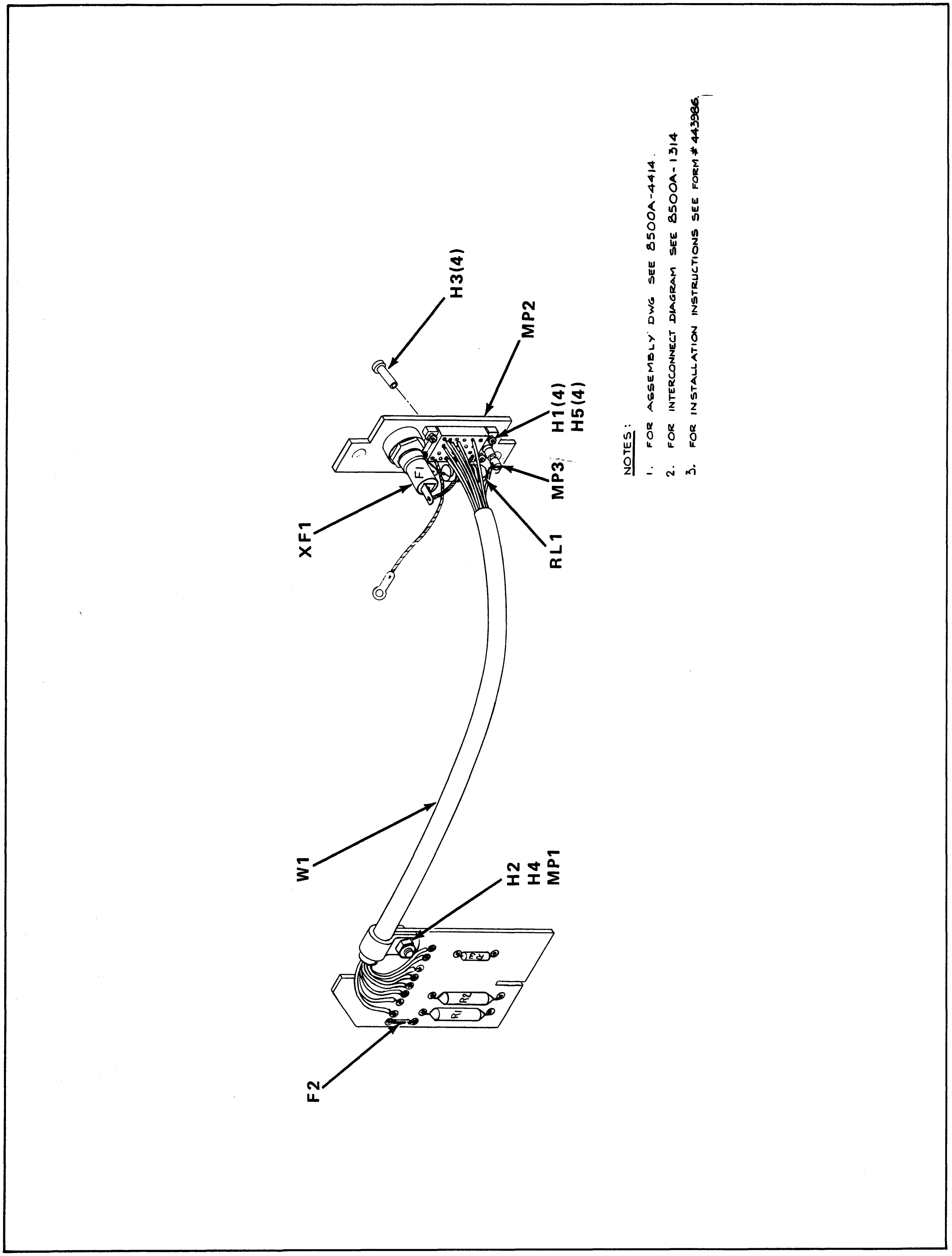


Figure 617-2. Harness Rear Input Assembly

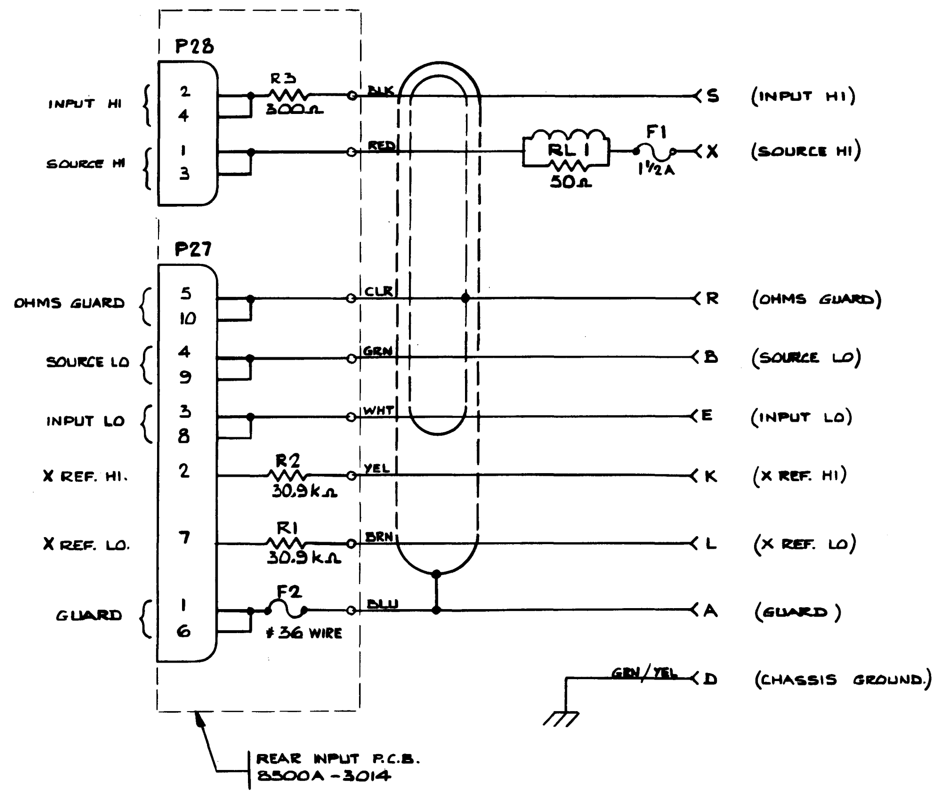


Figure 617-2. Harness Rear Input Assembly (cont)

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.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(-) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmablle read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey

70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303

72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
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Centrelab Electronics Div. of
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El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

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Minneapolis, Minnesota

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(404) 396-3224 (Atlanta)

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Tustin, CA 92680
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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

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with change under desired rev letter																					
			—	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R					
A2	Motherboard Assy (8502-4001)	481713	2	1	◆	X																		
A3	Bus Interconnect (MIS-4081)	458636	X																					
A4	Power Supply (8500A-4041)	448886	●	●	5	4	3	◆	◆	X														
A4	Power Supply																							
A5	Power Supply Interconnect (8500A-4032)	401760	X																					
A6	Controller Assy (8502A-4185T)	384024	6	X																				
A6A1	Controller PCB (8502A-4185)	471318	9	◆	8	7	◆	X																
A6A2	PROM-ROM-RAM PCB (8502A-4088)	458141	●	10	◆	X																		
A6	Controller Assy																							
A7	Front Panel Display (8502A)-4023)	481689	11	◆	X																			
A8	DC Signal Conditioner (MIS-4100)	383901	●	●	●	●	●	●	●	●	15	14	13	◆	◆	◆	12	X						
A9	Active Filter (MIS-4130)	383976	●	●	●	●	●	◆	◆	16	X													
A10	A/D Converter Assy																							
A10A1	A/D Analog Assy (MIS-4140)	383752	●	●	●	●	●	●	●	●	●	●	●	18	◆	17	X							
A10A1	A/D Digital Assy (MIS-4141)	383760	●	●	20	◆	19	X																
01	AC/DC Converter (Averaging) (MIS-4101)		●	●	●	●	●	●	●	●	23	◆	◆	◆	22	21	X							
02	Ohms Converter (MIS-4110)		●	●	●	●	●	26	25	◆	24	X												
03	Current Shunts (MIS-4104)		●	●	●	●	●	●	●	29	◆	28	27	◆	X									
04	Calibration Memory (8500A-4160)		●	●	●	●	●	●	X															

— A B C D E G F H I J K L M N P R

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
— = No revision letter on the PCB.
◆ = This revision does not affect the manual.

Table 7A-1. Manual Status and Back Dating Information (cont)

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in descending order (by no.), ending with change under desired rev letter																
			–	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R
05	IEEE-488 Interface (MB) (MIS-4172)		●	●	●	●	●	●	●	30	◆	X							
	IEEE-488 Interface (PB) (MIS-4072)		●	●	●	●	X												
	IEEE-488 Interface (PB) (MIS-4074)		◆	31	X														
06	Bit Serial Interface (MIS-4170)		●	●	●	●	●	●	●	●	●	◆	X						
07	Parallel Interface (MIS-4171)		●	●	●	●	33	32	X										
	Parallel Interface (MIS-4175)		◆	35	34	X													
08A	Isolator (External Trigger) (8502A-4181)		37	36	X														
09A	AC/DC Converter (RMS) (MIS-4103)		●	45	44	43	◆	42	41	40	39	38	X						
			–	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
– = No revision letter on the PCB.
◆ = This revision does not affect the manual.

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

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

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 ϕ pulse train of Figure 4-6 as follows:

FROM:	≥60ns	TO: >70ns
FROM:	80±ns	TO: blank
FROM:	95±5ns	TO: ≥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

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

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

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

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

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

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±10%, 20V	153056	56289	150D156X9020B2	REF
TO: C39	CAP, MYLAR, 0.1UF±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±5%, 1/4W	441451	80031	CR251-4-5P200E	1
TO: R3	RES, COMP, 2O0 ±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±10%, 1/2W	288282	89536	288282	1	1
TO: R14	RES, VAR, CERMET, 2K±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±5%, 1/4W	441469	80031	CR251-4-5P2K	1
TO: R25	RES, COMP 3K±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±5%, 1/2W	169839	01121	EB2015	1
TO: R3	RES, MF, 2K±1%, 1/8W	235226	91637	CMF552001F	1

CHANGE R2 as follows:

FROM: R2	RES, MF, 13K±1%, 1/8W	335539	91637	CMF551302F	1
TO: R2	RES, MF, 16.9k±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

TABLE OF CONTENTS

List of Mnemonics

ACK	– acknowledge
ACK LAT	– acknowledge late
AR	– analog return
DB	– data bus
DBIN	– data bus input signal (from μP)
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 μP)
INTE	– interrupt enable (from μP)
MEM RD	– memory read
MS ADDR BYTE	– memory select address byte
ϕ1	– clock pulse
ϕ2	– clock pulse
ϕLL	– phase-locked loop
RAM	– random access memory
ROM	– read only memory
RRDY	– reset ready
RST	– reset
RT	– real time
R/W	– read/write
μP	– microprocessor
VA	– analog supply voltage
V_{CC} ϕ2	– 5V clock pulse
V_{DD} ϕ2	– 12V clock pulse
SRDY	– set ready
SYN IINT	– synchronized internal interrupt
TTL PU	– TTL pull-up
WO	– write out
WR	– write

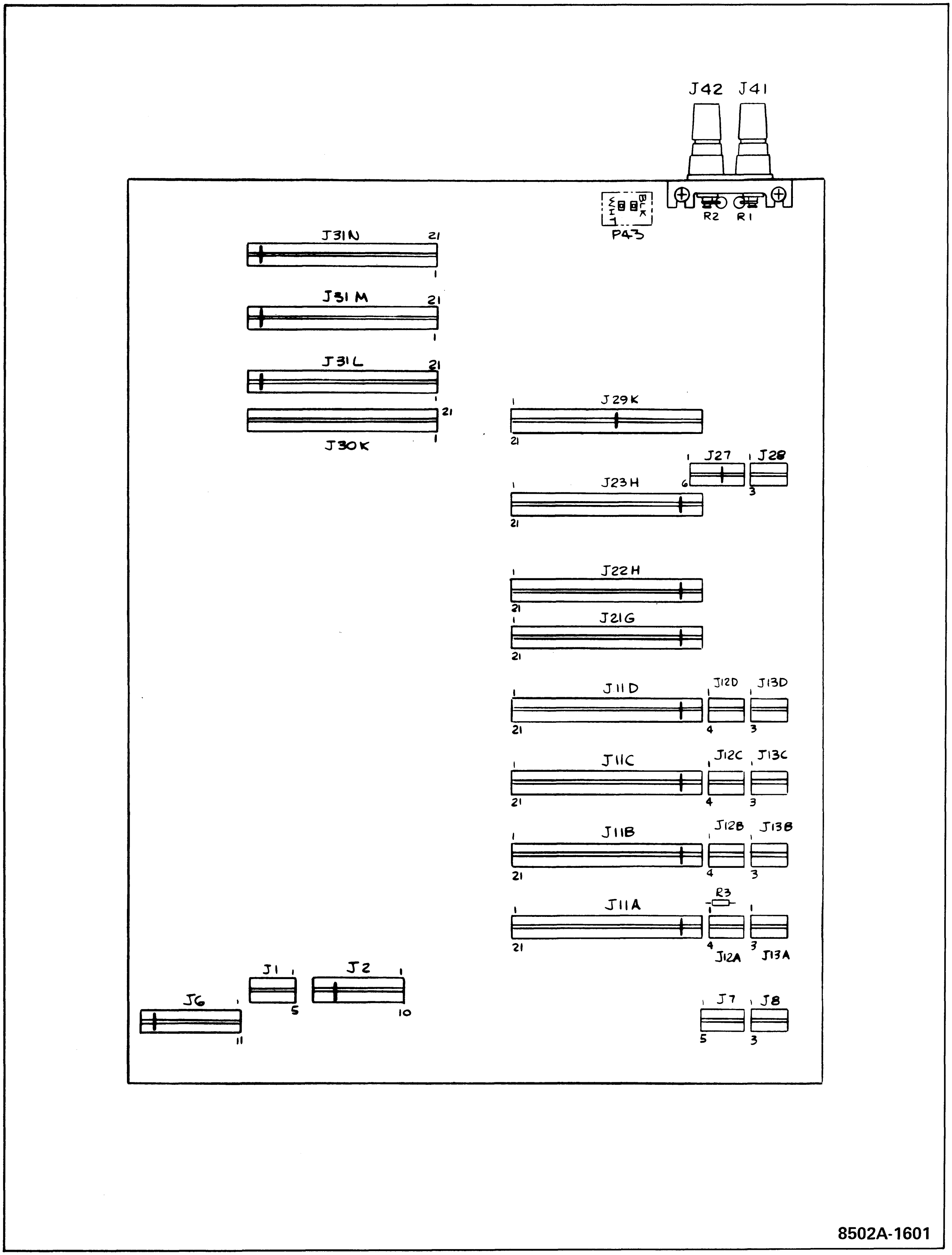
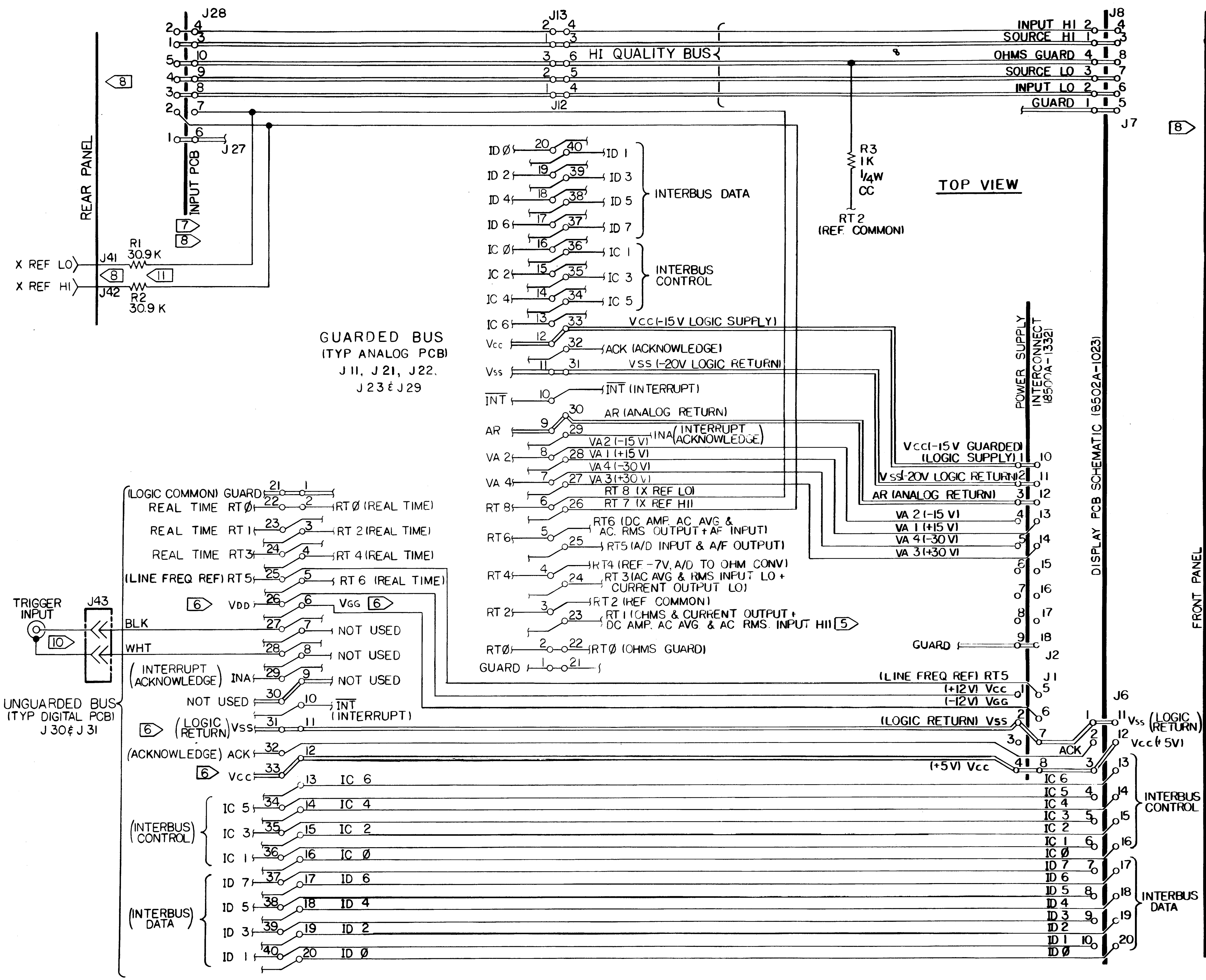


