

8520A

Digital Multimeter

Service Manual

P/N 541987
September 1980 Rev 1 8/86
©1986, John Fluke Mfg. Co., Inc. All Rights Reserved. Litho in U.S.A.



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

Table of Contents

SECTION	TITLE	PAGE
1	INTRODUCTION AND SPECIFICATIONS	1-1
1-1.	THE 8520A INSTRUCTION MANUAL SET	1-1
1-4.	LIST OF RECOMMENDED TEST EQUIPMENT	1-1
1-6.	SPECIFICATIONS	1-2
2	SHIPPING AND SERVICE INFORMATION	2-1
2-1.	SHIPPING INFORMATION	2-1
2-4.	SERVICE INFORMATION	2-1
2-7.	QUESTIONS/PROBLEMS	2-1
3	THEORY OF OPERATION	3-1
3-1.	INTRODUCTION	3-1
3-5.	FUNCTIONAL BLOCK DIAGRAM DESCRIPTION	3-1
3-7.	DC Volts	3-1
3-9.	AC and DC + DC Volts	3-5
3-11.	Ohms and Nanosiemens	3-5
3-13.	External Reference	3-5
3-15.	External Trigger Inputs	3-5
3-17.	Digital Data Flow	3-5
3-19.	DETAILED DESCRIPTION	3-5
3-21.	Power Supply (8520A-1023)	3-5
3-25.	Display Assembly (8520A-1011)	3-10
3-29.	Digital Assembly	3-10
3-64.	Analog Assembly	3-11
4	INSTRUMENT ASSEMBLY/DISASSEMBLY	4-1
4-1.	INTRODUCTION	4-1
4-3.	TOP/BOTTOM COVER	4-1
4-5.	Top Analog Guard Covers	4-1
4-7.	INTERNAL GUARD COVERS	4-1
4-9.	DC Buffer Guard	4-1
4-10.	AC Converter Guard	4-1
4-11.	FRONT PANEL DISPLAY ASSEMBLY	4-1
4-13.	ANALOG ASSEMBLY	4-2
4-15.	TRANSFORMER AND TRANSFORMER ASSEMBLY	4-2
4-17.	DIGITAL ASSEMBLY	4-2
4-19.	BOTTOM ANALOG SHIELD	4-3

TABLE OF CONTENTS, *continued*

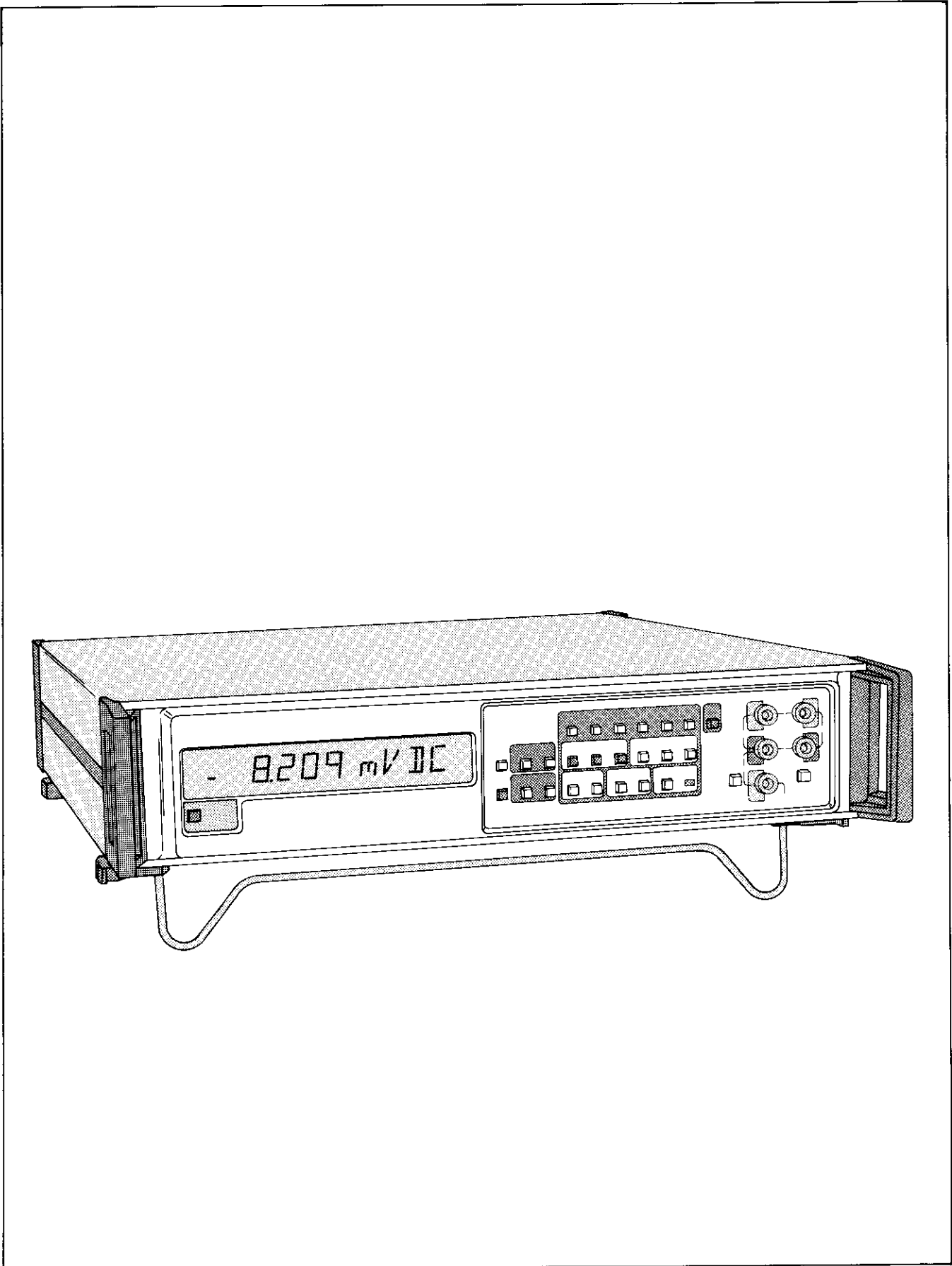
SECTION	TITLE	PAGE
5	TROUBLESHOOTING	5-1
	5-1. INTRODUCTION	5-1
	5-4. POWER ON PROCEDURE	5-1
	5-8. SPECIAL PROCEDURES	5-1
	5-10. Analog Controller Test	5-1
	5-22. A/D Converter Test	5-3
6	LIST OF REPLACEABLE PARTS	6-1
	TABLE OF CONTENTS	6-1
	6-1. INTRODUCTION	6-1
	6-4. HOW TO OBTAIN PARTS	6-2
7	GENERAL INFORMATION	7-1
7A	MANUAL CHANGE INFORMATION	7A-1
8	SCHEMATIC DIAGRAMS	8-1
	TABLE OF CONTENTS	8-1

List of Tables

TABLE	TITLE	PAGE
1-1.	Test Equipment	1-2
1-2.	8520A Specifications	1-3
3-1.	Component Identification	3-1
3-2.	Filter Settings	3-12
5-1.	Front Panel PCB Troubleshooting	5-3
5-2.	Digital PCB Troubleshooting	5-5
5-3.	Analog PCB Troubleshooting	5-8
5-4.	Error Codes	5-9
5-5.	Typical Voltages and Waveforms	5-10
5-6.	Keyswitch Test	5-11
5-7.	Analog Test Failure Patterns	5-12
5-8.	Analog Controller Latch Outputs	5-12
5-9.	Low Ohms Test	5-19
5-10.	Analog Controller Latch Tests	5-19
5-11.	Analog Controller UART Test	5-20
5-12.	Analog Controller Interrupt Test	5-20
5-13.	UART and Interrupt Troubleshooting Procedures	5-21

List of Illustrations

FIGURE	TITLE	PAGE
Frontispiece	8520A Digital Multimeter	vi
1-1.	Outline Drawing	1-7
3-1.	Assembly Placement	3-2
3-2.	8520A Block Diagram	3-3
3-3.	DC Volts	3-4
3-4.	AC Volts and AC + DC Volts	3-6
3-5.	Ohms and Nanosiemens	3-7
3-6.	External Reference DC Volts	3-8
3-7.	External Trigger Inputs	3-9
3-8.	Low Ohms Measurements	3-13
3-9.	High Ohms Measurements	3-13
5-1.	Analog Self Tests #1, 2, 3 Simplified Schematic	5-13
5-2.	Analog Self Test #4 Simplified Schematic	5-13
5-3.	Analog Self Tests #5, 6, 7 Simplified Schematic	5-14
5-4.	Analog Self Test #8 Simplified Schematic	5-15
5-5.	Analog Self Tests #9, 10, 11, 12 Simplified Schematic	5-16
5-6.	Analog Self Test #13 Simplified Schematic	5-17
5-7.	Analog Self Tests #14, 15, 16 Simplified Schematic	5-18
5-8.	A/D Converter Test	5-22



8520A Digital Multimeter

Section 1

Introduction and Specifications

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.

1-1. THE 8520A INSTRUCTION MANUAL SET

1-2. The John Fluke Model 8520A Digital Multimeter is documented by a set of three manuals: The 8520A Operator Manual, the 8520A Calibration Manual, and the 8520A Service Manual. The 8520A Operator Manual introduces the operator to the 8520A (along with the options and accessories), familiarizes the operator with all instrument controls, connectors, and indicators, and presents detailed local and remote operating information and procedures. The 8520A Calibration Manual provides general maintenance procedures, performance tests, and calibration adjustment procedures. The 8520A Service Manual contains the theory of operation, troubleshooting information, a list of replaceable parts, and schematics.

1-3. The information in this, the 8520A Service Manual, is divided into eight sections:

1 INTRODUCTION AND SPECIFICATIONS

Introduces the 8520A Instruction Manual Set, lists the recommended test equipment necessary to complete the Performance Tests and Calibration Adjustments, and lists the instrument specifications.

2 SHIPPING AND SERVICE INFORMATION

If there is a problem with your 8520A, this section describes how to get it corrected and how to ship the instrument.

3 THEORY OF OPERATION

Describes in detailed block diagrams the operation of the instrument at the block diagram level.

4 INSTRUMENT ASSEMBLY/DISASSEMBLY

Describes how to disassemble and reassemble the instrument.

5 TROUBLESHOOTING

A procedure to isolate faults in the instrument to a circuit or component level.

6 LIST OF REPLACEABLE PARTS

An illustrated list of components contained in the instrument. Includes the reference number, nomenclature, Fluke and Manufactures Part number, Manufactures Code and Quantity.

7 GENERAL INFORMATION AND MANUAL CHANGE INFORMATION

Information allowing the reader to backdate the manual to any previous revision level.

8 SCHEMATICS

Schematic diagrams of the electronic circuits in the instrument.

1-4. LIST OF RECOMMENDED TEST EQUIPMENT

1-5. Table 1-1, lists the test equipment required to complete the Adjustment Procedures described in the

Calibration Manual. Equivalent instruments can be substituted if the recommended models are not available. The Calibration Adjustment procedure is called out as part of the Troubleshooting procedure. The DMM and Oscilloscope are also required for fault isolation; how-

ever, in some cases a logic probe, e.g., the Tektronix P6401, may be substituted for the Oscilloscope.

1-6. SPECIFICATIONS

1-7. Table 1-2 lists the 8520A specifications.

Table 1-1. Test Equipment

ITEM	SPECIFICATIONS (MINIMUM)	NOMENCLATURE
DMM Oscilloscope DC Voltage Standard Ratio Standard AC Calibrator Power Amplifier Standard Resistor w/Accessories	5½ digits 0.005% dc accuracy General Purpose 0.001% Accuracy 0.1 ppm Resolution, 1 ppm Terminal Linearity $\geq 0.03\%$ Accuracy @ 20 kHz $\geq 0.044\%$ Accuracy @ 20 kHz	FLUKE 8800A TEKTRONIX T900 Series FLUKE 332D or 335D FLUKE 720A FLUKE 5200A FLUKE 5205A or 5215A ESI 1010 100Ω and 10 kΩ, ESI 1050 1 MΩ. ESI SB103 shorting bars, ESI PC101 Parallel Compensation Network
Load	1 MΩ/1μF	1 MΩ ±1% 1/8 W, mF resistor in parallel with a 1 μF ±20% 10V capacitor

Table 1-2. 8520A Specifications

DC VOLTS

Input Characteristics

RANGE	FULL-SCALE	RESOLUTION	INPUT RESISTANCE
100 mV	199.999	1 μ V	\geq 10,000 M Ω
1V	1.99999	10 μ V	\geq 10,000 M Ω
10V	16.0100	100 μ V	\geq 10,000 M Ω
100V	130.000	1 mV	10 M Ω
1000V	1024.00	10 mV	10 M Ω

Accuracy: \pm (% of input + number of digits)

RANGE	24 HOURS 23°C \pm 1°C	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	PLUS TEMP. COEFFICIENT PER °C *
100 mV	0.003 + 5	0.0065 + 6	0.011 + 10	0.0005 + 0.5
1V	0.003 + 1	0.006 + 2	0.011 + 2	0.0005 + 0.15
10V	0.002 + 1	0.005 + 1	0.009 + 1	0.0004 + 0.10
100V	0.003 + 1	0.007 + 2	0.012 + 2	0.0005 + 0.15
1000V	0.0035 + 1	0.0065 + 1	0.011 + 11	0.0005 + 0.10

*From 22°C to 0°C or 24°C to 50°C, 24 hours specification
From 18°C to 0°C or 28°C to 50°C, 90 day or 1 year specification

High Speed Accuracy: \pm (% of input + least significant bit)*

RANGE	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	PLUS TEMP. COEFFICIENT PER °C
100 mV	0.01 + 1	0.015 + 1	0.001 + .1
1V	0.01 + 1	0.015 + 1	0.001 + .05
10V	0.01 + 1	0.015 + 1	0.001 + .05
100V	0.01 + 1	0.015 + 1	0.001 + .05
1000V	0.01 + 1	0.015 + 1	0.001 + .05

*Typical with 60 Hz line, remote operation, 500 readings per second, 2-byte binary output with 14 bits of data.

Typical Normal Mode Rejection

LINE FREQ	FILTER SETTLLING TIME					
	25 ms	50 ms	100 ms	200 ms	500 ms	1s
50 Hz	65 dB	68 dB	71 dB	80 dB	*83 dB	86 dB
60 Hz	65 dB	68 dB	71 dB	85 dB	*88 dB	91 dB
400 Hz	53 dB	56 dB	60 dB	120 dB	*123 dB	126 dB

*Guaranteed minimum rejection

Common Mode Rejection True 100 dB at 50 Hz and 60 Hz with 1 k Ω unbalance in either lead.
Effective CMR is equal to normal mode rejection plus true CMR.

Maximum Input \pm 1000V Peak, HI to LO or GUARD to chassis terminals, and \pm 200V
Peak, GUARD to LO terminals, for any range.

Table 1-2. 8520A Specifications (cont)

Maximum Reading Rate

OPERATION	RESOLUTION	LINE	READING RATE
Local/Remote	5½ digits	50 Hz 60 Hz	200 rdgs/sec 240 rdgs/sec
Remote	4½ digits	50 Hz 60 Hz	>500 rdgs/sec >500 rdgs/sec

Input Current ≤ 50 pA for 30 days @ 18° to 28° C**AC VOLTS (TRUE RMS)****Input Characteristics**

RANGE	FULL-SCALE	RESOLUTION	INPUT IMPEDANCE
1V	1.99999	10 μ V	1 M Ω , ≤ 100 pF at the V/ Ω INPUT terminal
10V	16.0100	100 μ V	
100V	130.100	1 mV	
650V	650.000	10 mV	

Accuracy: \pm (% of input + % of full-scale)**

For 650V range multiply % FS

FREQUENCY	24 HOURS 23°C $\pm 1^\circ$ C			90 DAYS 23°C to 28°C			1 YEAR 18°C to 28°C		
	% of INPUT	+ % FS AC	+ % FS AC+DC	% of INPUT	+ % FS AC	+ % FS AC+DC	% of INPUT	+ % FS AC	+ % FS AC+DC
10 Hz to 20 Hz*	3.0	0.5	0.6	3.0	0.6	0.7	3.5	0.6	0.7
20 Hz to 40 Hz*	0.4	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.7
40 Hz to 20 kHz	0.08	0.02	0.06	0.1	0.03	0.08	0.15	0.05	0.16
20 kHz to 100 kHz	1.0	0.3	0.4	1.0	0.3	0.4	2.0	0.6	0.8
100 kHz to 300 kHz	2.4	0.6	0.6	2.4	0.6	0.6	4.0	1.0	1.0
300 kHz to 1 MHz	8.0	2.5	2.5	8.0	2.5	2.5	15.0	5.0	5.0

*Assumes smoothing using the Statistics Math Program (~8).

**From 0.1% of Range to Full Scale

Temperature Coefficient	18°C to 0°C or 28°C to 50°C, to 20 kHz.
AC MODE	\pm (.007% of input + .007% FS)/°C
AC + DC MODE	\pm (.007% of input + .014% FS)/°C
Maximum Input	± 1000 V, Peak HI to LO or GUARD to chassis terminals, and ± 200 V Peak GUARD to LO terminals for any range.
Volt-Hertz Product	$\leq 2 \times 10^7$ (slew rate ≤ 177 V/ μ Sec)
Crest Factor	Exceeds 4:1 @ full scale, increasing downscale.
Maximum Reading Rate	10 rdgs/sec (for <300 Hz use reading rates of 5, 2, or 1 rdg/sec to insure stated accuracy)

Table 1-2. 8520A Specifications (cont)

OHMS

Input Characteristics

RANGE	FULL-SCALE	RESOLUTION	CURRENT THRU UNKNOWN	OPEN CURRENT VOLTAGE
10Ω	19.9999	100 μΩ	10 mA	<8V
100Ω	199.999	1 mΩ	10 mA	
1000Ω	1999.99	10 mΩ	1.0 mA	
10 kΩ	19.9999	100 mΩ	0.1 mA	
100 kΩ	199.999	1Ω	14.5 μA(max)	
1 MΩ	1.99999	10Ω	1.5 μA(max)	
10 MΩ	19.9999	1 kΩ	1.5 μA(max)	

Accuracy :±(% of input + number of digits)

RANGE	24 HOURS 23°C ±1°C	90 DAYS 18°C TO 28°C	1 YEAR 18°C TO 28°C	PLUS TEMP. COEFFICIENT PER °C*
10Ω	0.0045 + 6	0.0080 + 7	0.0140 + 12	0.0007 + 0.2
100Ω	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
1000Ω	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
10 kΩ	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
100 kΩ	0.0040 + 2	0.0090 + 2	0.0140 + 3	0.0012 + 0.2
1 MΩ	0.0090 + 2	0.0160 + 2	0.0200 + 3	0.0020 + 0.2
10 MΩ	0.0300 + 1	0.0440 + 1	0.0450 + 3	0.0030 + 0.2

*From 18°C to 0°C or 28°C to 50°C

Maximum Input ±400V peak for any range.

Maximum Reading Rate: 10/sec at 100 KΩ and above.

OPERATION	RESOLUTION	LINE	READING RATE
Local/Remote	5½ digits	50 Hz 60 Hz	200 rdgs/sec 240 rdgs/sec
Remote	4½ digits	50 Hz 60 Hz	>500 rdgs/sec > 500 rdgs/sec

CONDUCTANCE

Range 100 nS

Full Scale 202.00 nS

Resolution 0.01 nS

Accuracy: ±(% of input + number of digits)

24 HOURS 23°C ± 1°C	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	*PLUS TEMP. COEFFICIENT PER °C
0.04 + 5	0.05 + 5	0.06 + 5	0.004 + 1

*From 18°C to 0°C or 28°C to 50°C

Maximum Input ±400V peak

Maximum Reading Rate 10 rdgs/sec

Table 1-2. 8520A Specifications (cont)

EXTERNAL REFERENCE

Operating Range $\pm 0.5\text{V}$ dc to $\pm 33\text{V}$ dc as long as external reference is within $\pm 16.5\text{V}$ of input LO terminal.

Input Impedance 10,000 M Ω between external reference HI or LO terminals and input LO terminals.

Accuracy

X-REF VOLTAGE	ACCURACY
16.5 to 33V	$\pm(A + B + 20 \text{ ppm})$
0.5V to 16.5V	$\pm A + B + (400 \text{ ppm } 1V_{\text{ref}} 1)$

NOTE: A = DC 10 volt range accuracy

B = Input voltage or resistance range accuracy

Maximum Input $\pm 180\text{V}$ peak between external reference HI or LO and input LO; $\pm 360\text{V}$ peak between external reference HI and LO.

Transfer Accuracy The following accuracy specifications apply when:
 Filter settling time is 500 or 1000 ms.
 Measurements are made more than 2 hours after warmup.
 Measurements are made within one range.
 Standard is checked at least every hour.
 Ambient temperature stability within $\pm 1^\circ\text{C}$.

DC VOLTAGE

RANGE	$\pm(\% \text{ OF INPUT} + \text{NUMBER OF DIGITS})$
100 mV	0.0020 + 4
1V	0.0020 + 1
10V	0.0010 + 1
100V	0.0020 + 1
1000V	0.0020 + 1

AC VOLTAGE (all ranges)

FREQUENCY	$\pm(\% \text{ OF INPUT} + \% \text{ OF FULL-SCALE})$
10 Hz to 20 Hz	1.0 + 0.2
20 Hz to 40 Hz	0.1 + 0.1
40 Hz to 20 kHz	0.005 + 0.007
20 kHz to 100 kHz	0.100 + 0.030
100 kHz to 1 MHz	0.500 + 0.060

AC VOLTAGE, DC COUPLED Same as AC Voltage except 40 Hz - 20 kHz, 0.005 + 0.010.

Resistance

RANGE	$\pm(\% \text{ OF INPUT} + \text{NUMBER OF DIGITS})$
10 Ω	0.0030 + 5
100 Ω	0.0020 + 2
1000 Ω	0.0020 + 2
10 k Ω	0.0020 + 2
100 k Ω	0.0020 + 2
1 M Ω	0.0050 + 2
10 M Ω	0.0100 + 1

Conductance $\pm(0.02\% \text{ of input} + 0.02 \text{ nS})$

Table 1-2. 8520A Specifications (cont)

GENERAL	
Interface	IEEE-488 - 1978 is standard.
Temperature	0°C to 50°C operating; -25°C to +75°C non-operating.
Relative Humidity	≤95% at 25°C, ≤75% at 40°C, ≤45% at 50°C.
Shock and Vibration	Meets MIL-T 28800B for type III, Class 5, Style E.
Power	100, 120, 220, or 240V ac, ±10%; 50,60, or 400 Hz ±5%, ≤50W.
Size	8.89 cm H/47.00 cm L/43.18 cm W (3½ in H/18½ in L/17 in W) See Figure 1-2.
Weight	9.56 kg (21 lbs)
Protection Class Code 1	Relates solely to insulation of grounding properties in IEC 348.

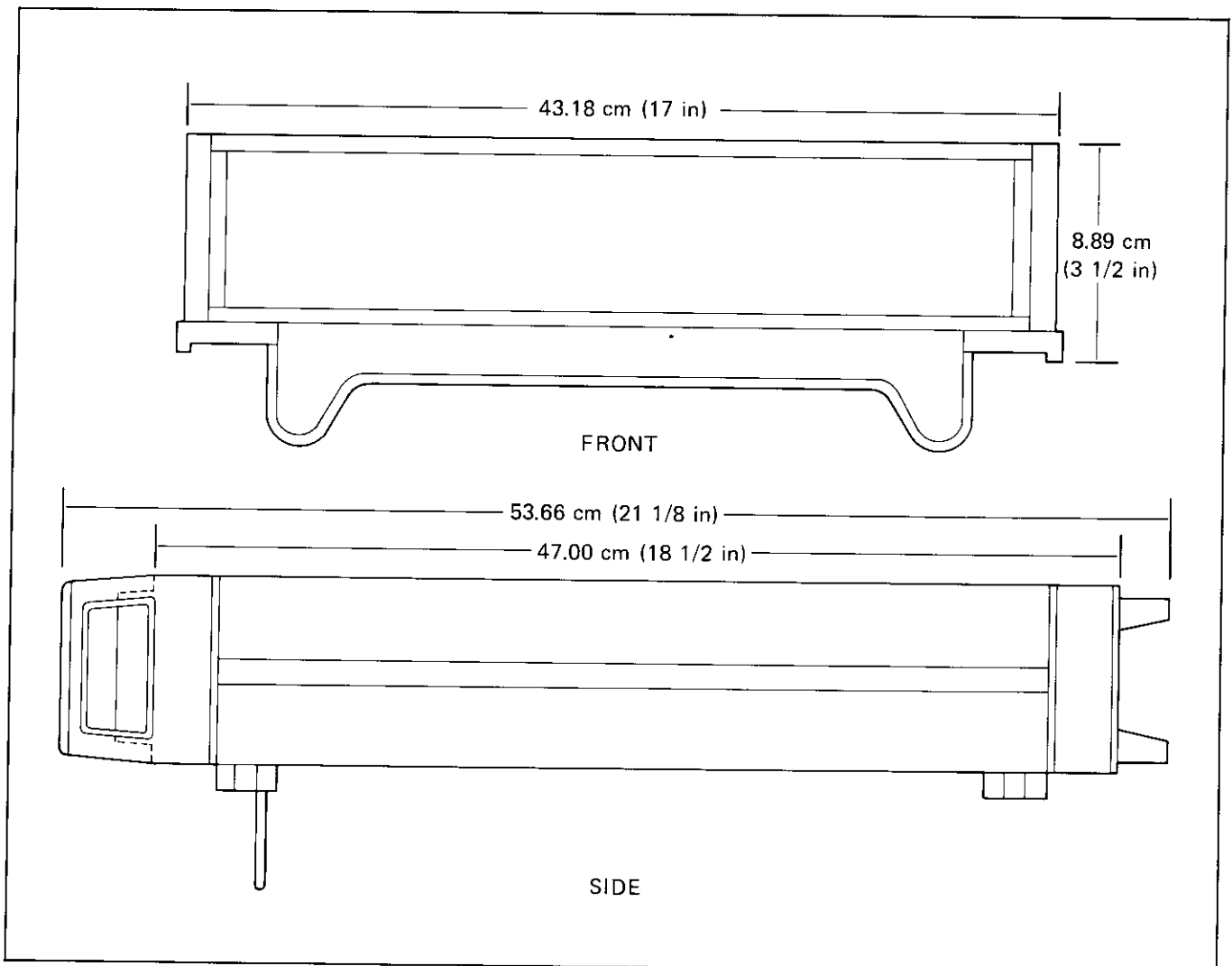


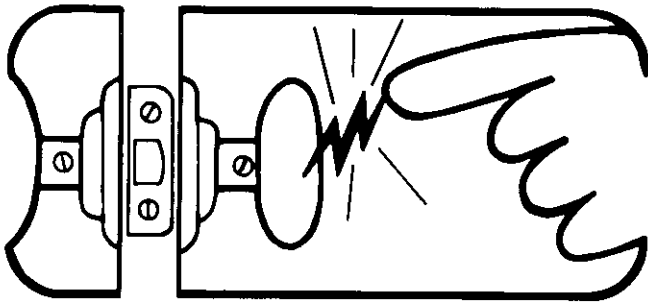
Figure 1-2. Outline Drawing



static awareness



A Message From
John Fluke Mfg. Co., Inc.



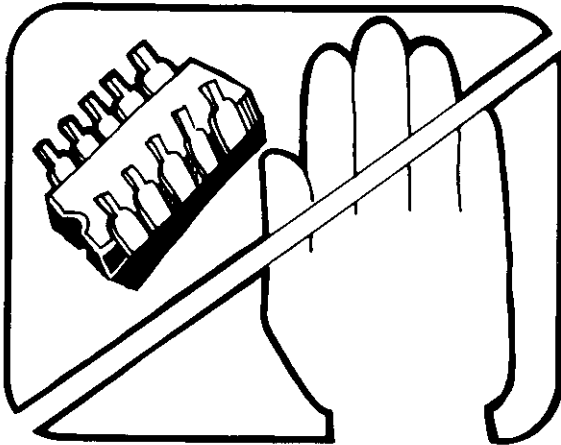
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

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.

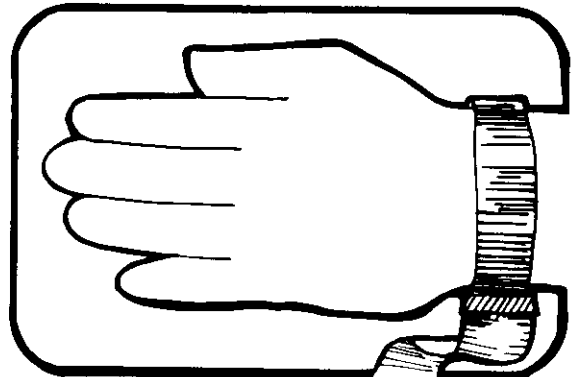
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol



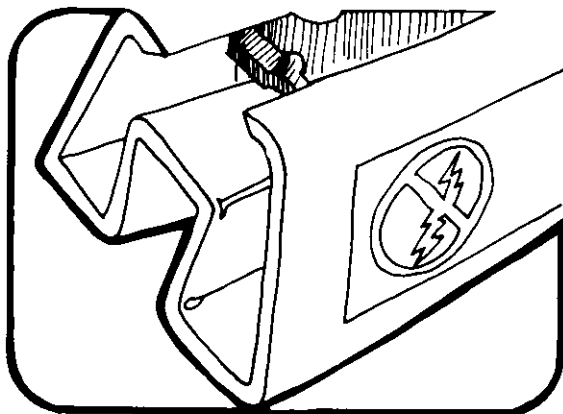
The following practices should be followed to minimize damage to S.S. devices.



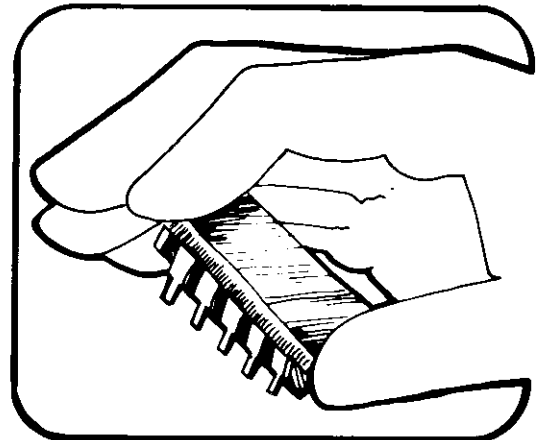
1. MINIMIZE HANDLING



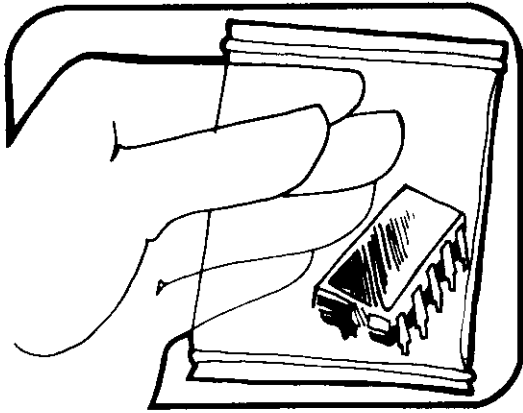
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



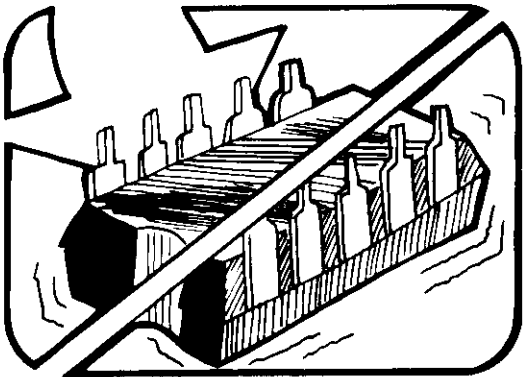
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



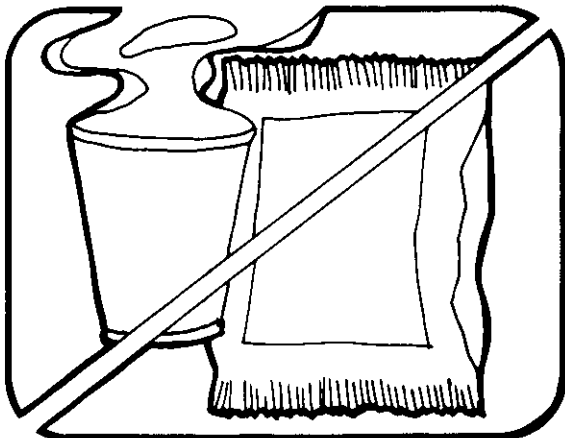
4. HANDLE S.S. DEVICES BY THE BODY



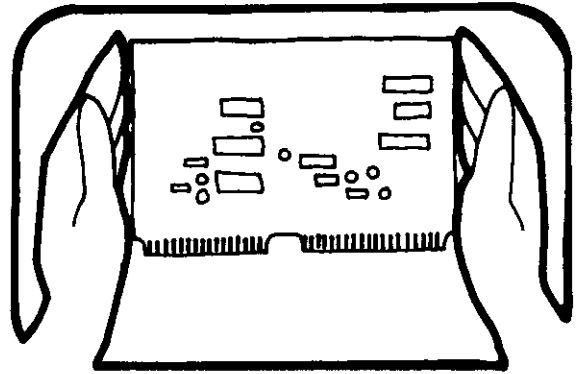
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



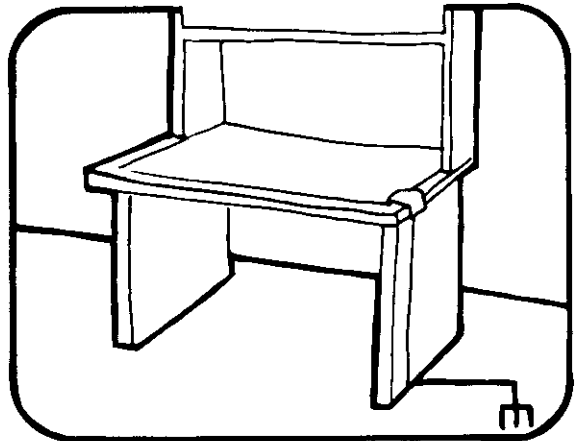
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



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



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 HELPS TO PROTECT 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.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

PORTIONS REPRINTED
WITH PERMISSION FROM TEKTRONIX, INC.
AND GENERAL DYNAMICS, POMONA DIV.

Section 2

Shipping and Service Information

2-1. SHIPPING INFORMATION

2-2. The 8520A is packaged and shipped in a foam-packed container. When you receive the 8520A, inspect the instrument thoroughly for possible shipping damage. Special instructions for inspection and claims are included on the shipping container.

2-3. If reshipment is necessary, use the original container. If the original container is not available, order a new one from John Fluke Mfg. Co., Inc. / P.O. Box C9090 / Everett, Washington 98204, Telephone (206) 347-6100.

2-4. SERVICE INFORMATION

2-5. Each John Fluke Model 8520A Digital Multimeter is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of this manual.

2-6. Factory authorized calibration and service for all Fluke products is available at many locations worldwide. A complete list of Fluke service centers is included in Section 7A of this manual. If requested, an estimate will be provided to the customer before any work is begun on an instrument after its warranty period has expired.