Figure 8-1. A2 Motherboard PCB Assembly



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NOTES:

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 J11 ONLY. NO INTERCONNECT EXISTS BETWEEN J11, PIN 23 & OTHER CONNECTORS ON GUARDED BUS

6. FUNCTION WILL VARY DEPENDING UPON BUS INTERCONNECTION INSTALLED IN UNIT.

FUNCTION	ISOLATOR (OPTION-01)	BUS INTERCONNECT (MIS-1081)
Vss	0	-20V
VDD	+12V	-8V
VGG	-12V	-32V
Vcc	+5V	-15V

7. CONNECTION FOR PARALLEL REAR INPUT-017 SEE 8500A-1314.

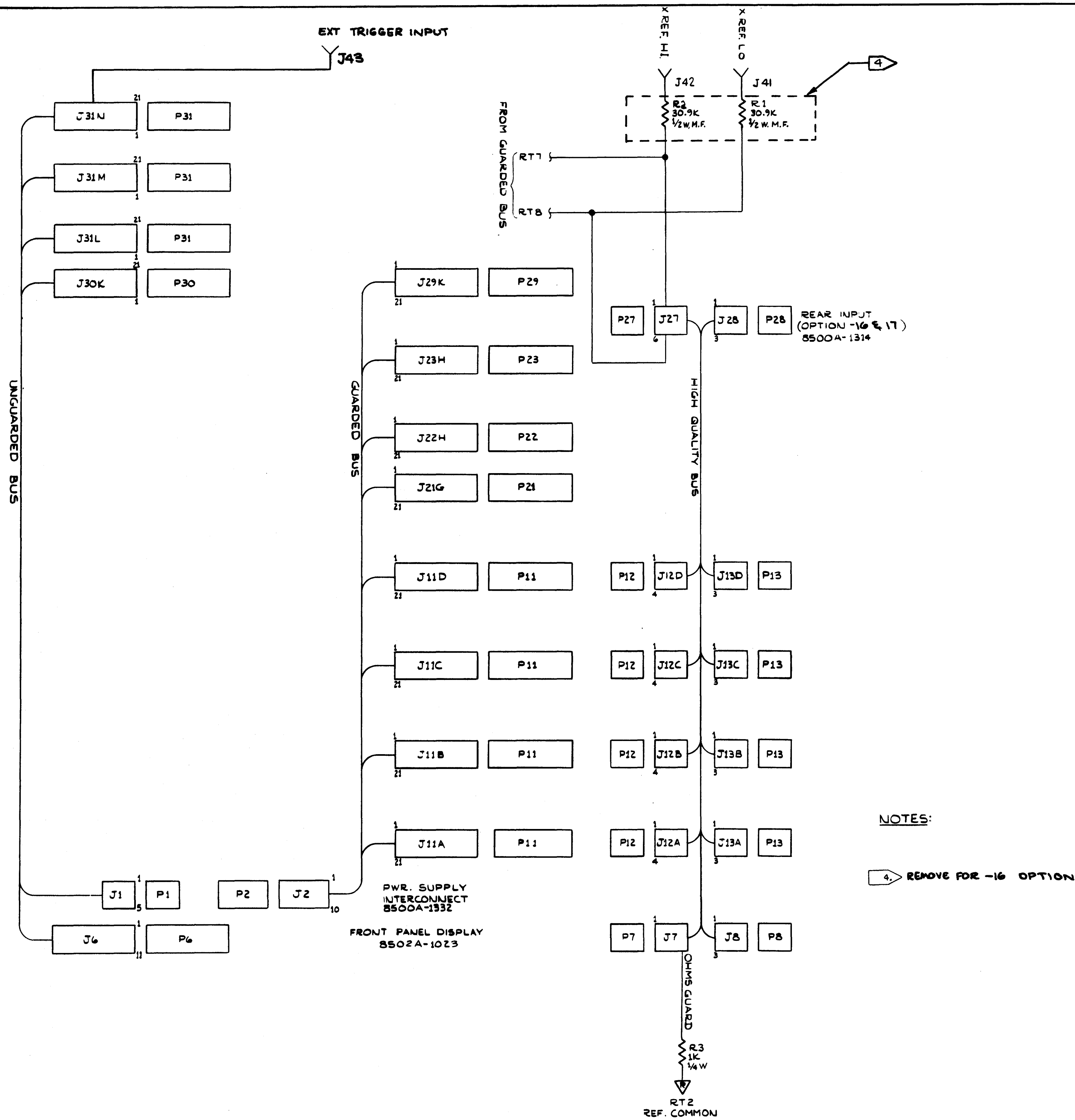
8. CONNECTION FOR SWITCED FRONT/REAR INPUT-016 SEE 8502A-1011

9. CONNECTION FOR FRONT PANEL INPUT SEE 8502A-16.

10. USED ON-081 ONLY.

11. RESISTORS R1 & R2 REMOVED ON -16 OPTION.

Figure 8-1. A2 Motherboard PCB Assembly (cont)



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
OHMS 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 (WHEN I/O 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	N	L M N
PARALLEL INTERFACE (OPTION -07)	M.I.S.-1171	N	L M N
IEEE INTERFACE (OPTION -05)	M.I.S.-1072 M.I.S.-1172	N	L M N

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

8502A-1301
Sht 1 of 2

Figure 8-2. Interconnect Diagram Mother Assembly

FUNCTION TABLE

CONNECTOR	PIN NO.	FUNCTION
J1 (Unguarded Bus)	1	+12V Vdd
	2	Vss(Logic Return)
	3	NC
	4	+15V Vcc
	5	RT5 (Line Freq. Ref.)
	6	-12V Vgg
	7	Vss(Logic Return)
	8	+5V Vcc
J2 (Guarded Bus)	1	-15V Vcc(Logic Supply)
	2	-20V Vss(Logic Return)
	3	AR(Analog Return)
	4	-15V VA2
	5	-30V VA4
	6	NC
	7	NC
	8	NC
	9	Guard
	10	-15V Vcc(Logic Supply)
	11	-20V Vss(Logic Return)
	12	AR(Analog Return)
	13	+15V VA1
	14	+30V VA3
	15	NC
	16	NC
	17	NC
	18	Guard
J6 (unguarded Bus)	1	Vss (Logic Return)
	2	ACK (Acknowledge)
	3	+5V Vcc
	4	IC5 (Interbus Control)
	5	IC3 (Interbus Control)
	6	IC1 (Interbus Control)
	7	ID7 (Interbus Data)
	8	ID5 (Interbus Data)
	9	ID3 (Interbus Data)
	10	ID1 (Interbus Data)
	11	Vss (Logic Return)
	12	+5V Vcc
	13	IC6 (Interbus Control)
	14	IC4 (Interbus Control)
	15	IC2 (Interbus Control)
	16	IC0 (Interbus Control)
	17	ID6 (Interbus Data)
	18	ID4 (Interbus Data)
	19	ID2 (Interbus Data)
	20	ID0 (Interbus Data)
J7 (High Quality Bus)	1	Guard
	2	Input Lo
	3	Source Lo
	4	Ohm's Guard
	5	Guard
	6	Input Lo
	7	Source Lo
	8	Ohm's Guard
J8 (High Quality Bus)	1	Source Hi
	2	Input Hi
	3	Source Hi
	4	Input Hi
J11A, J11B, J11C, J11D (Guarded Bus)	1	Guard
	2	RT0 (Ohm's Guard)
	3	RT2 (Ref. Common)
	4	RT4 (Ref. -7V. A/D to Ohm's Conv.)
	5	RT6 (DC. AMP., AC. Avg., & AC. RMS. Output. +A/F. Input)
	6	RT8 (X. Ref. Lo.)
	7	-30V VA4
	8	-15V VA2
	9	AR (Analog Return)
	10	$\overline{\text{INT}}$ (Interupt not)
	11	-20V Vss (Logic Return)
	12	-15V Vcc (Logic Supply)
	13	IC6 (Interbus Control)
	14	IC4 (Interbus Control)
	15	IC2 (Interbus Control)
	16	IC0 (Interbus Control)

FUNCTION TABLE

CONNECTOR	PIN NO.	FUNCTION
J11A, J11B, J11C, J11D (Guarded Bus)	17	ID6(Interbus Data)
	18	ID4(Interbus Data)
	19	ID2(Interbus Data)
	20	ID0(Interbus Data)
	21	Guard
	22	RT0(Ohms Guard)
	23	RT1(Ohms & Current Output HI. +DC. AMP., AC. Avg.,& AC. RMS. Input Hi.)
	24	RT3(AC. Avg.,& RMS. Input Lo) +(Current Output Lo.)
	25	RT5(A/D Input & A/F Output)
	26	RT7(X.Ref. Hi)
	27	+30V VA3
	28	+15V VA1
	29	INA(Interupt Acknowledge)
	30	AR(Analog Return)
	31	-20V Vss(Logic Return)
	32	ACK(Acknowledge)
	33	-15V Vcc(Logic Supply)
	34	IC5 (Interbus Control)
	35	IC3 (Interbus Control)
	36	IC1 (Interbus Control)
	37	ID7 (Interbus Data)
	38	ID5 (Interbus Data)
	39	ID3 (Interbus Data)
	40	ID1 (Interbus Data)
J12A, J12B, J12C, J12D (High Quality Bus)	1	Input Lo
	2	Source Lo
	3	Ohms Guard
	4	Input Lo
	5	Source Lo
	6	Ohms Guard
J13A, J13B, J13C, J13D (High Quality Bus)	1	Source Hi
	2	Input Hi
	3	Source Hi
	4	Input Hi
J27 (High Quality Bus)	1	Guard
	2	X Ref. Hi
	3	Input Lo
	4	Source Lo
	5	Ohms Guard
	6	Guard
	7	X Ref. Lo
	8	Input Lo
	9	Source Lo
	10	Ohms Guard
J28 (High Quality Bus)	1	Source Hi
	2	Input Hi
	3	Source Hi
	4	Input Hi
J21G, J22H, J23H, J29K (Guarded Bus)	1	Guard
	2	RT0 (Ohms Guard)
	3	RT2 (Ref. Common)
	4	RT4 (Ref.-7V. A/D to Ω Conv.)
	5	RT6 (DC. AMP., AC. Avg.,& AC.RMS. Output. +A/F. input)
	6	RT8(X.Ref. Lo)
	7	-30V VA4
	8	-15V VA2
	9	AR(Analog Return)
	10	$\overline{\text{INT}}$ (Interupt not)
	11	-20V Vss (Logic Return)
	12	-15V Vcc (Logic Supply)
	13	IC6 (Interbus Control)
	14	IC4 (Interbus Control)
	15	IC2 (Interbus Control)
	16	IC0 (Interbus Control)
	17	ID6 (Interbus Data)
	18	ID4 (Interbus Data)
	19	ID2 (Interbus Data)
	20	ID0 (Interbus Data)

FUNCTION TABLE

CONNECTOR	PIN NO.	FUNCTION
J21G, J22H, J23H, J29K (Guarded Bus)	21	Guard
	22	RT0(Ohms Guard)
	23	11
	24	RT3(AC. Avg.,& RMS. Input Lo + Current Output Lo.)
	25	RT5(A/D Input & A/F.Output)
	26	RT7(X.Ref. Hi)
	27	+30V VA3
	28	+15V VA1
	29	INA(Interupt Acknowledge)
	30	AR(Analog Return)
	31	-20V Vss(Logic Return)
	32	ACK(Acknowledge)
	33	-15V Vcc(Logic Supply)
	34	IC5(Interbus Control)
	35	IC3(Interbus Control)
	36	IC1(Interbus Control)
	37	ID7(Interbus Data)
	38	ID5(Interbus Data)
	39	ID3(Interbus Data)
	40	ID1(Interbus Data)
J30K, J31N, J31M, J31L (Unguarded Bus)	1	Guard(Logic Common)
	2	RT0 (Real Time 0)
	3	RT2 (Real Time 2)
	4	RT4 (Real Time 4)
	5	RT6(Real Time 6)
	6	Vgg 12
	7	NC
	8	NC
	9	NC
	10	$\overline{\text{INT}}$(Interrupt not)
	11	Vss(Logic Return) 12
	12	Vcc 12
	13	IC6(Interbus Control)
	14	IC4(Interbus Control)
	15	IC2(Interbus Control)
	16	IC0(Interbus Control)
	17	ID6(Interbus Data)
	18	ID4(Interbus Data)
	19	ID2(Interbus Data)
	20	ID0(Interbus Data)
	21	Guard(Logic Common)
	22	RT0(Real Time 0)
	23	RT1(Real Time 1)
	24	RT3(Real Time 3)
	25	RT5(Line Freq. Ref)
	26	Vdd 12
	27	NC TRIGGER INPUT HI
	28	NC TRIGGER INPUT LO
	29	INA(Interrupt Acknowledge)
	30	NC
	31	Vss(Logic Return) 12
	32	ACK(Acknowledge)
	33	Vcc 12
	34	IC5(Interbus Control)
	35	IC3(Interbus Control)
	36	IC1(Interbus Control)
	37	ID7(Interbus Data)
	38	ID5 (Interbus Data)
	39	ID3 (Interbus Data)
	40	ID1 (Interbus Data)

Notes:

11. This Bus line is not used for 8500A 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

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Figure 8-2. Interconnect Diagram Mother Assembly (cont)

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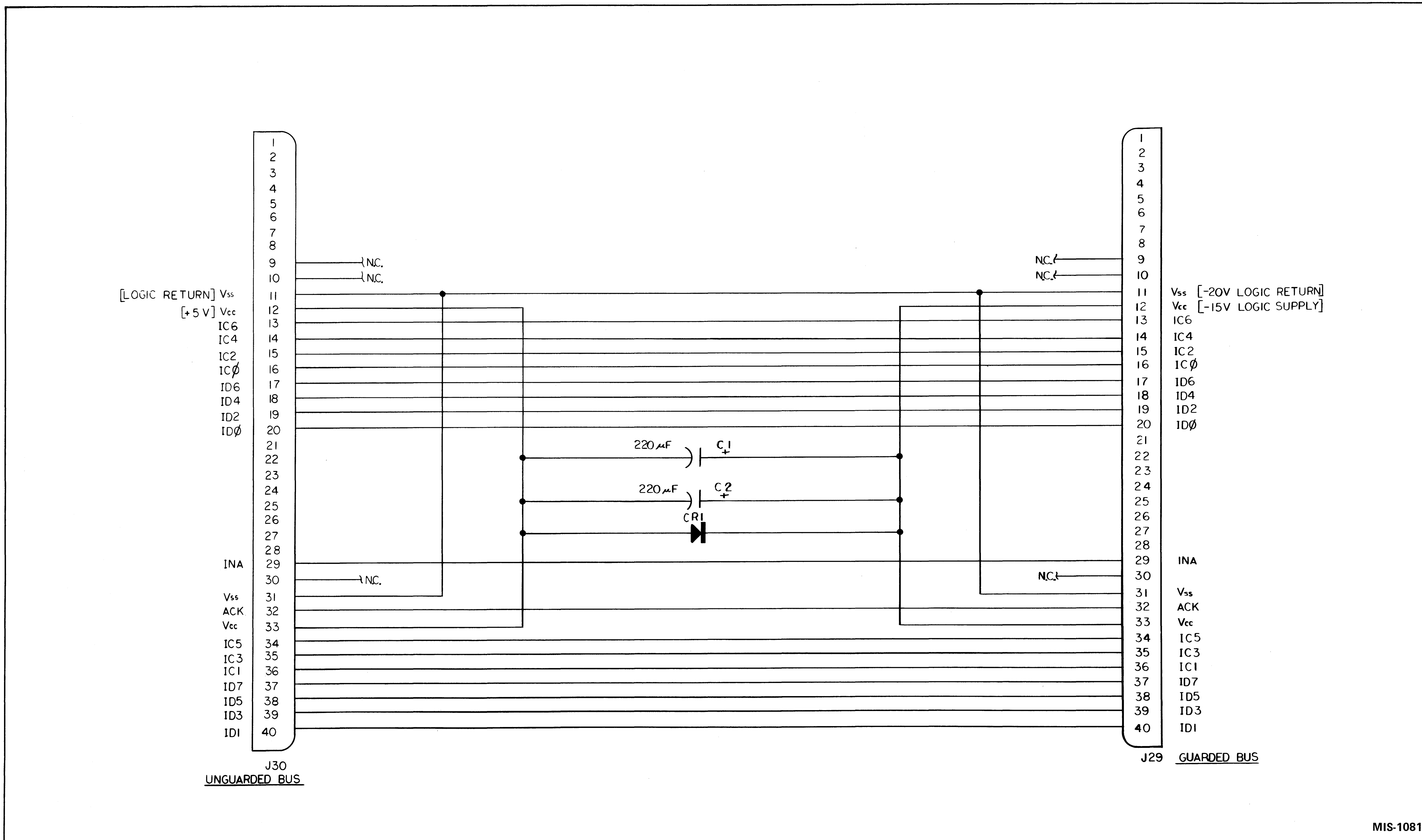
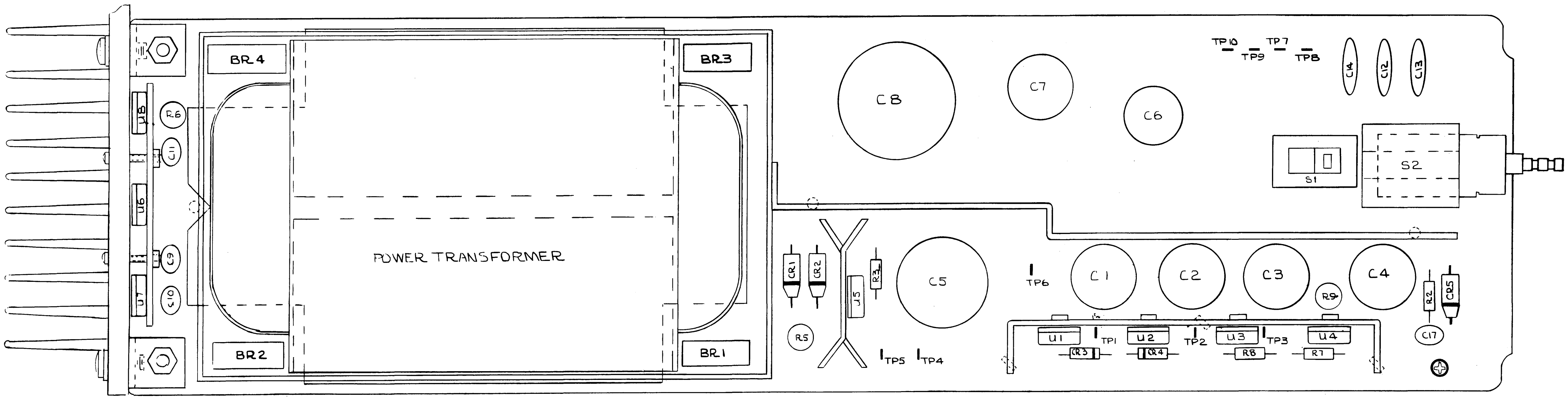
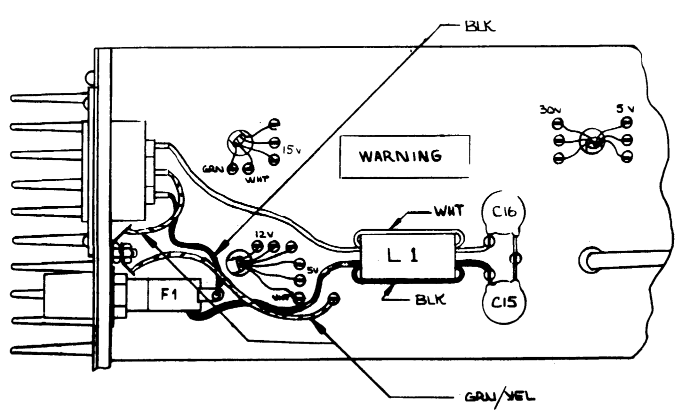


Figure 8-3. Bus Interconnect





DETAIL OF CKT 1

8500A-1651

Figure 8-4. A4 Power Supply PCB Assembly— Type 51

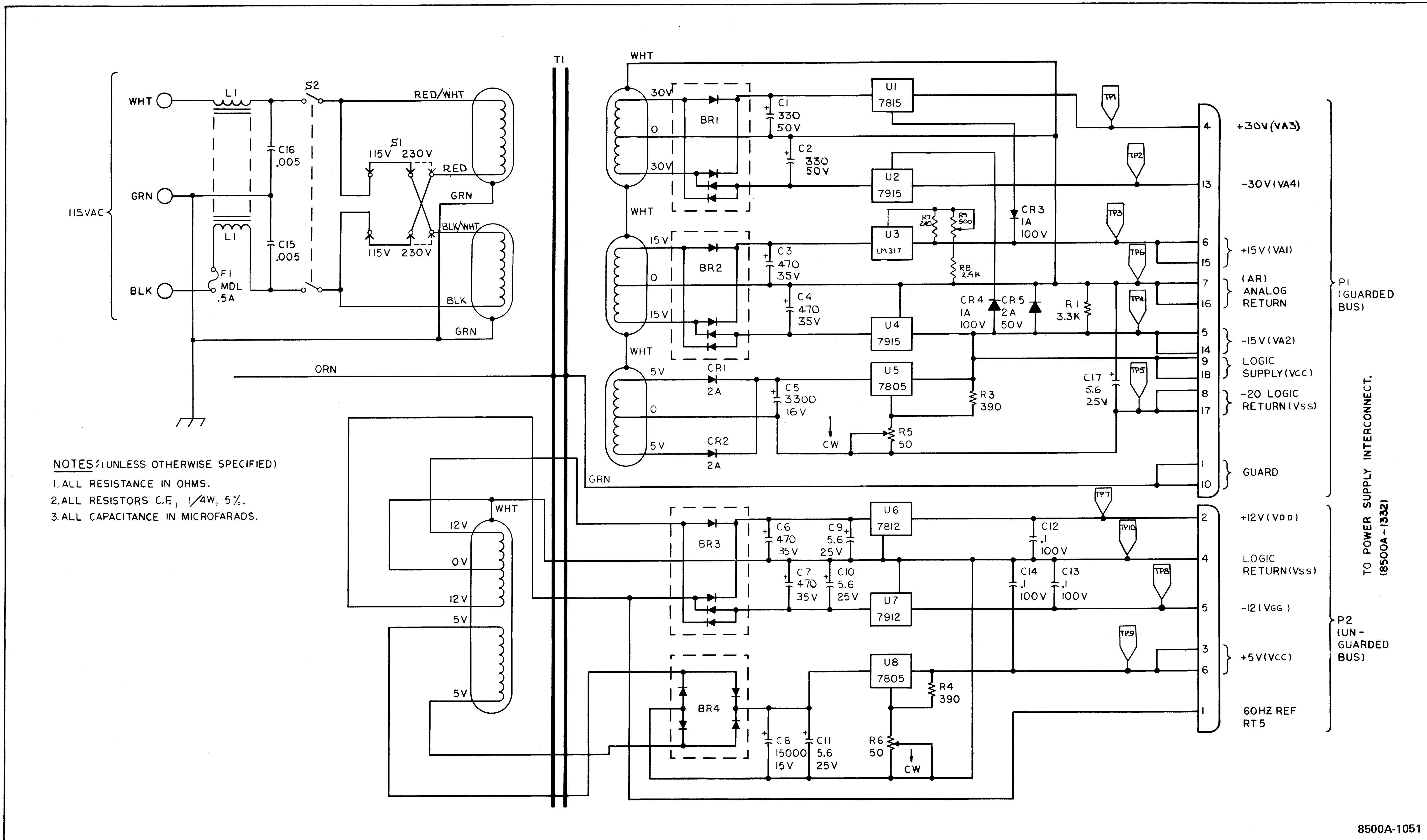


Figure 8-4. A4 Power Supply PCB Assembly — Type 51 (cont)