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual deals with the 8520A theory of operation. It begins with an explanation of the component numbering and placement system, followed by an overall block diagram and then a detailed description of each block.

3-3. COMPONENT NUMBERING SYSTEMS

3-4. The 8520A is laid out on four printed circuit boards designated A1 through A4 plus the switches and connectors mounted on the front and rear panels. The two main boards, which lay flat across the instrument interior, are sectionalized into individual circuits. All components in a section are numbered within a series to identify the section within the assembly. Table 3-1 contains the series identification numbers and their corresponding section titles. A component number A2 R15 identifies resistor R15 in the Digital Controller section of the A2 Digital PCB Assembly. Other examples are: A2 U108 is IC U108 in the IEEE Interface section of the Digital Assembly, A3 BR702 would be bridge rectifier BR702 in the Power Supply section of the A3 Analog Assembly. In many cases the PCB Assembly is identified by name rather than "A" number, but in those cases the component number holds true. Figure 3-1 shows the location placement of the four assemblies within the instrument and of the individual sections on the Digital and Analog Assemblies.

3-5. FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

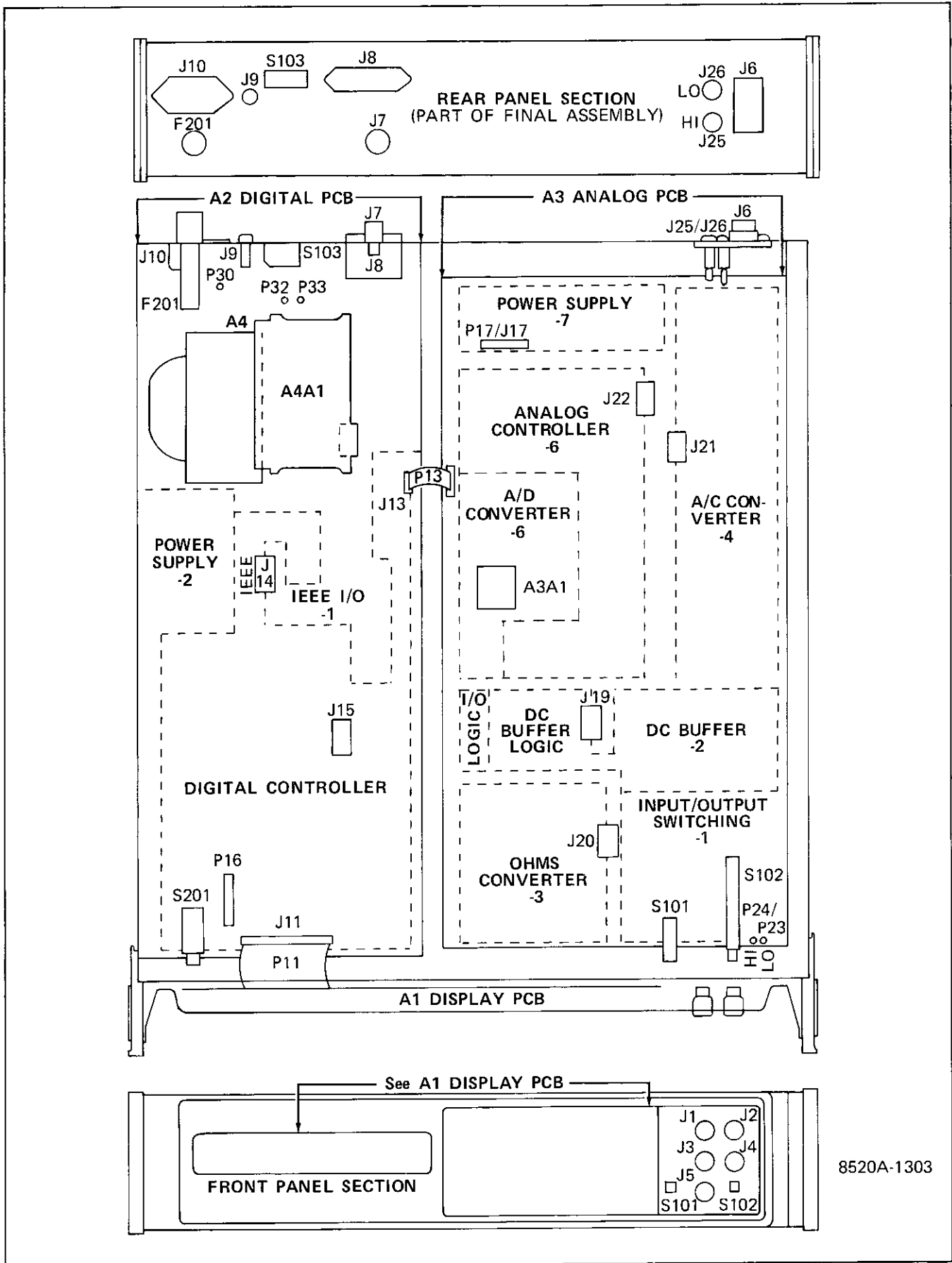
3-6. Figure 3-2 is a block diagram of the circuits within the 8520A. The path of signal flow through the blocks during each of the functions available with the instrument is described in subsequent paragraphs. The signal path varies for each function until the analog data is changed to digital in the A/D Converter. From that point on, the signal flow is the same for all functions.

Table 3-1. Component Identification

SECTION TITLE	COMPONENT IDENTIFICATION
Digital PCB	A2
Digital Controller	XX
IEEE Interface	1XX
Power Supply	2XX
Analog PCB	A3
I/O Switching	1XX
DC Buffer	2XX
Ohms Converter	3XX
AC Converter	4XX
A/D Converter	5XX
Analog Controller	6XX
Power Supply	7XX

3-7. DC Volts

3-8. With DC Volts selected, an input between zero and 1000V dc can be applied to the Front Panel Input Terminals and applied to the I/O Switching Circuit. In the 100 and 1000 volt ranges, the signal is divided by 64 to bring it within the ± 16.5 volt limits of the DC Buffer. The DC Buffer filters the dc input at the selected speed, conditions it to the proper levels and outputs a varying signal, between zero and ± 16.5 volts, proportional to the input signal. The proportional analog signal is converted to digital data. The signal flow for a dc voltage input is shown in Figure 3-3.



8520A-1303

Figure 3-1. Assembly Placement

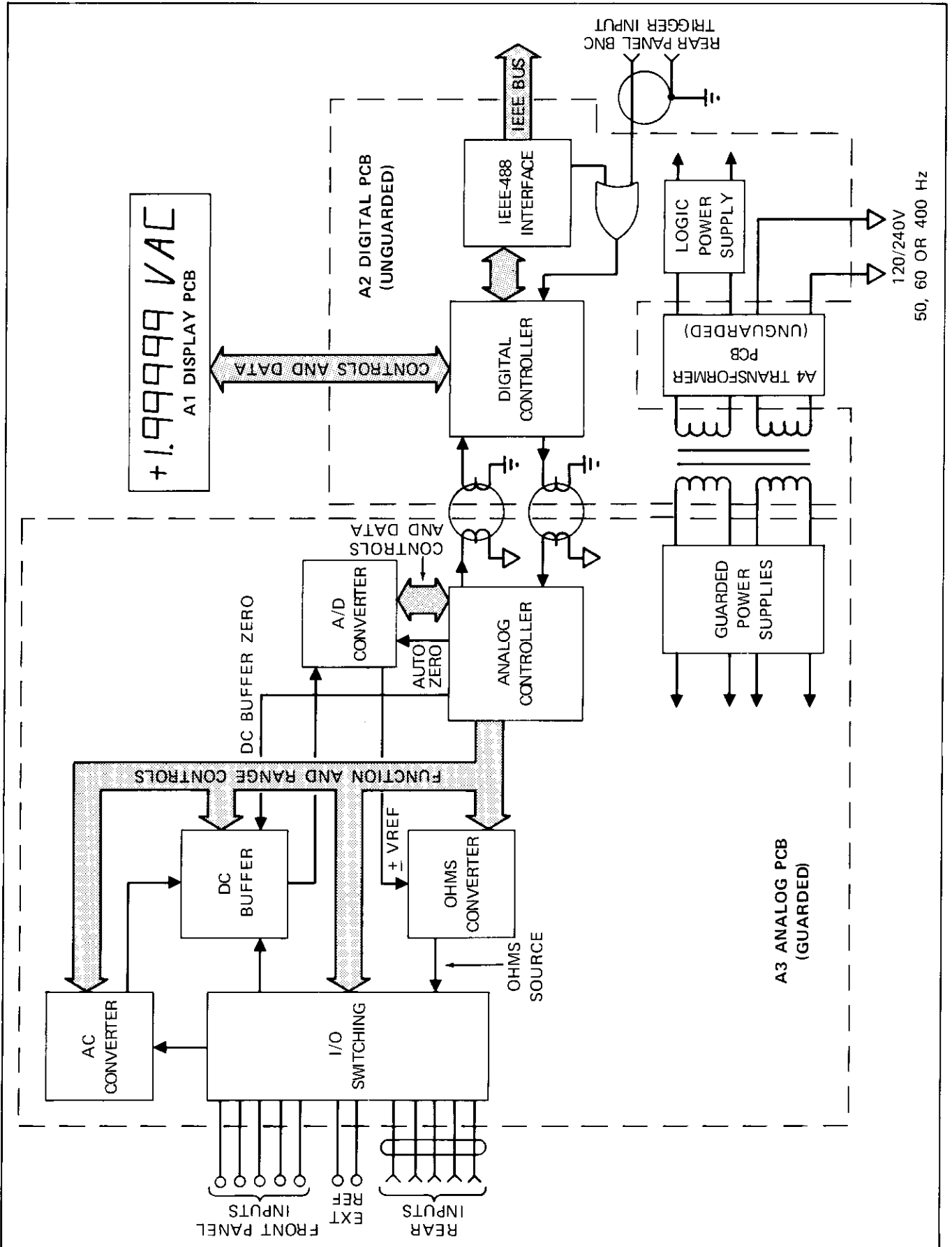


Figure 3-2. 8520A Block Diagram

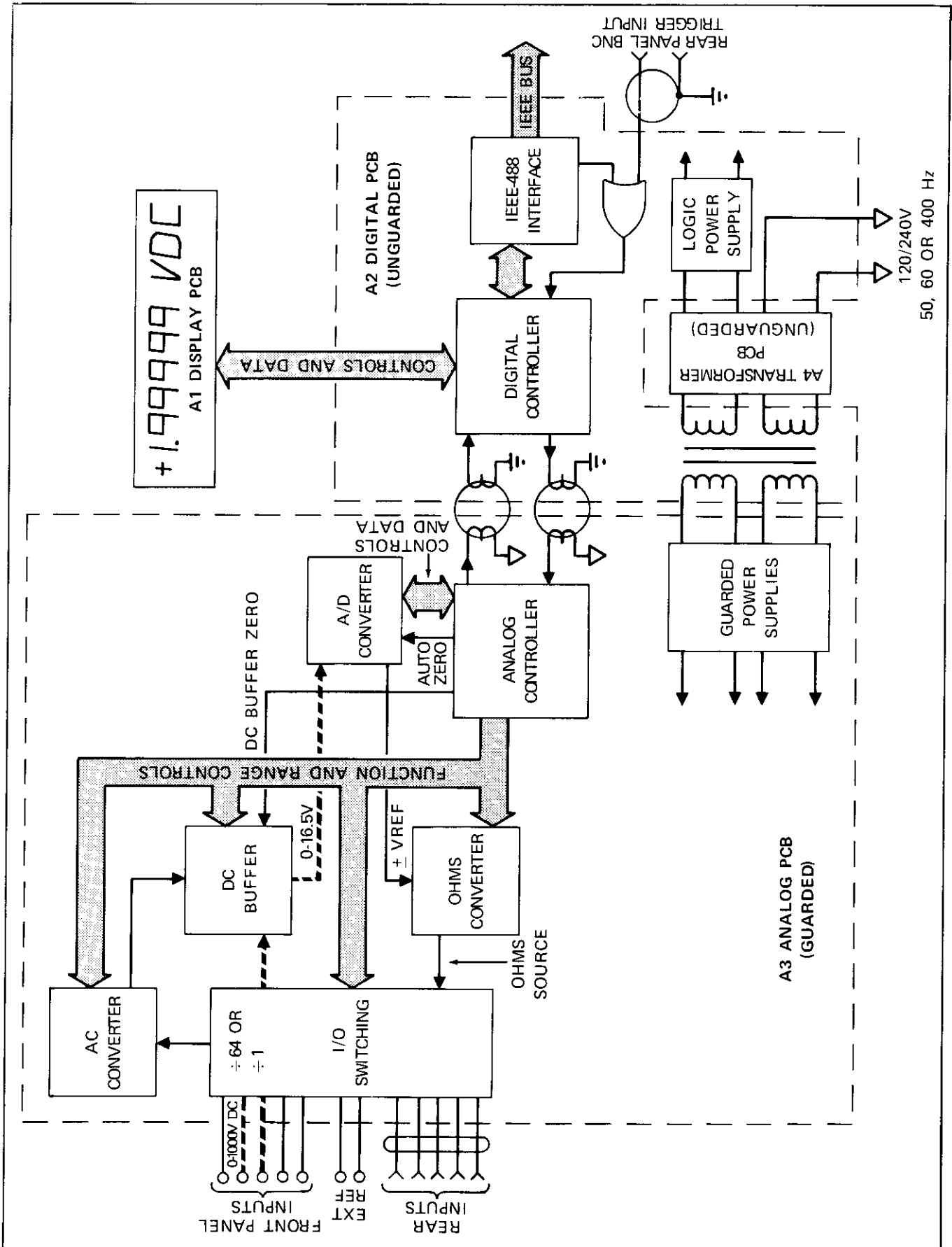


Figure 3-3. DC Volts

3-9. AC and AC + DC Volts

3-10. Figure 3-4 shows the signal path when either AC volts or AC + DC volts are selected. The maximum 650V rms or 1000V peak signal is input to the I/O Switching circuit from the input terminals, but is routed directly to the AC Converter without change. Coupling into the AC Converter varies with the function selected, either through a capacitor for ac or around the capacitor for direct coupling for AC + DC. The AC Converter changes the zero to 650V ac input to a zero to 16.5V dc proportional signal and applies it to the DC Buffer. The DC Buffer treats the input just as it did the dc input, filtering, conditioning, and applying it to the A/D Converter for conversion to a digital signal.

3-11. Ohms and Nanosiemens

3-12. A resistance measurement is input to the I/O Switching section and then routed without change to the applicable portion of the Ohms Converter, low or high ohms. Measurements are made using a current reference for values of 19.9999 kilohms or less (LO OHMS) or a voltage reference and the ratio technique for values of 20 kilohms or greater (HI OHMS). The resulting voltage drop is proportional to the value of the measured resistance and is routed to the DC Buffer, through the I/O Switching section, and to the A/D Converter for conversion to digital data. Conductance measurements in nanosiemens are treated as a high ohms measurement and then inverted to obtain the reciprocal of the value. Figure 3-5 has the signal flow highlighted for a resistance operation.

3-13. External Reference

3-14. Signal flow for an external reference measurement is shown in Figure 3-6. External reference differs from a dc measurement only in the input of the external reference on the rear panel terminals. The input and the reference are multiplexed in the I/O Switching section, and the resultant voltages are sent alternately to the DC Buffer to be conditioned and to the A/D Converter to be changed to digital data. The actual computation of ratio is performed on the two A/D outputs by the Digital Controller.

3-15. External Trigger Inputs

3-16. External triggers may originate in one of three different locations as shown in Figure 3-7. These are from the Front Panel MANUAL keyswitch, the rear panel BNC connector if enabled, and the IEEE Bus if addressed. Once in the Digital Controller, trigger action does not vary between the external triggers and the internal trigger.

3-17. Digital Data Flow

3-18. Data is converted to a digital format in the A/D Converter which operates in combination with the Analog Controller. Switching signals for control of the analog functions are sent from the Digital Controller to the Analog Controller which latches the information and sends it to the applicable section. A/D Converter outputs are sent over the guard crossing to the Digital Controller and then processed as required for display or transmission over the IEEE-488 Bus.

3-19. DETAILED DESCRIPTION

3-20. A description of each operational section in the block diagram is given in the paragraphs below. The Power Supply circuits are described first, followed by the Display, Digital, and Analog Assemblies. The Power Supply has portions of its circuitry on both the Analog and Digital Assemblies, as well as on the Transformer Assembly. Refer to the schematic listed after the paragraph title during the discussion of the circuit.

3-21. Power Supply (8520A-1023)

3-22. The Power Supply schematic is a combination drawing including components located on the Digital Assembly (A2), the Analog Assembly (A3), the Transformer Assembly (A4), the front and rear panels, and transformer T201. Input line voltage is routed to the transformer primary through the front panel power switch and the line voltage selection switches on the Transformer Assembly.

3-23. Two secondary windings go to the analog assembly for the guarded power supplies. One secondary goes to the regulator through the rectifiers CR703 and CR704 to provide the +5 volts for the logic circuits. This is accomplished by tying -15 volts to logic high which puts logic common at -20 volts with respect to analog common. The other secondary is rectified by the bridge network BR701 for ± 15 volt outputs from regulators U705 (+15V) and U706 (-15V). Another tap from the same secondary is rectified in BR702 for ± 27 volt outputs from U704 (+27V) and U707 (-27V).

3-24. On the Digital Assembly, the regulator U202 takes the rectified output from CR1 and CR2 on the transformer assembly and, with its associated components, provides the unguarded +5V operating voltage for the logic circuits. The unregulated +5 volt output and its return are sent to the display assembly for use there. Another use for the secondary is 5V XFMR SEC which monitors line frequency. R210, in parallel with U202, provides an increased load capability. Test jumper J201 disconnects the supply, R210, and the load, so that the supply can be checked without a load.

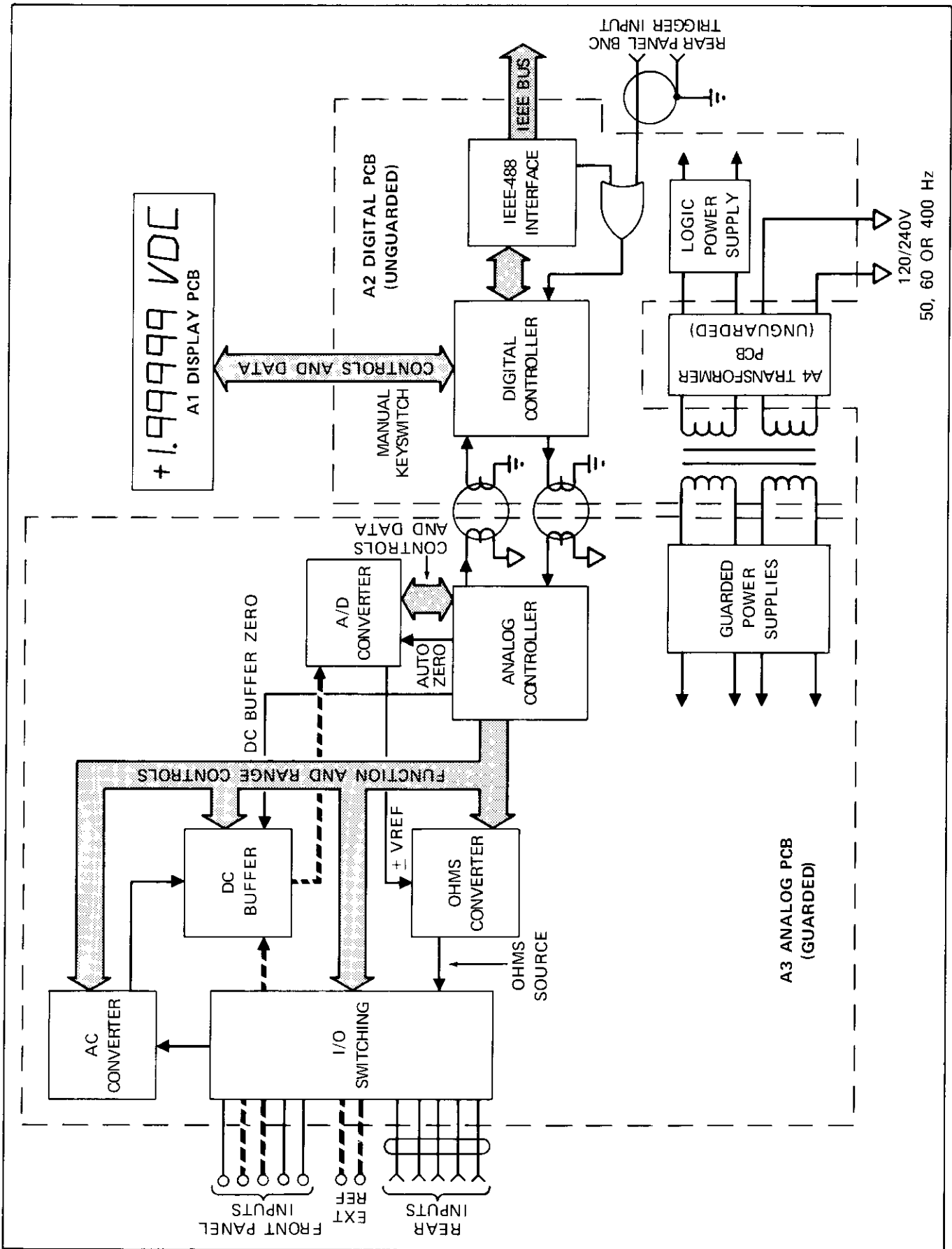


Figure 3-6. External Reference DC Volts

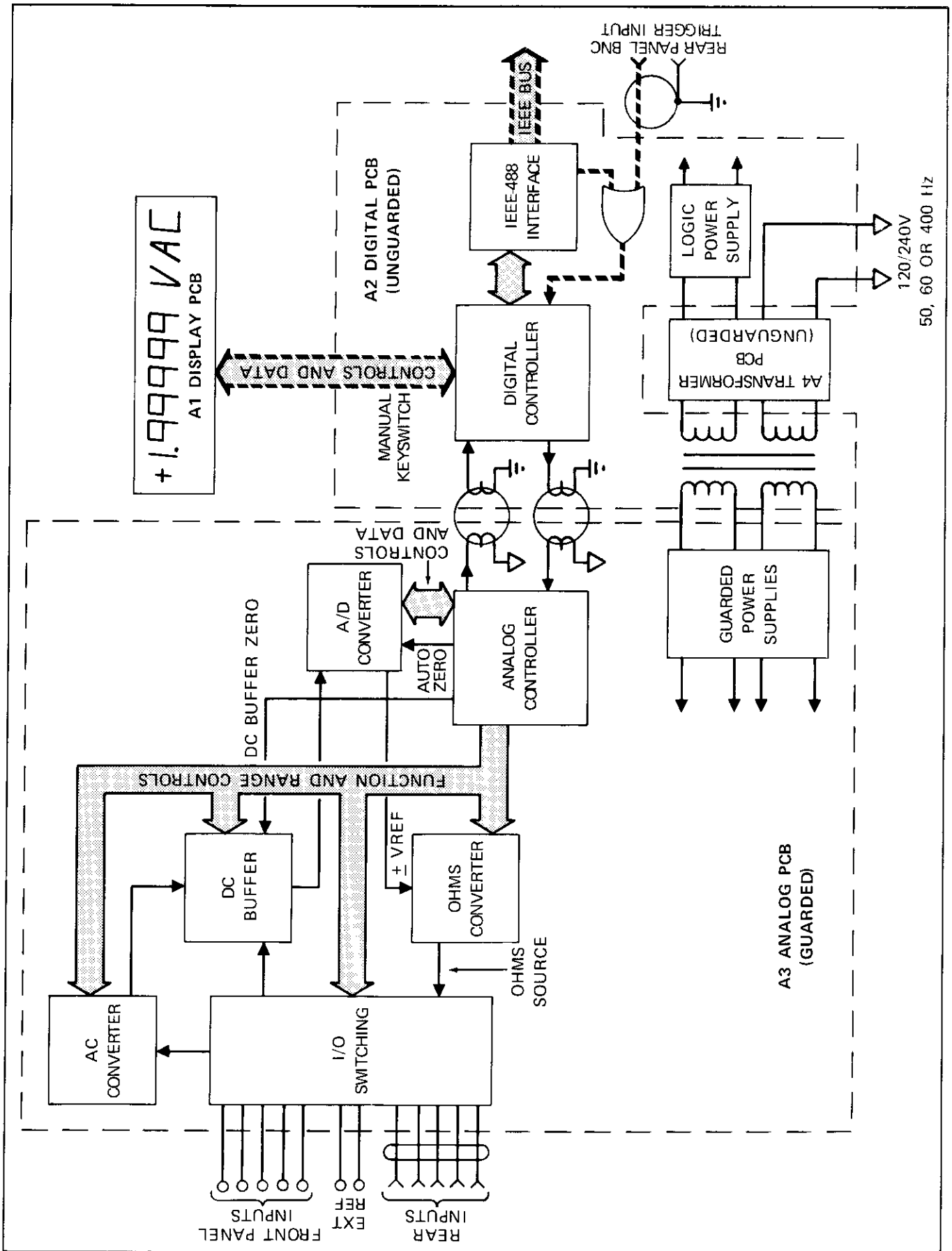


Figure 3-7. External Trigger Inputs

3-25. Display Assembly (8520A-1011)

3-26. Segment control data from the controller is placed in U9 and U12 alternately and applied to the display in parallel through the segment drivers (U10/U11 and U23/U24). The driver outputs are multiplexed for the applicable character. The common cathodes of the display are latched into U1 by the Controller with U2 and U3 acting as the digit drivers. One character from the numeric display (7 segment LEDs) and one-half of one character from the alphanumeric display (14 segment LEDs) are addressed simultaneously. The display can be totally blanked with the DISPBLANK signal to prevent damage to the display. DISPBLANK originates on the Digital Controller and is generated if the switch matrix is not read at least once every 16 ms.

3-27. The switch matrix rows and the display are enabled at the same time. Depression of a switch gives a column signal. Decoding the row/column combination in the Controller identifies the depressed switch for the program.

3-28. The normal sequence for a display assembly operation begins with the clearing of U1 to prevent ghosting on the display. Data for the first numeric and one-half alphanumeric characters are then sent to U9 and U12 respectively and the display is turned "on" for 2 ms from U1. The process is repeated, stepping through the eight possible displays and turning "on" each indicator pair in turn at a 60 times per second refresh rate.

3-29. Digital Assembly

3-30. The digital assembly is divided into three separate sections. The Digital Controller and IEEE Interface are individually covered in subsequent paragraphs. The third section, the Unguarded power Supply was covered previously as part of the composite Power Supply description.

3-31. DIGITAL CONTROLLER (8520A-1021)

3-32. The digital controller section contains the microprocessor, the ROM with the operating program, the RAM for temporary storage and burst memory, and the various control circuits. Each of these circuits is detailed in sub-paragraphs below.

3-33. Clock Circuit

3-34. The microprocessor is provided with a 4 MHz square wave by the clock circuit. Crystal Y1 is an 8 MHz oscillator that clocks the standard binary counter, U20. Outputs from the counter in addition to the 4 MHz, are 2 MHz for use in the Guard Crossing circuitry and 1 MHz for use in the IEEE circuitry. The parallel inverters at U19-10 and U19-12, with R6, keep the rise and fall time of the clock within specifications. Ringing is kept within acceptable levels by R7.

3-35. Microprocessor

3-36. The microprocessor is a single component with fully decoded and timed output signals to control standard memory or peripheral circuits. Supply voltage for the device is +5V dc and the only clock required is a single-phase, 5V, 4 MHz square wave.

3-37. The internal register configuration of the microprocessor contains 208 bits of Read/Write memory accessible to the program. The registers include two sets of general purpose accumulator and flag registers that may be used as four 16-bit pairs or as eight 8-bit individuals. Also included is a 16-bit stack pointer that allows implementation of multiple level interrupts and unlimited subroutine nesting. Tabular data manipulation and relocatable code implementation is accomplished with the two 16-bit index registers. The Memory Refresh register provides automatic transparent refresh of external dynamic memories. The interrupt vector register forms the upper 8-bits of a pointer to an interrupt service address table during the interrupt response mode, while the lower 8-bits of the pointer are supplied by the interrupting device. An indirect call is made then to the service address formed. The last register is a 16-bit program counter.

3-38. Reset

3-39. The instrument circuitry is automatically reset at power up. When one shot U36-12 is not triggered, it provides U22-13 and 12 with a high and low signal respectively to provide a reset to the controller assembly. Line voltage (FLINE) input from U23-11 (divided by 7 at U32-13 if the line frequency is 400 Hz) triggers U36, releasing the counter U28, which in turn clocks U22 on a count of eight to remove the reset. This places the reset on the circuit for a predetermined time during power up.

3-40. When power is removed, U36-12 times out and sets U22 to apply a reset to the circuitry. Resistor R19 and capacitor C29 provide a timeout for resetting the instrument by shorting test points TP9 and TP10 together.

3-41. Wait

3-42. A WAIT signal is input to the microprocessor at U18-24 to indicate that the addressed memory or I/O device needs an extended bus cycle. It can be generated from the IEEE circuit or by U9 as the result of an M1 output from the microprocessor. M1 is active when the microprocessor is performing an op code fetch cycle. The M1 memory access is shorter than all other cycles, in order to provide for the refresh cycle (not used). One WAIT state is added to allow for the access time of the ROMs.

3-43. Interrupt

3-44. There are three sources of interrupts. These are: the IEEE circuit, the guard crossing circuit, and the phase

locked loop circuit. The interrupt signals are combined in a wired OR circuit for an input to the microprocessor at U18-16. R26 is a passive pull-up for the line and, in conjunction with C31, filters high frequency chassis noise (>10 MHz) to prevent spurious interrupts. U17-4 in the OR circuit is active (low) from an interrupt from the IEEE. The UART "data available" output is connected to the interrupt line via U33-2, which is enabled at U33-1 from U8-15, and U17-11. Line synchronous interrupts (MARK) are generated by U17-6 each time the phase-locked loop output has a positive transition. The MARK is enabled and cleared by signal MARK EN at U35-1 from U8-19.

3-45. Phase-Locked Loop

3-46. Digital noise rejection is accomplished by averaging line synchronous samples. A/D samples are synchronized to the AC line by the phase-locked loop (PLL). The line frequency input (U29-14) is multiplied by 8 by the PLL circuitry U29 and U28. The PLL output (U29-4) which is eight times the input frequency (8/7 for 400 Hz line) provides a clock for MARK interrupts (U35-3), display blanking (U21-1), and the guard crossing trigger flip flop (U1-3).

3-47. Guard Crossing

3-48. The Guard Crossing transfers data between the Digital and Analog Controllers using virtually identical circuits on each assembly. On the digital controller it consists of the UART U26, the one-shot U36, the pulse transformer U38, gates from U37 and U30, and their associated components. The UART converts the eight bits of parallel data received on the bus (U26-26 through 33) into a serial data stream, adding parity, start, and stop bits. The 125k baud serial data from U26-25 is inverted (U30-6) to modulate the 2 MHz signal from U20-13. The high voltage driver U37-5 then sends the signal through the pulse transformer U38-3 to the guarded analog controller.

3-49. Modulated 2 MHz data from the analog controller is received by the pulse transformer. The one-shot U36 stretches the 2 MHz bursts into a digital series stream of the original 125k baud rate. The UART converts it to a parallel format and outputs it to the bus on U26-5 through 12.

3-50. Memory Select

3-51. The memory for the digital controller consists of two RAMs (four with Option -010), three ROMs, and their control circuits U2 and U3. Address line A15 from the microprocessor enables either RAM or ROM. If it is high, RAM is addressed, if low, ROM. When MEMREQ is low, both RAM and ROM are enabled.

3-52. When RAM is addressed A10, A11, and A12 select either the standard memory (U6 and U7) or the optional memory (U4 and U5) with A10 low and high, respectively.

3-53. One of the three ROMs (U10, U11, and U12) is enabled by U3 from the decoded A13 and A14 signals. U13 and U14 are not installed; their sockets are left open for special applications or future expansion.

3-54. Display Blank

3-55. The phase locked-loop clocks U21-1 to count toward eight. If it reaches that count without being reset by the SW signal from U25-8, U21-6 goes high and blanks the front panel display.

3-56. Guard Crossing Trigger

3-57. A short pulse is generated in this circuit for the Analog Controller. It is generated at U21-11 and sent through U37-3 to the pulse transformer (U38-6).

3-58. Sources of the trigger are: the external trigger from either the rear panel (U23-2) or the IEEE (U23-1), the MARK trigger U8-6, or the software trigger at U33-13 from the decoded address at U25-10.

3-59. External Trigger

3-60. The external trigger edge is selected by the Schmitt trigger circuit at U39. The external clocks U35-11, if enabled by EXT TRIG EN at U35-13 from U8-16.

3-61. IEEE-488 INTERFACE (8520A-1022)

3-62. All device interface functions defined by the IEEE-488 1978 Interface Standard are performed within U101. The bidirectional data lines (DI01-DI08) from U108 and U109 are normally three-state drivers; however, when parallel poll is selected they change to open collector. The control lines in U110 are bidirectional under the control of U101. Control lines NRFD, NDAC, and SRQ have open collector outputs; the remaining control lines are three-state.

3-63. The interface is addressed from the digital controller with A7 high and A6 low. A0, A1, and A2 are used to address the internal registers in U101. Switches S103 place the instrument IEEE address on the bus when U102 is enabled from U101. Timing is a 1 MHz clock derived from the Digital Controller 4 MHz clock. The 1 MHz clock is synchronized to the microprocessor I/O access cycle by U103, U104, and U105.

3-64. Analog Assembly

3-65. The Analog Assembly is divided into seven separate sections. Six are covered individually in subsequent paragraphs while the seventh, the Guarded Power Supply, was covered previously as part of the composite Power Supply.

3-66. I/O SWITCHING (8520A-1031)

3-67. Manual selection of input terminals and guard source, electrical selection of function, routing of signals, filtering, and multiplexing are performed in the I/O Switching section.

3-68. Switch S102 selects between the front panel input terminals and the rear panel connector. When the switch is out, the front panel terminals are connected through the switch to the internal circuitry. If the switch is depressed, the rear panel connector is used. The guard is controlled by S101. If S101 is pressed in, the front panel guard terminal, and therefore anything connected to it, is connected to the internal V guard. When S101 is out, (NORMAL) the V guard is connected through the switch to chassis ground, and the front panel guard terminal is open circuited.

3-69. After selection at S102, the input signal is routed through the contacts of K103. For all functions except low ohms K103 is de-energized, and the signal is routed to other circuits for further direction. In low ohms (K103 energized) the signal is routed directly to the Ohms Converter. K101 is energized in the 2-terminal ohms function to connect the input terminals to the source terminals.

3-70. AC or AC + DC measurements are routed to the AC Converter through the energized contacts of K104. Relay K102 is energized for the 100 mV and 10V dc ranges, passing through the 150 k Ω current limiting resistor R110 on its path to the DC Buffer. For the 100V and 1000V ranges, the signal is divided by a factor of 64 in R107. With the high input impedance of the DC Buffer, energizing the relay (K102) does not cause any attenuation.

3-71. High voltage transients in excess of 1.6 kV are clamped by R104 and RV101 through RV104. Thermister R103 and RV105 provide high voltage protection between guard and chassis. The transistors Q101 and Q102, and the diodes CR107 and CR108 limit the input to the multiplexer stage to ± 18.7 volts.