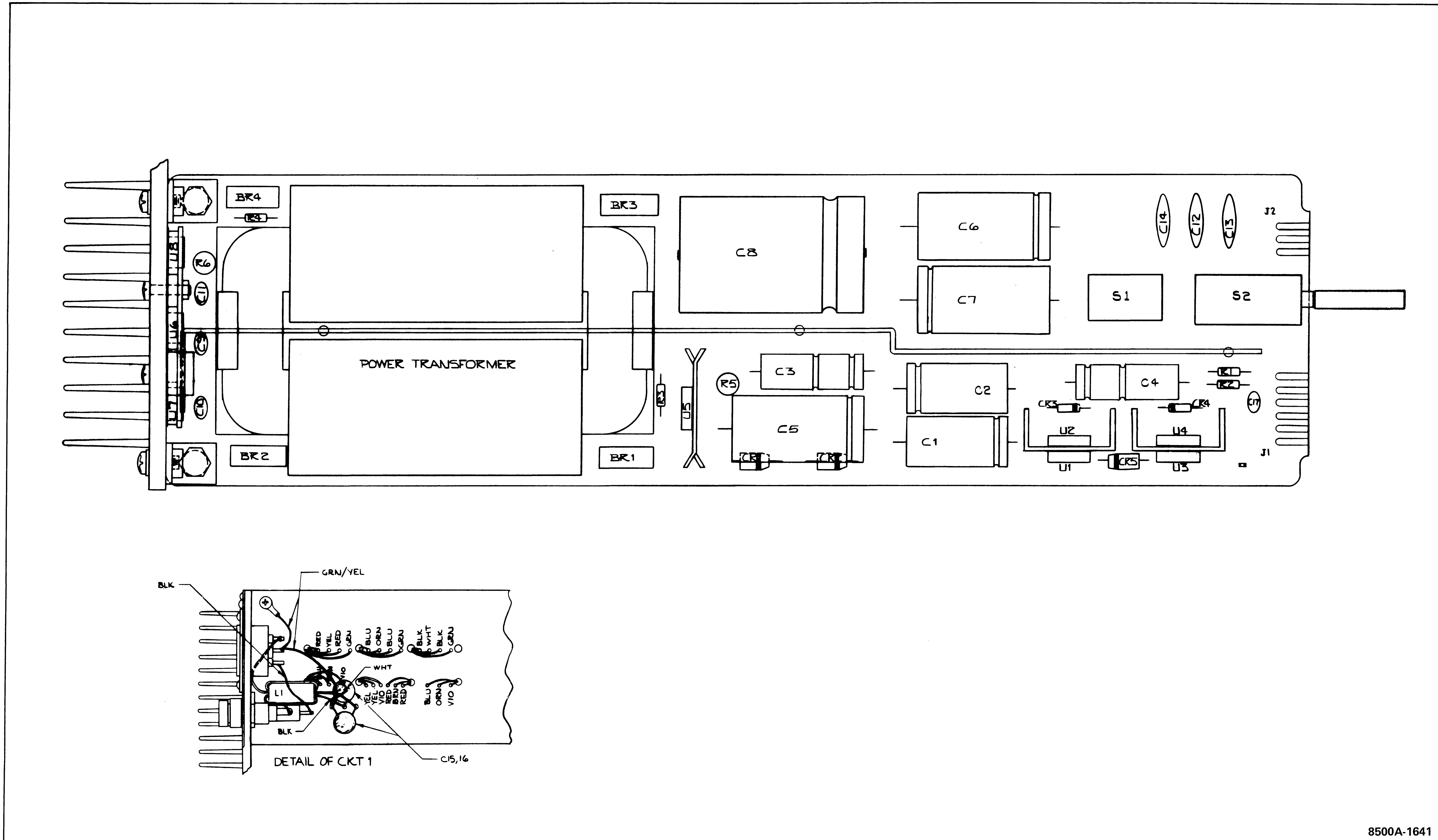


Figure 8-5. A4 Power Supply PCB Assembly—
Type 41

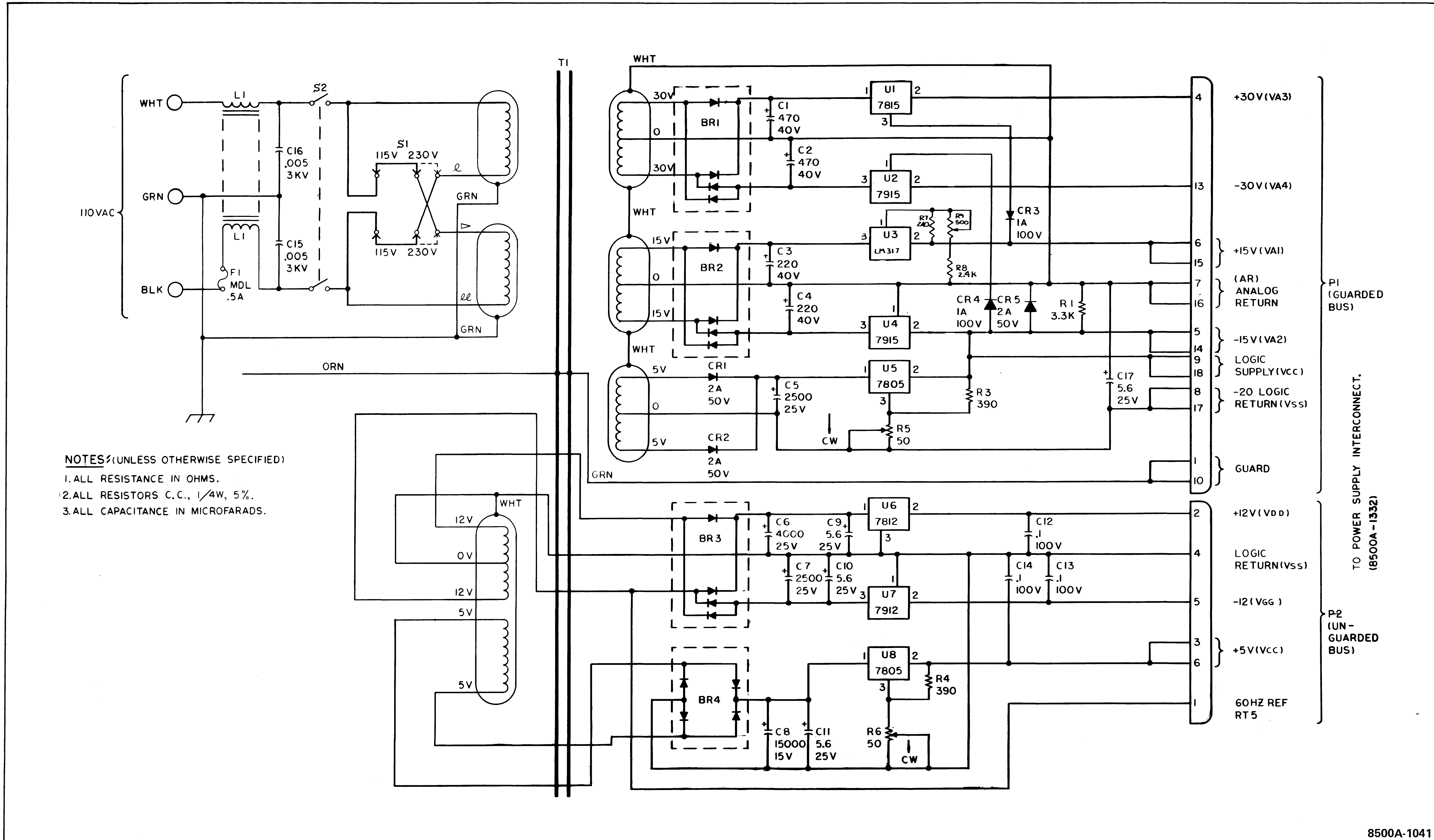


Figure 8-5. A4 Power Supply PCB Assembly—Type 41 (cont)

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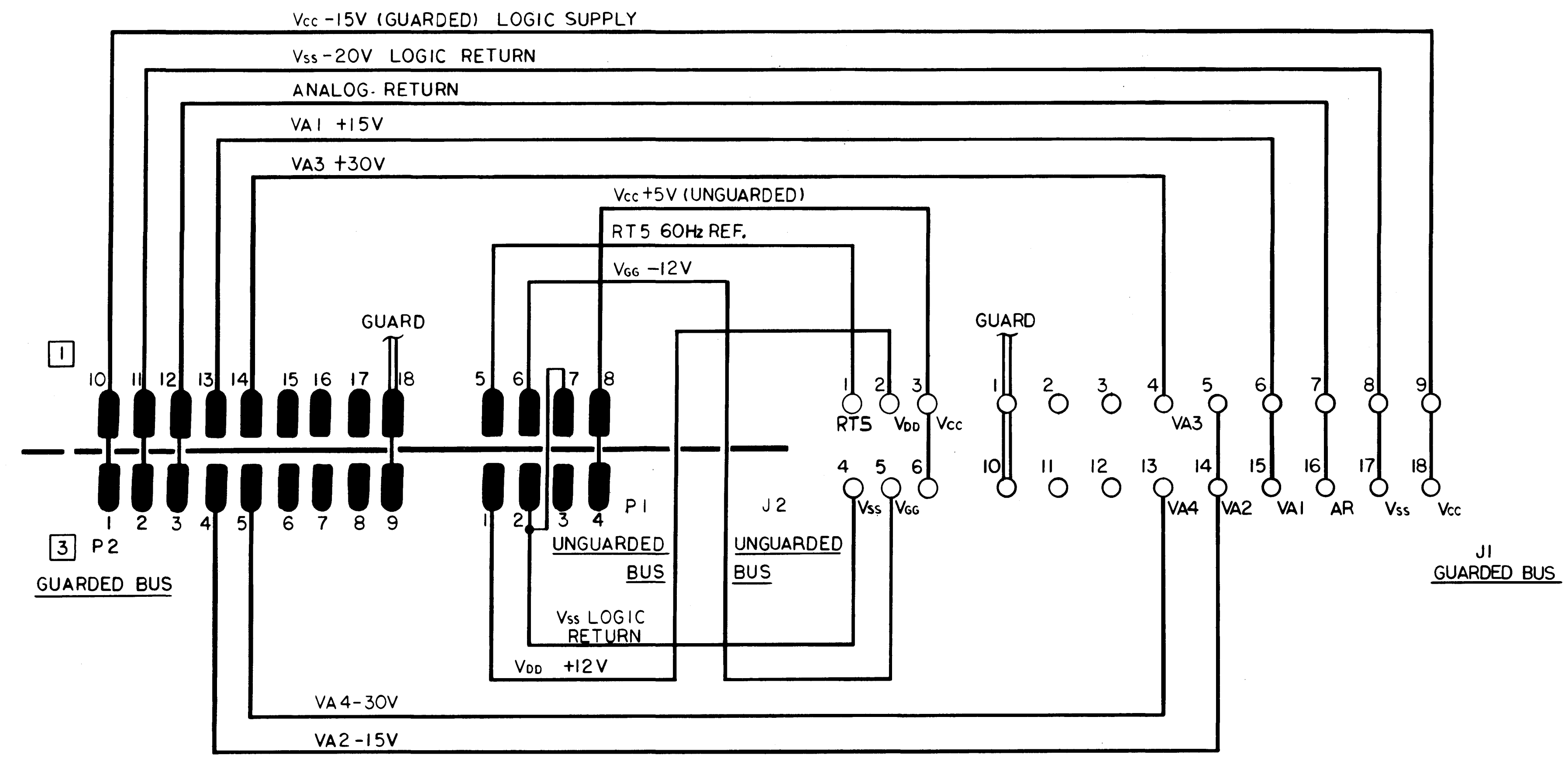
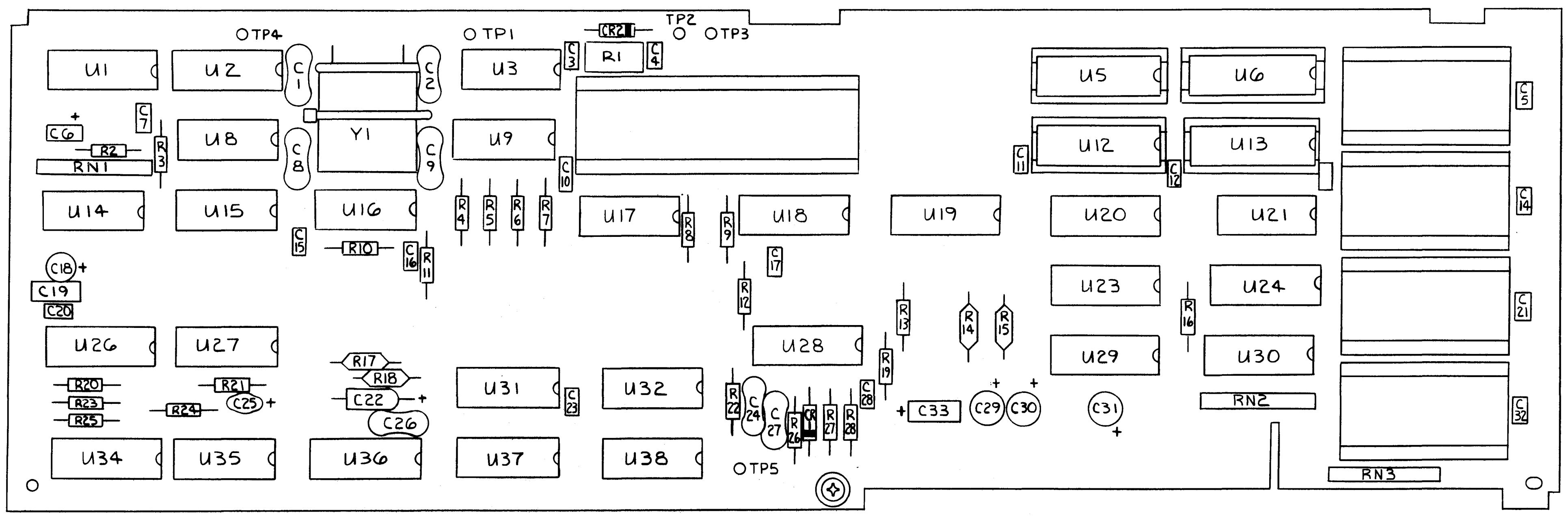


Figure 8-6. A5 Power Supply Interconnect



8502A-1786

Figure 8-7. A6 Controller PCB Assembly—
Single PCB Version

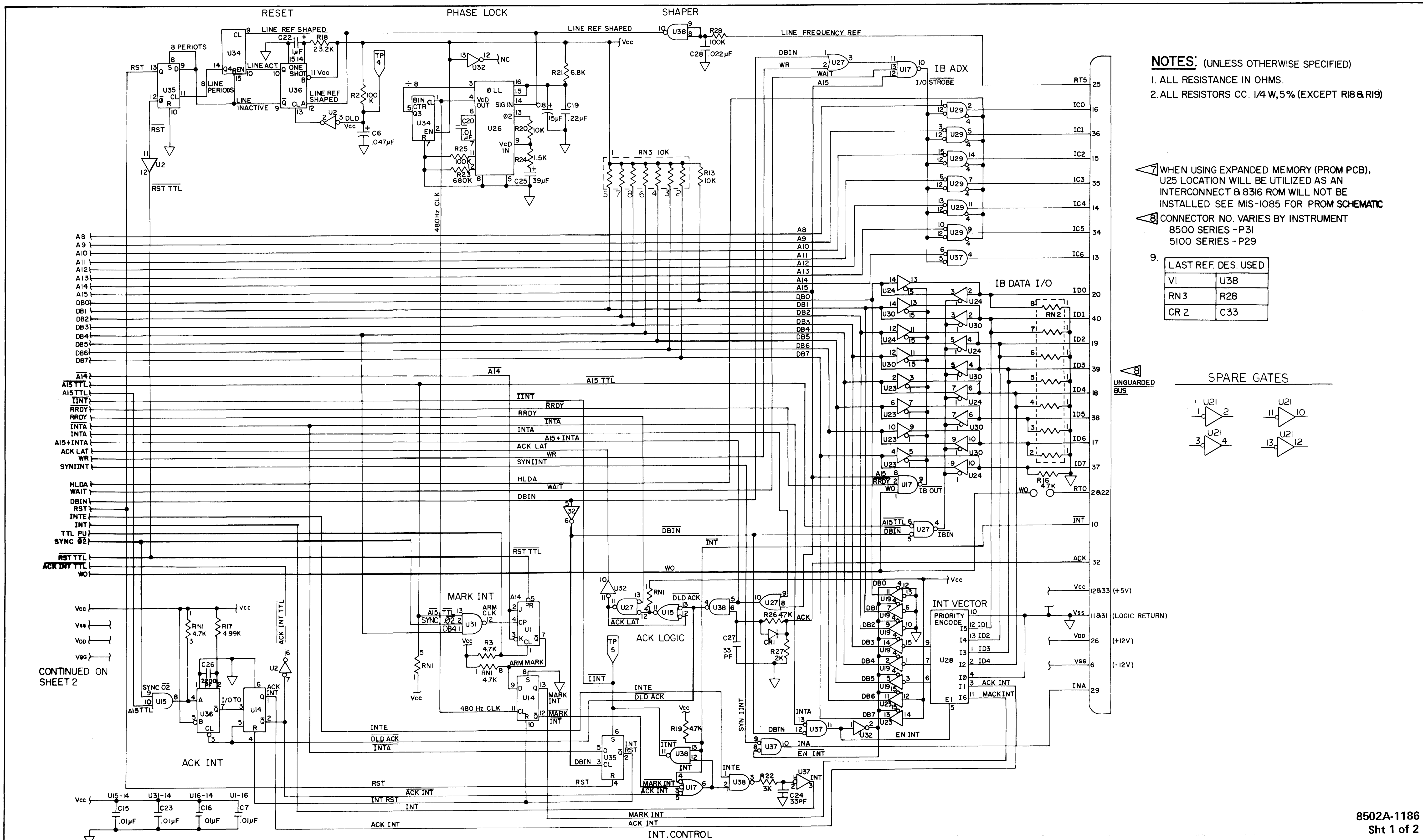


Figure 8-7. A6 Controller PCB Assembly— Single PCB Version (cont)

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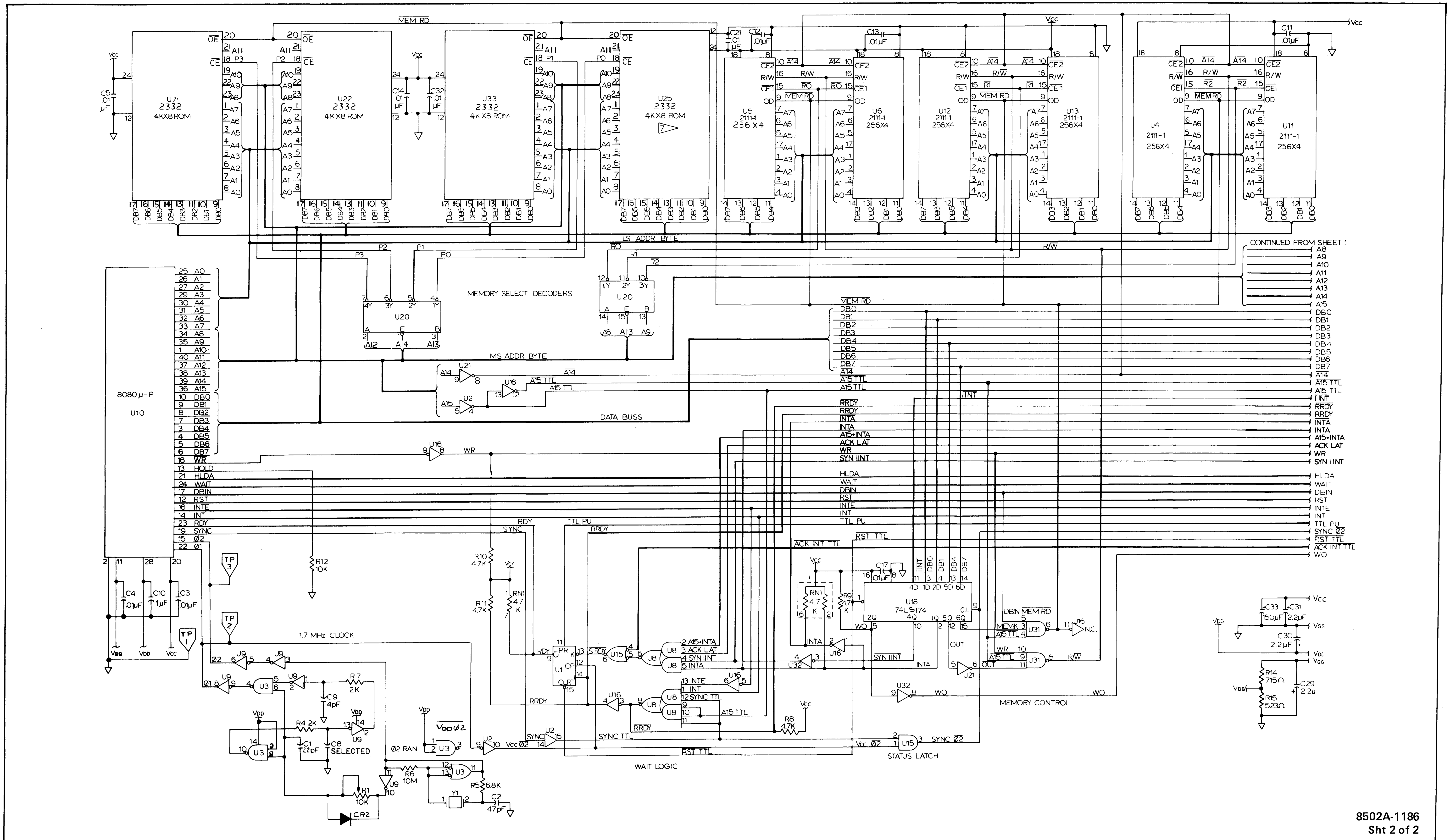
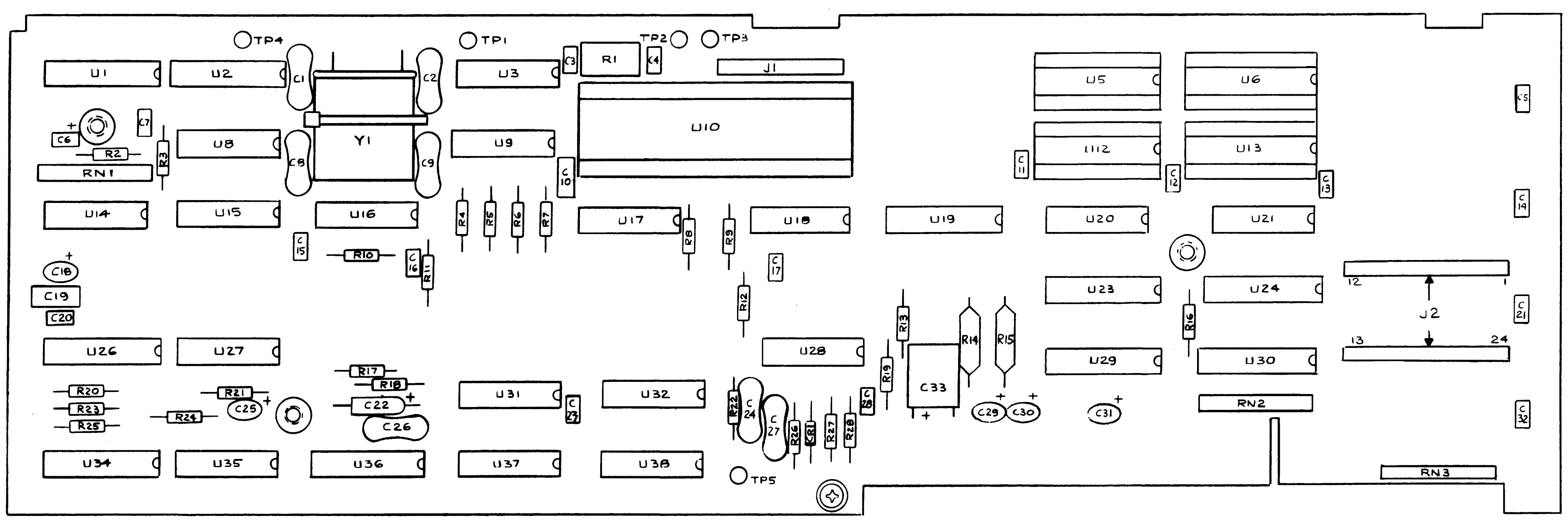


Figure 8-7. A6 Controller PCB Assembly—
Single PCB Version (cont)



8502A-1785

Figure 8-8. A6A1 Controller PCB Assembly—
Double PCB Version

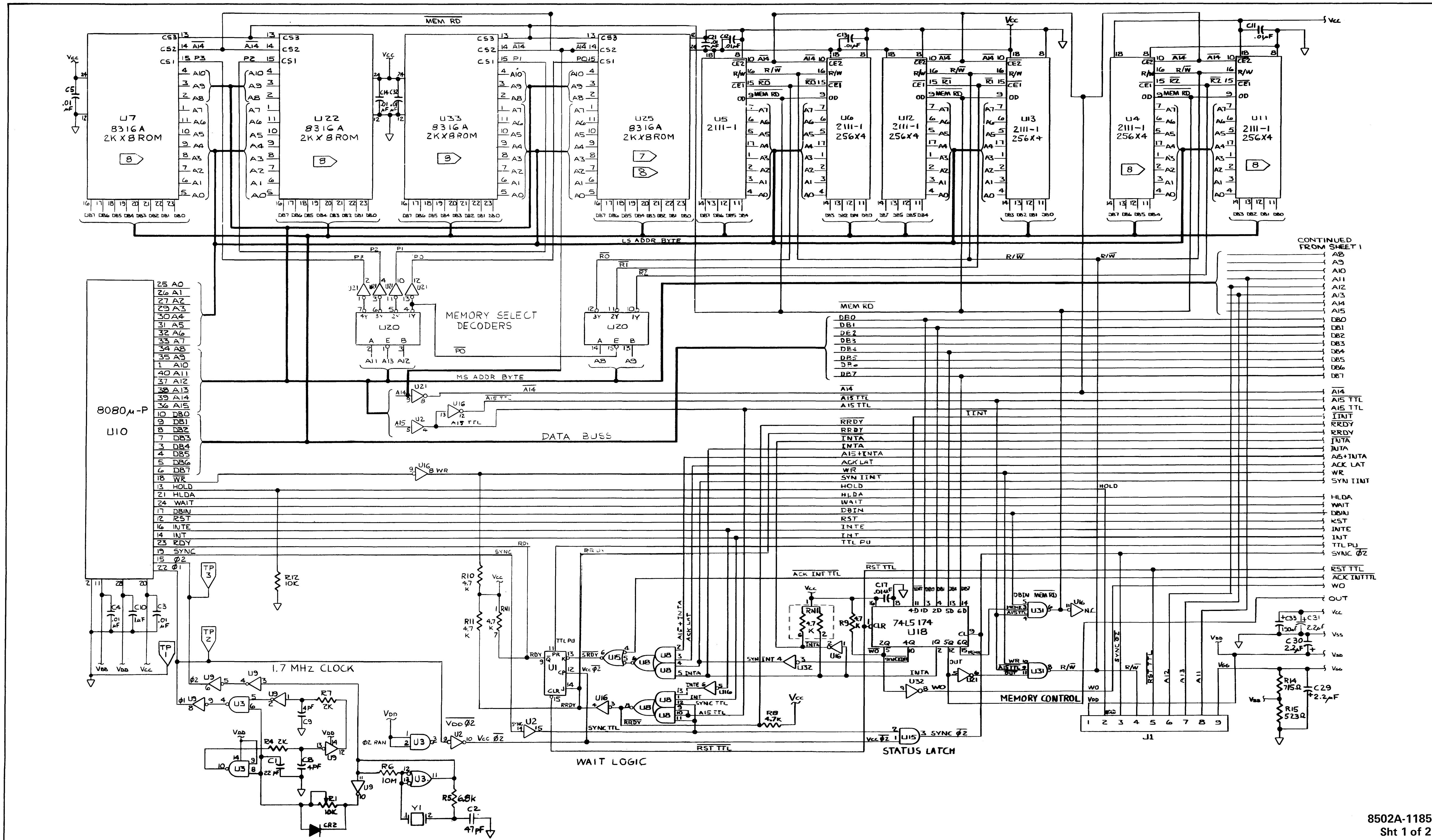


Figure 8-8. A6A1 Controller PCB Assembly—
Double PCB Version (cont)

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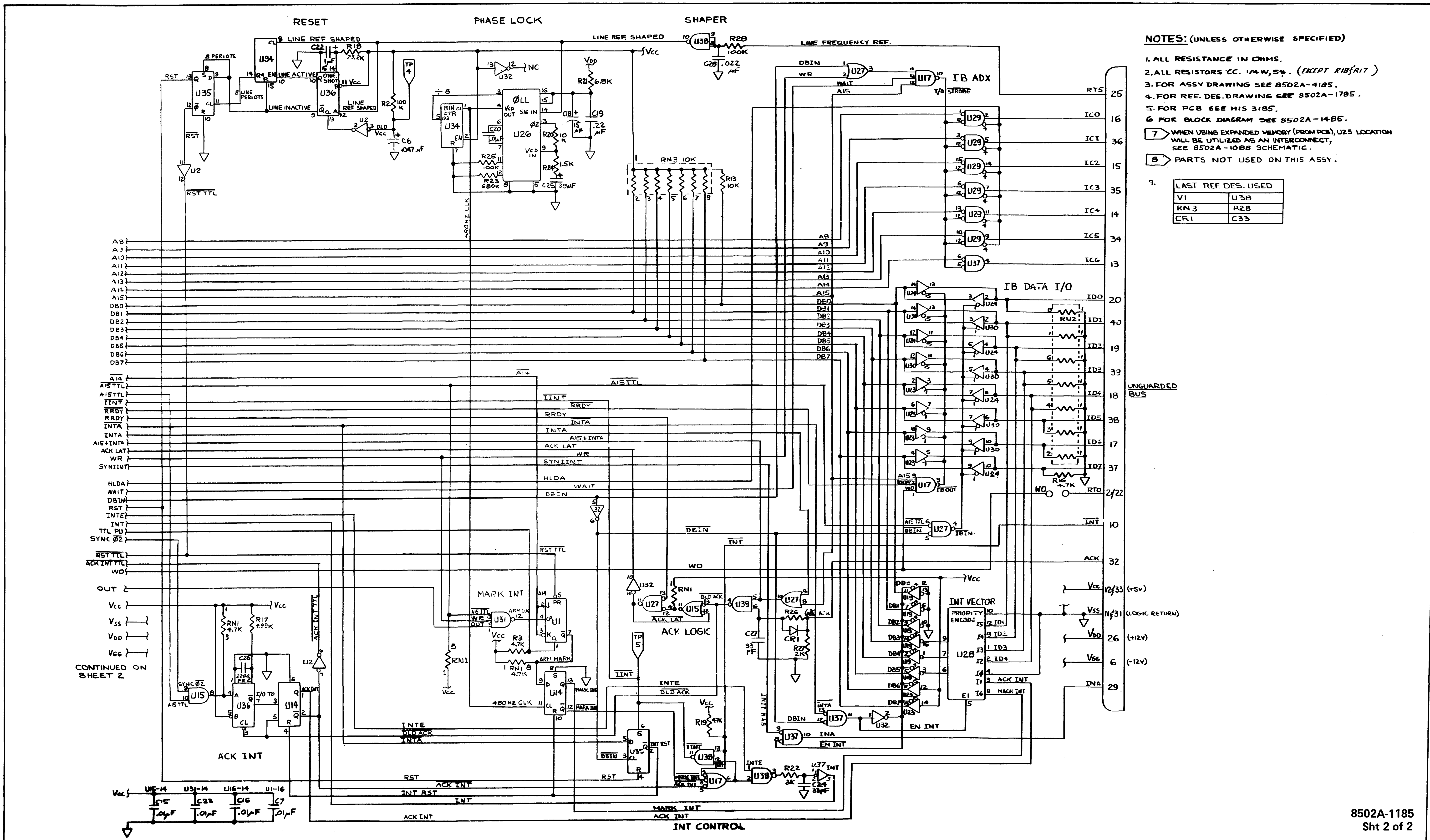


Figure 8-8. A6A1 Controller PCB Assembly— Double PCB Version (cont)