3-72. Digital signals into the multiplexer stage from the A/D Converter are translated into -27V for a logic high and "Open" for logic low (by U103, U102, and Q110), to operate the applicable FET switch from Q103 through Q108. An "Open" input to the FET gate turns the switch "on" and allows the applicable input signal to pass through to the DC Buffer section.

3-73. DC BUFFER (8520A-1032)

3-74. The DC Buffer section accepts the data input from the I/O Switching section, filters it at the selected speed, and conditions the signal to the proper levels for the A/D Converter. The eventual input to the A/D Converter will be a chopped dc signal, varying between zero and ± 16.5 volts, and proportional to the input signal.

3-75. Filter Circuit

3-76. The filtering stage consists of a fast filter which is a single pole RC network and a slow filter which is a three

pole active filter. The settling time is determined by the reading rate, which also controls the number of samples averaged. The Analog Controller selects the slow filter on power initialization and switches automatically with the reading rate. Table 3-2 gives the settling time, number of samples, and reading rate for each filter.

Table 3-2. Filter Settings

FILTER	SETTLING TIME	NO. OF SAMPLES AVERAGED	READING RATE
Fast	5 ms	1	≥ 120 /sec
Fast	25 ms	4	40-60/sec
Fast	50 ms	8	20/sec
Fast	100 ms	16	10/sec
Slow	200 ms	16	5/sec
Slow	500 ms	64	2/sec
Slow	1000 ms	128	≤ 1 /sec

3-77. Buffer Circuit

3-78. The input to the buffer circuit is a unity gain amplifier (U210 and associated components) which establishes the signal $V_{\text{BOOTSTRAP}}$ equal to the input signal. This bootstrap voltage is used in the biasing circuits for the FET switches and in the driving circuit. The automatic zero circuit of FET switches Q231 and Q233 is turned on when a measurement is not being taken. When the switches are turned on, the voltage at the junction of Q231/C230 equals the input (V_{in}) plus the offset of U210. The voltage at the junction Q233/C230 equals V_{in} , plus the offset of U210, plus the offset of U211. As a result, the negative of the offset of U211 is stored on C230, and when a measurement cycle takes place and FET switch Q232 is turned on, the stored voltage cancels the offset of U211. The net offset voltage is zero.

3-79. The driving circuit changes the signal from a -15V and -20V logic system into a +2V and -0.5V system for the D-MOS FETS. The signal then passes through the non-inverting output amplifier (U211) with its gain determined by the state of the FET switches in its output. The gain will be either unity with Q236 on for the 10V and 1000V ranges, eight with Q237 on for the 1V and 100V ranges, or sixty four with Q238 on for the 100 mV range. The end result is dc voltage output to the A/D Analog section that is between zero and ± 16.5 volts and proportional to the input.

3-80. OHMS CONVERTER (8520A-1033)

3-81. The ohms converter produces a current in the unknown resistance (R_x) being measured so that the voltage drop is proportional to the value of R_x . The method used varies with the magnitude of the resistance.

3-82. If R_X is $\leq 19.9999 \text{ k}\Omega$, it is placed in the feedback loop of an op amp as shown in Figure 3-8. In this configuration, the voltage at the high input terminal should be at or near zero with an infinite input impedance. As a result, all of the current delivered by the reference current (I_{REF}) flows through R_X which can be computed from the output voltage (V_O) with the formula $R_X = V_O/I_{REF}$.

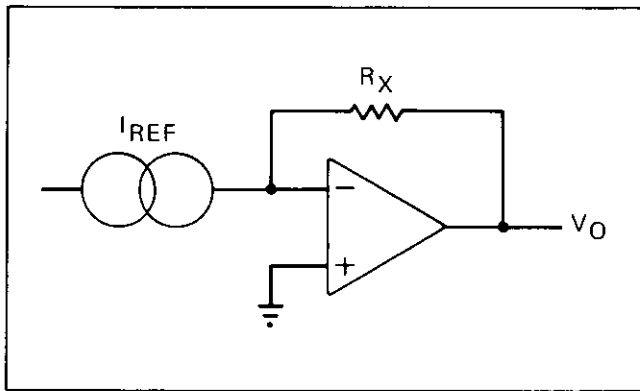


Figure 3-8. Low Ohms Measurement

3-83. With resistances $> 20.000 \text{ k}\Omega$, a voltage reference (V_{REF}) is used in lieu of the I_{REF} as shown in Figure 3-9. With a known reference resistor, the value of R_X can be computed from the formula $R_X = R_{REF} (V_O/V_{REF} - V_O)$.

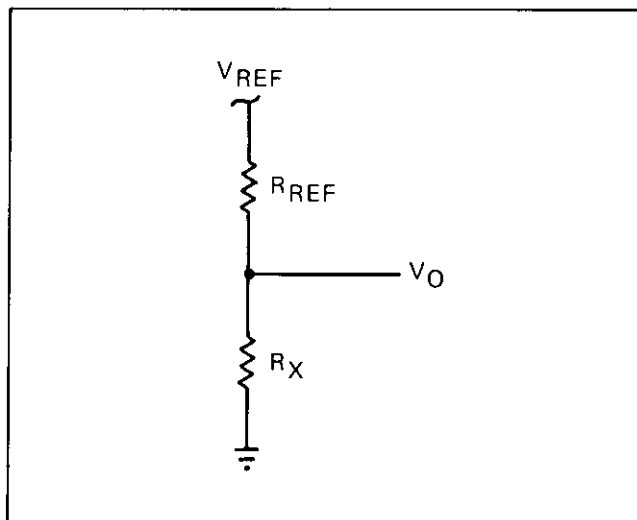


Figure 3-9. High Ohms Measurements

3-84. The output of the ohms amplifier is connected through the I/O Switching section to the DC Buffer and digitized in the A/D Converter. The gain of the DC Buffer varies with the range selected and is 64 for 10Ω , 1

for $10 \text{ M}\Omega$, and 100 nS ; and 8 for the remaining ranges. Once amplified and digitized R_X is computed using the formulas above.

3-85. Measurements of less than 20 kilohms are made using a precision current reference. Measurements of 20 kilohms, or greater, and conductance are made using a voltage reference. Each method is described in further detail below.

3-86. Low Ohms

3-87. An accurate reference voltage of -6.5V is input to U302 of the current source from the Analog A/D circuit. The 3.077 gain of the inverting op amp places $+20\text{V}$ at TP304 and on one side of the precision resistor network (R310, R313, R316). When the low ohms function is selected, that portion of the network applicable to the range selected is held at virtual ground so that $I_{REF} = 20\text{V}/R_{REF}$. The value of I_{REF} varies from 0.1 mA for the $10 \text{ k}\Omega$ range to 1.0 mA for the 1000Ω range with K301 energized, to 10 mA for the 100 and 10Ω ranges with K302 energized. On the three lowest ranges, the relay contact resistance, when taken with the lead resistance, could have a significant effect on I_{REF} . This error is counteracted by the feedback paths through Q305 for the 10 and 100Ω ranges and through Q306 for the 1000Ω range. This constitutes a Howland Current Source which theoretically offers infinite output resistance.

3-88. High Ohms

3-89. Resistances $\geq 20 \text{ k}\Omega$ and conductance measurements are made using a reference resistance and V_{REF} of 6.5 volts . The voltage reference is sampled by the I/O Switching section. This ensures that long term variations are removed whenever a high ohms range is selected. The reference resistance is $450 \text{ k}\Omega$ (R321 and R315) with K303 energized for the $100 \text{ k}\Omega$ range. For the 1M , 10M , and 100 nS ranges, K303 is de-energized to add R319 and R320 to the circuit and provide a reference of $4.5 \text{ M}\Omega$. Relay K304 is energized for all high ohms ranges.

3-90. Input Ohms Amplifier

3-91. The input ohms amplifier has a bi-polar differential input stage (Q309), an op amp (U303) and a large current sink capability with high voltage protection in the transistor array U301. The output is also protected by the positive temperature coefficient thermistor R101 and the zener diode CR105 in the I/O Switching section.

3-92. The input stage is protected by current limiting resistor R332, plus Q310 and Q311. If the input terminals are left open in low ohms, Q317, and the divider R113 (I/O Switching section), and R343 clamp the output voltage to less than 8 volts. It also opens the feedback path to the ohms amplifier. For a standby function, a feedback path is provided through a turned on Q308.

3-93. AC CONVERTER (8520A-1034)

3-94. The 8520A AC Converter is a true RMS Converter. It mathematically obtains the conversion by ranging the input to 1 volt full-scale signal, averaging the square value of the signal, and then taking the square root of the averaged squared signal.

3-95. The converter accepts signals from the input terminals through the I/O Switch and converts the signal to a dc level proportionate to the RMS value of the input. The dc output signal will be between zero volts and plus 16.5 volts (full scale reading). The signal is routed through five stages, which are: the ranging amplifier, balance amplifier, squaring amplifier, square root amplifier, and integrator/filter.

3-96. The range and balance amplifiers operate independently, but the remaining three work in conjunction with each other. The range amp brings the input signal within the 1V rms range. The balance amp converts the signal to a dc absolute value. The conversion to rms is performed by the squaring amp, integrator, and square root amp, using a double logarithmic response, i.e., $2 \log X = \log X^2$.

3-97. Range Amplifier

3-98. The range amplifier is an inverting amplifier with four user selectable ranges. They are, at full scale, 2, 16, 128, and 1024 volts (limited to 650V rms or 1000V peak for safety). The three higher ranges are multiples of eight (2^3) for simpler microprocessor implementation in ranging. A full scale output of the range amp is 1 volt.

3-99. Either AC or AC plus DC can be accepted in the range amp. C401 normally blocks dc. However, if the AC + DC function is selected, K401 is energized to bypass the capacitor. FET switches Q401 through Q409, and Q421 are turned on by the Analog Controller in the sequence shown in the chart on the schematic diagram.

3-100. Using the 100V range as an example, the schematic chart shows that FETs Q403, Q404, and Q421 are enabled, and the remaining Range Amplifier FETs are disabled. Q403 and Q404 are enabled to route the input signal through the 100V attenuation circuit prior to application to U401. Q421 is enabled to ground out any stray capacitance from the 10V range.

3-101. Amplifier U401 uses both feedback and summing node shunt capacitance to provide for stable operation as an adjustment of high frequency gain. The stray capacitance of the FET switches also provides stability to the amplifier on the 1 volt range. Failure of one of the stabilizing capacitors could result in oscillation within that range.

3-102. All dc adjustments of the Range Amplifier are normalized to the 1 volt range adjustment (R487). The frequency adjustments and capacitive adjustments are normalized to the 1000 volts range adjustment (R438).

3-103. Balance Amplifier

3-104. The balance amp is a precision halfwave rectifier in an inverting unity-gain configuration. It consists of U402 for the gain, and the dual transistor transconductance drivers Q410 and Q411 for fast switching of the rectifier diodes. The current is forced through the hot carrier diodes CR405 or CR406 and through either R454 or R456, as determined by the polarity of the signal. The output of the balance amplifier can be viewed at TP403.

3-105. Squaring Amplifier

3-106. Outputs of the range amp and balance amp are summed at the input of the squaring amp (U403). The op amp output (J419) represents twice the natural logarithm of the summed current input. The squaring is accomplished using the forward biased PN junctions of a transistor (Q414A, Q415B) and the inverse result from Q415A, as controlled by the output of the Square Root amplifier. Q414 and Q415 are dual transistors designed to provide logarithmic conformity and good frequency characteristics. They are placed in the circuit so their offsets cancel, allowing a tighter gain adjustment with R481. High frequency stabilization between 300 kHz and 1 MHz is provided by R468 and C455.

3-107. Integrator/Filter

3-108. The integrator is a transfer impedance amplifier (U404) which produces a voltage at its output (J420) for a current input. The output of the squaring amp is acted on by the Integrator/Filter and Square Root amplifier to produce a dc voltage that is the RMS value of the signal at the input. The circuit has two selectable filters of 100/200 ms (fast) and 500/1000 ms (slow). The filters are switched on and off with the FET switches, Q416 through Q419. The slow filter is switched in with Q416 and Q417, and the fast filter is switched in with Q418 and Q419. The filter is a three-pole filter with the FET switches shifting the poles lower in frequency (slow) or higher (fast).

3-109. Square Root Amplifier

3-110. The square root amp (U405) operates in conjunction with the integrator in performing the square root function. The squaring amp provides the current drive for Q415A, which is the current source for the integrator. The square root amp is in the feedback loop of the integrator. Any signal at the output of the integrator affects both the square root amplifier and the integrator. The output voltage of the square root amp (TP404) is the natural logarithm of the current through R483.

3-111. Stability for the overall loop is provided by C446. Diode CR408 and R482 prevent the circuit, i.e., square root amp and integrator, from latching.

3-112. Feedforward Temperature Compensation (FTC) Circuit

3-113. The FTC circuit (U408) is not in the signal path for the ac measurement. It is used to correct for dc drift in the balance (U402) and squaring (U403) amplifiers. The result is the excellent high frequency performance of the ac converter while maintaining dc performance.

3-114. A/D CONVERTER (8520A-1035)

3-115. The A/D Converter uses Fluke's patented Recirculating Remainder (R²) method of converting a dc input signal into a binary, byte-serial, data stream. Operation of the A/D Converter is controlled by the microprocessor in the Analog Controller. The converter consists of five sections, which are: the reference circuit, the polarity detector, the automatic zero, the current ladder, and the X and Y remainders. A sample is generated when five passes through the ladder network have been executed, resulting in 21 bits of binary data. It requires 1.77 ms to complete the five passes (one sample) in the high speed mode.

3-116. The Reference circuit (U501, U502, U503, and associated components) provides a 6.5 volt reference to the current ladder. The reference varies in polarity as the inverse of the input. In some units U501 is replaced with a Ref Amp PCB Assembly (schematic 8520A-1045 or 8520A-1046) that plugs into the Analog Assembly in place of U501. Operation of the ref amp circuit is identical to the discrete component U501, and either may be used as a replacement.

3-117. The first step in the sample process is the autozero. The Analog Controller command makes "AZ" active on the gates of FET switches Q528 and Q532 to zero the circuit in preparation for a new input. When auto zero is complete, the Controller makes "G" and then "I" active to close FET switches Q529 and Q512, respectively. This allows the input to enter U506, which acts as a polarity detector.

3-118. The Reference circuit is assigned the opposite polarity from the input, based on a polarity decision made by the Analog Controller. The correct polarity reference voltage is applied to the current ladder. Each branch of the current ladder has twice the resistance of the succeeding branch, corresponding to the binary digits 8, 4, 2, 1, and 0.5. The microprocessor closes the FET switches in the ladder, one at a time, starting with Q521 as a pass is made through the ladder. If there is excess current from the ladder, it will flow in CR505. The FET switch remains closed, and the excess current is tried on the next switch in succession. If there is no excess current, or there is a current debt, current flows through CR506

and causes a polarity change in the ladder. The polarity change causes the Controller to re-open the FET switch and try the next switch in succession. The same process is repeated on the four remaining FET switches to complete the first pass. In most cases there is current remaining after the pass. Switch Q529 opens when the pass is complete and switch Q531 is closed by the controller to store the remainder in the "X" channel.

3-119. The remainder current flows in the loop around U505 where there is a voltage gain of 10, and is stored in C506 when switches Q526 and Q531 are closed by the Analog Controller. Once the remainder is stored, the Controller opens Q512, Q526, and Q531 and closes Q529 and Q525. This returns the current to the ladder with a current gain of 16, in comparison to the original remainder, which is required to continue the 8, 4, 2, 1, 0.5 conversion. Thus, an "error" of 0.5 on the first pass becomes an input of "8" on the next pass.

3-120. The procedure for a pass through the ladder is then repeated, substituting the "Y" channel for the "X" When the pass through the ladder is completed, Q524 and Q530 are closed for the gain in U504, and C505 stores the remainder. Then Q512, Q524, and Q530 open and Q523 closes to retrieve the remainder for another pass. The retrieve "X" switch, Q525, remains closed until Q524 and Q530 close to store the "Y" remainder.

3-121. The process alternates between the "X" and "Y" channels until the five passes through the ladder are complete. Each pass overlaps by one bit, to allow for correction of the bit switch closures that are in error. The analog controller then correlates the data into a three byte word, sends the sample for display, and prepares the circuit for the next sample.

3-122. An example using a DC Buffer output of -10.2 volts follows. The circuit is autozeroed, Q532 closes, then Q512 closes, and the reference voltage is set at +6.5 volts. Q521 turns on, and remains on. When the Controller closes Q519, a polarity change occurs, and the switch must be reopened. When Q517 is closed, it remains on. Like Q519, Q515 and Q513 are reopened. Thus, the "8" and "2" bits are on. The first pass ends, and there is a remainder of -0.2 volts which is stored in the "X" channel as a voltage of +2.0 volts. It is retrieved with a net gain of sixteen to appear equivalent to an input of -3.2 volts, and the process is repeated. This time only Q517 and Q515 remain closed, and there is again a remainder of -0.2 to be stored in the "Y" channel. The process is repeated three more times. However, the passes will be identical to the second, other than alternating storage channels.

3-123. To review the process, it begins with an autozero followed by setting the reference voltage. The next step is the first pass through the ladder. The remainder is amplified and stored and then sent through the ladder.

This is repeated for five passes and then the sample is sent to be displayed, and the cycle begins again for another sample.

3-124. ANALOG CONTROLLER (8520A-1036)

3-125. Range and function information from the Digital Controller is accepted by the Analog Controller, interpreted, and output to circuits on the Analog PCB. Some signals for the measuring circuits originate with the microcomputer in the Analog Controller. Each of the circuits within the Analog Controller are detailed below.

3-126. Guard Crossing Circuit

3-127. Data from the Digital Controller enters the circuit in serial form at pulse transformer U627. The resultant output fires the "single shot" U609 for a serial input to the UART U602. The data is processed, and output, as parallel data, to the controller bus.

3-128. Data originating in the Analog Controller is transmitted on the bus, in parallel to U602. Then it is translated to bit-serial format and output through U610 and U614 to the crossing and the Digital Controller.

3-129. Microcomputer

3-130. The microcomputer is a mask programmed one-chip microprocessor, complete with its integral RAM and ROM. Under the control of the program, as modified by interrupts from the digital controller, the microcomputer outputs data to the I/O circuits and the data bus.

3-131. Switch S601 is not installed in the circuit. An 8-pin dip socket is available to insert a four-pole dip switch, if desired, for use during troubleshooting. Jumpers may also be used to short across the socket pins when required. Switch 1 would be the two pins toward the front of the instrument if this method is used.

3-132. I/O Circuits

3-133. Data on the bus is latched in U603 and decoded in U604 to provide control signals to the UART U602 or

a strobe to one of the following latches or buffers: U607-9, U608-4, U611-1, 15, U612-1, U617-9, U618-11, U619-11, U620-11, and U621-11. Data from the bus is latched into or strobed through the applicable latch or buffer to transmit a command to another circuit or place data on the bus for the microcomputer.

3-134. Interrupt Circuit

3-135. Data on the bus (DB0-DB5) is latched into U607 on the decoded signal from the I/O circuit. A signal at U607-12 and U607-15 are ANDed with TBE and DAV, from the UART, respectively to generate an interrupt at wired OR U615 and at U601-6. The remaining signals at U607 provide enabling signals to monitor the UART S1 and EPE signals, the microcomputer T0 signal, and the trigger circuit.

3-136. Trigger Circuit

3-137. Guard crossing transformer U627 (pins 6, 8, 9, and 11) is bidirectional and receives trigger strobes from the Digital Controller. The interrupt circuit controls the output of the trigger at U608-9 to insure that a trigger interrupt does not interfere with a reading in progress. U608-13 is held low from U607-10 in the interrupt circuit to disable the latch when a reading is in progress. When the reading is complete, U607-10 goes high, enabling the latch to await the next trigger.

3-138. Reset Circuit

3-139. A reset signal is sent to the microcomputer from the Reset Circuit any time that power is applied or lost. Line voltage triggers the retriggerable one shot U609. The one-shot output, in conjunction with a low output at U605-4, enables the counter U605 and allow the line voltage to pulse the counter. When the count sets U605-4 high, the counter is disabled and stays that way until the one-shot U609 is not triggered. Removal of the constantly recurring pulses reset the counter, and the low going output resets U607 and gives a RESET signal to the microcomputer.

Section 4

Instrument Assembly/ Disassembly

4-1. INTRODUCTION

4-2. Each of the following procedures deals with the removal/replacement of a single item or feature from the instrument. They are listed in a disassembly sequence, however, all previous steps may not be required to obtain access to the desired part/assembly of the instrument. Reassembly can be accomplished by performing the steps of the applicable procedure in a logically reversed sequence.

4-3. TOP/BOTTOM COVER

4-4. Removal and replacement of both the top and bottom covers is accomplished in the same manner once the desired cover has been placed toward the operator for ready access.

1. Remove the three screws across the front edge of the cover.
2. Remove the three screws across the rear edge of the cover.
3. Lift the cover straight up, guiding it out of the grooves in the front and rear panels.

4-5. TOP ANALOG GUARD COVERS

4-6. The analog section has a top guard cover with access ports for the calibration adjustments. The top cover must be removed to gain access to the instrument compartment prior to beginning the procedure.

1. Remove the screws securing the top guard cover to the internal guard chassis.
2. Remove the side screws, one centered on each side, through the access ports.
3. Lift the rear end of the top guard straight up, then remove it from the instrument compartment

by moving it toward the rear to clear the lip on the front of the compartment.

4-7. INTERNAL GUARD COVERS

4-8. The analog assembly has two internal guard covers. One is located over a portion of the AC Converter, and the other over part of the DC Buffer. In both cases, the top cover and the top analog guard cover must be removed to gain access to the internal guards. Separate procedures are given for removing each of the guard covers.

4-9. DC Buffer Guard

1. Press upward on the side of guard at the front right corner until it releases from the studs.
2. Lift the guard up and toward the center of the instrument to clear the wiring harness along the side of the guard.

4-10. AC Converter Guard

1. Press upward on the side of the guard at the front left corner until it releases from the studs.
2. Lift the guard up and away from the enclosed components.

4-11. FRONT PANEL DISPLAY ASSEMBLY

4-12. The Front Panel must be removed to gain access to the Display Assembly and its components. To reach screws required for removal, the top cover must be removed. Removal of the top analog guard cover is not required but removal does improve access to the screw heads.

1. Remove the two screws located on the rear upper corners, attaching the front panel to the frame.

2. Using both hands, squeeze the top and bottom of the panel together to clear the tabs holding the panel in place.
3. Once the panel is clear of the tabs, move the panel forward to clear the tabs.
4. Remove the wires connecting the front panel input connectors to the Analog Assembly using a pair of needle-nose pliers.

NOTE

To facilitate the replacing of wires on terminals during assembly, the color code is molded into the panel next to each terminal.

5. Disconnect the ribbon cable connecting the Display Assembly to J11 on the Digital Assembly.
6. Remove the four screws securing the Display Assembly to the frame and lift the assembly clear of the instrument.

4-13. ANALOG ASSEMBLY

4-14. Remove the Analog Assembly from the instrument compartment using the following procedure. Prior to starting, the top cover, the top analog guard cover, and either the front panel or the five wires to the front panel input terminals must be removed.

1. Disconnect the ribbon cable connecting the Analog Assembly to the Digital Assembly.
2. Loosen the four retaining screws and remove the cover from the transformer and Transformer Assembly.
3. Disconnect the cable connecting the transformer to the Analog Assembly and take it back through the slot in the transformer compartment.
4. Remove the two screws attaching the rear input connector to the rear panel, then push the connector through the rear panel into the instrument compartment.
5. Remove the 11 screws securing the assembly to the instrument frame. Six of the screws are through the PCB to the bottom guard, and the other five fasten the hardware attached to the rear of the assembly to the rear panel.
6. Lift the rear of the assembly and move it out toward the rear of the instrument, exercising caution to prevent damage to the GUARD and

REAR INPUT switches that are attached to the front of the assembly.

4-15. TRANSFORMER AND TRANSFORMER ASSEMBLY

4-16. Remove the transformer and Transformer Assembly from the instrument compartment using the following procedure. Prior to starting, the top cover and the top analog guard cover must be removed from the instrument.

1. Loosen the four retaining screws and remove the cover from the transformer.
2. Disconnect the cable connecting the transformer and Analog Assembly from the Analog Assembly and bring the cable back through the center divider into the transformer compartment.
3. Remove the cable clamp from the transformer compartment frame.
4. Remove the eight screws attaching the transformer compartment to the frame. Four are used on the outside frame and four on the center frame.
5. Lift the transformer compartment containing the transformer and Transformer Assembly straight up and out of the instrument compartment.

4-17. DIGITAL ASSEMBLY

4-18. Remove the Digital Assembly from the instrument compartment using the following procedure. Prior to starting, the top cover, the transformer, and the Transformer Assembly must be removed from the instrument.

1. Disconnect one end of the guard crossing ribbon cable connecting the Analog and Digital Assemblies, and bring the cable through the slot in the center guard and frame.
2. Remove the three screws holding C201 to the outside frame.
3. Remove the three hex-head bolts and nuts securing the IEEE connector to the rear panel.
4. Disconnect the three input line-power wires from the lugs on the assembly.
5. Turn the instrument over, and remove the bottom cover from the instrument if not previously done.

6. Remove the five screws securing the Digital Assembly PCB to the tabs in the instrument compartment.

7. Lift up the front of the assembly and slide the PCB forward and out of the instrument compartment.

4-19. BOTTOM ANALOG SHIELD

4-20. Once all other assemblies have been removed from the instrument compartment, the bottom portion of the analog guard can be removed by taking out the three screws from the outside frame and the three from the center frame. Since this item is hardware with no active components, removal is seldom necessary.

Section 5

Troubleshooting

5-1. INTRODUCTION

5-2. Troubleshooting for the 8520A is contained in Tables 5-1 through 5-9, Figures 5-1 through 5-7, and in the following paragraphs. These tables are tabular flow charts that direct you to another step, as determined by the response to a decision step. If no decision is required perform the next step of the table in sequence.

5-3. The troubleshooting tables are built around the self tests incorporated into the software. However, the tables assume there is some response when the POWER switch is depressed by the Operator. If there is no response from the instrument use the Power On Procedure below before proceeding. If there is a response it may be an Error Code (the display shows "Err XX" with the "XX" representing a two character display). A list of these Error Codes and a brief explanation of each is given in Table 5-4. The tables cover procedures for troubleshooting the Front Panel, the Digital PCB, and the Analog PCB. Until you accumulate sufficient experience you should progress through the tables in sequence. You will either skip rapidly through the table or be referred to another table if the problem is not with the circuit covered.

5-4. POWER ON PROCEDURE

5-5. If the instrument does not respond to the power on command check the power supply test points (TP7XX on the analog pcb and TP201 on the Digital PCB) for the correct voltages as shown on Table 5-5, Typical Voltages and Waveforms. If all voltages are correct, continue with the Front Panel Troubleshooting, Table 5-1.

5-6. If all of the voltage tests are out of tolerance or absent, check the transformer primary inputs, i.e. the line cord, the fuse, the thermal fuse, the voltage selector switches and their settings, the line voltage outlet, the POWER switch, and the connectors to the Transformer PCB. If all of these are good check the transformer itself.

5-7. If part of the voltage tests are within tolerance check the secondaries and/or rectifier circuits for the failed tests. The Digital PCB Power Supply has an

adjustment and J201 can be removed to prevent any loading from the digital circuits. There are no adjustments on the Analog PCB Power Supply; however most of the circuits have jumper plugs that can be removed to insure the test does not fail due to loading by the circuits. Remove J19 from the Analog PCB to disable the DC Buffer and I/O Switching circuits, J20 for the Ohms Converter, J21 for the AC Converter, and J22 for the Analog Controller.

5-8. SPECIAL PROCEDURES

5-9. Special procedures are provided for testing the Analog Controller and A/D Converter circuits. The procedures are called out in the Analog PCB Troubleshooting tables when required.

5-10. Analog Controller Tests

5-11. Three test programs are available in the Analog controller microprocessor to test the digital functions of the Analog PCB. These tests may be an aid in troubleshooting the Analog Controller if the instrument consistently displays an error message, fails all steps of Math Program 1 Test #1 (the power supply outputs should be checked first), or consistently reads gross errors during measurements. Prior to beginning the microprocessor tests, the presence of the signals described in the first sub-paragraph below should be verified. An 8-pin dip switch must be installed in the empty S601 socket, next to the analog controller microprocessor, before any of the tests can be selected. In addition, the instrument input terminals must be "open" and the guard crossing cable disconnected. These conditions cause a front panel error display, which should be ignored during these tests. When the instrument operates as a voltmeter, the microprocessor does not check the status of S601; however, if TP607 is shorted to TP608, it resets the analog controller microprocessor and the switch status is "read". When the tests are completed, return the instrument to voltmeter operation by setting all of the switches on S601

to OFF, reconnecting the guard crossing cable, and shorting TP607 to TP608, which forces the microprocessor to check the status of S601. The selection method and operation of each of these tests are described below.

5-12. ANALOG CONTROLLER INPUT SIGNALS

5-13. Verify the presence of the following signals before testing the Analog Controller microprocessor:

1. Readings of -15V dc at TP603 and -20V dc at TP604 for a +5V dc logic signal.
2. A line frequency square wave at U614-4.
3. A 2 MHz square wave clock at TP605.
4. A pulse (ALE) approximately every 12.5 msec at TP602 (variable with the input line frequency).
5. A logic high reading (INT) at TP606.
6. A logic high that goes low at TP601 (RESET) when TP607 is shorted to TP608, and returns high approximately 400 ms (60 ms for a 400 Hz line frequency) after the short is removed.

5-14. LATCH TEST

5-15. This test applies a continuous circulating signal to a component selected by the S601 test switch. The microprocessor checks the status of S601 constantly during the Latch Test to determine which component receives the signal. The output of the selected component can be monitored with an oscilloscope or logic probe. Use the following procedure to perform the latch test:

1. Insure S601 is installed and the guard crossing cable is disconnected.
2. Set switch #1 of S601 to ON and the remaining switches to OFF.
3. Short TP607 to TP608 to reset the Analog Controller.
4. Select the component to be exercised by setting S601 to the position indicated in Table 5-10.
5. Observe the output pins of the selected component for a recurring pulse.

NOTE

An oscilloscope setting of 5 volt/div and 50 us/div should give a display of the recurring pulse.

6. Set the switches on S601 for either the next test or all OFF (to resume voltmeter operations), then short TP607 to TP608 to reset the Analog Controller and make it "read" the switch setting.

5-16. UART TEST

5-17 The UART test checks the response from the transmitted data. Before each test a byte of data is written

into Port 1 (U601-27 through 34). An incorrect response stops the test and the failed step can be determined by reading the data byte in Port 1. If the test fails, all of the data bits in the port are at a constant state. If the test passes the test is continuously repeated and the three low order bits are changing states constantly. Use the following procedure to perform the UART test:

1. Insure S601 is installed and the guard crossing cable is disconnected.
2. Set switch #2 on S601 to ON and the remaining switches to OFF.
3. Short TP607 to TP608 to reset the Analog Controller.
4. Monitor the status of Port 1 for a constant level, i.e. either always high or always low, on all eight bits of the port.
5. If the three low order bits (U601-29,28,27) are constantly changing states the instrument passes the test. If all eight bits are at a constant level the controller is locked on the failed test and the missing signal can be identified by decoding the three bits using Table 5-11. Once the missing signal has been identified refer to the UART and Interrupt Troubleshooting Procedures paragraph that follows the Interrupt Test.
6. Set the switches S601 for either the next test or all OFF (to resume voltmeter operations), then short TP607 to TP608 to reset the Analog Controller and force it to "read" the switch setting.

5-18. INTERRUPT TEST

5-19. The Analog Controller microprocessor generates a DAV and an external trigger interrupt for use within the instrument. They are tested in a series of six steps, with a byte of data written into Port 1 (U601-27 through 34) at the beginning of each step. If the step fails the byte is locked into Port 1 and it can be decoded to determine the failed step. If the test passes it is continuously repeated and the four low order bits are constantly changing states. Use the following procedure to perform the interrupt test:

1. Insure S601 is installed and the guard crossing cable is disconnected.
2. Set switch #4 of S601 to ON and the remaining switches to OFF.
3. Short TP607 to TP608 to reset the Analog Controller.
4. Monitor the status of Port 1 for a constant level, i.e. either always high or always low, on all eight bits of the port.
5. If the four low order bits (U601-30,29,28,27) are at changing level the instrument passes the test. If all eight bits are at a constant level the controller is locked on the failed test and the missing signal can

be identified by decoding the four bits using table 5-12. Once the missing signal has been identified refer to the UART and Interrupt Troubleshooting Procedures paragraph that follows this test.

6. Set the switches on S601 for either the next test or all OFF (to resume voltmeter operations), then short TP607 to TP608 to reset the Analog Controller and force it to "read" the switch setting.

5-20. UART AND INTERRUPT TROUBLESHOOTING PROCEDURES

5-21. Once the missing signal has been identified the tests in Table 5-13 can be used to locate the defective component(s). The table lists only the pertinent IC's; however, associated components should be checked at the same time. Check for missing components, improper values, defective components, shorted inputs or outputs, bent legs that could produce capacitive coupling (CMOS) or thermal problems, shorted bus lines, or lines shorted to logic common or logic ground. Repair or replace the defective component(s) when located then repeat the test during which the fault was found.

5-22. A/D Converter Test

5-23. The A/D Converter test permits the examination of the A/D ladder during a conversion. A known voltage is applied to the terminals and the output monitored for a waveform that can be translated to a digital number corresponding to the most significant digit of the input. Use the following procedure to perform the A/D Converter test:

1. Prepare the instrument for normal operation. Select Volts DC and fix the range at 10 Volts.

2. Apply a known input >0 and <0.2 volts from a variable source to the input terminals.

3. Using a dual trace oscilloscope connect one trace to TP509 for sync and observe the waveform at TP508 with the other.

4. The waveform at TP508 can be decoded to the digital value of the most significant digit. It represents values of 8, 4, 2, 1, and 0.5. In this case all should be high, as shown for 0 volts in Figure 5-8.

5. Vary the source to a known input >1.0 and <1.2 volts.

NOTE

The input must be read by the 8520A as >1 to insure data in the one bit but <1.5 (approximately) to keep data from the 0.5 bit. An input of 1.1 volts insures the correct digital value.

6. The waveform at TP508 changes to that shown in Figure 5-8 for 1 volt.

7. Rotate the source through the remaining voltages in Figure 5-8. Insure the input is greater than the basic so the tolerance of the instrument does not put the input below the basic value.

8. Verify the waveform representing the digital count at TP508 is correct for each input voltage.

9. If the waveform is incorrect for any input check that portion of the ladder.

Table 5-1. Front Panel PCB Troubleshooting

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
	<i>NOTE</i> <i>All tests are made in relation to ∇ at TP6 unless otherwise noted.</i>		
1	Disconnect the instrument from any external controller.		
2	Depress the POWER switch to apply power to the instrument.		
3	Does any portion of the Display or any indicator illuminate?	17	4
4	Is VUNREG present at TP7 ($\approx 8V$)?	5	15
5	Are there recurring strobe pulses at U7-11?	7	6
6	Check U7 and its inputs from the digital PCB. Replace or repair as required then resume at step 3.		
7	Is there approximately 4.1V present at TP4. (VUNREG less the 3.9V drop of Zener CR1.)	9	8
8	Check Zener diode CR1 and R2. Repair as required then resume at Step 3.		
9	Is U1-1 High?	10	15
10	Does U1-11 toggle?	11	15

Table 5-1. Front Panel PCB Troubleshooting (cont)

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
11	Is Vcc1 present at TP5 ($\approx 5V_{dc}$)?	12	15
12	Does at least one input data line (D0-D7) toggle?	13	15
13	Do all the outputs of U1 toggle?	16	14
14	Check U1 and RN1. Repair or replace as required then resume at step 3.		
15	Check the connector, cable, and output from the Digital PCB. Repair as required the resume at step 3.		
16	If all the above checks are good, but none of the display segments are illuminated it indicates a massive failure, i.e. two or more components. Check combinations that would effect both the 7-segment and 14-segment displays, e.g. U2 and U3, etc. Repair as required then resume at step 3.		
17	Is the REMOTE indicator illuminated?	18	19
18	Check for an invalid \overline{REMOTE} input from the Digital PCB. Repair as required then resume at step 17.		
19	Select Math Program #1 (TEST), Test #3 (Key & LED Tests). Push RESET one time to select the first step of the LED test, i.e. all Segments and indicators illuminated.		
20	Does the display have the same segment blank in all 7-segment displays?	21	26
21	Do all outputs of U9 toggle?	23	22
22	Check U9 and its inputs from the digital PCB. Repair as required then resume at step 19.		
23	Do all inputs to U10/U11 toggle?	25	24
24	Check U21, CR2 and RN3. Repair as required then resume at step 19.		
25	Check for a constant low output from U10/U11. Repair as required then resume at step 19.		
26	Does the display have the same segment blank in all four sections of the two dual 14-segment displays?	27	32
27	Do all outputs of U12 toggle?	29	28
28	Check U12 and its inputs from the digital PCB. Repair as required then resume at step 19.		
29	Do all inputs to U23/U24 toggle?	31	30
30	Check U22 and RN6. Repair as required then resume at step 26.		
31	Check for a constant low output from U23/U24. Repair as required then resume at step 19.		
32	Is one 7-segment display digit and/or one half of a 14-segment display blank?	33	34
33	Check that the output from U2/U3 and U1 that drives that segment or segments toggles. Repair as required then resume at step 19.		
34	Is one segment in one display blank?	35	36
35	Replace the affected LED. If the problem is not corrected check the land pattern leading to the affected LED. Repair as required then resume at step 19.		
36	Depress RESET one time to advance the display.		
37	Do any segment(s) still glow, except the decimal point of the first digit?	38	39
38	Check U5. Repair as required then resume at step 19.		
39	Depress and release the RESET key switch for each step to sequence through every segment of the 7-segment and 14-segment display.		
40	Does more than one segment of the display illuminate during any single step of the sequence?	41	42

Table 5-1. Front Panel PCB Troubleshooting (cont)

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
41	Check the transistor arrays U10, U11, U23, and U24. Repair as required then resume at step 39.		
42	Depress any Keyswitch except SHIFT to go to the Key portion of Program #1, Test #3.		
43	Sequence through the keys checking for the indication shown in Table 5-6.		
44	Are all indications correct?	50	45
45	Does at least one indicator illuminate?	47	46
46	Check U6-1/15 for a strobe, check the outputs of U5 for a toggling signal, and check the inputs to U6 with the applicable switch depressed for a pulse. Repair or replace as required then resume at step 42.		
47	Are the indicators correct for the keyswitches that have a display?	48	49
48	Check for a row signal on the switches affected from U5. Repair as required then resume at step 42.		
49	Check U6 for incorrect test indications. Repair as required then resume at step 42.		
50	The Front Panel troubleshooting is complete.		

Table 5-2. Digital PCB Troubleshooting

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
1	This test of the Digital PCB assumes that the instrument either does not operate correctly, or if the readings are incorrect an attempted Calibration Procedure was unsuccessful. <i>NOTE</i> <i>All measurements made during the procedure are in reference to TP2 (TP10 alternate), unless stated otherwise.</i>		
2	Is the Front Panel Display illuminated?	21	3
3	Is +5V dc present at TP1 (Vcc)?	7	4
4	Is Vunreg (approx 8V) present at J12-3,6 (or Front Panel TP7)?	5	6
5	Check U202 and its associated circuitry. Repair as required then resume at step 2.		
6	Check the rectifier CR1/CR2, the filter on the Transformer PCB A4, and the transformer T201. Repair as required then resume at step 2.		
7	Is there a high logic level at TP3 ($\overline{\text{RESET}}$)?	9	8
8	Check the RESET circuit U22, U28, U36, U23, and their associated components. Repair as required then resume at step 2.		
9	Is there a 4 MHz clock at TP7?	11	10
10	Check Y1 (8 MHz crystal), U19, U20, and their associated components. Repair as required then resume at step 2.		

Table 5-2. Digital PCB Troubleshooting (cont)


STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE																						
		YES	NO																					
	<i>NOTE</i> <i>An active signal, as used in the remainder of these tests, means a constantly changing logic level, changing levels at a rate that makes it difficult to interpret the data.</i>																							
11	Is there an active signal present at TP6 ($\overline{\text{INT}}$)?	13	12																					
12	Check U17 and its enabling Interrupt inputs. These include the Phase Lock Loop circuit through U35, DR from the UART through U33-2, and IEEE INTR from the IEEE circuit through U34-12. Repair as required then resume at step 2.																							
13	Check the following microprocessor signal points for an active signal: <table style="margin-left: 40px; border: none;"> <tr> <td>TP5</td> <td>$\overline{\text{M1}}$</td> <td>(Output)</td> </tr> <tr> <td>TP8</td> <td>$\overline{\text{WAIT}}$</td> <td>(Input)</td> </tr> <tr> <td>U18-20</td> <td>$\overline{\text{IOREQ}}$</td> <td>(Output)</td> </tr> <tr> <td>U18-19</td> <td>$\overline{\text{MEMREQ}}$</td> <td>(Output)</td> </tr> <tr> <td>U18-28</td> <td>$\overline{\text{RFSH}}$</td> <td>(Output)</td> </tr> <tr> <td>U18-21</td> <td>$\overline{\text{RD}}$</td> <td>(Output)</td> </tr> <tr> <td>U22</td> <td>$\overline{\text{WR}}$</td> <td>(Output)</td> </tr> </table>	TP5	$\overline{\text{M1}}$	(Output)	TP8	$\overline{\text{WAIT}}$	(Input)	U18-20	$\overline{\text{IOREQ}}$	(Output)	U18-19	$\overline{\text{MEMREQ}}$	(Output)	U18-28	$\overline{\text{RFSH}}$	(Output)	U18-21	$\overline{\text{RD}}$	(Output)	U22	$\overline{\text{WR}}$	(Output)		
TP5	$\overline{\text{M1}}$	(Output)																						
TP8	$\overline{\text{WAIT}}$	(Input)																						
U18-20	$\overline{\text{IOREQ}}$	(Output)																						
U18-19	$\overline{\text{MEMREQ}}$	(Output)																						
U18-28	$\overline{\text{RFSH}}$	(Output)																						
U18-21	$\overline{\text{RD}}$	(Output)																						
U22	$\overline{\text{WR}}$	(Output)																						
14	Are all points active?	16	15																					
15	Check for a WAIT input from U33-4 (IEEE WAIT) and U33-5 (U9 circuit with M1 input). If any of the remaining signals are incorrect check the microprocessor U18 (substitution is normally the best method of checking the microprocessor). Repair as required then resume at step 2.																							
16	Is there a high logic level at U18-17 ($\overline{\text{NMI}}$)?	18	17																					
17	Check U1 and its associated components. Repair as required then resume at step 2.																							
18	Is U19-8 ($\overline{\text{DISPLAY BLANK}}$) at a high level?	20	19																					
19	Check U21, U19, U25, and their controlling inputs. Repair as required then resume at step 2.																							
20	Refer to the Front Panel Troubleshooting Table. Repair as required then resume at step 2 of this procedure.																							
21	Perform Math Program #1, Test #2.																							
22	Does the Front Panel display PASS DGTL only?	33	23																					
23	Is Err 14 ROM displayed during the test?	24	25																					
24	Check the decoder U3. Repeat test #2 while checking the data and address lines of U10, U11, and U12 for an active state. Repair as required then resume at step 21.																							
25	Is Err 15 RAM displayed during the test?	26	27																					
26	Check the decoder U2. Repeat test #2 while checking the data and address lines of U4 through U7 for an active state. Repair as required then resume at step 21.																							
27	Is Err 17 HDWR displayed during the test?	28	21																					
28	Perform Math Program #1, Test #4. <i>NOTE</i> <i>This test program constantly sends a hex 40 (0100 0000) across the guard crossing from the digital microprocessor to the analog microprocessor, and back to the digital microprocessor. This is in addition to the sequential signal sent to the display.</i>																							
29	Is the waveform reproduced below present at U26-20 (UART SI)? 	31	30																					

Table 5-2. Digital PCB Troubleshooting (cont)

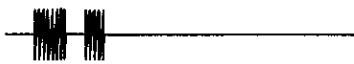
STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE													
		YES	NO												
30	Is the waveform above present at U26-25 (UART SO)?	31	32												
31	Check the UART U26, the address and data lines, and the microprocessor U18. Repair as required then resume at step 21.														
32	Proceed through the guard crossing circuit checking the waveform at each component. The waveform should be similar to the one shown below, i.e. the data level a burst of ac; however, the base line level will vary between components due to inverting gates or circuits. Check the signal at U30-4, U37-5, and U38-14 on the digital PCB; U627-3, U602-20, U602-25, U614-12, U610-3, and U627-9 on the Analog PCB; and U38-6 and U36-4 on the digital PCB. If the signal goes into the analog UART but does not come out refer to the Analog PCB troubleshooting table. Repair as required then resume at step 21.														
															
33	Does an attempted measurement reading result in an Err 3(X) UART or Err A(X) GARD display?	34	37												
34	Check the phase lock loop for the proper signals for the actual input line voltages.														
	<table border="0"> <tr> <td>Line Freq</td> <td>U29-14</td> <td>U29-4</td> </tr> <tr> <td>50 Hz</td> <td>50 Hz</td> <td>400 Hz</td> </tr> <tr> <td>60 Hz</td> <td>60 Hz</td> <td>480 Hz</td> </tr> <tr> <td>400 Hz</td> <td>57 Hz</td> <td>457 Hz</td> </tr> </table>	Line Freq	U29-14	U29-4	50 Hz	50 Hz	400 Hz	60 Hz	60 Hz	480 Hz	400 Hz	57 Hz	457 Hz		
Line Freq	U29-14	U29-4													
50 Hz	50 Hz	400 Hz													
60 Hz	60 Hz	480 Hz													
400 Hz	57 Hz	457 Hz													
35	Are the signals correct for the input line voltage?	37	36												
36	Check U29, U28, U32, U23, and their associated components. If the problem is not in the Phase Lock Loop check the UART circuit beginning at step 28. Repair as required then resume at step 33.														
37	Is the instrument used in an IEEE system?	38	46												
	<p><i>NOTE</i></p> <p><i>The assumption is made at this time that the instrument can be controlled, and responds correctly, to local commands from the From Panel. Accuracy of the instrument has not, as yet, been verified.</i></p>														
38	Connect the instrument to an IEEE Bus and address it from the Bus Controller.														
39	Does the front panel REMOTE indicator illuminate?	41	40												
40	Verify the LED and R1 are good, and that voltage is present on the front panel, then check U8. Repair as required then resume at step 38.														
41	Does the instrument correctly respond to IEEE commands?	46	42												
42	Depress Front Panel Local and then the Front Panel RESET switch twice in rapid succession to reset the instrument and observe the Front Panel Display for the correct IEEE address as set on the IEEE Address switches.														
		45	44												
43	Is the correct address displayed?														
44	Check for the following signals: ASE to pulse with the reset, the Data Bus lines, the 1 MHz clock, M1, WR, IOREQ, IEEE WAIT, and IEEE ADDR are active. Check U102, S103, and RN101 for address errors or incorrect data lines. Check U103 through U106 and their associated components for problems in the other lines. If the above signals are correct check U101. Repair as required then resume at step 38.														

Table 5-2. Digital PCB Troubleshooting (cont)

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
45	Give a command from the system controller while checking gates U107 through U110 for the same response, observing the correct signal flow direction (U108 through U110 are bi-directional). If the signals respond correctly check U101. These components can be checked by substitution or with a static bus controller (e.g. the Ziatech ZT-488). Techniques for troubleshooting using static bus controllers are explained in Fluke TB-13. Repair as required then resume at step 38.		
46	Test of the Digital PCB is complete. If readings are incorrect check the Analog PCB using the Analog Troubleshooting Table.		

Table 5-3. Analog PCB Troubleshooting

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
	<i>NOTE</i>		
	<i>The test in this table assumes that the instrument responds to front panel commands and the fault is one of incorrect readings rather than a massive failure. A calibration adjustment procedure should be attempted prior to troubleshooting.</i>		
1	Remove any leads connected to the instrument input terminals.		
2	Select Math Program #1 (TEST), Test #1 (Analog).		
3	Step completely through the test, recording the number of any sub-tests that fail.		
4	Did any sub-test fail?	5	14
5	Did only one sub-test fail?	9	6
6	Compare the numbers of the failed sub-tests against the examples given in Table 5-7, comparing for a duplicate failure pattern.		
7	Does the failure pattern match one of those in the table?	8	9
8	Check the component indicated and its associated circuitry. Repair or replace as required then resume at step 2.		
9	Check the Analog Controller Output latches for the test(s) that failed using the applicable line(s) of Table 5-8.		
10	Are the latches in the states listed for that sub-test in the table?	13	11
11	Perform the analog controller latch test described in the Troubleshooting Paragraph.		
12	Do all the latches perform as required?	13	8
13	Trace the analog signal for the failed subtest through the applicable circuit(s) using the simplified schematics in Figures 5-1 through 5-7, and the typical test point voltages and Waveforms in Table 5-5. If the trouble is isolated to the Analog Controller or A/D Converter refer to the tests in the text portion of the troubleshooting section. Repair as required then resume at step 2.		
14	Is the trouble in low ohms (<20 Kohms)?	15	18

Table 5-3. Analog PCB Troubleshooting (cont)

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
15	Check the low ohms circuit using Table 5-9.		
16	Are all circuit indications as shown in the Table?	18	17
17	Trace the signal path for the failed low ohms test through the circuit using Table 5-5, typical Voltages and Waveforms. Repair as required then resume at step 15.		
18	Perform the Calibration Adjustment procedure given in Section 6 of the 8520A Calibration Manual.		
19	Can the Calibration Adjustment procedure be successfully completed?	21	20
20	Trace the defective adjustment circuit using the typical voltage and waveform in Table 5-5 and the schematics. Repair as required then resume at step 18.		
21	Troubleshooting the analog circuits is complete.		

Table 5-4. Error Codes

ERROR	DISPLAY	EXPLANATION
00	Blank	No Errors
01	Err01 HV	High Voltage present with ohms function selected
02	None	Syntax error during remote operation
03	Err03 NOVR	Numeric or register overflow
03	Err03 RTD	Failure of RTC algorithm to coverage
04	Err04 KEY	Invalid use of a control
05	Err05 FLTR	Cannot increase filter in ASYNC reading rate
06	Err06 ZERO	ZERO (Math Program #2) cannot be selected with the VAC or VA+D function
07	Err07 IEEE	IEEE-488 input buffer overflow
08	or VXRF	External Reference input $> \pm 16.5V$ dc with Math Program #3 selected
09	ur VXRF	$\pm 0.5V$ dc difference between EXTERNAL REFERENCE HI and LO terminals with Math Program #3 selected.
10	HHHHH (function)	Normal input overrange
11	Err11 HDWR	Improper echo from A/D Microprocessor
12	rrtoo FAST	Reading rate too fast for selected filter and/or Math Program
14	Err14 ROM	ROM checksum error
15	Err15 RAM	RAM does not check out
16	Err16 LINE	Cannot determine line frequency at POWER ON
17	Err17 HDWR	Sync failure between the microprocessor and the A/D Converter
18	OPen INPUT	V/ Ω INPUT terminals not open during Analog Test (Math Program #1)
22	Err22 HDWR	Error while measuring volts for ohms change
23	Err23 HDWR	Time error, incorrect response from A/D Converter
24	Err24 HDWR	Resync error: instrument controller to A/D Converter
25	Err25 HDWR	Ohms Reference Error
30	Err30 UART	No A/D response to microprocessor within time limits
31	Err31 UART	Microprocessor detects parity error
32	Err32 UART	Microprocessor detects overrun error
33	Err33 UART	Parity and overrun errors (Error Codes 31 & 32)

Table 5-4. Error Codes (cont)

ERROR	DISPLAY	EXPLANATION
34	Err34 UART	Microprocessor detects framing error
35	Err35 UART	Parity and framing error (Error Codes 31 & 34)
36	Err36 UART	Overrun and framing errors (Error Codes 32 & 34)
37	Err37 UART	Parity, overrun, and framing errors (Error Codes 31, 32, & 34)
A1	ErrA1 GARD	Undefined interrupt at A/D
A3	ErrA3 GARD	Analog interrupt activated
A5	ErrA5 GARD	Parity, overrun, or framing error at A/D
A7	ErrA7 GARD	Illegal command at A/D

Table 5-5. Typical Voltages and Waveforms

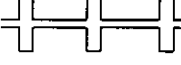
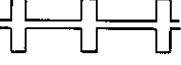

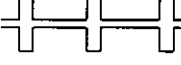
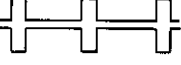


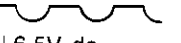
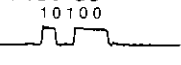
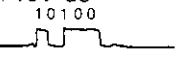
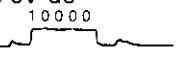



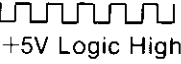

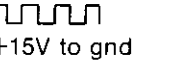
HI TP	LO TP	HI MNEMONIC	TYPICAL READING/WAVEFORM W/INPUT			REMARKS
			10V dc	10V ac @ 400 Hz	1K Ω	
		Analog				
102	103	DC INPUT	+10V dc	N/A	-1V dc	
104	103	MUX OUT	+10V dc	+10V dc	-1V dc	
202	207	BUF INP	+10V dc	+10V dc	-1V dc	
204	207	MEAS				Peak \approx 2V + input V Base \approx -.5V + input V
205	207	ZERO				
206	207	BUF OUT	+10V dc	10V dc	+8V dc	
Q227-5	207		+12 \pm 2V dc	+12 \pm 2V dc	+10 \pm 2V dc	
Q234-5	207		+12 \pm 2V dc	+12 \pm 2V dc	+10 \pm 2V dc	
304	302	20V	N/A	N/A	20V dc	
305	302	0V	N/A	N/A	0V dc	
306	302	SRLO	N/A	N/A	-1.3V dc	
U403-7	402	+8V	N/A	+8.0V dc	N/A	
U403-4	402	-8V	N/A	-8.0V dc	N/A	
401	402	AC INP	N/A	10V dc	N/A	
403	402	BAL OUT	N/A		N/A	Peak \approx 0.9V above baseline
404	402	SQ RT	N/A	-0.57V dc	N/A	
405	402		N/A		N/A	Peak \approx 0.9V below baseline
502	501	+V _{REF}	+6.5V dc	+6.5V dc	+6.5V dc	
503	501	-V _{REF}	-6.5V dc	-6.5V dc	-6.5V dc	
505	501	A/D INPUT	+10V dc	+10V dc	+8V dc	
508	501	INT OUT				Dependent upon A/D Input Synced to TP 509
603	604		+5V Logic High			-15V to gnd
602	604	\overline{ALE}				PERIOD = 2.5 μ S
605	604	2 MHz				2 MHz Clock
606	604	\overline{INT}	+5V Logic High	+5V Logic High	+15V to gnd	-15V to gnd
601	604	\overline{RESET}	+5V Logic High	+5V Logic High	+5V Logic High	-15V to gnd
703	705	+27V	+27.6 \pm 1.1V dc	+27.6 \pm 1.1V dc	+27.6 \pm 1.1V dc	
704	705	+15V	+15 \pm 0.6V dc	+15 \pm 0.6V dc	+15 \pm 0.6V dc	
706	705	-15V	-15 \pm 0.6V dc	-15 \pm 0.6V dc	-15 \pm 0.6V dc	
707	705	-27V	-27.6 \pm 1.1V dc	-27.6 \pm 1.1V dc	-27 \pm 1.1V dc	
701	702	-15 LH	+5 +0.2/-0.1V dc	+5 +0.2/-0.1V dc	+5 +0.2/-0.1V dc	-15V High -20V Low

Table 5-5. Typical Voltages and Waveforms (cont)

HI TP	LO TP	HI MNEMONIC	TYPICAL READING/WAVEFORM W/INPUT			REMARKS
			10V dc	10V ac @ 400 Hz	1KΩ	
		Digital				
1	2	Vcc	+5+0.2/-0.1V dc			
3	2	RESET	+5V Logic High			
4	2		+5V Logic High			
5	2	MI				
6	2	INT				
7	2	φ				
8	2	WAIT				
101	013	IEEE ENABLE				
102	103	IEEE TRIGGER	Logic Low			
201	202	Vcc	+5 +0.2/-0.1V dc			

1 ms
-1 μs

Table 5-6. Keyswitch Test

KEYSWITCH			
VDC (+/-)	D	DP	
VAC (7)	C	DP	
Ω2 WIRE (8)	DP	E	
Ω4 WIRE (8)	G	E	
nS (CE)	F	E	
PROGRAMS IN USE/OFF	E	E	
STATUS (MENU)	G	G	
BURST SIZE	F	G	
BURST LOCATION	E	G	
AUTO RANGE (.)	D	G	
▲RANGE (4)	C	G	
▼RANGE (5)	DP	D	
EXT/AUTP TRIGGER (6)	G	D	
ARM BNC TRIGGER (EXP)	F	D	
MANUAL TRIGGER	E	D	
PROGRAM SELECTION	F	F	
PROGRAM DATA	E	F	
READING RATE ▲(0)	D	F	
READING RATE ▼(1)	C	F	
FILTER ▼(2)	DP	C	
FILTER ▲(3)	G	C	
LOCAL(/)	F	C	
AT the Same Time:			
SHIFT and PROGRAM SELECTION	G and F	F	
AT the Same Time:			
RESET and nS (CE)	D and F	E	

Table 5-7. Analog Test Failure Patterns

FAILED TEST															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
			X												
X		X	X												
	X			X											
		X			X	X									
			X	X	X	X	X				X	X	X	X	
		X	X	X	X							X	X	X	
						X				X					
							X	X	X	X	X	X	X	X	X
							X				X				
								X				X			
									X				X		
										X				X	

K102 remains energized
 K102 does not energize
 DC Buffer X1 amplifier
 DC Buffer X8 amplifier
 DC Buffer X64 amplifier
 Reference Voltage, R321, K103 remains energized, K101 does not energize
 K303 does not energize
 K303 remains energized
 K104 does not energize, K401 does not energize
 AC Converter Range 1V (Q401, 408, 409, 421 on)
 AC Converter Range 10V (Q401, 402, 408, 409 on)
 AC Converter Range 100V (Q403, 404, 421 on)
 AC Converter Range 650V (Q405, 406, 407, 421 on)

Table 5-8. Analog Controller Latch Outputs

IC#	PIN#	MNEMONIC	ACTIVE STATE	ANALOG TEST NO.															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
U618	2	\overline{X} REF LO	L	H	←	→	→	→	→	→	→	→	→	→	→	→	→	H	
	5	\overline{X} REF HI	L	H	←	→	→	→	→	→	→	→	→	→	→	→	→	H	
	6	\overline{DC} X 1	L	L	H	H	L	L	H	H	H	L	L	L	L	L	L	L	
	9	\overline{DC} X 8	L	H	L	H	H	H	L	H	←	→	→	→	→	→	→	H	
	12	\overline{DC} X 64	L	H	H	L	H	H	H	L	L	H	←	→	→	→	→	H	
	15	FAST \overline{DC}	L	H	←	→	→	→	→	→	→	→	→	→	→	→	→	H	
	16	SLOW \overline{DC}	L	L	←	→	→	→	→	→	→	→	→	→	→	→	→	L	
19	No Connection	X	L	←	→	→	→	→	→	→	→	→	→	→	→	→	L		
U619	2	LOW DC	H	L	L	L	H	L	←	→	→	→	→	→	→	→	L		
	5	LOW OHMS	H	L	←	→	→	→	→	→	→	→	→	→	→	→	L		
	6	2T/4T SEL	H	L	L	L	H	H	H	H	H	L	L	L	L	H	H	H	
	9	No Connection	X	H	←	→	→	→	→	→	→	→	→	→	→	→	→	H	
	12	$\overline{\Omega}$ REF	L	H	←	→	→	→	→	→	→	→	→	→	→	→	→	H	
	15	$\overline{DC} + \Omega$	L	L	←	→	→	→	→	→	→	L	H	←	→	→	→	H	
U620	2	SAC	L	L	←	→	→	→	→	→	→	→	→	→	→	→	L		
	5	FAC	L	H	←	→	→	→	→	→	→	→	→	→	→	→	H		
	6	10V AC	H	L	←	→	→	→	→	→	L	H	L	L	L	H	L	L	
	9	100V AC	L	H	←	→	→	→	→	→	H	L	H	H	H	L	H	H	
	12	10V AC	L	H	←	→	→	→	→	→	H	L	H	H	H	L	H	H	
	15	1V AC	L	H	←	→	→	→	→	→	H	L	L	H	H	L	L	H	H
U621	2	No Connection	X	L	←	→	→	→	→	→	L	H	L	←	→	→	→	L	
	5	No Connection	X	L	←	→	→	→	→	→	→	→	→	→	→	→	→	L	
	6	No Connection	X	L	←	→	→	→	→	→	L	H	L	←	→	→	→	L	
	9	HIGH OHMS	L	H	H	H	L	L	L	L	L	H	H	H	H	L	L	L	L
	12	200 K Ω	L	H	H	H	L	L	L	L	H	H	H	H	H	L	L	L	L
	15	20 +200 Ω	L	H	←	→	→	→	→	→	→	→	→	→	→	→	→	H	
U621	16	2 K Ω	L	H	←	→	→	→	→	→	H	L	H	←	→	→	→	H	
	19	OHMS CLAMP	L	L	←	→	→	→	→	→	L	H	L	←	→	→	→	L	

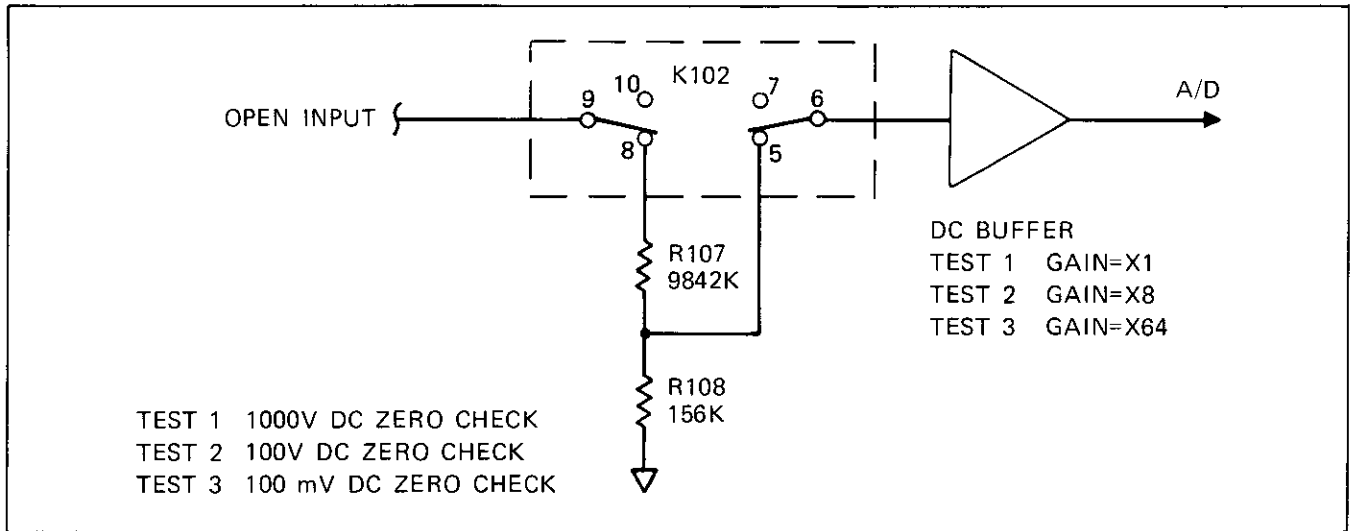
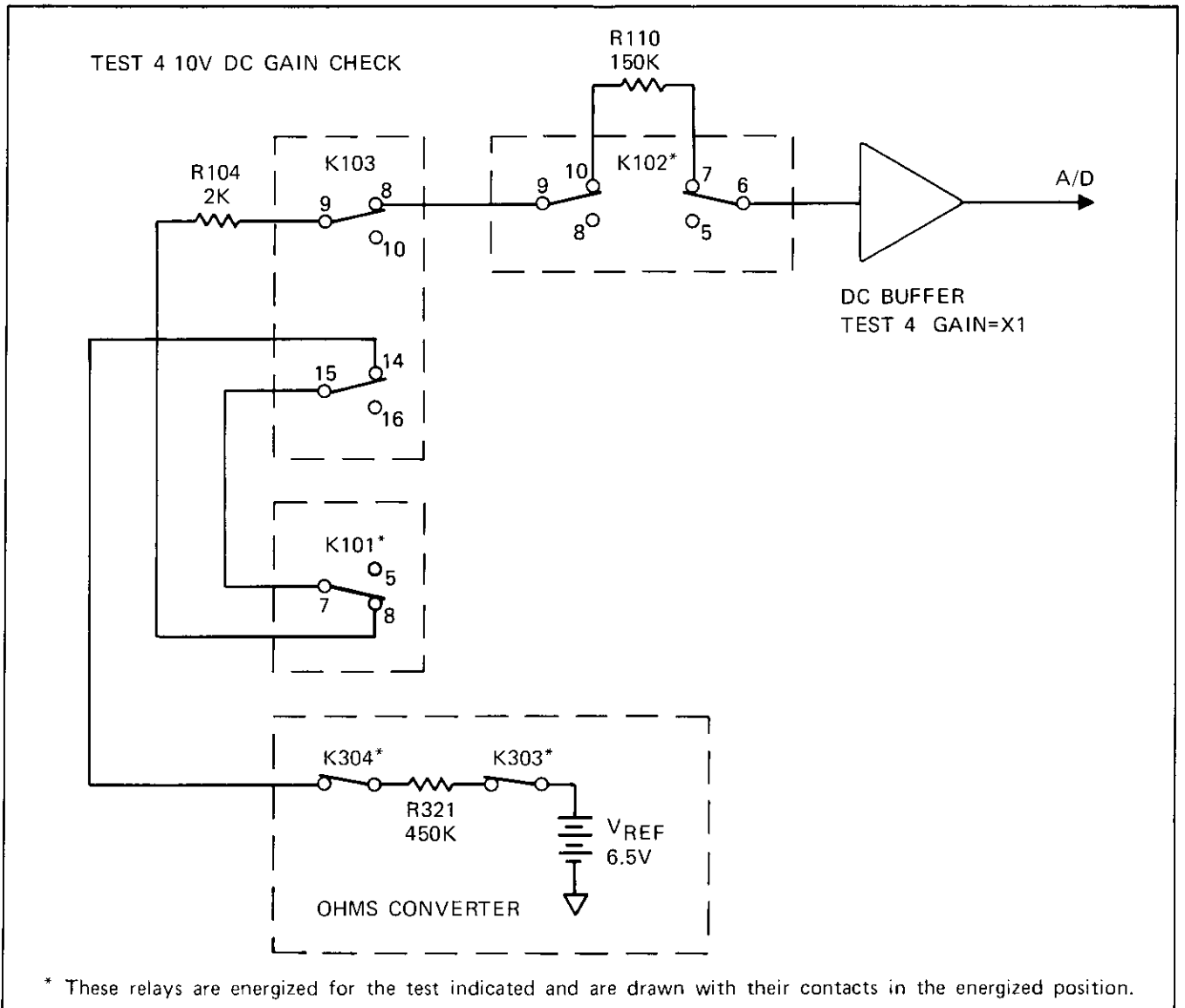


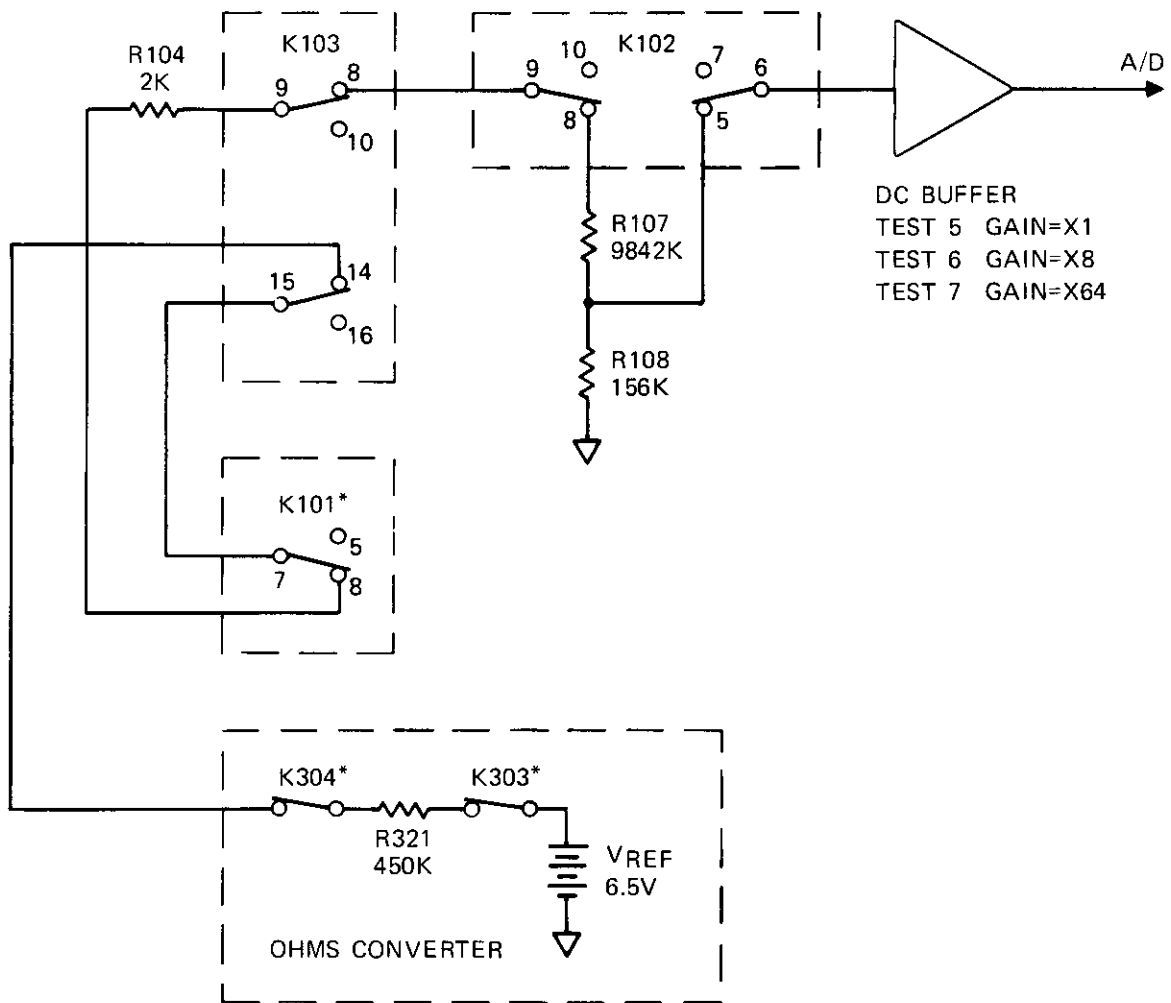
Figure 5-1. Analog Self Tests #1, 2, 3 Simplified Schematic



* These relays are energized for the test indicated and are drawn with their contacts in the energized position.