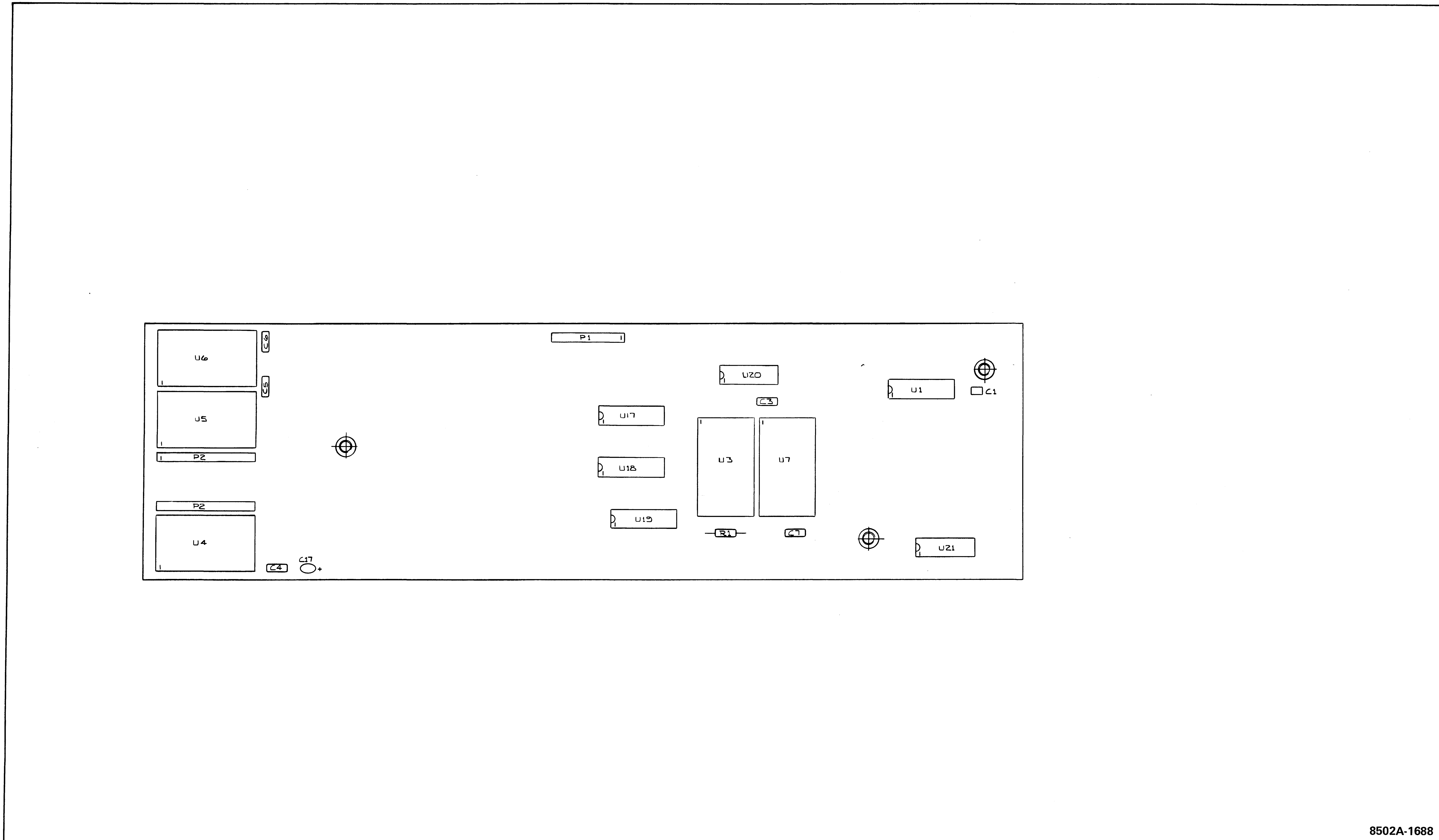


Figure 8-9. A6A2 Prom Rom PCB Assembly—Double PCB Version

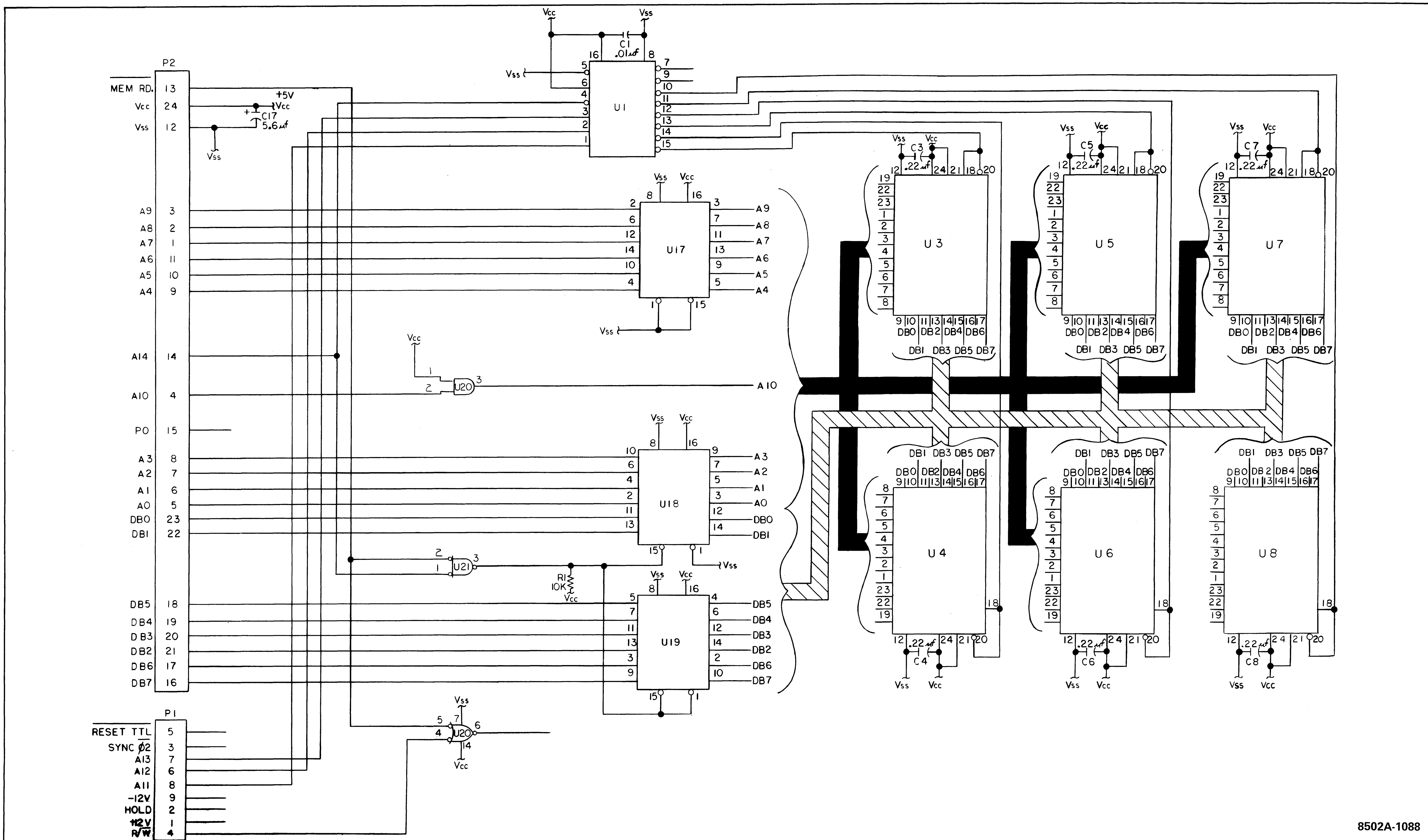


Figure 8-9. A6A2 Prom Rom PCB Assembly–
Double PCB Version (cont)

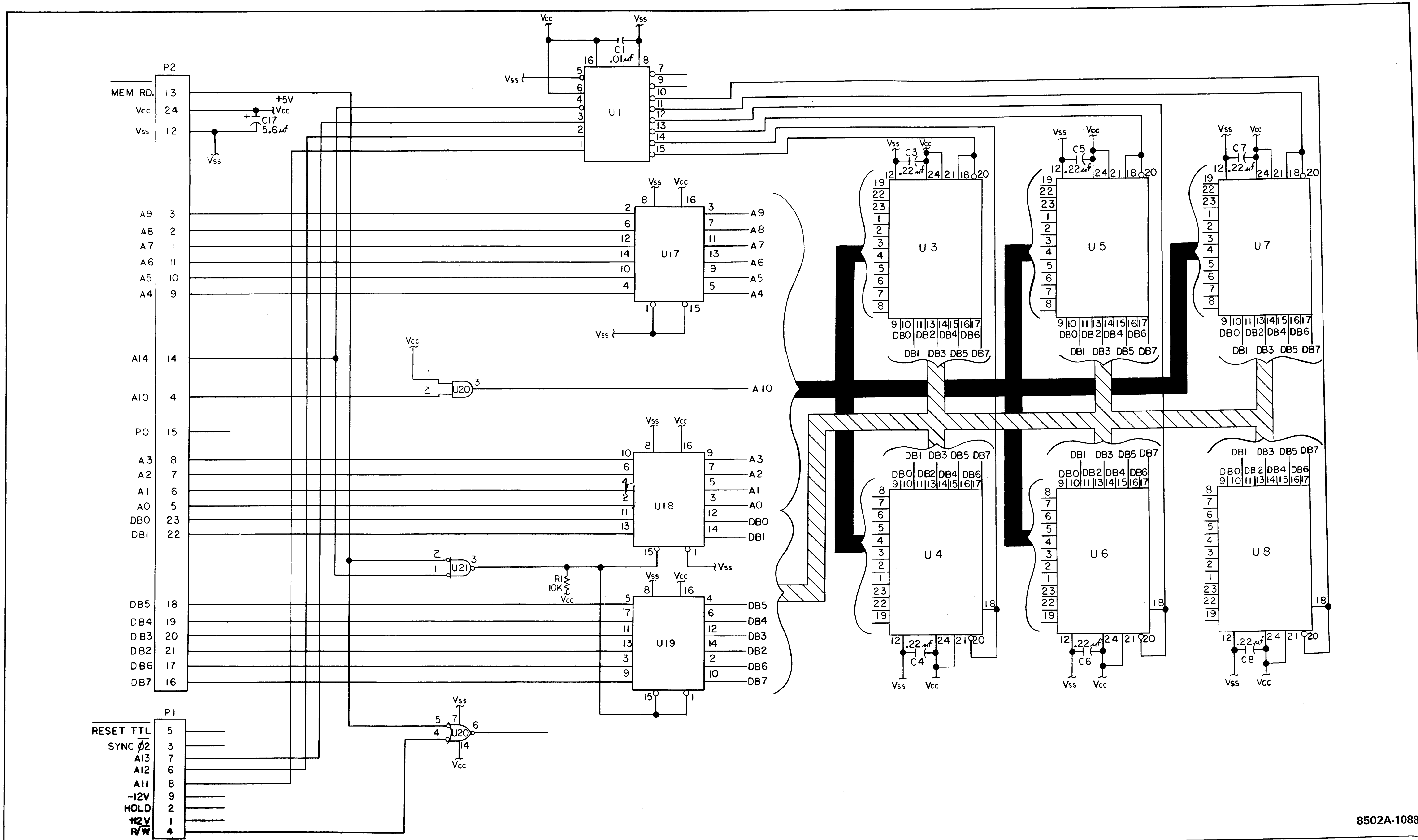
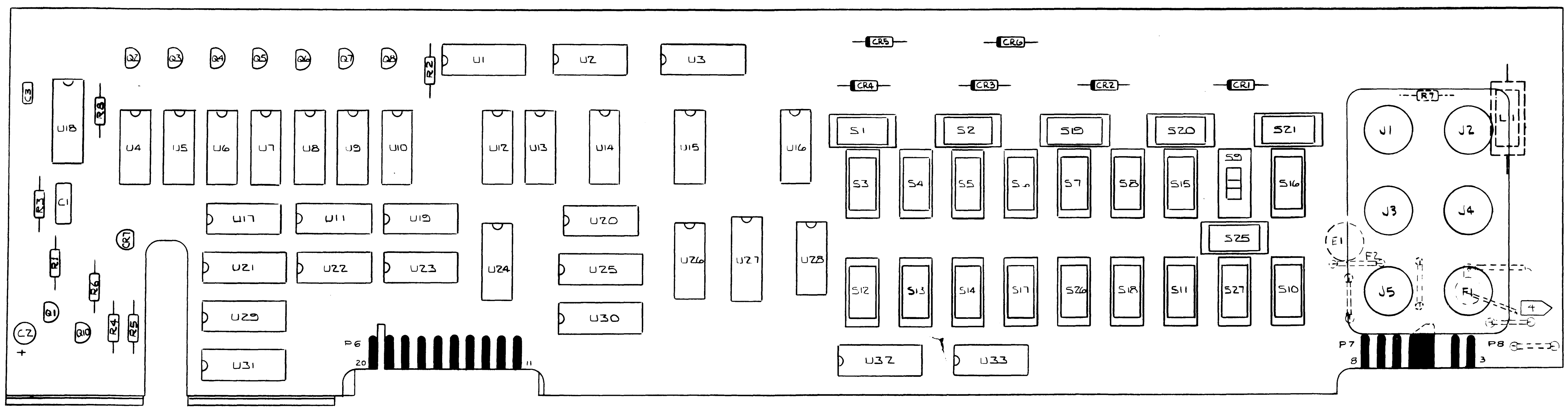


Figure 8-9. A6A2 Prom Rom PCB Assembly— Double PCB Version (cont)

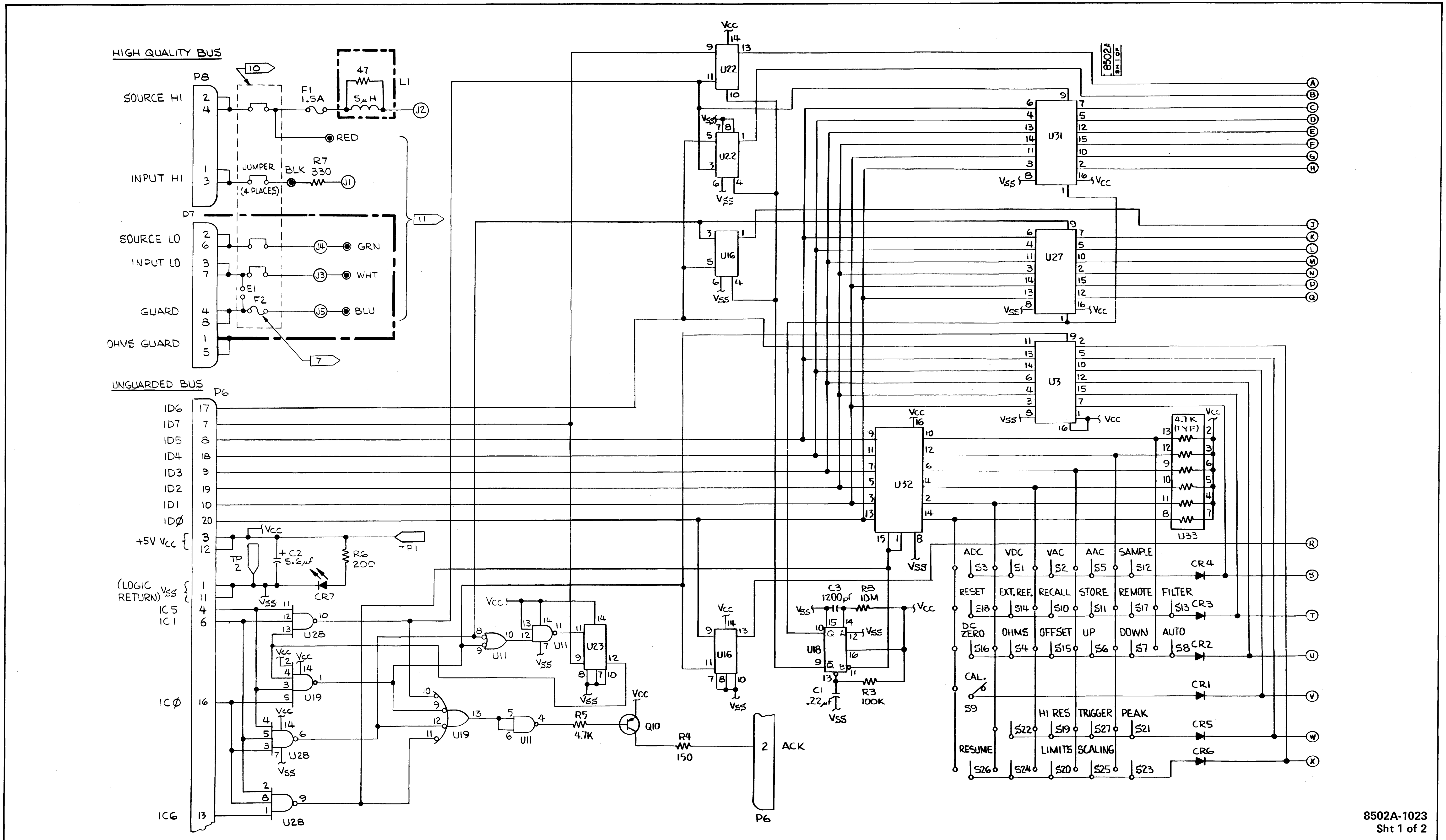


NOTES:

4 JUMPER AND FUSE CONNECTIONS, FAR SIDE.

8502A-1623

Figure 8-10. A7 Front Panel Display PCB Assembly



8502A-1023
Sht 1 of 2

Figure 8-10. A7 Front Panel Display PCB Assembly (cont)