Figure 5-2. Analog Self Test #4 Simplified Schematic

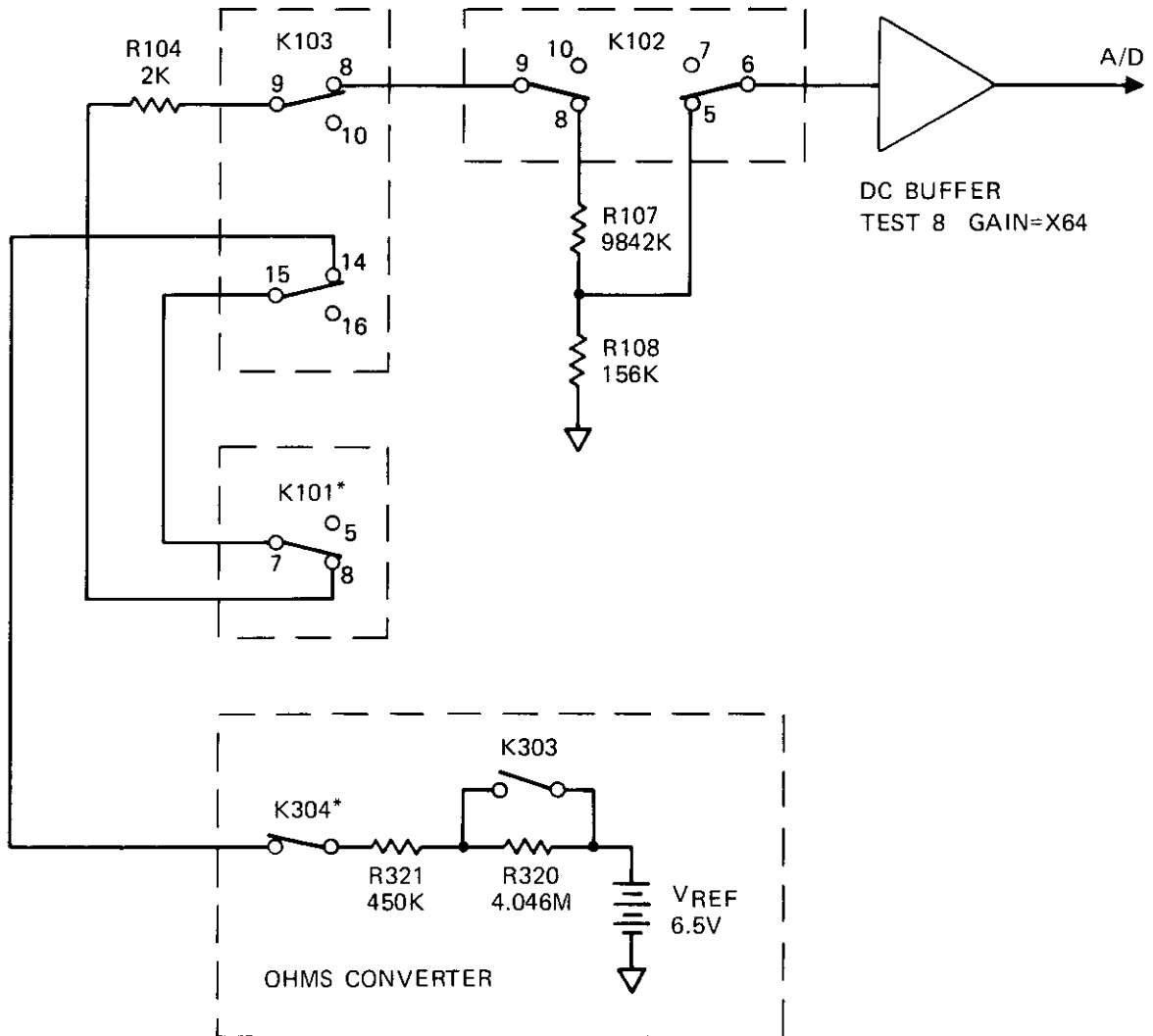
TEST 5 1000V DC GAIN CHECK
 TEST 6 100V DC GAIN CHECK
 TEST 7 100 mV DC GAIN CHECK



* These relays are energized for the tests indicated and are drawn with their contacts in the energized position.

Figure 5-3. Analog Self Tests #5, 6, 7 Simplified Schematic

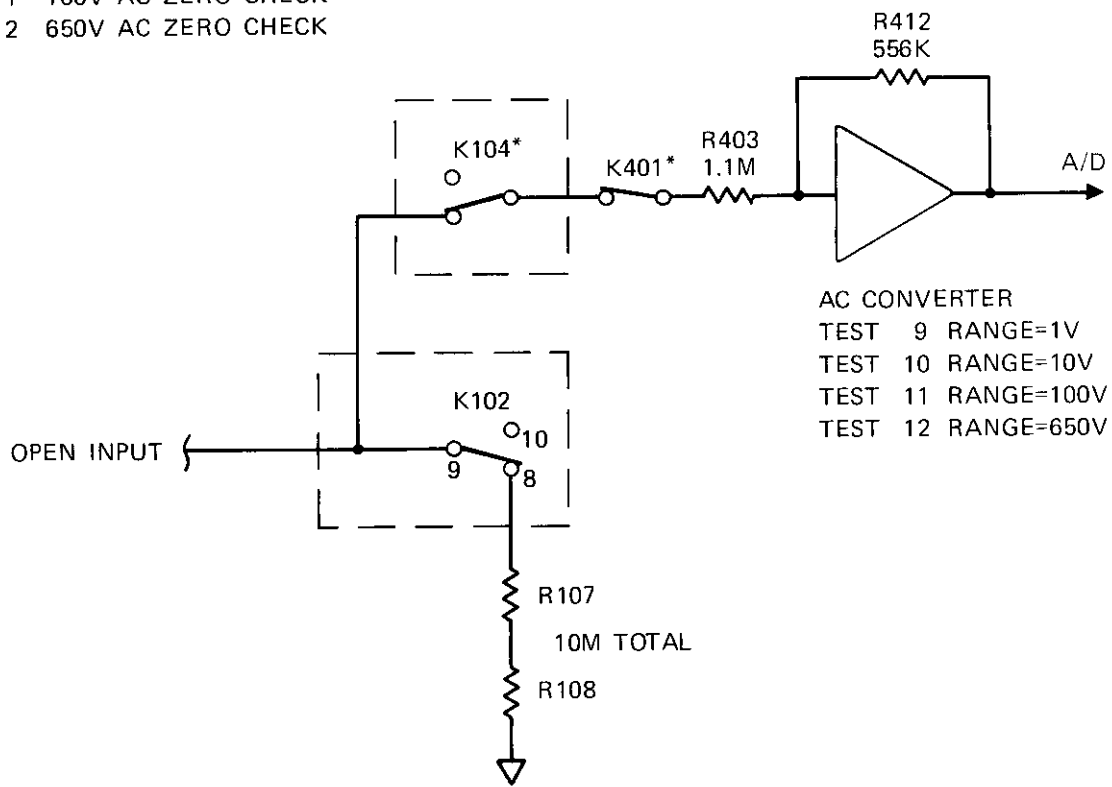
TEST 8 10M OHM RANGE CHECK



* These relays are energized for the test indicated and are drawn with their contacts in the energized position.

Figure 5-4. Analog Self Test #8 Simplified Schematic

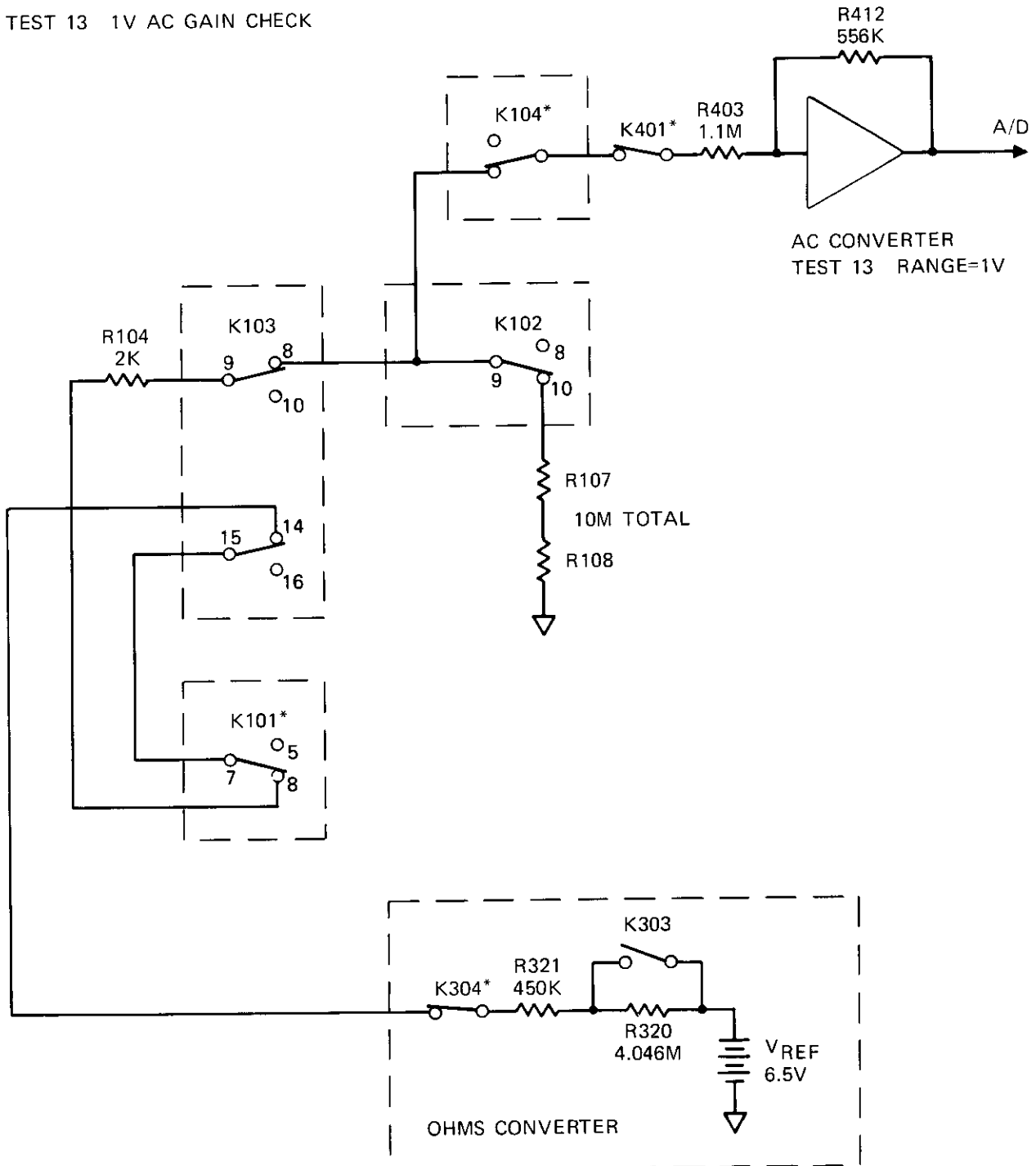
TEST 9 1V AC ZERO CHECK
 TEST 10 10V AC ZERO CHECK
 TEST 11 100V AC ZERO CHECK
 TEST 12 650V AC ZERO CHECK



* These relays are energized for the tests indicated and are drawn with their contacts in the energized position.

Figure 5-5. Analog Self Tests #9, 10, 11, 12 Simplified Schematic

TEST 13 1V AC GAIN CHECK



* These relays are energized for the test indicated and are drawn with their contacts in the energized position.

Figure 5-6. Analog Self Test #13 Simplified Schematic

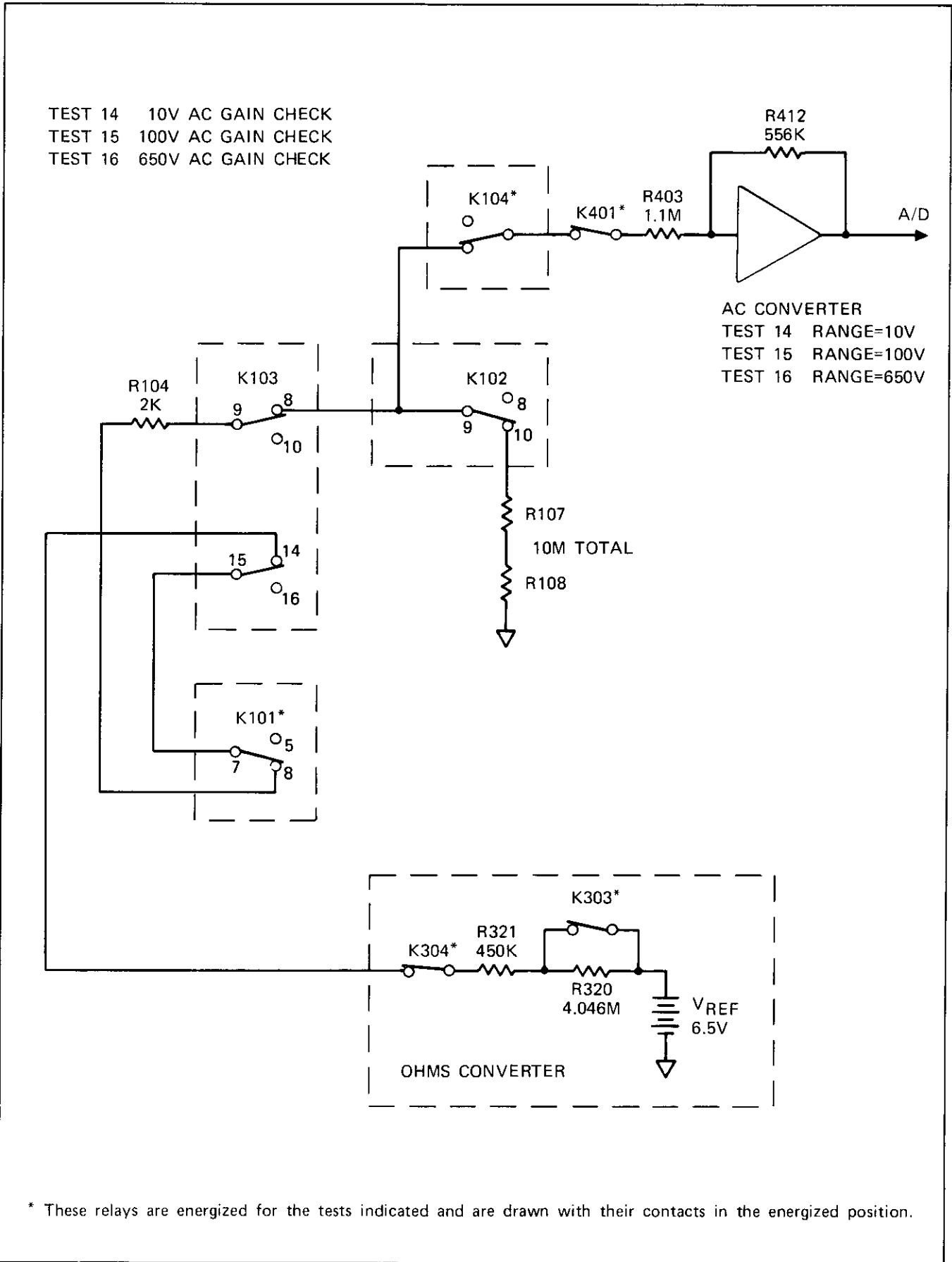


Figure 5-7. Analog Self Tests #14, 15, 16 Simplified Schematic

Table 5-9. Low Ohms Tests

	4 TERMINAL 10 Ω	4 TERMINAL 100 Ω	4 TERMINAL 1000 Ω	4 TERMINAL 10 K Ω
K101	OFF	OFF	OFF	OFF
K102	ON	ON	ON	ON
K103	ON	ON	ON	ON
K104	OFF	OFF	OFF	OFF
Q103	OFF	OFF	OFF	OFF
Q104	ON	ON	ON	ON
Q106	OFF	OFF	OFF	OFF
Q107	OFF	OFF	OFF	OFF
Q108	OFF	OFF	OFF	OFF
GAIN DC BUFFER	64	8	8	8
Q236	OFF	OFF	OFF	OFF
Q237	OFF	ON	ON	ON
Q238	ON	OFF	OFF	OFF
Q308	OFF	OFF	OFF	OFF
Q305	ON	ON	OFF	OFF
Q306	OFF	OFF	ON	OFF
K301	OFF	OFF	ON	OFF
K302	ON	ON	OFF	OFF
K304	OFF	OFF	OFF	OFF

Table 5-10. Analog Controller Latch Tests

TESTS	S601 Switch Number				LOCATION
	1	2	3	4	
Port 2	OFF	OFF	OFF	OFF	U601-21-24, 35-38
Port 1	OFF	OFF	OFF	ON	U601-27-34
U617	OFF	OFF	ON	OFF	U617-2, 5, 7, 10, 12
U621	OFF	OFF	ON	ON	U621-2, 5, 6, 9, 12, 15, 16, 19
U620	OFF	ON	OFF	OFF	U620-2, 5, 6, 9, 12, 15, 16, 19
U619	OFF	ON	OFF	ON	U619-2, 5, 6, 9, 12, 15, 16, 19
U618	OFF	ON	ON	OFF	U618-2, 5, 6, 9, 12, 15, 16, 19
U604	OFF	ON	ON	ON	U604-1-11, 13

Table 5-11. Analog Controller UART Test

PORT 1 BYTE	U601 (PORT 1)			RESPONSE
	29 (2)	28 (1)	27 (0)	
0000 0001	L	L	H	The interrupt mask has been set for local echo and even parity (data 10 Hex) and a data byte (A9 Hex) written into the UART. The software has written 01 Hex into Port 1 and is waiting for the TBE bit (U602-22) to be set true.
0000 0010	L	H	L	After receipt of TBE the software writes a 02 Hex in Port 1 and waits for DAV (U602-19) to be set true.
0000 0011	L	H	H	After receipt of DAV the software writes 03 Hex in Port 1 and compares E3 Hex with the UART status, i.e. U602 pins 24 (EOC), 22 (TBE), and 19 (DAV) high, pins 13 (PE), 14 (FE), and 15 (OR) low, and U601 pins 18 (D6) and 19 (D7) are high. If they are the same the test continues, otherwise it stops with 03 Hex in the Port.
0000 0100	H	L	L	If the status byte matches, the software writes 04 Hex into Port 1 and compares the UART data to A9 Hex. If they are the same the test continues, otherwise it stops with 04 Hex in the Port.

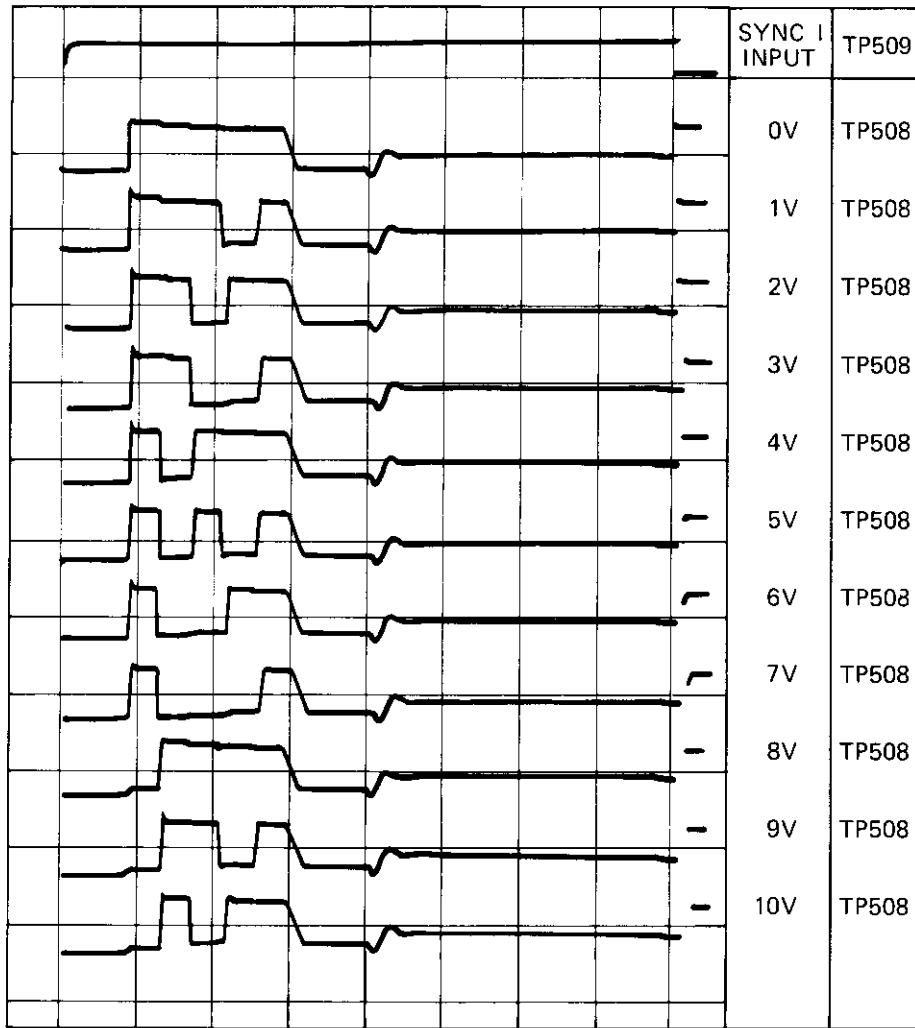
Table 5-12. Analog Controller Interrupt Test

PORT 1 BYTE	U601 (PORT 1)				RESPONSE
	30 (3)	29 (2)	28 (1)	27 (0)	
0000 0100	L	H	L	L	The software writes 04 Hex in Port 1 and 11 Hex on the data lines for the interrupt mask register (U607) for local echo, even parity, and DAV interrupt enable. Local echo strobes the UART write line (U602-23) and a data byte is transferred out on U602-25 to the digital circuitry and then back on U602-20. The software then waits for U601-6 (INT) to go low before going to the next step.
0000 0101	L	H	L	H	When INT goes low the software writes 05 Hex in Port 1 and compares the interrupt vector with F1 Hex to insure that U601 pins 16, 17, 18, and 19 are high during the interrupt vector strobe (U604-7) and that only the DAV interrupt is active. If they compare the test continues, otherwise it stops with 05 Hex in the port.
0000 0110	L	H	H	L	If there is a match the software writes 06 Hex in port 1 and 10 Hex on the data lines to disable the interrupt. It then verifies that INT on U601-6 goes high.
0000 0111	L	H	H	H	When INT goes high the software writes 07 Hex in Port 1 and F4 Hex in the interrupt mask register (U607). It then strobes the UART write line (U602-23) then clocks U608-9 high through U614-12 and U610-3. When INT (U601-6) goes low it continues with the test, otherwise it stops with 07 Hex in the Port.
0000 1000	H	L	L	L	When INT goes low the software writes 08 Hex in Port 1 and compares the interrupt vector with F4 Hex to verify that U601 pins 16, 17, 18, and 19 are high during the interrupt vector strobe (U604-7) and that only the TRIGGER interrupt (U608-9) is active. If they compare the test repeats itself, otherwise it stops with 08 Hex in the Port.

Table 5-13. UART and Interrupt Troubleshooting Procedures

STEP NO.	ACTION	GO TO STEP FOR CORRECT RESPONSE	
		YES	NO
	<i>NOTE</i>		
	<i>The first 9 steps are the same regardless of the test that failed.</i>		
1	Check the CPU (U601) for defective pins on the ports or outputs. Repeat the failed test.		
2	Does the test operate satisfactorily?	21	3
3	Check the IC's Connected to the data bus for shorted or defective pins. They are U603, U607, U611, U612, U617, U618, U619, U620, and U621. Repeat the failed test.		
4	Does the test operate satisfactorily?	21	5
5	Check the reset circuitry (U605, U609, and U614), that initiates the test by forcing a reading of the program. Repeat the failed test.		
6	Does the test operate satisfactorily?	21	7
7	Check the address decoding circuitry (U603, U604, U613, and U614). Repeat the failed test.		
8	Does the test operate satisfactorily?	21	9
9	Check the UART (U602).		
10	Does the test operate satisfactorily?	21	11
11	Is the port locked in 02 Hex during the UART Test?	12	14
12	Check U607, U610, and U615. Repeat the failed test.		
13	Does the test operate satisfactorily?	21	20
14	Is the port locked in either 03 Hex or 04 Hex during the UART Test or in one of the Interrupt tests?	15	16
15	Check the UART Transmit/Receive circuitry (U609, U610, U612, and U615). Repeat the failed test.		
16	Does the test operate satisfactorily?	21	20
17	Is the port locked in any of the Interrupt Tests?	18	20
18	Check the Interrupt circuitry (U607, U608, U612, and U613). Repeat the failed test.		
19	Does the test operate satisfactorily?	21	20
20	All checks have been completed; however, the instrument still does not perform the test satisfactorily. Repeat all checks looking for a failure that took place during the checks. Check for open or shorted lead patterns and other tests of this type.		
21	Troubleshooting of the UART and Interrupt circuits is complete.		

A/D LADDER BIT TEST DURING FIRST PASS



8	4	2	1	1/2
BIT				

SCOPE SET 1V/DIV VERTICAL
50 μs/DIV HORIZONTAL

Figure 5-8. A/D Converter Test

Section 6

List of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NAME	DRAWING NO.	TABLE NO. PAGE		FIGURE NO. PAGE	
Final Assembly	8520A T & B, FA	6-1	6-3	6-1	6-4
A1 Display PCB Assembly	8520A-4011	6-2	6-8	6-2	6-9
A2 Digital (Controller) PCB Assembly	8520A-4020	6-3	6-10	6-3	6-12
A3 Analog PCB Assembly	8520A-4030	6-4	6-14	6-4	6-19
A3A1 Ref Amp PCB Assembly (Horizontal)	8520A-4046	6-5A	6-21	6-5A	6-21
A3A1 Ref Amp PCB Assembly (Vertical)	8520A-4045	6-5B	6-22	6-5B	6-22
A4 Transformer Assembly	8520A-4202	6-6	6-23	6-6	6-24
A4A1 Transformer PCB Assembly	8520A-4040	6-7	6-23	6-6	6-24

6-1. INTRODUCTION

6-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the Options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

6-3. Parts lists include the following information:

1. Reference Designation.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufactures. (See Section 7 for Code-to-Name list.)
5. Manufacture's Part Number.
6. Total Quantity of components per assembly.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of 2 years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for 1 year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked (see paragraph 5-7). 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 spares quantity for the items in that particular assembly.

6-4. HOW TO OBTAIN PARTS

6-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. or its authorized representatives 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.

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

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

6-7. A Recommended Spare Parts Kit for your basic instrument is available from the factory. This kit contains those items listed in the REC QTY column of the parts list in the quantities recommended.

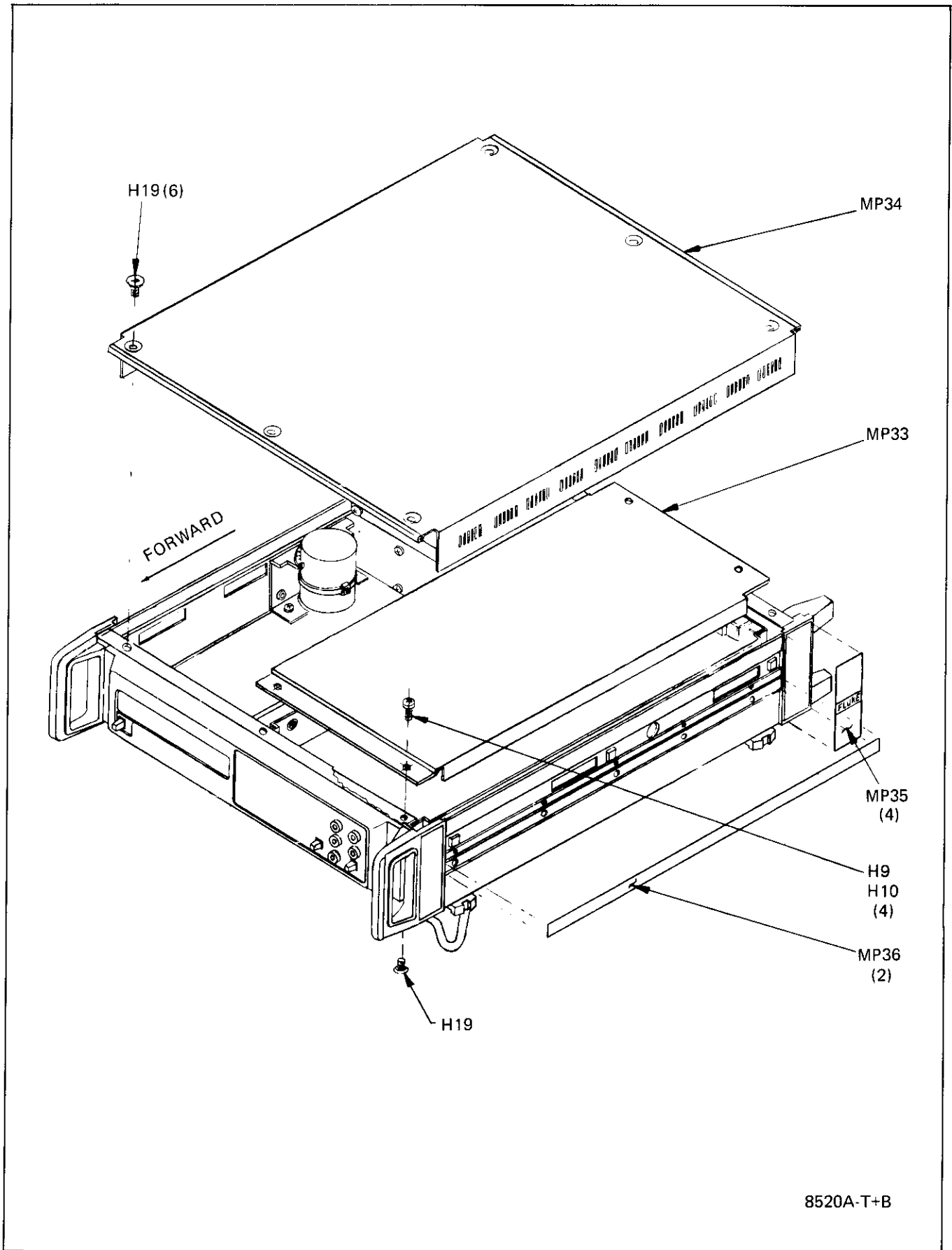
6-8. Parts price information is available from the John Fluke Mfg. Co., Inc. or its representatives. Prices are also available in a Fluke Replacement Parts Catalog, which is available on request.

CAUTION

Indicated devices are subject to damage by static discharge.

TABLE 6-1. 8520A FINAL ASSEMBLY
(SEE FIGURE 6-1.)

REFERENCE DESIGNATOR	FLUKE STOCK	MFRS SPLY CODE	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O -E
A->NUMERIC-->	S	----	----	----	----	----
-----	-----	-----	-----	-----	-----	-----
DESCRIPTION	NO	NO	NO	NO	NO	NO
A 1	*	516625	89536	516625		1
A 2	*	496828	89536	496828		1
A 3	*	496836	89536	496836		1
A 4	*	496869	89536	496869		1
F 201		109322	71400	MDL1-2		1
FL 1		321273	05245	3EF2		1
H 1		295105	89536	295105		4
H 2		177030	89536	177030		4
H 3		114983	89536	114983		4
H 4		110320	89536	110320		4
H 5		147603	89536	147603		2
H 6		320085	89536	320085		8
H 7		114355	89536	114355		8
H 8		185918	89536	185918		8
H 9		152140	89536	152140		23
H 10		403923	89536	403923		17
H 11		177022	89536	177022		26
H 12		147611	89536	147611		2
H 13		175943	89536	175943		1
H 14		110270	89536	110270		1
H 15		110817	89536	110817		2
H 16		110619	89536	110619		2
H 17		240820	89536	240820		2
H 18		129082	73734	19022		2
H 19		320093	89536	320093		12
H 20		385401	89536	385401		4
J 9		225623	89536	225623		1
MP 1		491191	89536	491191		1
MP 2		581553	89536	581553		1
MP 3		491092	89536	491092		1
MP 4		491084	89536	491084		1
MP 5		491175	89536	491175		1
MP 6		491076	89536	491076		1
MP 7		491100	89536	491100		1
MP 8		496893	89536	496893		1
MP 9		496760	89536	496760		1
MP 10		534479	89536	534479		1
MP 11		394296	89536	394296		2
MP 12		394338	89536	394338		2
MP 13		292870	89536	292870		4
MP 14		307363	89536	307363		4
MP 15		375188	61935	031.1653		1
MP 16		460238	61935	031.1666		1
MP 17		502690	89536	502690		1
MP 18		523712	89536	523712		1
MP 19		472316	89536	472316		2
MP 20		372342	89536	372342		6
MP 21		372334	89536	372334		6
MP 22		113837	89536	113837		1
MP 23		100073	83330	2149		1
MP 24		101352	71400	5681-15		1
MP 25		472795	89536	472795		1
MP 26		149450	89536	149450		1
MP 27		218529	89536	218529		1
MP 28		149443	89536	149443		1
MP 29		172080	89536	172080		2
MP 30		165951	31827	3-4-1		1
MP 31		523704	89536	523704		1
MP 32		101345	89536	101345		1
MP 33		490987	89536	490987		1
MP 34		491183	89536	491183		1
MP 35		394379	89536	394379		4
MP 36		525998	89536	525998		2
MP 37		520825	89536	520825		1
MP 38		231407	89536	231407		1
MP 39	*	581561	89536	581561		1
MP 40		225615	89536	225615		1
S 201		507871	71468	SCH. 1XF.0003-01		1
TM 1		541979	89536	541979		1
TM 2		541987	89536	541987		1
TM 3		541995	89536	541995		1
TM 4		719336	89536	719336		1
W 1		284174	89536	284174		1
W 2		496877	89536	496877		1
W 3		496885	89536	496885		1
W 4		474148	89536	474148		1
W 5		515668	89536	515668		1



8520A-T+B

Figure 6-1. 8520A Final Assembly

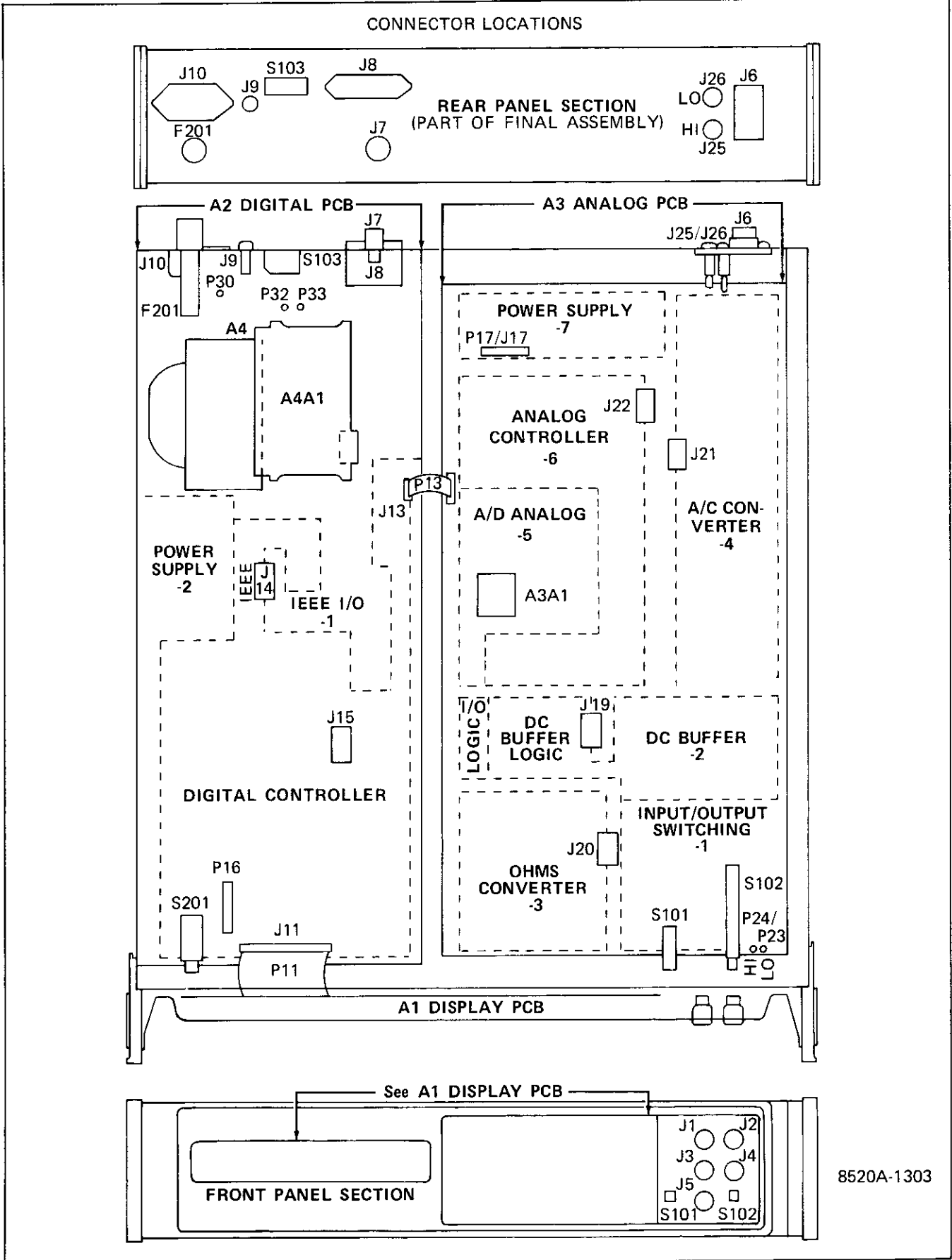


Figure 6-1. 8520A Final Assembly (cont)

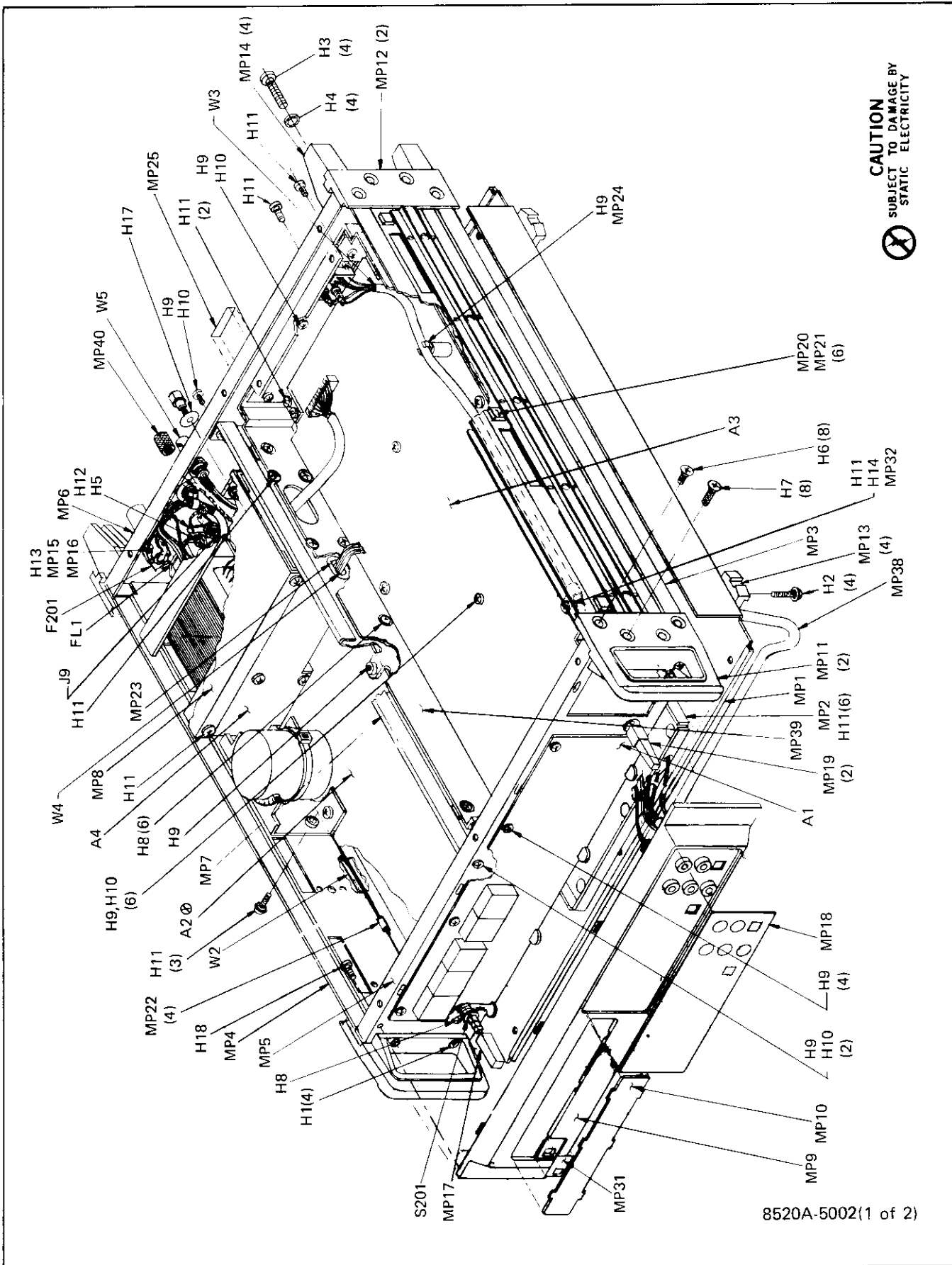


Figure 6-1. 8520A Final Assembly (cont)

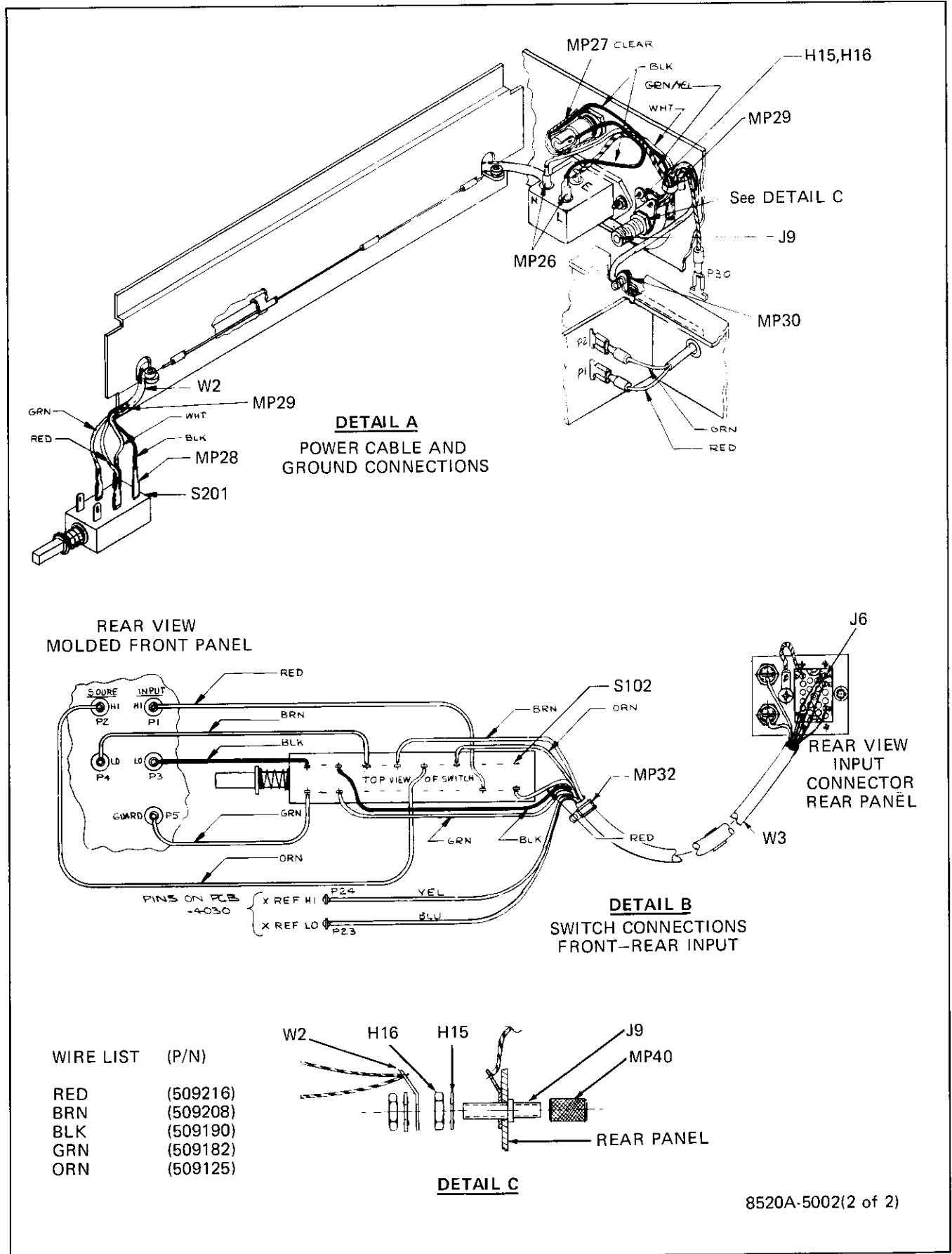


Figure 6-1. 8520A Final Assembly (cont)

TABLE 6-2. A1 DISPLAY PCB ASSEMBLY
(SEE FIGURE 6-2.)

REFERENCE DESIGNATOR	FLUKE STOCK	MFRS SPLY CODE	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
A->NUMERICS->>	S	-----	-----	-----	-----	-----
		DESCRIPTION				
CR 2	*	DIODE,S1,BV= 75.0V, IO=150MA,500 MW	203323	07910	1N4448	1 1
DS 7	*	LED,RED,RECTANGLE,PCB MOUNT	504761	14936	MV57124	1 1
DS 13	*	DIODE,LED,DUAL 7 SEG AND 7 SEG TOVFLO	585422	89536	585422	1 1
DS 19, 20	*	DIODE,LED,RED, 2 X 14 SEGMENTS	478065	50579	DL02614	2 1
E 4- 7		TERM,UNINSUL,FEEDTHRU,HOLE,TURRET	179283	88245	2010R-5	4
J 1		CABLE,FLAT,JMPR,20 CONDUCT,0.100 SP	500975	89536	500975	1
MP 1		PUSHBUTTON-SQUARE-, LIGHT PUTTY GREY	401307	89536	401307	15 1
MP 2		PUSHBUTTON-SQUARE-, LIGHT BLUE	406736	89536	406736	1 1
MP 3		SPACER,LED .125 LG	786707	89536	786707	1
MP 4		FILTER,LIGHT	578617	89536	578617	2 1
R 1		RES,CF,270,+5%,0.25W	348789	80031	CR251-4-5F270E	1 4
R 2		RES,CF,680,+5%,0.25W	368779	80031	CR251-4-5F200E	1
RN 1		RES,NET,SIP,10 PIN,9 RES,2.7K,+2%	484303	89536	484303	1 1
RN 2, 7, 8		RES,NEG,SIP,8 PIN,7 RES,1K,+2%	414557	80031	95081002CL	3
RN 3, 6		RES,NET,DIP,16 PIN,8 RES,430,+5%	484295	89536	484295	2
RN 4, 9		RES,NET,DIP,16 PIN,8 RES,82,+5%	478859	89536	478859	2
S 1- 3, 5,		SWITCH,PUSHBUTTON,SFNO MOMENTARY	507319	89536	507319	18
S 7- 10, 12,			507319			
S 13, 16, 18-			507319			
S 24			507319			
S 4, 6, 14,		SWITCH,PUSHBUTTON,SFNO MOMENTARY	507335	89536	507335	4 1 1
S 15			507335			1
S 11		SWITCH,PUSHBUTTON,SFNO MOMENTARY	525170	89536	525170	1
S 12, 13		PUSH BUTTON SQUARE	531525	89536	531525	2 1
S 17		SWITCH,PUSHBUTTON,SFNO MOMENTARY	524082	89536	524082	1
U 1	*	IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR	454892	01295	SN74LS273N	1
U 2, 3	*	IC,ARRAY,4 TRANS,NPN,DARLINGTON PAIRS	454306	56289	UNL2064B	2 1
U 5, 7	*	IC,CMOS,HEX OPEN DRAIN BUFFER	473389	12040	MM74C906N	2 1
U 6	*	IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	1 1
U 9, 12	*	IC,CMOS,8BIT ADDRESSBLE LATCH SER INPUT	453258	02735	CD4099BE	2 1
U 10, 11, 23,	*	IC,ARRAY,4 TRANS,PNP,MEMORY DRIVER	477828	12040	DH3467CN	4 1
U 24	*		477828			
U 21, 22	*	IC,ARRAY,7 TRANS,NPN,COMMON EMITTER	407866	49671	CA3081	2 1
VR 1	*	ZENER,UNCOMP, 3.9V, 5%, 64.0MA, 1.0W	535641	04713	1N4733	1 1

NOTE 1 = SWITCHES S4,S6,S11,S14,S15 AND S17 COME COMPLETE WITH DIODES.
THESE DIODES CANNOT BE REPLACED. ORDER ONLY AS A COMPLETE UNIT.

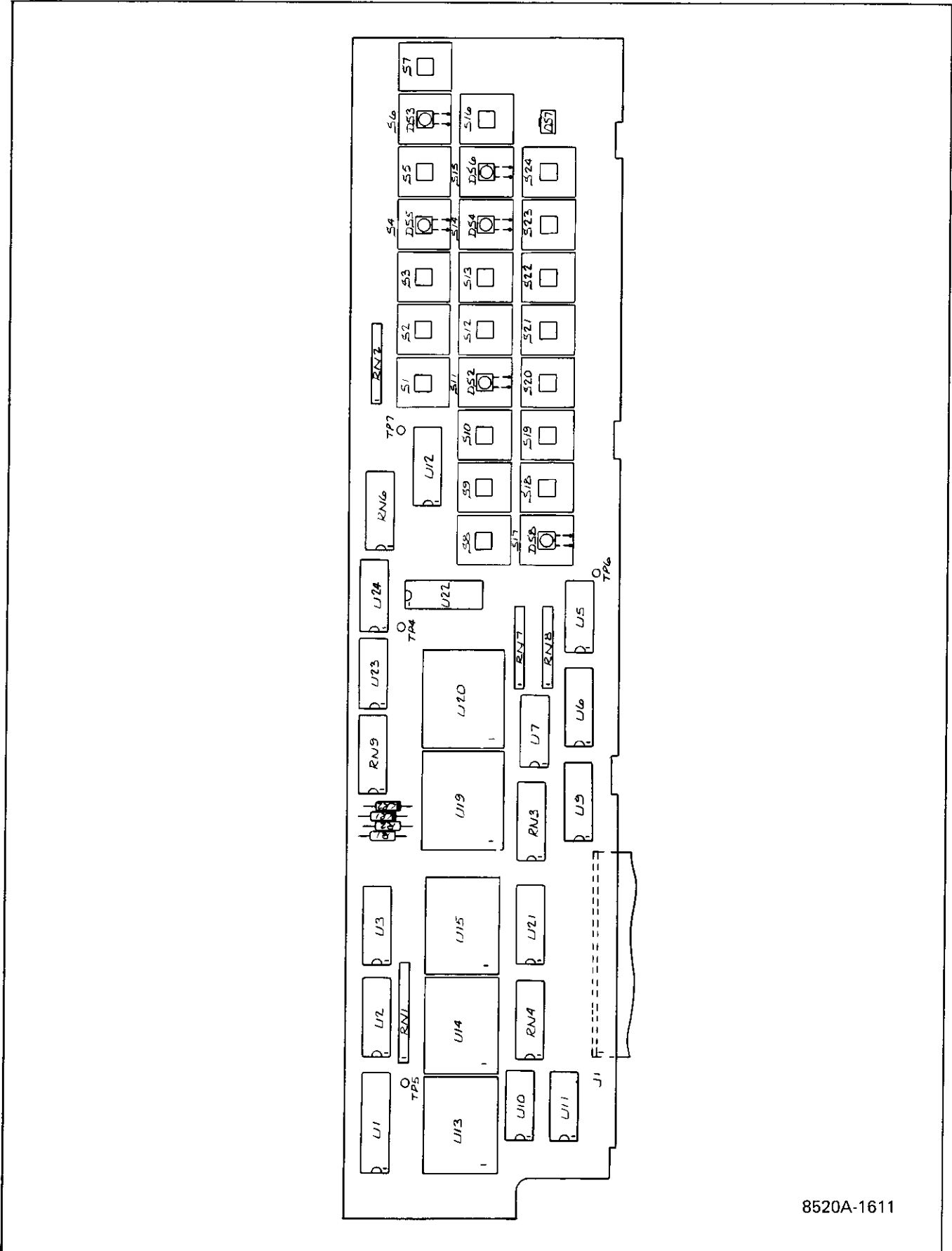


Figure 6-2. A1 Display PCB Assembly

8520A-1611

TABLE 6-3. A2 DIGITAL PCB ASSEMBLY
 (SEE FIGURE 6-3.)

REFERENCE DESIGNATOR A->NUMERICS-->	S	DESCRIPTION	FLUKE STOCK NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
C	1	CAP, TA, 10UF, +-20%, 10V	176214	56289	196D106X0010KA1	1		
C	2- 11, 14,	CAP, CER, 0.025UF, +-20%, 100V, Z5W	168435	56289	C023B101H253M	20		
C	16- 18, 21,		168435					
C	24, 101-108		168435					
C	12, 204	CAP, TA, 22UF, +-20%, 15V	423012	56289	196D226X0015KA1	2	1	
C	13, 32	CAP, MICA, 47PF, +-5%, 500V	148536	72136	CM15E470J	2		
C	15	CAP, CER, 0.05UF, +80-20%, 25V, Y5U	148924	72982	5855-000-Y5U0-503Z	1		
C	19, 22	CAP, CER, 0.01UF, +-20%, 100V, X7R	407361	72982	8121-A100-W5R-103M	2		
C	20, 27, 28,	CAP, TA, 1UF, +-10%, 35V	161919	56289	196D010X0035G	4		
C	30		161919					
C	23	CAP, TA, 39UF, +-20%, 6V	163915	56289	196D394X0020KA1	1		
C	25, 31	CAP, MICA, 100PF, +-5%, 500V	148494	72136	DM15F101J	2		
C	29, 203	CAP, TA, 10UF, +-20%, 15V	193623	56289	196D106X0015A1	2		
C	109	CAP, CER, 0.01UF, +80-20%, 100V, Z5W	149153	56289	C023B101F103M	1		
C	201	CAP, AL, 22000UF, +75-10%, 15V	479220	56289	32DX223G015BA2A	1	1	
C	202	CAP, TA, 0.22UF, +-20%, 35V	161331	56289	196D224X0035HA1	1		
CR	1, 2	* DIODE, SI, BV= 75.0V, IO=150MA, 500 MW	203323	07910	1N4448	2	1	
CR	20	* LED, RED, LUM INT= 1 MCD, W/STANDOFFS	429555	12040	NLS5053	1	1	
CR	202, 203	* DIODE, SI, 100 PIV, 1.0 AMP	343491	01295	1N4002	2	1	
H	1	SCREW, MACH, PHP, S, STL, 4-40X5/16	335141	89536	335141	1		
H	2	SCREW, MACH, PHP, S, STL, 4-40X1-7/16	403782	89536	403782	1		
H	3	SCREW, MACH, PHP, STL, 10-32X5/16	417105	89536	417105	2		
H	4	WASHER, SHLDR, NYLON, #4	436386	86928	5607-45	1		
H	5	NUT, PRESS, BROACH, STL, 4-40	380196	24347	KF2-440	2		
H	6	SCREW, THD FORM, PHPD, STL, 5-20X5/16	494641	89536	494641	2		
J	8	CONN, MICRO-RIBBON, PLUG, PWB EDGE, 24	485763	00779	552791-1	1		
J	11	SOCKET, 1 ROW, PWB, 0.100CTR, 20 POS	443077	00779	583773-9	1		
J	12	CONN, PWB EDGE, REC, 0.150 CTR, 8 POS	354951	00779	583407-5	1		
J	13	SOCKET, 1 ROW, PWB, 0.100CTR, 4 POS	461756	00779	583773-1	1		
J	14, 18, 19	HEADER, PROGRAMMED	495507	89536	495507	3		
J	16	HEADER, 1 ROW, 0.100CTR, 11 PIN	494666	00779	1-640456-1	1		
J	17	HEADER, 1 ROW, 0.100CTR, 4 PIN	417329	89536	417329	1		
J	201	SOCKET, 1 ROW, PWB, 0.100CTR, 5 POS	417899	52072	CA-05S-TSD	1		
L	1	CHOKER, 6TURN	320911	89536	320911	1		
MP	1	SPACER, RND, SOLUBLE, 0.062IDX0.1560D	296319	32559	T0806	2		
MP	2	NAT NYLON 0.090X0.175X0.100X0.155	102277	89536	102277	1		
MP	3	CABLE TIE, 11"L, 0.190"W, 3.0 DIA	501734	89536	501734	1		
MP	4	INSUL PART, TRANS, SILICONE, POWER	508630	89536	508630	1		
MP	5	BRACKET, CAPACITOR/REGULATOR	490490	89536	490490	1		
P	201	CONNECTING LINK	523167	89536	523167	1		
Q	1	* TRANSISTOR, SI, PNP, SMALL SIGNAL	195974	64713	2N3906	1		
R	1, 2, 4,	RES, CF, 1K, +-5%, 0.25W	573170	80031	CR251-4-5P1K	8		
R	5, 8, 14,		573170					
R	15, 26		573170					
R	6	RES, CF, 150, +-5%, 0.25W	343442	80031	CR251-4-5P150	1		
R	7, 23, 24	RES, CF, 51, +-5%, 0.25W	572990	89536	572990	3		
R	9, 16, 19,	RES, CF, 10K, +-5%, 0.25W	573394	80031	CR251-4-5P10K	6		
R	101, 102		573394					
R	10	RES, MF, 100K, +-1%, 0.125W, 100PPM	248807	91637	CMF551003F	1		
R	11	RES, MF, 681K, +-1%, 0.125W, 100PPM	381517	91637	CMF556813F	1		
R	12	RES, MF, 1.5K, +-1%, 0.125W, 100PPM	313098	91637	CMF551501F	1		
R	13	RES, MF, 10K, +-1%, 0.125W, 100PPM	168260	91637	CMF551002F	1		
R	17	RES, CF, 100K, +-5%, 0.25W	573584	80031	CR251-4-5P100K	1		
R	18	RES, MF, 28K, +-1%, 0.125W, 100PPM	291385	91637	CMF552802F	1		
R	21	RES, MF, 82.5K, +-1%, 0.125W, 100PPM	246223	91637	CMF558252F	1		
R	25	RES, CF, 270, +-5%, 0.25W	573071	89536	573071	1		
R	27	RES, CF, 750, +-5%, 0.25W	573162	80031	CR251-4-5P750E	1		
R	104	RES, CF, 100, +-5%, 0.25W	573014	80031	CR251-4-5P100E	1		
R	105	RES, CF, 470, +-5%, 0.25W	573121	80031	CR251-4-5P470E	1	1	
R	201	RES, WW, FUSIBLE, 0.1, +-10%, 2W	485672	89536	485672	1		
R	202	RES, MF, 249, +-1%, 0.125W, 25PPM	448043	91637	CMF552490F	1		
R	203	RES, MF, 649, +-1%, 0.125W, 100PPM	309955	91637	CMF556490F	1		
R	204	RES, VAR, CERM, 200, +-10%, 0.5W	275743	89536	275743	1		
R	205	RES, CF, 390, +-5%, 0.25W	573105	80031	CR251-4-5P390E	1		
R	209	RES, CC, 10K, +-10%, 0.5W	108118	01121	EB1031	1		
R	210	RES, WW, 13, +-5%, 5W	520197	89536	520197	1		
RN	1, 101	RES, NET, SIP, 10 PIN, 9 RES, 10K, +-2%	414003	80031	95081002CL	2		
RN	2	RES, NET, DIP, 16 PIN, 15 RES, 10K, +-5%	355305	89536	355305	1		
S	1	SWITCH, PUSHBUTTON, SPNO MOMENTARY	507319	89536	507319	1		
S	103	SWITCH, MODULE, DIP, 8 POS	495168	95146	DYS-8	1		
TP	1- 10, 30,	TERM, FASTON, TAB, SOLDR, 0.110 WIDE	512889	02660	62395	18	1	
TP	32, 33, 101,		512889					
TP	102, 201, 202		512889					
U	1, 35	* IC, CMOS, DUAL D F/F, +EDG TRG	418830	12040	MH74C74	2	1	

TABLE 6-3. A2 DIGITAL PCB ASSEMBLY
(SEE FIGURE 6-3.)

REFERENCE DESIGNATOR	A->NUMERICS-->	S	-----DESCRIPTION-----	FLUKE STOCK --NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	O T -E	N
U	2, 3	*	IC,LSTTL,3-8 LINE DCDR W/ENABLE	407585	01295	SN74LS138N	2			
U	8	*	IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR	454892	01295	SN74LS273N	1	1		
U	9,103,105	*	IC,LSTTL,DUAL D F/F,+EDG TRG,W/CLR	393124	01295	SN74LS74N	3	1		
U	10		I.C., EPROM, PROGRAMMED	729145	89536	729145	1			
U	11		I.C., EPROM, PROGRAMMED	729152	89536	729152	1			
U	12		I.C., EPROM, PROGRAMMED	729160	89536	729160	1			
U	13	*	IC, 2K X 8 STAT RAM	584144	33297	uFD4016C-2	1	1		
U	16	*	IC,LSTTL,QUAD 2 INPUT NAND GATE	393033	01295	SN74LS00N	1	1		
U	17	*	IC,LSTTL,HEX INVERTER W/OPEN COLLECT	394536	01295	SN74LS05	1	1		
U	18	*	IC,NMOS,8 BIT MICROCOMPUTER	478073	50088	HK3800-4CPU	1			
U	19	*	IC,TTL,HEX INVERTER	292979	01295	SN7404N	1			
U	20	*	IC,LSTTL,SYNC DIV BY 16 BINARY COUNTR	495598	01295	SN74LS163N	1	1		
U	21, 28	*	IC,CMOS,DUAL SYNC BINRY UP CNTR	355164	04713	MC14520BCP	2	1		
U	22	*	IC,CMOS,DUAL D F/F,+EDG TRIG	340117	02735	CD4013AE	1	1		
U	23	*	IC,CMOS,QUAD 2 IN NAND W/SCHMT TRIG	404632	02735	CD4039BE	1	1		
U	24	*	IC,LSTTL,OCTL BUS TRNSCVR W/3-ST OUT	477406	01295	SN74LS245N	1	1		
U	25	*	IC,TTL,4-16 LINE DCDR W/DUAL STROBE	293217	01295	SN74154N	1			
U	26		IC,CMOS,UNIV ASYNC RECEIVER/TRANSMITR	658856	89536	658856	1			
U	27, 31	*	IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	2	1		
U	29	*	IC,CMOS,PHASE LOCKED LOOP,16 PIN DIP	403584	02735	CD4046AE	1			
U	30	*	IC,LSTTL,QUAD 2 INPUT NOR GATE	393041	01295	SN74LS02N	1	1		
U	32	*	IC,CMOS,PRESETTABLE DIV BY N COUNTER	478313	02735	CD4018BE	1	1		
U	33	*	IC,TTL,QUAD 2 INPUT AND GATE	393066	01295	SN74LS08N	1	1		
U	34,106	*	IC,LSTTL,HEX INVERTER	393058	01295	SN74LS04N	2	1		
U	36	*	IC,LSTTL,RETRG MONOSTAB MULTIVR W/CLR	404186	01295	SN74LS123N	1	1		
U	37	*	IC,TTL,DUAL NAND DRVR W/OPEN COLLECT	329706	01295	SN75452P	1	1		
U	38		PULSE,TRANSFORMER	509141	89536	509141	1			
U	39	*	IC,LSTTL,QUAD 2 IN NAND W/SCHMT TRIG	504449	01295	SN74LS132N	1	1		
U	101	*	IC,NMOS,GEN PURPOSE INTERFACE ADAPTOR	477794	04713	MC68488P	1	1		
U	102	*	IC,LSTTL,OCTL BUFFER W/3-ST&NOR ENABL	429902	12040	DM81LS95N	1	1		
U	104	*	IC,LSTTL,QUAD 2 INPUT OR GATE	393108	01295	SN74LS32N	1	1		
U	107	*	IC,LSTTL,QUAD INTERFACE BUS TRNSCVR	428649	04713	MC3446P	1	1		
U	108-110	*	IC,LSTTL,QUAD BUS XCVR W/3-STATE OUT	453480	04713	MC3448P	3	1		
U	202	*	IC,VOLT REG,ADJ,1.2 TO 37 V,1.5 AMPS	460410	12040	LM317T	1	1		
XU	10- 12		SOCKET,IC,28 PIN	448217	91506	328-AG39D	3			
XU	13, 14, 25		SOCKET,IC,24 PIN	376236	91506	324-AG39D	3			
XU	18, 26,101		SOCKET,IC,40 PIN	429282	09922	DILB40P-108	3			
XU	29, 38,110		SOCKET,IC,16 PIN	276535	91506	316-AG39D	7			1
Y	1	*	CRYSTAL,8MHZ,+/-0.5%,HC-18/U	485060	89536	485060	1	1		

NOTE 1 = ALSO INCLUDES XJ14,18,19.

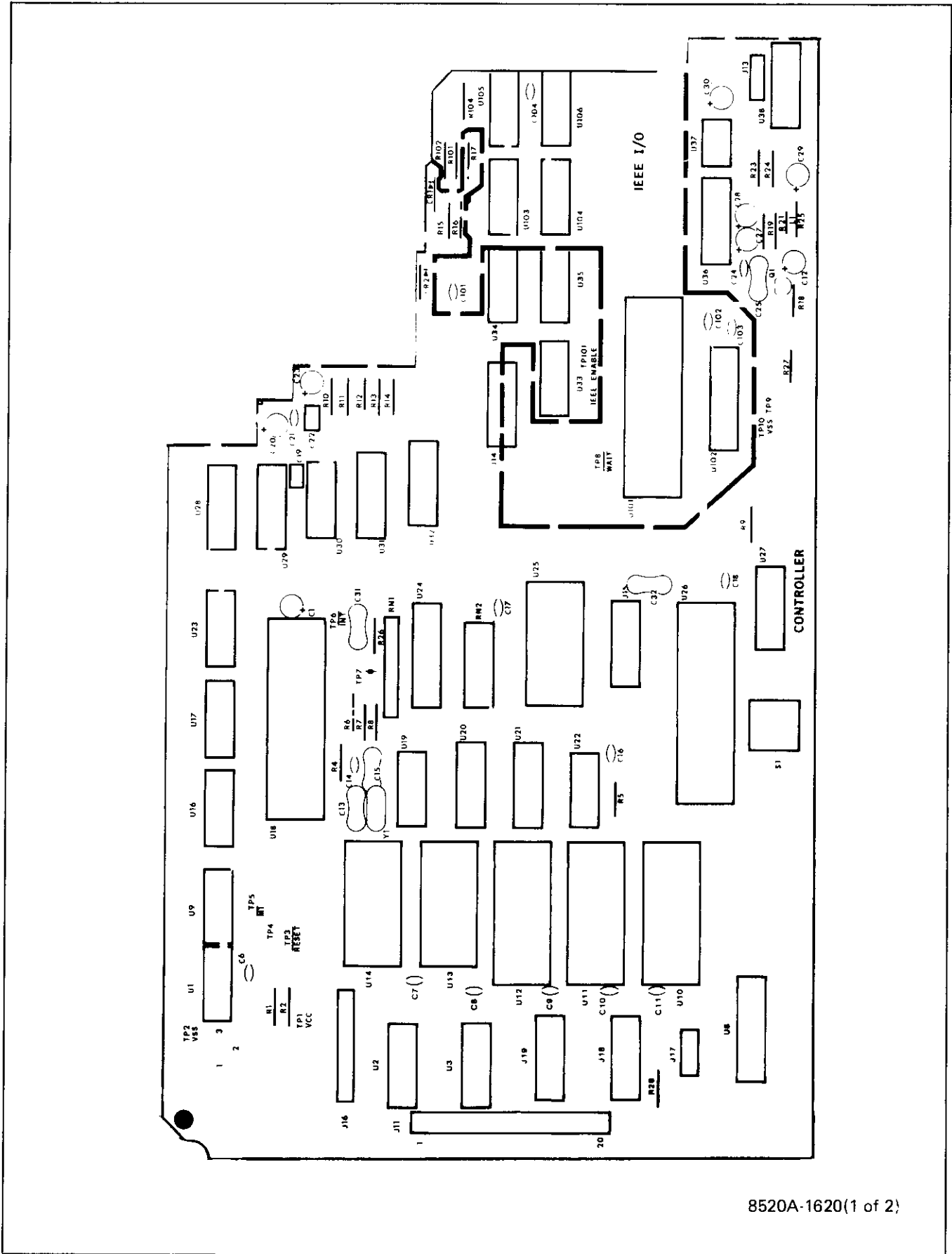
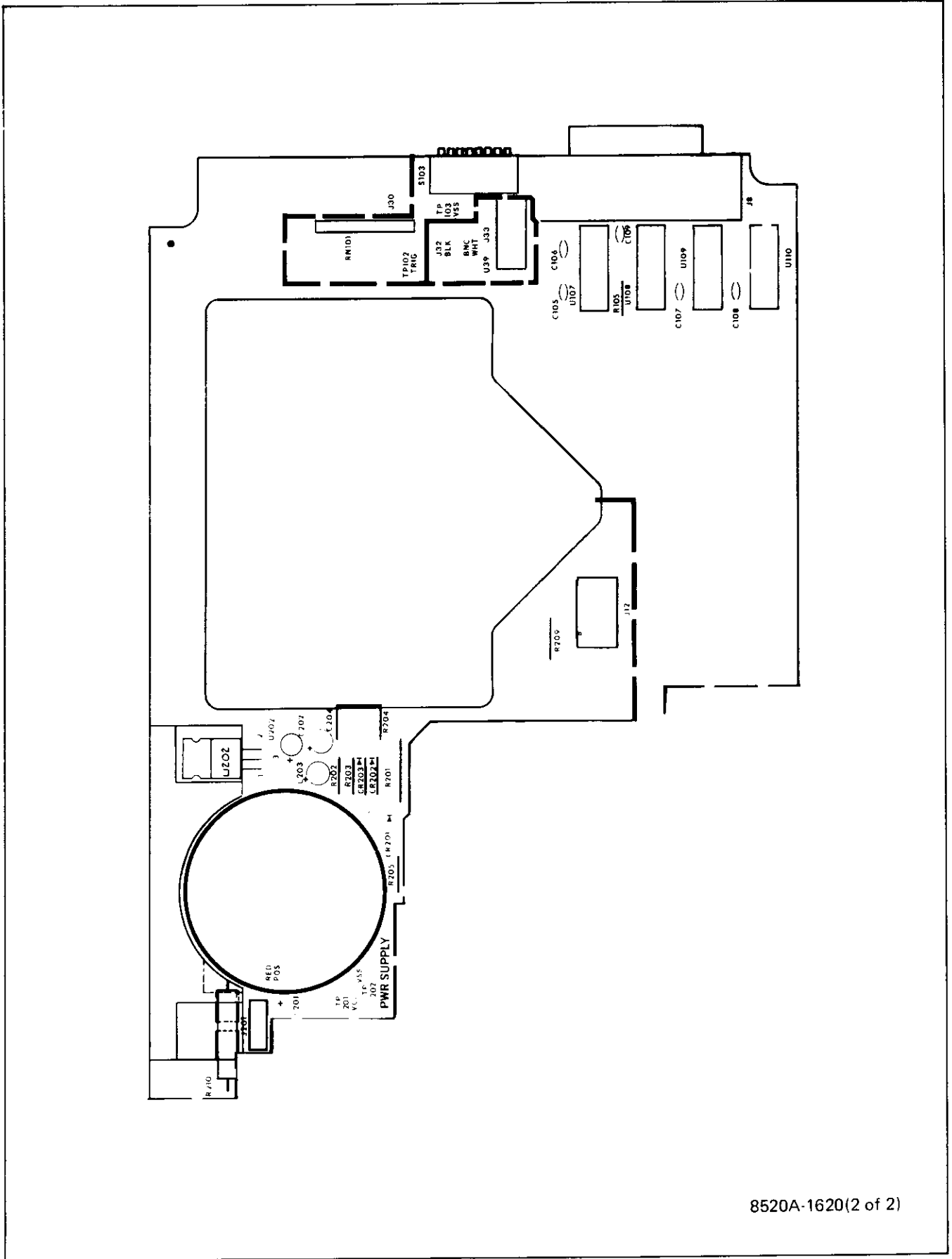


Figure 6-3. A2 Digital (Controller) PCB Assembly



8520A-1620(2 of 2)

Figure 6-3. A2 Digital (Controller) PCB Assembly (cont)

TABLE 6-4. A3 ANALOG PCB ASSEMBLY
(SEE FIGURE 6-4.)