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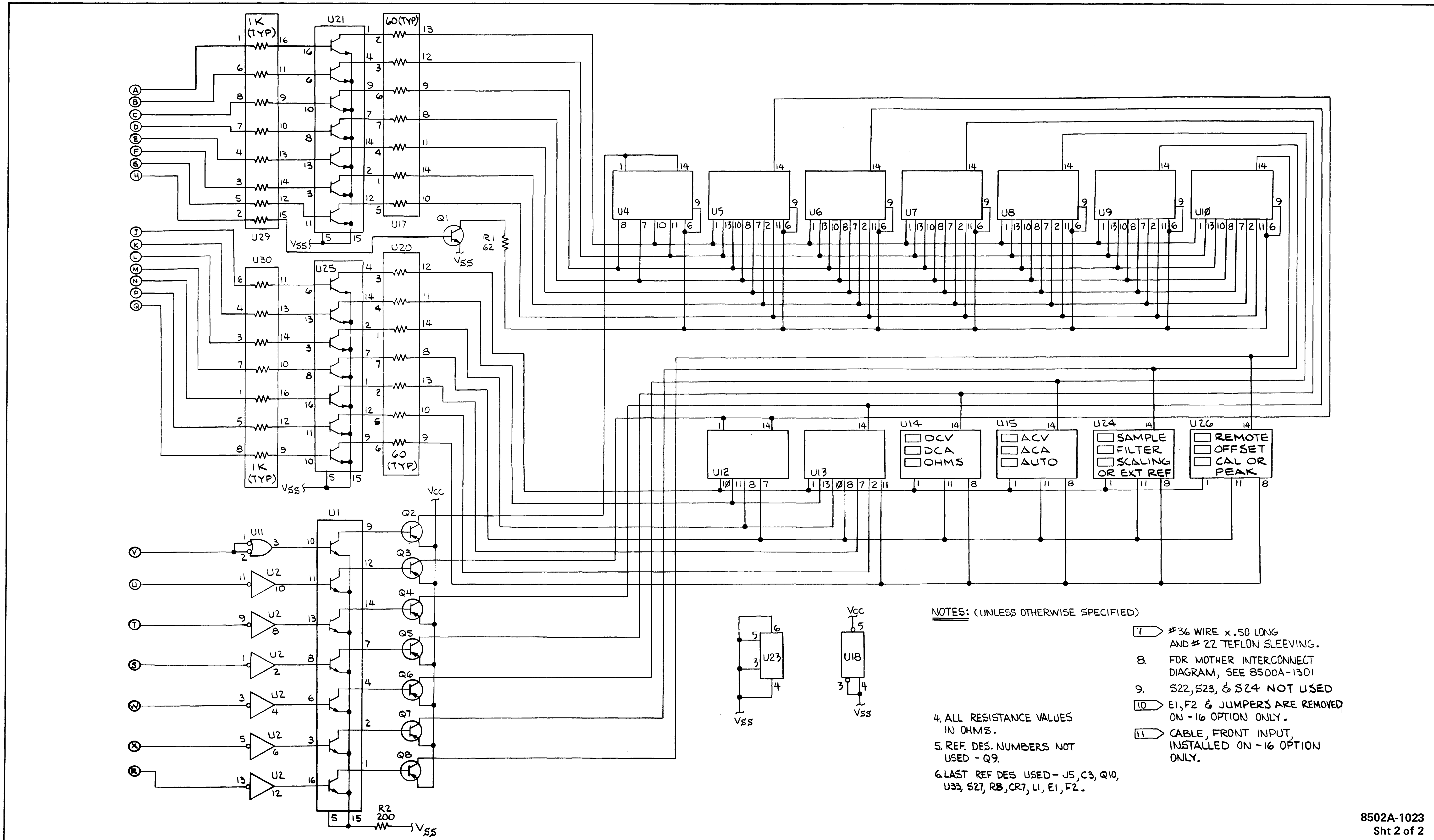
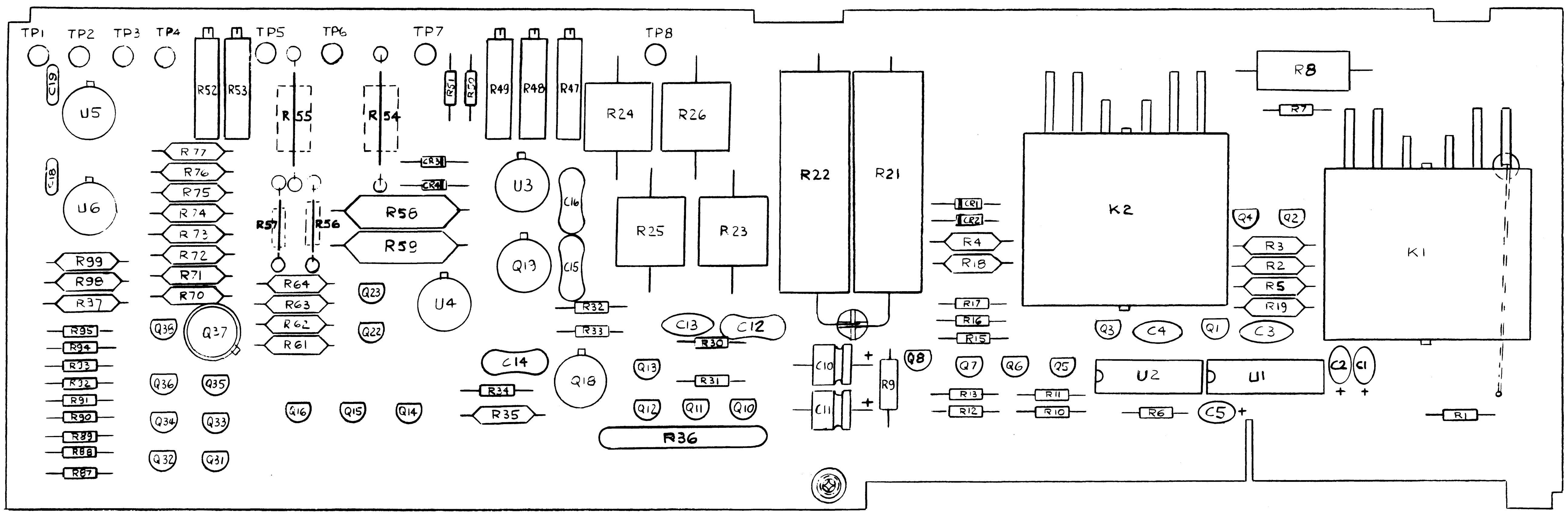


Figure 8-10. A7 Front Panel Display PCB Assembly (cont)

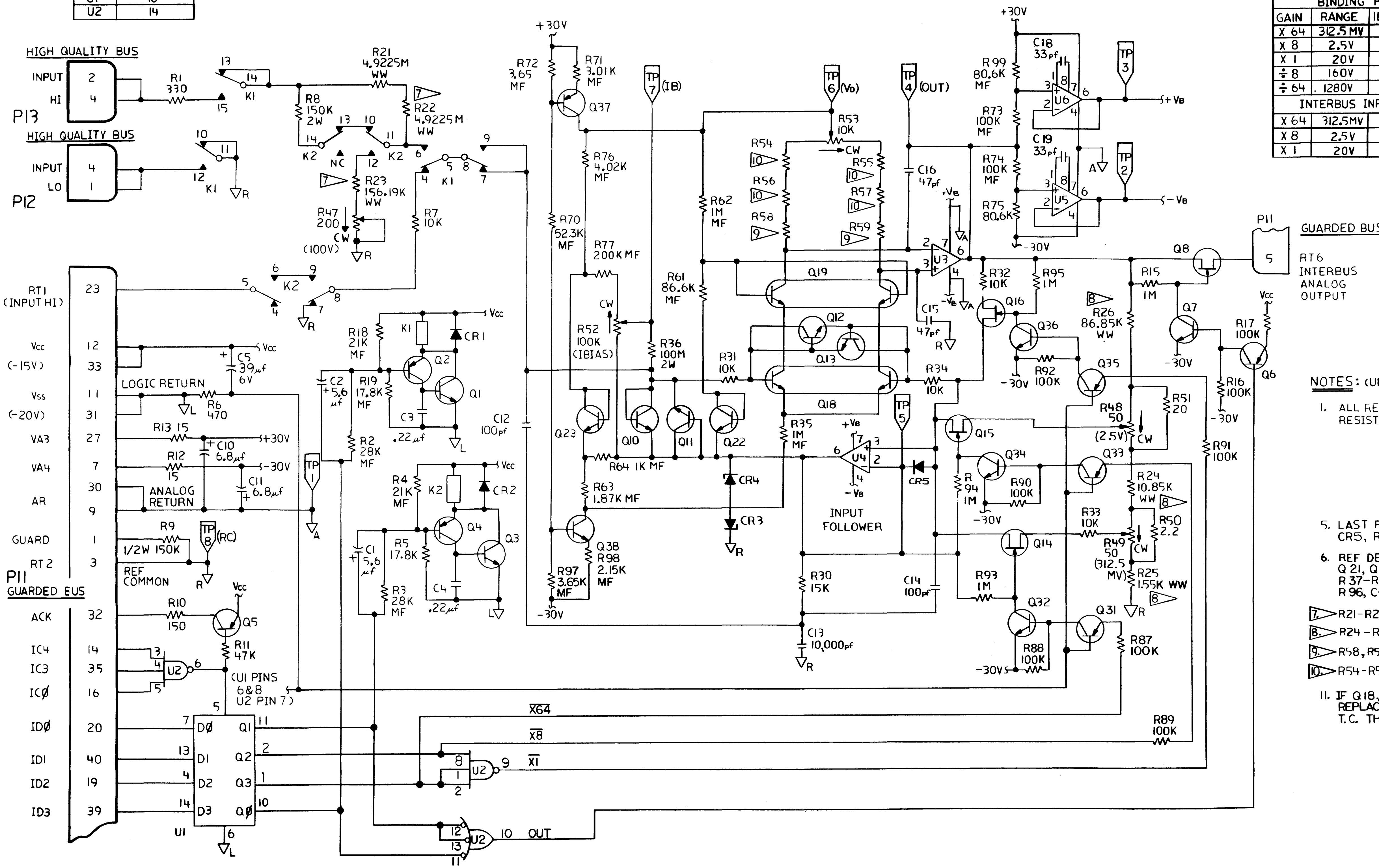
R54, R55, R56 & R57 WILL BE DETERMINED DURING TESTING. RESISTORS MAY BE INSTALLED.



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	ID0
X 64	312.5 MV	0	1	1	0
X 8	2.5V	1	0	1	0
X 1	20V	1	1	1	0
÷ 8	160V	1	0	0	0
÷ 64	1280V	1	1	0	0
INTERBUS INPUT (RT2)					
X 64	312.5MV	0	1	0	1
X 8	2.5V	1	0	0	1
X 1	20V	1	1	0	1

NOTES: (UNLESS OTHERWISE NOTED)

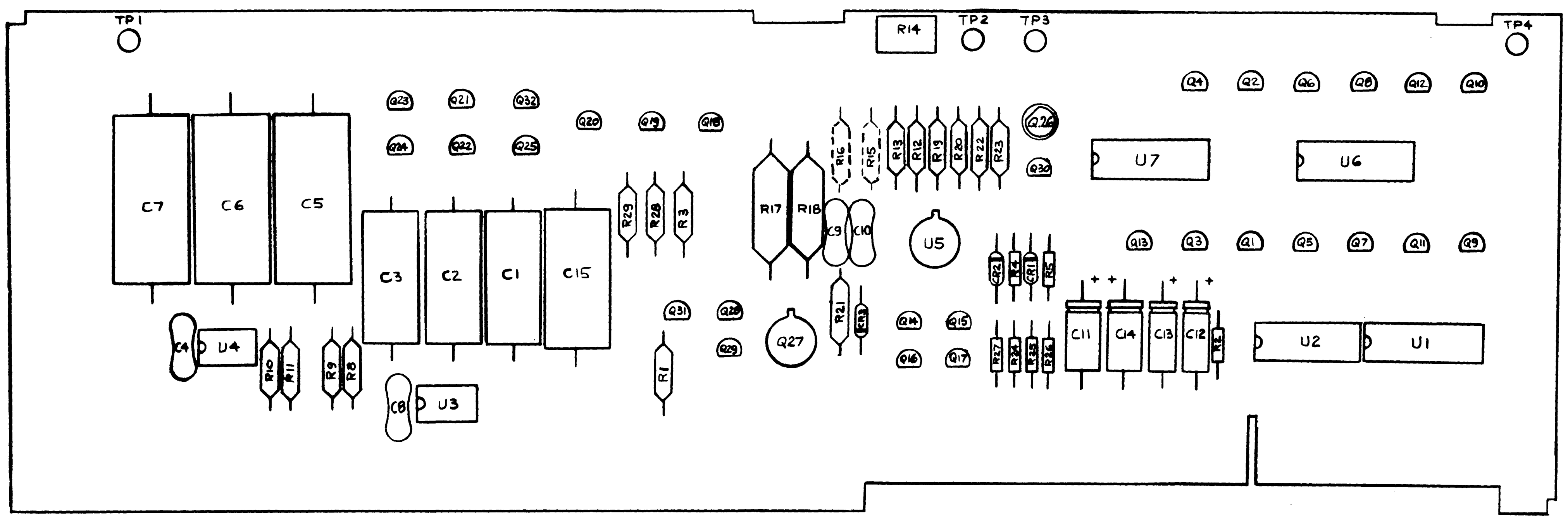
1. ALL RESISTORS 1/4 W, CC, AND ALL RESISTANCE IN OHMS.
5. LAST REF DES NO'S USED: U6, Q38 CR5, R99, C21.
6. REF DES NO'S NOT USED: Q9, Q17, Q20, Q21, Q24-Q30, R14, R20, R27-R29, R37-R46, R60, R65-R69, R78-R86, R96, C6-C9, C17.

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.