REFERENCE DESIGNATOR A->NUMERICS-->	S	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	R S -Q	O T -E
A 1	*	REFERENCE MODULE PCB (HORIZONTAL)	527994	89536	527994			1
A 1	*	REFERENCE MODULE PCB (VERTICAL)	530626	89536	530626			1
BR 701, 702	*	DIODE, SI, RECT, BRIDGE, BV=200V, IO=1.0A	296509	09423	FB200	2	1	
C 101		CAP, MICA, 120PF, +-5%, 500V	148486	14655	CD15FD121J0	1		
C 221		CAP, POLYPR, 4700PF, +-10%, 200V	512830	89536	512830	1		
C 222, 223		CAP, POLYPR, 0.047UF, +-10%, 50V	413328	84411	JF86	2		
C 224		CAP, POLYES, 0.047UF, +-10%, 50V	271858	06001	75F1R5A474	1	1	
C 225, 231, 403, 408		CAP, VAR, 0.25-1.5PF, 1700V, TEFLON	218206	72982	530-000	4		
C 226, 237-240, 305-307		CAP, TA, 6.8UF, +-20%, 35V	363713	56289	196D685X0035KA1	8		
C 227, 229, 233, 235		CAP, MICA, 430PF, +-5%, 500V	177980	14655	CD15FD431J0	4		
C 230		CAP, POLYCA, 1UF, +-10%, 50V	271619	84411	X463UW1029, 50W	1		
C 236		CAP, MICA, 47PF, +-5%, 500V	148536	72136	CM15E470J	1		
C 241, 308		CAP, TA, 39UF, +-20%, 6V	163915	56289	196D394X0020KA1	2		
C 243		CAP, CER, 0.0012UF, +-10%, 500V, Z5R	106732	71590	CF122	1		
C 244		CAP, CER, 150PF, +-2%, 100V, COG	512988	89536	512988	1		
C 301, 303, 433, 502, 503		CAP, MICA, 33PF, +-5%, 500V	160317	02799	DM15E330J	5		
C 302, 304, 510, 511, 602		CAP, MICA, 100PF, +-5%, 500V	148494	72136	DM15F101J	5		
C 310-312, 435		CAP, CER, 0.22UF, +-20%, 50V, Z5U	309849	71590	CW3C0C224K	4		
C 314, 315		CAP, CER, 2200PF, +-20%, 100V, X7R	358291	89536	358291	2		
C 401		CAP, POLYES, 0.22UF, +-10%, 1000V	485797	52763	MKT-1822322/10	1		
C 402		CAP, PORC, 2.2PF, +-0.25PF, 1700V AC	340273	95275	VY10CA2K2CA	1		
C 404, 501		CAP, MICA, 15PF, +-5%, 500V	148569	72136	DM15C150J	2		
C 409		CAP, CER, 6.8PF, +-0.1PF, 500V, COJ	485383	56289	561CC0JBA102AE6R8B	1		
C 412		CAP, MICA, 390PF, +-5%, 500V	148437	72136	DM15F391J	1		
C 414		CAP, MICA, 62PF, +-1%, 500V	494617	14655	CD15FD620A0	1		
C 415		CAP, MICA, 560PF, +-1%, 300V	494609	14655	CD15FC561A0	1		
C 416		CAP, CER, 6.8PF, +-0.25PF, 50V, M7J	715243	89536	715243	1		
C 417		CAP, CER, 4700PF, +-20%, 100V, X7R	362871	72982	8121-A100-W5R-472M	1		
C 419		CAP, MICA, 820PF, +-1%, 500V	226167	14655	CD19FD821A0	1		
C 420		CAP, MICA, 3600PF, +-1%, 500V	529149	14655	CD19FD362A0	1		
C 422		CAP, CER, 0.047UF, +-20%, 50V, Z5U	460733	71590	CW20C473M	1	1	
C 424-427, 431, 432, 438, 447, 448, 601, 610, 615		CAP, TA, 1UF, +-10%, 35V	161919	56289	196D010X0035G	12		
C 428		CAP, MICA, 2PF, +-0.5PF, 500V	175208	72136	DM15C020E	1		
C 429, 430		CAP, CER, 0.05UF, +80-20%, 25V, Y5U	148924	72982	5855-000-Y5U0-503Z	2		
C 436, 441		CAP, POLYPR, 0.068UF, +-10%, 100V	485441	89536	485441	2		
C 437		CAP, POLYES, 0.012UF, +-10%, 50V	402883	80031	75F1R5A123	1		
C 440		CAP, POLYES, 0.015UF, +-10%, 50V	402891	80031	75F1R5A153	1		
C 442, 443		CAP, POLYPR, 0.047UF, +-10%, 100V	446773	89536	446773	2		
C 446		CAP, CER, 5000PF, +-20%, 100V, Z5V	175232	56289	C023B101H253M	1		
C 450-453		CAP, TA, 10UF, +-20%, 20V	330662	56289	196D106X0020KA1	4		
C 455		CAP, MICA, 51PF, +-5%, 500V	277210	14655	CD15ED510J0	1		
C 456, 611, 612, 614, 616, 708		CAP, TA, 22UF, +-20%, 15V	423012	56289	196D226X0015KA1	6		
C 504		CAP, CER, 300PF, +-10%, 500V, X7W	105734	71590	BB60301KW7W	1		
C 505, 506		CAP, POLYPR, 0.022UF, +-10%, 100V	494948	89536	494948	2		
C 507, 508, 719, 720		CAP, TA, 4.7UF, +-20%, 50V	363721	56289	196D475X9015HA1	4		
C 509		CAP, POLYES, 0.47UF, +-10%, 100V	369124	89536	369124	1		
C 603, 619		CAP, CER, 100PF, +-10%, 100V, COG	557322	89536	557322	2		
C 604-607		CAP, TA, 10UF, +-20%, 10V	176214	56289	196D106X0010KA1	4		
C 608, 609		CAP, TA, 10UF, +-20%, 15V	193623	56289	196D106X0015A1	2		
C 617		CAP, MICA, 5PF, +-0.5PF, 500V	148577	89536	148577	1		
C 618		CAP, MICA, 22PF, +-5%, 500V	148551	02799	DM15C220J	1		
C 706		CAP, AL, 10000UF, +30-20%, 16V	494831	89536	494831	1		
C 707		CAP, TA, 2.2UF, +-20%, 20V	161927	56289	196D225X0020HA1	1		
C 709, 710		CAP, AL, 470UF, +50-20%, 50V	478792	89536	478792	2		
C 711, 712		CAP, AL, 330UF, +50-20%, 100V	484436	89536	484436	2		
C 717, 718		CAP, TA, 22UF, +-20%, 35V	394775	56289	196D226X0035TE4	2		
CR 105	*	ZENER, UNCOMP, 16.0V, 5%, 15.5MA, 1.0W	313221	12969	UZ8716	1	1	
CR 107-110	*	ZENER, UNCOMP, 18.0V, 5%, 7.0MA, 0.4W	327973	04713	1N967B	4	1	
CR 215, 305-307, 312, 407-410, 501, 502, 507	*	DIODE, SI, BV= 75.0V, IO=150MA, 500 MW	203323	07910	1N4448	12	1	
CR 218, 219, 503-506	*	DIODE, SI, BV= 90.0V, IO= 75MA, SELCTD IR	260554	07910	CD55105	6	1	
CR 220, 412, 705,	*	DIODE, SI, 100 PIV, 1.0 AMP	343491	01295	1N4002	4	1	

TABLE 6-4. A3 ANALOG PCB ASSEMBLY
(SEE FIGURE 6-4.)

REFERENCE DESIGNATOR A->NUMERICS->	S	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	R S -Q	O T -E
CR 706	*		343491					
CR 301,304	*	ZENER,UNCOMP, 10.0V,10%, 12.5MA, 0.4W	113324	07910	1N961A	2	1	
CR 313	*	ZENER,UNCOMP, 4.7V,10%, 20.0MA, 0.4W	387084	07910	1N750	1	1	
CR 402	*	DIODE,SI,BV= 20.0V,I0= 50MA,SELCTD IR	348177	07263	FD7223	1	1	
CR 404	*	ZENER,UNCOMP, 6.8V, 5%, 20.0MA, 0.4W	260695	07910	1N754A	1	1	
CR 405,406,408	*	DIODE,SI,SCHOTTKY BARRIER,SMALL SIGNAL	313247	28484	HF5082-6264	3	1	
CR 703,704,707, CR 709	*	DIODE,SI, 50 PIV, 2.0 AMP	347559	05277	1N5400	4	2	
CR 708	*	LED,RED,LUM INT= 1 MCD,W/STANDOFFS	429555	12040	NLS5053	1	1	
E 1, 2		TERM,INSUL,FEEDTHRU,BIFURCATED	281865	12615	SL-841-777	2		
H 1		NUT,PRESS,BROACH,STL,4-40	380196	24347	KF2-440	2		
H 2		SCREW,MACH,PHP,S,STL,4-40X1/4	256156	89536	256156	2		
H 3		WASHER,SHLDR,NYLON,#4	436386	86928	5607-45	5		
H 4		SCREW,MACH,PHP,STL,4-40X5/16	152116	89536	152116	5		
J 19- 22		HEADER, PROGRAMMED	504373	51167	14-675-191	4		
J 418-420		CONNECTING LINK	523159	89536	523159	3		
J 502		HEADER, PROGRAMMED	495507	51167	16-675-191	1	1	
K 101		RELAY,ARMATURE,2 FORM C,4.5VDC	519710	89536	519710	1		
K 102		RELAY,ARMATURE,2 FORM C,4.5VDC	514240	26806	AZ-420-12-203	1		
K 103		RELAY,ARMATURE,4 FORM C,4.5VDC	422931	77342	R10-E3713-3	1		
K 104,304,401		RELAY,REED,1 FORM A,5VDC	500132	89536	500132	3		
K 301-303		RELAY,REED,1 FORM A,4.5V	772285	89536	772285	3		
L 201,202		CORE,TOROID,FERRITE,.047X.138X.118	321182	89536	321182	2		
L 601		CHOKER,6TURN	320911	89536	320911	1		
MP 1		BRACKET,ANALOG HEATSINK	490995	89536	490995	1	1	
MP 2		HEATSINK	347740	05820	260-18D	1		
MP 3		INSUL PART,TRANS,SILICONE,POWER	508630	89536	508630	5		
MP 4		SUPPORT,RESISTOR	545079	89536	545079	1		
MP 5		SHIELD DC BUFFER	496786	89536	496786	1		
MP 6		SHIELD, AC CONVERTER	514984	89536	514984	1		
MP 7		BALL STUD	347542	89536	347542	6		
MP 8		SPACER,RND,SOLUBLE,0.062IDX0.1560D	296319	32559	T0806	2		
MP 9		SPACER,SWAGED,HEX,BRASS,6-32X3/4	194076	89536	194076	2		
P 17		HEADER,1 ROW,0.100CTR,11 PIN	494666	00779	1-640456-1	1		
P 23, 24		PIN,SINGLE,PWB,0.058 DIA	233411	00779	60599-3	2		
Q 103,106-108, Q 224	*	TRANSISTOR,SI,N-JFET,TO-92	483099	27014	SF53017	5	1	
Q 104,221,223	*	TRANSISTOR,SI,N-JFET,HI-VOLTAGE,TO-92	524157	32293	ITS31250	3	1	
Q 111-114,236- Q 238	*	TRANSISTOR,SI,N-JFET,HI-VOLTAGE,TO-92	393314	17856	5T3824	7	1	
Q 115,116,310, Q 311	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	168716	07263	S19254	4	1	
Q 225,226	*	TRANSISTOR,SI,PNP,HI-SPEED SWITCH	369629	07263	543576	2	1	
Q 227,234	*	TRANSISTOR,SI,N-JFET,DUAL,TO-71	478172	32293	ITS02P	2	1	
Q 228-230,235, Q 304	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	5	2	
Q 231-233	*	TRANSISTOR,SI,N-DMOS FET,TO-72	394122	18324	SD210	3	1	
Q 239,240	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	266619	07263	2N4888	2	1	
Q 305,306,528- Q 532	*	TRANSISTOR,SI,N-JFET,TO-92	508697	21845	FS933	7	1	
Q 308	*	TRANSISTOR,SI,N-JFET,TO-92	343830	12040	NSSF50024	1	1	
Q 309	*	TRANSISTOR,SI,NPN,DUAL,TO-5	478099	12040	LM3940M	1	1	
Q 314,315	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	203489	09214	11C2322	2	2	
Q 317	*	TRANSISTOR,SI,PNP,SM SIG,DARLINGTON	524140	04713	MPS-A63	1	1	
Q 401,403-406	*	TRANSISTOR,SI,N-JFET,TO-92	288324	89536	288324	5	1	
Q 402,407-409, Q 416-419,421, Q 506-509,514, Q 516,518,520, Q 522	*	TRANSISTOR,SI,N-JFET,TO-92,SWITCH	261578	15818	U2366J	18	1	
Q 410	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	229898	04713	MPS6522	1	4	
Q 411	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218081	04714	MPS6520	1	1	
Q 411	*	ZENER,UNCOMP, 8.2V, 5%, 20.0MA, 0.4W	386771	04713	1N756A	1	1	
Q 414,415	*	TRANSISTOR,MATCHED	504191	89536	504191	1	1	
Q 501,502,503	*	MATCHED J-FETS	274795	89536	274795	2	1	
Q 316,510,511	*		274795					
Q 504,505	*	TRANSISTOR,SI,N-JFET,SWITCHING,TO-92	370072	15818	U3422J	2	1	
Q 512,513,515, Q 517,519,521, Q 523-526	*	FIELD EFFECT GROUPED N-CHANNEL 10 PCS	492306	89536	492306	1		
Q 527	*		492306					
R 101,102	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	1	1	
R 103	*	THERMISTOR,RECT.,POS.,500,+-40%,25C	500017	89536	500017	2		
R 104	*	THERMISTOR,RECT.,POS.,1K,+-40%,25C	494740	50157	180Q10215	1	1	
	*	RES,WW,2K,+-1%,7W	682328	89536	682328	1		

TABLE 6-4. A3 ANALOG PCB ASSEMBLY
(SEE FIGURE 6-4.)

REFERENCE DESIGNATOR A->NUMERICS-->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S -Q	N O T -E
R 109		RES, VAR, CERM, 200, +-10%, 0.5W	275743	89536	275743	1		
R 110		RES, CC, 150K, +-5%, 2W	110122	01121	HB1545	1		
R 111		RES, CF, 220K, +-5%, 0.25W	573642	80031	CR251-4-5P220K	1		
R 112		RES, CF, 150K, +-5%, 0.25W	573600	89536	573600	1		
R 113		RES, CC, 1M, +-10%, 0.5W	108134	01121	EB1051	1		
R 114, 115		RES, MF, 150K, +-1%, 0.125W, 100PPM	241083	91637	CMF551503F	2	3	
R 120, 121		RES, CF, 8.2K, +-5%, 0.25W	441675	80031	CR251-4-5P8K2	2		
R 223, 252, 254		RES, MF, 71.5K, +-1%, 0.125W, 100PPM	291435	91637	CMF557152F	3		
R 224		RES, MF, 169K, +-1%, 0.125W, 100PPM	289454	91637	CMF551693F	1		
R 225, 226, 240,		RES, MF, 1K, +-1%, 0.125W, 100PPM	168229	91637	CMF551001F	4		
R 241			168229					
R 227, 228, 231,		RES, MF, 20K, +-1%, 0.125W, 100PPM	291872	91637	CMF552002F	8		
R 243, 244, 247,			291872					
R 324, 326			291872					
R 229		RES, MF, 93.1K, +-1%, 0.125W, 100PPM	223586	91637	CMF559312F	1		
R 230		RES, MF, 14.7K, +-1%, 0.125W, 100PPM	226225	91637	CMF551472F	1		
R 232, 237		RES, MF, 1.21K, +-1%, 0.125W, 100PPM	229146	91637	CMF551211F	2		
R 234		RES, MF, 1.87K, +-1%, 0.125W, 100PPM	267229	91637	CMF551871F	1		
R 235		RES, MF, 1.47K, +-1%, 0.125W, 100PPM	293654	91637	CMF551471F	1		
R 236		RES, VAR, CERM, 5K, +-10%, 0.5W	327569	11236	360T-502A	1		
R 239, 462		RES, MF, 1.3K, +-1%, 0.125W, 100PPM	343921	91637	CMF551301F	2		
R 242, 712		RES, CF, 390, +-5%, 0.25W	573105	80031	CR251-4-5P390E	2		
R 251, 253, 425,		RES, VAR, CERM, 100, +-10%, 0.5W	275735	11236	360T-101A	6		
R 426, 520, 527			275735					
R 255, 256		RES, CF, 15, +-5%, 0.25W	348755	80031	CR251-4-5P15E	2		
R 257, 258, 334-		RES, CF, 150, +-5%, 0.25W	573030	80031	CR251-4-5P150E	5		
R 336			573030					
R 261, 264, 312,		RES, CF, 10K, +-5%, 0.25W	573394	80031	CR251-4-5P10K	6		
R 613, 614, 621			573394					
R 265, 266		RES, CF, 4.7K, +-5%, 0.25W	573311	80031	CR251-4-5P4K7	2		
R 267, 269		RES, MF, 2.74K, +-1%, 0.125W, 100PPM	293761	91637	CMF552741F	2		
R 268		RES, MF, 6.65K, +-1%, 0.125W, 100PPM	294918	91637	CMF551272F	1		
R 270, 505		RES, MF, 51.1K, +-5%, 0.125W, 100PPM	289553	91637	CMF555112F	2		
R 271		RES, MF, 12.7K, +-1%, 0.125W, 100PPM	217448	91637	CMF551272F	1		
R 272		THERMISTOR, DISC, NEG., 10K, +-10%, 25C	104596	73168	JA41J1	1		
R 273		RES, CC, 4700M, +-10%, 0.25W	603530	01121	CB477	1	1	
R 280		RES, CC, 10, +-10%, 0.125W	321125	01121	RB1001	1		
R 303		8520A OHMS REF RES	503821	89536	503821	1		
R 305, 512, 517,		RES, CF, 1K, +-5%, 0.25W	573170	80031	CR251-4-5P1K	5		
R 612, 622			573170					
R 306		RES, MF, 76.8K, +-1%, 0.125W, 25PPM	257394	91637	CMF557682F	1		
R 307		RES, MF, 57.6K, +-1%, 0.125W, 25PPM	484915	91637	CMF555762F	1		
R 308		RES, MF, 25.5K, +-1%, 0.125W, 25PPM	446666	91637	CMF552552F	1		
R 309, 342		RES, CF, 100, +-5%, 0.25W	573014	80031	CR251-4-5P100E	2		
R 311, 422, 519		RES, VAR, CERM, 500, +-10%, 0.5W	325613	89536	325613	3		
R 314, 433, 521,		RES, VAR, CERM, 50, +-10%, 0.5W	447862	11236	360T-500A	4		
R 710			447862					
R 315, 518		RES, VAR, CERM, 1K, +-10%, 0.5W	275750	11236	360T-102A	2		
R 317		RES, VAR, CERM, 50K, +-10%, 0.5W	335778	11236	360T-503A	1		
R 318		RES, MF, 191K, +-1%, 0.125W, 100PPM	375923	91637	CMF551913F	1		
R 319, 408, 481		RES, VAR, CERM, 10K, +-10%, 0.5W	485458	32997	3299W-CR2-103	3		
R 320	*	RES, CERM, 4.0455M, +-0.1%, 0.75W	474932	89536	474932	1		
R 321		RES, CERM, 449.55K, +-0.1%, 0.33W	478990	89536	478990	1		
R 322		RES, MF, 13.7K, +-1%, 0.125W, 100PPM	236752	91637	CMF551372F	1		
R 323		RES, MF, 2K, +-1%, 0.125W, 100PPM	235226	91637	CMF552001F	1		
R 325		RES, VAR, CERM, 25K, +-10%, 0.5W	500769	32997	3299W-W-253	1		
R 327, 328		RES. SET, 2M T.C. MATCHED	290320	89536	290320	1		
R 329		RES, MF, 12.1K, +-1%, 0.125W, 100PPM	234997	91637	CMF551212F	1		
R 330		RES, MF, 3.16M, +-1%, 0.125W, 100PPM	494815	91637	CMF553164F	1		
R 331, 601		RES, CF, 10K, +-5%, 0.25W	348839	80031	CR251-4-5P10K	2		
R 332		RES, WW, 10K, +-5%, 6W	500025	89536	500025	1		
R 341		RES, MF, 37.4K, +-1%, 0.125W, 100PPM	226241	91637	CMF553742F	1		
R 343		RES, CF, 330K, +-5%, 0.25W	641159	89536	641159	1		
R 401		RES, CC, 560, +-5%, 0.25W	572685	01121	CB5615	1		
R 403		RES, CERM, 1.1104M, +-0.05%, 0.75W, 5PPM	493627	19647	TF050R	1		
R 412		RES, MF, 556.39K, +-0.1%, 0.125W, 25PPM	485367	91637	CMF55	1		
R 421		RES, MF, 79.24K, +-0.1%, 0.125W, 25PPM	485334	89536	485334	1		
R 427, 428, 488		RES, CF, 2K, +-5%, 0.25W	573238	80031	CR251-4-5P2K	3		
R 432		RES, MF, 8.8091K, +-0.1%, 0.125W, 25PPM	485342	89536	485342	1		
R 435		RES, CF, 62K, +-5%, 0.25W	348904	80031	CR251-4-5P62K	1		
R 436		RES, MF, 1.1108K, +-0.1%, 0.125W, 25PPM	485359	91637	485359	1		
R 437		RES, MF, 47.5K, +-1%, 0.125W, 100PPM	289546	91637	CMF554752F	1		
R 438		RES, VAR, CERM, 20K, +-10%, 0.5W	335760	11236	360T-203A	1		
R 439		RES, CF, 51K, +-5%, 0.25W	573535	89536	573535	1		

TABLE 6-4. A3 ANALOG PCB ASSEMBLY
(SEE FIGURE 6-4.)

REFERENCE DESIGNATOR A->NUMERICS-->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S	O T	N E
R 440		RES, VAR, CERM, 50, +-10%, 0.5W	500009	32997	3299W-CR2-500	1			
R 441		RES, MF, 4.975K, +-0.1%, 0.125W, 25PPM	340232	89536	340232	1			
R 442		RES, MF, 1.69, +-1%, 0.125W, 100PPM	236869	91637	CMF551690F	1			
R 443, 461, 514		RES, MF, 1M, +-1%, 0.125W, 100PPM	268797	91637	CMF551004F	3			
R 444, 528		RES, CF, 1.5K, +-5%, 0.25W	573212	80031	CR251-4-5P1K5	2			
R 445, 463		RES, VAR, CERM, 200K, +-10%, 0.5W	381921	32997	3299W-CR2-204	2			
R 446, 447		RES, CF, 2.4K, +-5%, 0.25W	573253	89536	573253	2			
R 448, 452, 482, R 529		RES, CF, 510, +-5%, 0.25W	573139	89536	573139	4			
R 449, 451		RES, CF, 3K, +-5%, 0.25W	441527	80031	CR251-4-5P3K	2			
R 450		RES, CF, 9.1K, +-5%, 0.25W	441691	80031	CR251-4-5P9K1	1			
R 453		RES, MF, 4.99K, +-1%, 0.125W, 100PPM	168252	91637	MFF1-84991	1			
R 454		RES, CF, 750, +-5%, 0.25W	573162	80031	CR251-4-5P750E	1			
R 455		RES, MF, 5K, +-0.1%, 0.125W, 25PPM	340240	91637	CMF555001B	1			
R 456		RES, CF, 560, +-5%, 0.25W	385948	80031	CR251-4-5P560E	1			
R 457		RES, MF, 10K, +-0.1%, 0.125W, 25PPM	435065	89536	435065	1			
R 458		RES, MF, 20K, +-0.1%, 0.125W, 25PPM	340620	91637	CMF55	1			
R 459		RES, CF, 240K, +-5%, 0.25W	442459	80031	CR251-4-5P240K	1			
R 464		RES, CF, 750, +-5%, 0.25W	441659	80031	CR251-4-5P750E	1			
R 466		RES, CC, 5.1, +-5%, 0.25W	281832	01121	CB5R15	1			
R 467, 475, 476		RES, CF, 300K, +-5%, 0.25W	573659	89536	573659	3			
R 468		RES, CF, 6.8K, +-5%, 0.25W	573352	89536	573352	1			
R 470		RES, MF, 316K, +-1%, 0.125W, 100PPM	289496	91637	CMF553163F	1		1	
R 472, 473		RES, CF, 47K, +-5%, 0.25W	573527	80031	CR251-4-5P47K	2			
R 474, 477		RES, CF, 43K, +-5%, 0.25W	573519	89536	573519	2			
R 478		RES, CF, 2K, +-5%, 0.25W	441469	80031	CR251-4-5P2K	1			
R 479		RES, CF, 82, +-5%, 0.25W	573006	89536	573006	1			
R 480		RES, MF, 315K, +-0.1%, 0.125W, 25PPM	485375	89536	485375	1			
R 489		RES, CF, 5.6, +-5%, 0.25W	572917	89536	572917	1			
R 501, 508		RES, MF, 6.49K, +-1%, 0.125W, 100PPM	294900	91637	CMF556491F	2			
R 502		RES, MF, 100, +-1%, 0.125W, 100PPM	168195	91637	CMF551000F	1			
R 503, 504		RES, VAR, CERM, 5K, +-10%, 0.5W	493593	32997	3299W-CR2-502	2			
R 506, 510		RES, CF, 27K, +-5%, 0.25W	573477	80031	CR251-4-5P27K	2			
R 507, 511		RES, CF, 20K, +-5%, 0.25W	573444	80031	CR251-4-2P20K	2			
R 513		RES, VAR, CERM, 100K, +-10%, 0.5W	369520	11236	360T-104A	1			
R 515		RES, MF, 133K, +-1%, 0.125W, 100PPM	289074	91637	CMF551333F	1			
R 516		RES, MF, 143, +-1%, 0.125W, 100PPM	192906	91637	CMF551430F	1			
R 522		RES, VAR, CERM, 20, +-20%, 0.5W	275727	11236	360T-200B	1			
R 523, 532		RES, MF, 26.7K, +-1%, 0.125W, 100PPM	245779	91637	CMF552672F	2			
R 524		RES, MF, 28.7K, +-1%, 0.125W, 100PPM	235176	91637	CMF552872F	1			
R 525		RES, MF, 33.2K, +-1%, 0.125W, 100PPM	291393	91637	CMF553322F	1			
R 526		RES, MF, 49.9K, +-1%, 0.125W, 100PPM	268821	91637	CMF554992F	1			
R 530		RES, CF, 15K, +-5%, 0.25W	573428	80031	CR251-4-5P15K	1			
R 534, 535		RES, CF, 47, +-5%, 0.25W	572982	80031	CR251-4-5P47E	2			
R 538		RES, MF, 130, +-1%, 0.125W, 100PPM	485698	91637	CMF551300F	1			
R 539		RES, MF, 200, +-1%, 0.125W, 100PPM	245340	91637	CMF552000F	1			
R 602		RES, MF, 121K, +-1%, 0.125W, 100PPM	229369	89536	229369	1			
R 603		RES, MF, 28K, +-1%, 0.125W, 100PPM	291385	91637	CMF552802F	1			1
R 604		RES, CF, 51, +-5%, 0.25W	572990	89536	572990	1			
R 606		RES, CF, 100K, +-5%, 0.25W	573584	80031	CR251-4-5P100K	1			
R 609		RES, CF, 1M, +-5%, 0.25W	573691	80031	CR251-4-5P1M	1			
R 619		RES, CF, 820, +-5%, 0.25W	442327	80031	CR251-4-5P820E	1			
R 623		RES, CF, 1.2K, +-5%, 0.25W	573196	89536	573196	1			
R 709		RES, WW, FUSIBLE, 0.1, +-10%, 2W	485672	89536	485672	1			
R 711		RES, CF, 390, +-5%, 0.25W	441543	80031	CR251-4-5P390E	1			
R 713, 714		RES, CF, 3.3K, +-5%, 0.25W	348813	80031	CR251-4-5P3K3	2			
RN 101		RES, NET, SIP, 8 PIN, 7 RES, 200K, +-2%	485128	89536	485128	1			
RN 104	*	RES, NET, CERM, TOL, TC, MATCHED	479287	89536	479287	1			
RN 202, 301		RES, NET, DIP, 14 PIN, 7 RES, 100K, +-5%	516930	89536	516930	2			
RN 203	*	RES NET ASSY TESTED (122-6.8K(3))8520	502922	89536	502922	1			
RN 302	*	RES NET ASSY TESTED (2K-200K(4))8520	502971	89536	502971	1			
RN 401		RES, NET, SIP, 6 PIN, 5 RES, 22K, +-2%	520122	89536	520122	1			
RN 402		RES, NET, SIP, 8 PIN, 7 RES, 4.7K, +-2%	412916	80031	95081002CL	1			
RN 501	*	RES NET ASSY TESTED (85-100K(10))8520	502948	89536	502948	1			
RN 502	*	RES NET ASSY TESTED (25K-400K(8))8520	502963	89536	502963	1			
RN 503		RES, NET, SIP, 6 PIN, 5 RES, 100K, +-2%	412726	89536	412726	1			
RN 504		RES, NET, SIP, 8 PIN, 7 RES, 100K, +-2%	412908	89536	412908	1			
RN 505		RES, NET, DIP, 16 PIN, 8 RES, 100K, +-5%	380618	89536	380618	1			
RN 601		RES, NET, SIP, 10 PIN, 9 RES, 10K, +-2%	414003	80031	95081002CL	1			
RN 602, 603		RES, NET, SIP, 8 PIN, 7 RES, 10K, +-2%	412924	80031	95081002CL	2			
RV 101, 102		VARIATOR, 390V, +-10%, 1.0MA	423475	09214	V390MAX781	2			
RV 101, 102		VARIATOR, 390, +-10%, 1.0MA	697383	89536	697383	2		1	
RV 103-105		VARIATOR, 330V, +-20%, 1.0MA	520874	09214	V330MAX5B	3		1	
RV 701		VARIATOR, 33V, +-10%, 1.0MA	485391	89536	485391	1		1	

TABLE 6-4. A3 ANALOG PCB ASSEMBLY
(SEE FIGURE 6-4.)