11. IF Q18, Q19, Q22, R54 OR R55 ARE REPLACED IT WILL BE NECESSARY TO T.C. THE MODULE

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

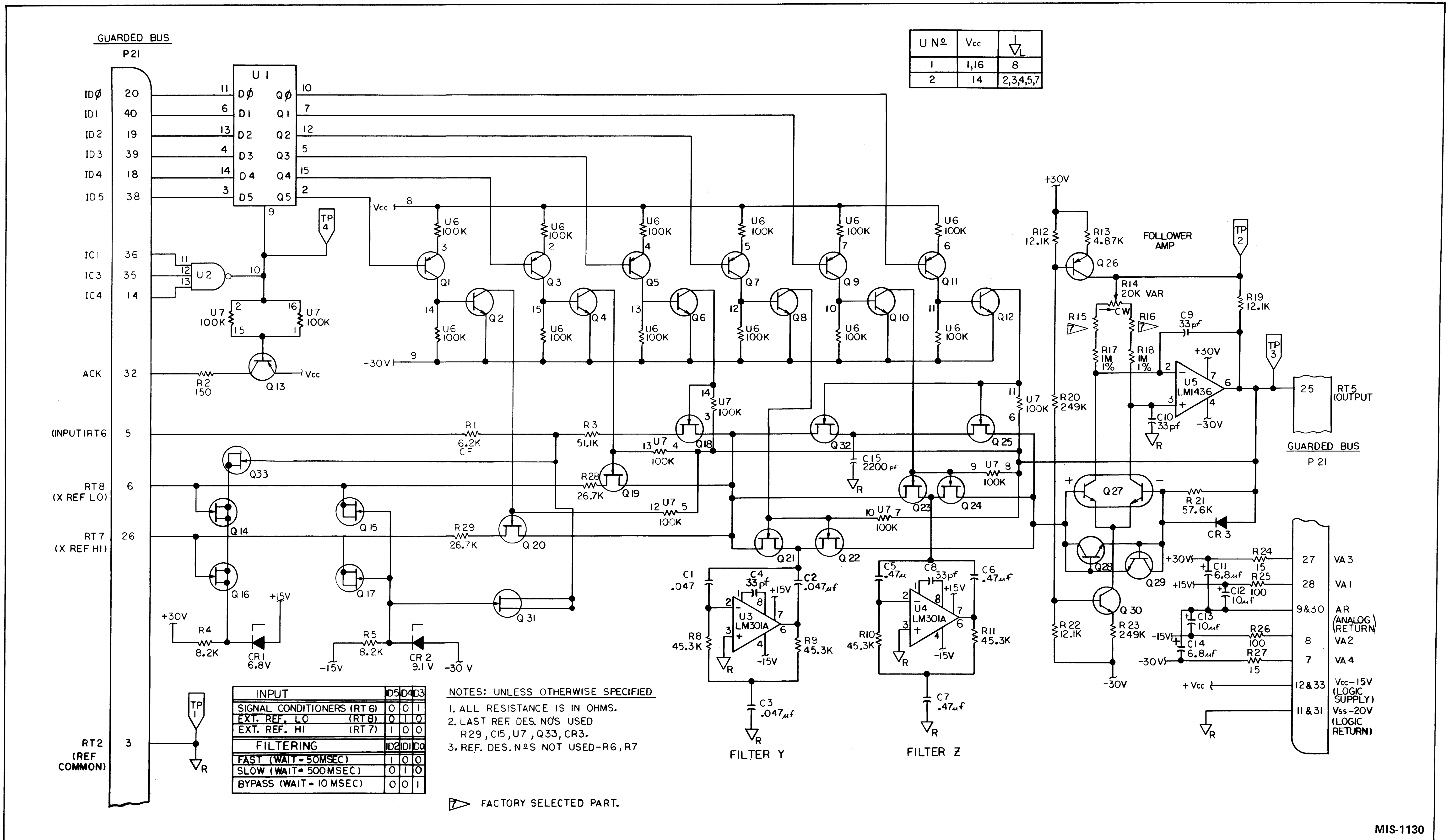
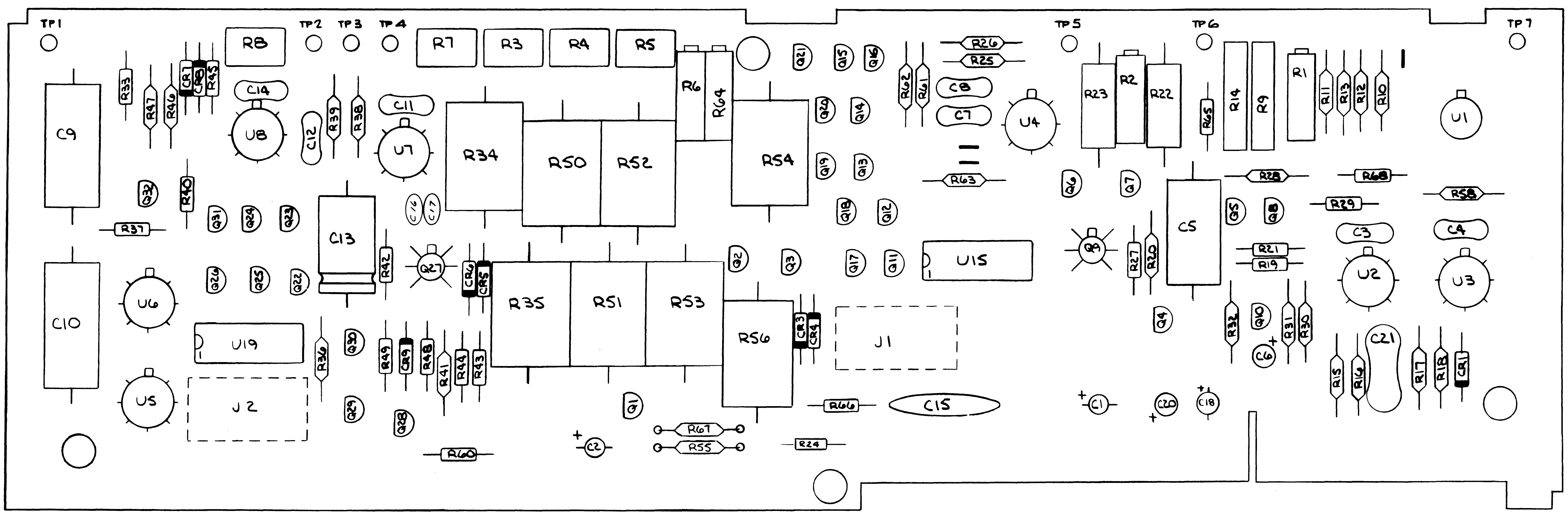


Figure 8-12. A9 Active Filter PCB Assembly (cont)



MIS-1740

Figure 8-13. A10A1 Analog Display PCB Assembly

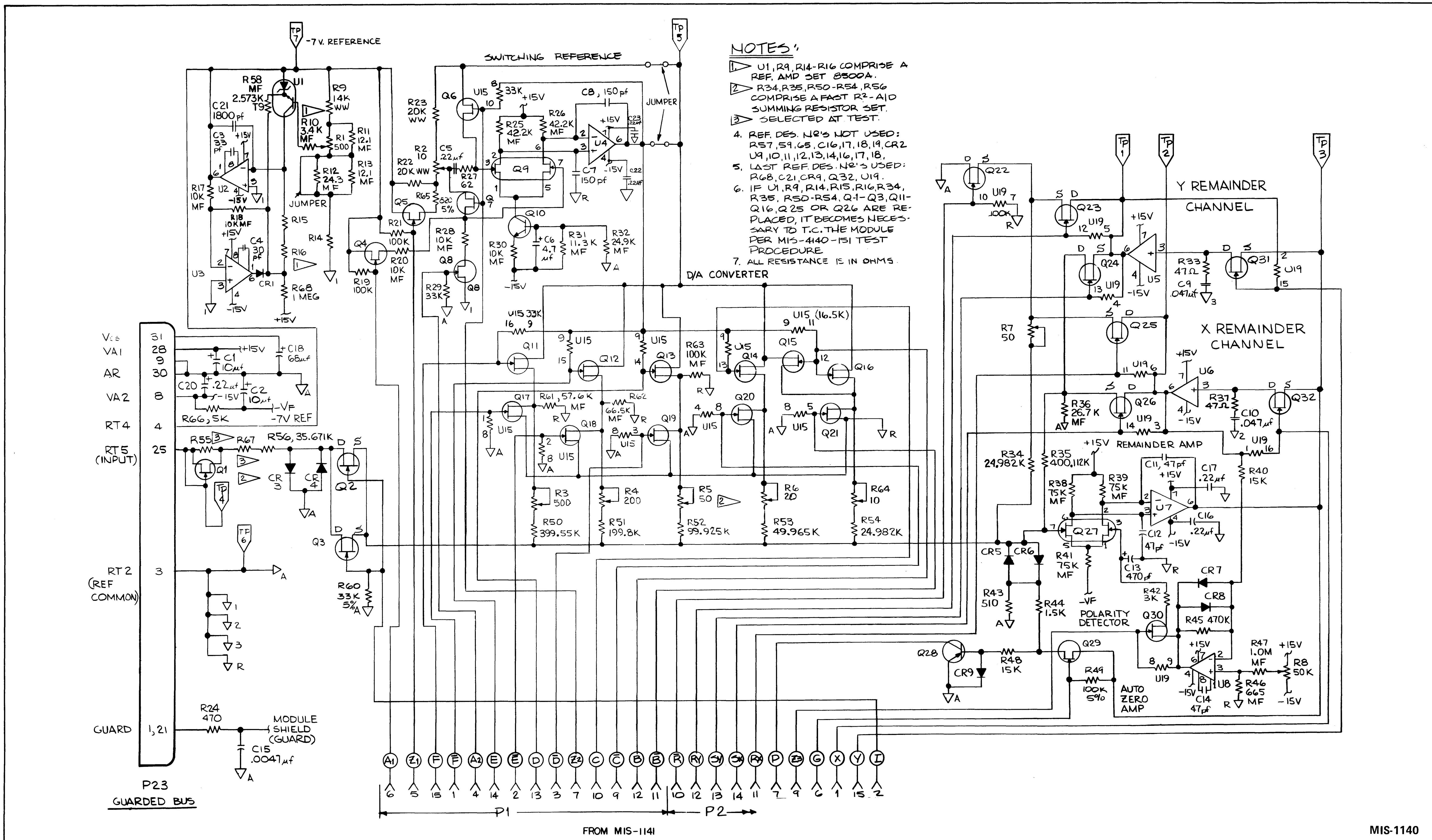


Figure 8-13. A10A1 Analog Display PCB Assembly (cont)

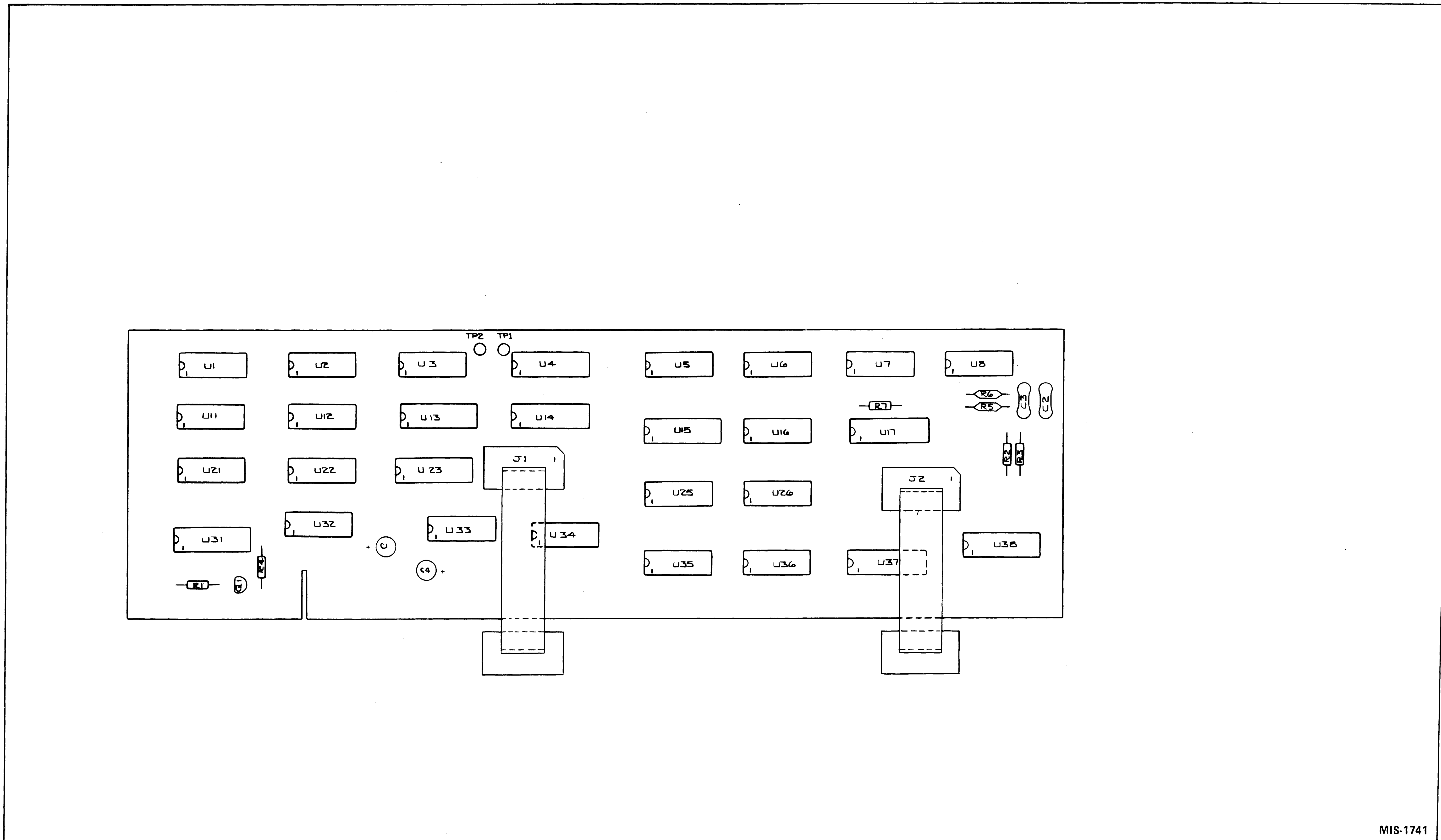


Figure 8-14. A10A2 Fast RR A/D Converter Digital PCB Assembly

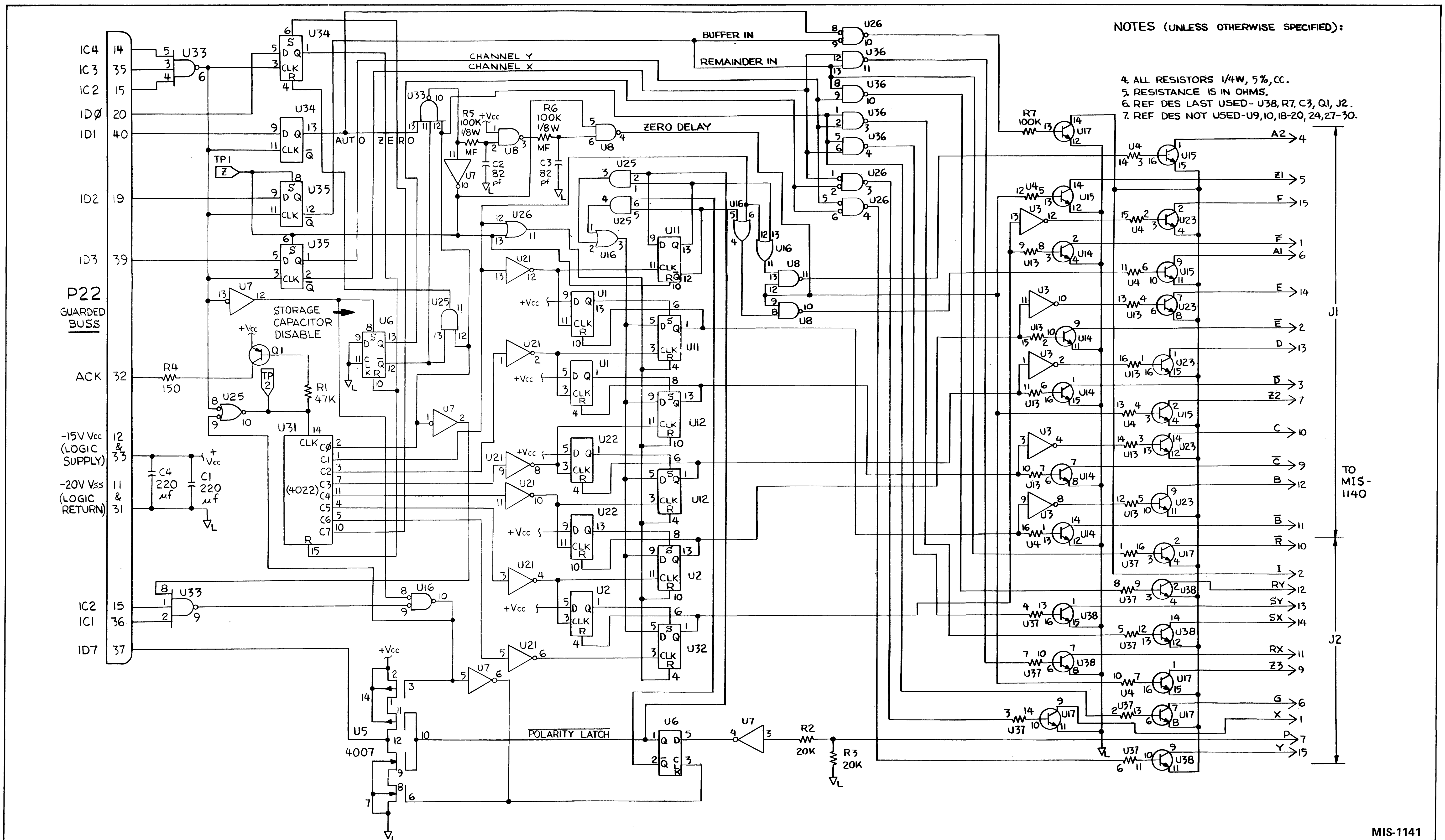


Figure 8-14. A10A2 Fast FF A/D Converter Digital PCB Assembly (cont)