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK	MFRS SPLY	MANUFACTURERS PART NUMBER	TOT QTY	R S T	N O T
A->NUMERICS-->	S-----	--NO--	CODE--	--OR GENERIC TYPE--		-Q-	-E-
S 101	SWITCH, 2 POLE-2 THROW	504852	89536	504852	1		
S 102	SWITCH, 8 POLE-2 THROW	504845	89536	504845	1	1	
TP	TEST POINTS	512889	02660	62395	42		
U 101	* IC,ARRAY,7 TRANS,NPN,DARLINGTON PAIRS	483081	01295	ULN2004AN	1	1	
U 102,209	* IC,BIPLR,5CHNL HI-VOLT DISPLAY DRIVER	504795	56289	UPH-480	2	1	
U 103,206	* IC,CMOS,HEX OPEN DRAIN P-CHNL BUFFER	418947	12040	MM74C907N	2	1	
U 205	* IC,OP AMP,JFET INPUT,8 PIN DIP	472779	12040	LF386N	1	1	
U 207	* IC,LSTTL,HEX INVERTER	393058	01295	SN74LS04N	1	1	
U 208	* IC,LSTTL,QUAD 2 INPUT NAND GATE	394205	01295	SN74LS03N	1	1	
U 210,211	* IC,OP AMP,GEN PURPOSE,COMPENSATD,TO-5	392902	12040	LM1436H	2	1	
U 301	* IC,ARRAY,5 TRANS,5 ISD: 2-PNP,3-NFN	418954	02735	CA3096E	1	1	
U 302,303	* IC,OP AMP,GENERAL PURPOSE,8 PIN DIP	478107	12040	308AN	2	1	
U 401	* IC,OP AMP,JFET INPUT,TO-5 CASE	429951	12040	LF357AH	1		
U 402	* IC,OP AMP,JFET INPUT,TO-5 CASE	477869	12040	LF357H	1	1	
U 403	* IC,OP AMP,JFET INPUT,TO-5 CASE	429837	12040	LF356F	1	1	
U 404	* IC,OP AMP,DUAL,JFET INPUT,8 PIN DIP	495119	12040	LF353BN	1	1	
U 405	* IC,OP AMP,JFET INPUT,8 PIN DIP	483305	12040	LF351BN	1	1	
U 406	* IC,BIPLR,7CHNL HI-VOLT DISPLAY DRIVER	504894	56289	UPH481	1	1	
U 407	* IC,VOLT REG,FIXED,+8 VOLTS,0.1 AMPS	429647	07263	A78L08AWC	1	1	
U 408,502,503	* IC,OP AMP,GEN PURPOSE,TO-78 METAL CAN	288928	12040	LM308AH	3	1	
U 409	* IC,VOLT REG,FIXED,-8 VOLTS,1.5 AMPS	407635	04713	MC7908CT	1	1	
U 501	ZENER REF AMP	510669	89536	510669			1
U 504-506	* IC,OP AMP,JFET IN,COMPENSTD,8 PIN DIP	418780	12040	LF351	3	1	
U 601	* IC,NMOS,8 BIT MICROCOMPUTR,8520A-8120	524496	89536	524496	1		
U 602	* IC,CMOS,UNIV ASYNC RECEIVER/TRANSMITR	658854	89536	658854	1		
U 603,607,617	* IC,CMOS,HEX D F/F,+EDG TRG,W/RESET	404509	12040	MM74C174N	3		
U 604	* IC,TTL,4-16 LINE DCDR W/DUAL STROBE	293217	01295	SN74154N	1	1	
U 605	* IC,CMOS,DUAL SYNC BINRY UP CNTR	355164	04713	MC14520BCP	1	1	
U 608	* IC,CMOS,DUAL D F/F,+EDG TRG	418830	12040	MM74C74	1	1	
U 609	* IC,LSTTL,RETRG MONOSTAB MULTIVR W/CLR	404186	01295	SN74LS123N	1		
U 610	* IC,TTL,DUAL NAND DRVR W/OPEN COLLECT	329706	01295	SN75452P	1	1	
U 611,612	* IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	2	1	
U 613	* IC,TTL,QUAD 2 INPUT AND GATE	393066	01295	SN74LS08N	1	1	
U 614,616	* IC,CMOS,HEX INVERTER	404699	12040	MM74C04N	2	1	
U 615	* IC,LSTTL,HEX INVERTER W/OPEN COLLECT	394536	01295	SN74LS05	1	1	
U 618-621	* IC,LSTTL,OCTAL D F/F,+EDG TRG,W/CLEAR	458892	01295	SN74LS273N	4	1	
U 622-624	* IC,BIPLR,8CHNL HI-VOLT DISPLAY DRIVER	504902	56289	UPH-482	3	1	
U 627	TRANSF,PULSE,DIP PACK	500298	32997	4252-1034	1	1	
U 703	* IC,VOLT REG,FIXED,+5 VOLTS,1.5 AMPS	428847	04713	MC7805CT	1	1	
U 704	* IC,VOLT REG,FIXED,+12 VOLTS,1.5 AMPS	413195	04713	MC7812TP	1	1	
U 705	* IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	413187	04713	MC7815CT	1	1	
U 706	* IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	413179	04713	MC7915CP	1	1	
U 707	* IC,VOLT REG,FIXED,-12 VOLTS,1.5 AMPS	381665	04713	MC7912CP	1	1	
X 1-14	SOCKET,SINGLE,PWB,FOR 0.012-0.022 PIN	376418	22526	75060-005	14		
XJ 418-420	SOCKET,1 ROW,PWB,0.100CTR,4 POS	417311	30035	JS-109-1-04	4		
XK 101,103	RELAY SOCKET,4 POLE	441964	77342	R10273606	2		
XK 101,103	RELAY SOCKET,ACCESSORY,SPRING,4 POLE	500108	77342	20C250	2		
XK 102	RELAY SOCKET,ACCESSORY,SPRING,2 POLE	376459	77342	20C249	1		
XK 102	RELAY SOCKET,2 POLE	376665	77342	27E501	1		
XSW601	SOCKET,IC,8 PIN	478016	91506	308-AG39D	1		
XU 103,206,207,	SOCKET,IC,14 PIN	276527	09922	DILB8P-108	10	1	2
XU 608,614,616		276527					2
XU 210,211,402,	SOCKET,IC,TO-99,8 PIN,CIRCULAR	408450	89536	408450	11		4
XU 403,408,502,		408450					4
XU 503		408450					4
XU 601,602	SOCKET,IC,40 PIN	429282	09922	DILB40P-108	2		
XU 603,605,607,	SOCKET,IC,16 PIN	276535	91506	316-AG39D	7		3
XU 611,612,617		276535					3
XU 604	SOCKET,IC,24 PIN	376236	91506	324-AG39D	1		
XU 703-707	SOCKET,TRANS,3 PIN	402958	89536	402958	5		
Y 601	* CRYSTAL,6MHZ,+0.01%,HC-18/U	461665	89536	461665	1		

NOTE 1 = ONLY ONE OF THESE ITEMS IS INSTALLED.

NOTE 2 = ALSO INCLUDES XJ19-XJ22.

NOTE 3 = ALSO INCLUDES XJ502.

NOTE 4 = ALSO INCLUDES XQ227,234,414,415.

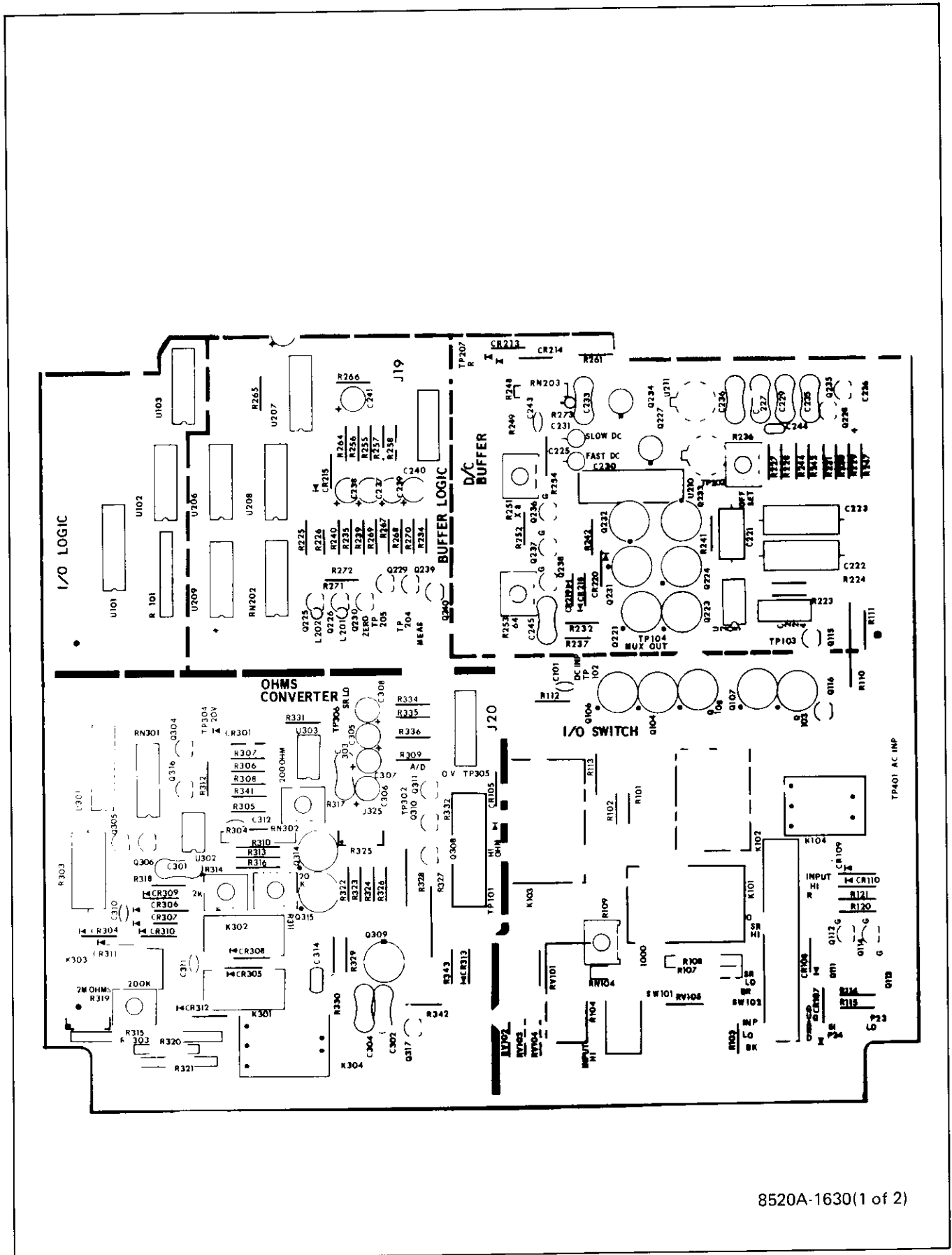
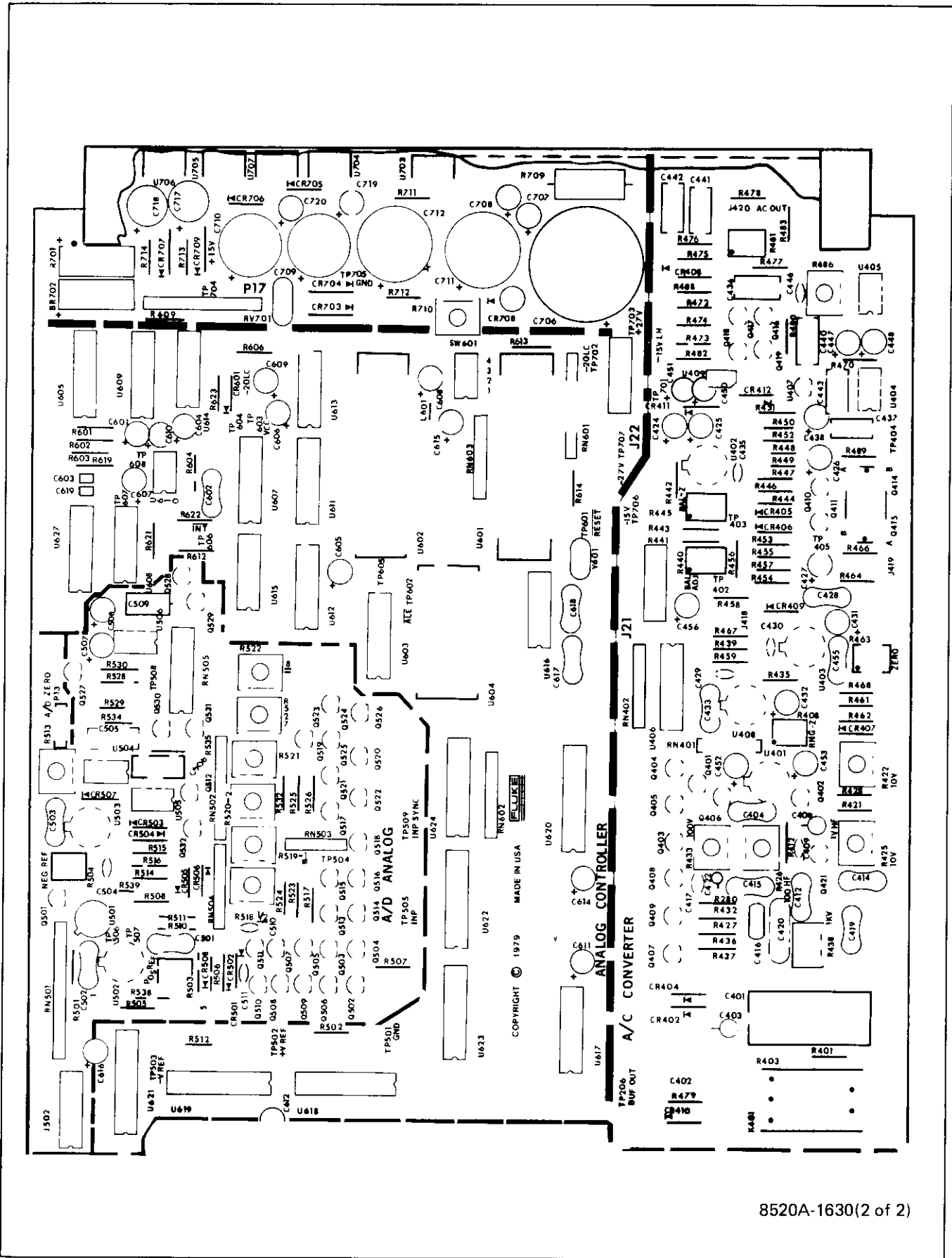


Figure 6-4. A3 Analog PCB Assembly



8520A-1630(2 of 2)

Figure 6-4. A3 Analog PCB Assembly (cont)

TABLE 6-5A. A3A1 REF AMP PCB ASSEMBLY (HORIZONTAL)
(SEE FIGURE 6-5A.)

REFERENCE DESIGNATOR	A->NUMERICS-->	S-----DESCRIPTION-----	FLUKE STOCK --NO--	MFRS SPLY CODE--	MANUFACTURERS PART NUMBER --OR GENERIC TYPE--	TOT QTY	R S T	N O T
C	1	CAP, CER, 2000PF, +100-0Z, 1000V, Z5U	105569	71590	DA140-139CB	1		
C	2, 3	CAP, TA, 2.2UF, +-20%, 20V	161927	56289	196D225X0020HA1	2		
CR	1, 2	* DIODE, SI, BV= 75.0V, IO=150MA, 500 MW	203323	07910	1N4448	2	1	
MP	1	SPACER, MOUNT, NYLON	152207	07047	10123-DAP	1	1	
R	1	RES, CF, 1M, +-5%, 0.25W	348987	80031	CR251-4-5F1M	1		
R	2	RES, MF, 3.74K, +-1%, 0.125W, 25PPM	260547	91637	CMF553741F	1		
R	3	RES, VAR, CERM, 2K, +-10%, 0.5W	285163	89536	285163	1		
R	5	RES, MF, 15.4K, +-0.1%, 0.125W, 25PPM	340604	91637	CMF551542F	1		
R	6	RES, MF, 10.05K, +-0.1%, 0.125W, 25PPM	340216	89536	340216	1		
R	7	RES, MF, 4.02K, +-1%, 0.125W, 100PPM	235325	91637	CMF554021F	1		
U	1	* IC, OP AMP, DUAL, JFET INPUT, 8 PIN DIP	495119	12040	LF353BN	1		
U	2	* REFERENCE-AMP-SET	523407	89536	523407	1	1	1

NOTE 1 = REF AMP SET INCLUDES R15, R16.

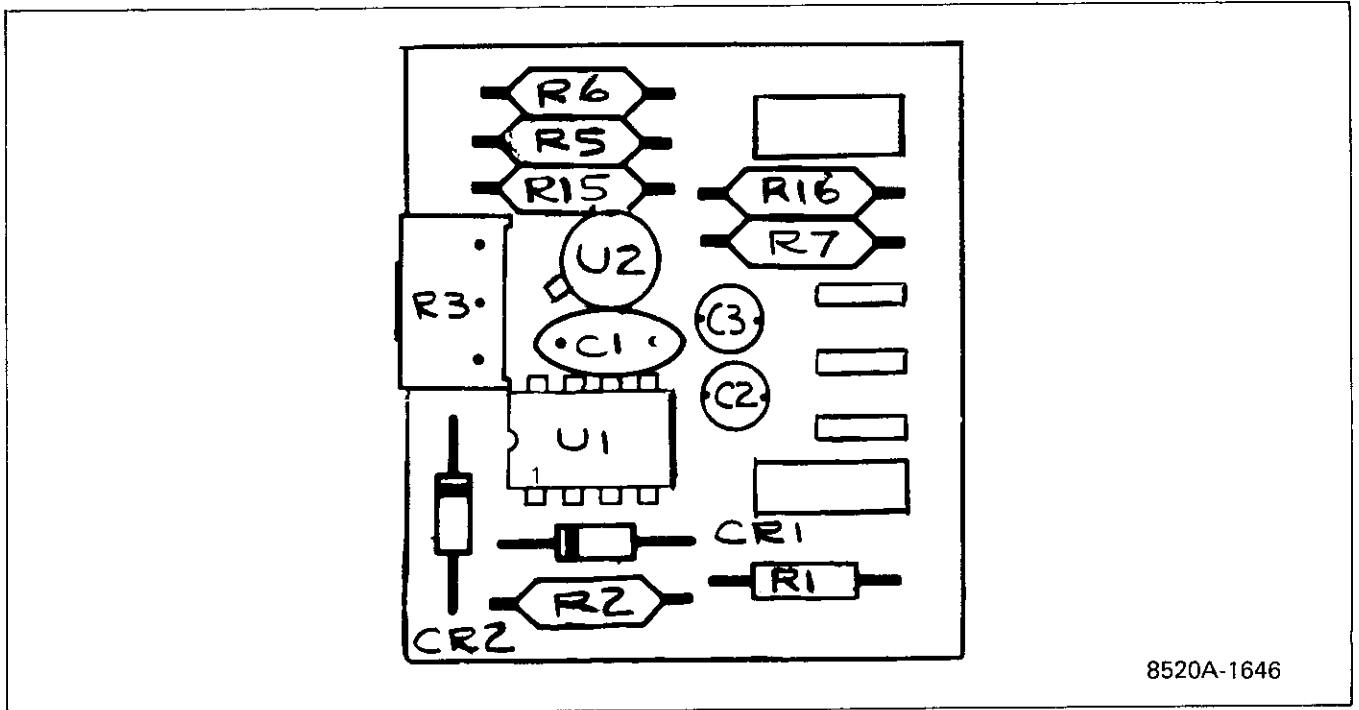
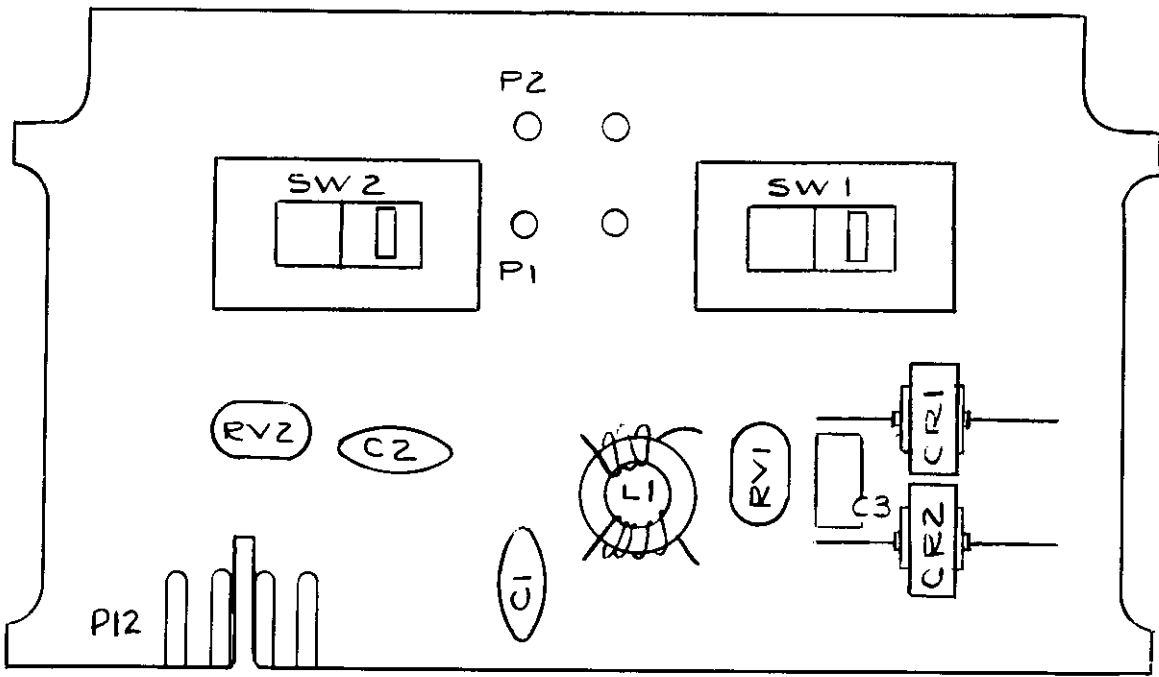
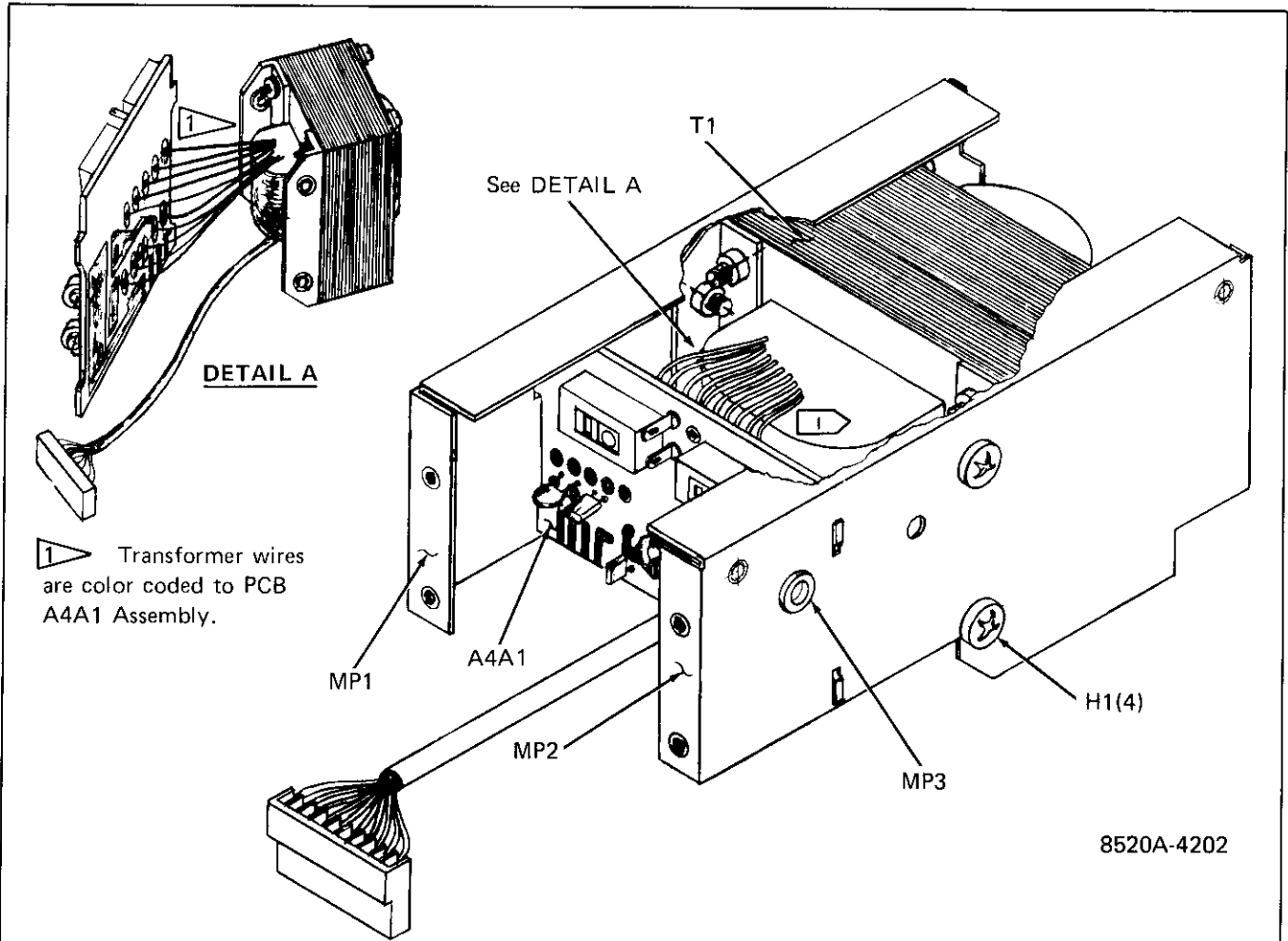


Figure 6-5A. A3A1 Ref Amp PCB Assembly (Horizontal)



8520A-1640

Figure 6-6. A4 Transformer Assembly

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

Federal Supply Codes for Manufacturers

D9816 Westermann Wilhelm Augusta-Anlage Mannheim-Nackarau Germany	01101 Wabash Inc (Formerly Wabash Magnetics) Wabash, IN	02697 Parker-Iannifin Corp. O-Ring Div Lexington, KY	04423 Telonic Berkley Inc. Laguna Beach, CA
S0482 Sony Corp. Tokyo, Japan	01121 Allen Bradley Co. Milwaukee, WI	02735 RCA-Solid State Div. Somerville, NJ	04713 Motorola Inc. Semiconductor Group Phoenix, AZ
S3774 Oshino Electric Lamp Works Tokoyo, Japan	01281 TRW Electronics & Defense Sector R F Devices Lawndale, CA	02768 ITW (IL Tool Works) Fastex Division Des Plaines, IL	04946 Standard Wire and Cable Rancho Dominguez, CA
0AD86 IN General El Paso, TX	01295 TX Instruments Inc. Semiconductor Group Dallas, TX	02799 Arco Electronics Inc. Chatsworth, CA	05173 General Radio NY,NY. Replaced by:
0AE89 Autosplice Inc. Woodside, NY	01526 Genicom Waynesboro, VA	03296 Nylon Molding Corp. Monrovia, CA	24655 Genrad,INC. Concord, MA
0BW21 Noritake Co. Inc. Burlington, MA	01537 Motorola Communications & Electronics Inc. Franklin Park, IL	03445 Lercan Electronics Inc Burbank, CA	05236 Jonathan Mfg. Co. Fullerton, CA
0AN10 Topaz Semiconductor Inc San Jose, CA	01686 RCL Electronics/Shallcross Inc. Electro Components Div. Manchester, NH	03508 General Electric Co. Semiconductor Products & Batteries Auburn, NY	05245 Corcom Inc. Libertyville, IL
0DSM7 Conductive (Pkg) Containers Inc. Brookfield, WI	01884 Sprague Electric Co. (Now 56289)	03797 Genisco Technology Corp. Eltronics Div. Rancho Dominguez, CA	05276 ITT Pomona Electronics Div. Pomona, CA
0CLN7 Emhart Fastening Group Shelton, CT	01961 Varian Associates Inc. Pulse Engineering Div. Convoy, CT	03877 Gilbert Engineering Co.Inc Incon Sub of Transatron Electronic Corp. Glendale, AZ	05277 Westinghouse Elec. Corp. Semiconductor Div. Youngwood, PA
0FB81 S-Mos Systems Inc. San Jose, CA	01963 Cherry Electrical Products Corp Waukegan, IL	03888 KDI Electronics Inc. Pyrofilm Div. Whippany, NJ	05347 Ultronix Inc Grand Junction, CO
0FFP1 Eveready LTD Ever Ready Special Battery Div. Dawley Telford Salop UK	02111 Spectrol Electronics Corp. City of Industry, CA	03911 Clairex Corp. Clairex Electronics Div. Mount Vernon, NY	05397 Union Carbide Corp. Materials Systems Div. Cleveland. OH
00199 Marcon Electronics Corp Keamy, NJ	02114 Amperex Electronic Corp. Ferrox Cube Div. Saugerties, NY	03980 Muirhead Inc. Mountainside, NJ	05571 Sprague Electric Co. (Now 56289)
00213 Nytronics Comp. Group Inc. Darrington, NC	02131 General Instrument Corp. Government Systems Div. Westwood, MA	04009 Cooper Industries, Inc. Arrow Hart Div. Hartford, CT	05574 Viking Connectors Inc Sub of Criton Corp. Chatsworth, CA
00327 Welwyn International Inc. Westlake, OH	02395 Sonar Radio Corp. Hollywood, FL	04217 Essex International Inc. Wire & Cable Div. Anaheim, CA	05791 LYN-TRON Burbank, CA
00656 Aerovox Corp. New Bedford, MA	02533 Leigh Instruments Ltd. Frequency Control Div. Don Mills, Ontario, Canada	04221 Midland-Ross Corp. Midtex Div. N. Mankato, MN	05820 EG & G Wakefield Engineering Wakefield, MA
00686 Film Capacitors Inc. Passaic, NJ	02606 Fenwal Labs Division of Travenal Labs Morton Grove, IL	04222 AVX Corp. AVX Ceramics Div. Myrtle Beach, SC	05839 Advance Electrical Chicago, IL
00779 AMP, Inc. Harrisburg, Pennsylvania	02660 Bunker Ramo-Eltra Corp. Amphenol NA Div. Broadview, IL.		05972 Loctite Corp. Newington, CT

Federal Supply Codes for Manufacturers (cont)

06001 General Electric Co. Electric Capacitor Product Section Columbia, SC	07047 Ross Milton Co., The Southampton, PA	08111 MF Electronics New Rochelle, NY	1B715 (United Shoe & Nylock Corp) -Nylock Fastener Corp.- Paramus, NJ
06141 Fairchild Weston Systems Inc. Data Systems Div. Sarasota, FL	07138 Westinghouse Electric Corp. Industrial & Government Tube Div. Horsesheds, NY	08235 Industro Transistor Corp. Long Island City, NY	10059 Barker Engineering Corp. Kenilworth, NJ
06192 La Deau Mfg. Co. Glendale, CA	07233 Benchmark Technology Inc. City of Industry, CA	08261 Spectra-Strip An Eltra Co. Garden Grove, CA	10389 IL Tool Works Inc. Licon Div. Chicago, IL
06229 Electrovert Inc. Elmsford, NY	07239 Biddle Instruments Blue Bell, PA	08445 Electri-Cord Mfg., Inc Westfield, PA	11236 CTS Corp. Resistor Products Div. Berne, IN
06383 Panduit Corp. Tinley Park, IL	07256 Silicon Transistor Corp. Sub of BBF Inc. Chelmsford, MA	08530 Reliance Mica Corp. Brooklyn, NY	11237 CTS Corp of CA Electro Mechanical Div. Paso Robles, CA
06473 Bunker Ramo Corp. Amphenol NA Div. SAMS Operation Chatsworth, CA	07261 Avnet Corp. Culver City, CA	08718 ITT Cannon Electric Phoenix Div. Phoenix, AZ	11295 ECM Motor Co. Schaumburg, IL
06540 Mite Corp Amatorm-Electrical Div	07263 Fairchild Semiconductor North American Sales Ridgeview, CT	08806 General Electric Co. Minature Lamp Products Cleveland, OH	11358 Columbia Broadcasting System CBS Electronic Div. Newburyport, MA
06555 Beede Electrical Instrument Penacook, NH	07344 Bircher Co. Inc., The Rochester, NY	08863 Nylomatic Fallsington, PA	11403 Vacuum Can Co. Best Coffee Maker Div. Chicago, IL
06665 Precision Monolithics Sub of Boums Inc. Santa Clara, CA	07374 Optron Corp Woodbridge, CT	08988 Skottie Electronics Inc. Archbald, PA	11502 (can also use 35009) TRW Inc. TRW Resistive Products Div. Boone, NC
06666 General Devices Co. Inc. INpolis, IN	07557 Campion Co. Inc. Philadelphia, PA	09021 Aircro Inc. Aircro Electronics Bradford, PA	11503 Keystone Columbia Inc. Freemont, IN
06739 Electron Corp. Littleton, CO	07597 Bumdy Corp. Tape/Cable Div. Rochester, NY	09023 Cornell-Dublier Electronics Fuquay-Varina, NC	11532 Teledyne Relays Teledyne Industries Inc. Hawthorne, CA
06743 Gould Inc. Foil Div. Eastlake, OH	07716 TRW Inc. (Can use 11502) IRC Fixed Resistors/ Burlington Burlington, VT	09214 General Electric Co. Semiconductor Products Dept. Auburn, NY	11711 General Instrument Corp. Rectifier Div. Hicksville, NY
06751 Components Inc. Semcor Div. Phoenix, AZ	07792 Lenna Engineering Corp. Northampton, MA	09353 C and K Components Inc. Newton, MA	11726 Qualidyne Corp. Santa Clara, CA
06776 Robinson Nugent Inc. New Albany, IN	07810 Bock Corp. Madison, WI	09423 Scientific Components Inc. Santa Barbara, CA	12014 Chicago Rivet & Machine Co. Naperville, IL
06915 Richeo Plastic Co. Chicago, IL	07910 Teledyne Semiconductor Mtn. View, CA	09969 Dale Electronics Inc. Yankton, SD	12020 Ovenaire Div. of Electronic Technologies Charlottesville, VA
06961 Vernitron Corp. Piezo Electric Div. Bedford, OH	07933 Raytheon Co. Semiconductor Div. Mountain View, CA	09975 Burroughs Corp. Electronics Components Detroit, MI	12038 Simco (Div of Ransburg Corp) Hatfield, PA
06980 ELMAC (See Varian) San Carlos, CA	08FG6 Calmos Systems Inc. Kanata, Ont. Canada	1A791 LFE Electronics Danvers, MA	12040 National Semiconductor Corp. Danbury, CT
	080A9 Dallas Semiconductor Dallas, TX		

Federal Supply Codes for Manufacturers (cont)

12060 Diodes Inc. Northridge, CA	13050 Potter Co. Wesson, MS	14704 Crydom Controls (Division of Int Rectifier) El Segundo, CA	16473 Cambridge Scientific Industries Div. of Chemed Corp. Cambridge, MD
12136 PHC Industries Inc. Formerly Philadelphia Handle Co. Camden, NJ	13103 Thermalloy Co., Inc. Dallas, TX	14752 Electro Cube Inc. San Gabriel, CA	16733 Cablewave Systems Inc. North Haven, CT
12300 AMF Canada Ltd. Potter-Brumfield Guelph, Ontario, Canada	13327 Solitron Devices Inc. Tappan, NY	14936 General Instrument Corp. Discrete Semi Conductor Div. Hicksville, NY	16742 Paramount Plastics Fabricators Inc. Downey, CA
12323 Practical Automation Inc. Shelton, CT	13511 Bunker-Ramo Corp. Amphenol Cadre Div. Los Gatos, CA	14949 Trompeter Electronics Chatsworth, CA	16758 General Motors Corp. Delco Electronics Div. Kokomo, IN
12327 Freeway Corp. Cleveland, OH	13606 Sprague Electric Co. (Use 56289)	15412 Amtron Midlothian, IL	17069 Circuit Structures Lab Burbank, CA
12406 Elpac Electronics Inc. Santa Ana, CA	13689 SPS Technologies Inc. Hatfield, NJ	15542 Scientific Components Corp. Mini-Circuits Laboratory Div. Brooklyn, NY	17117 Electronic Molding Corp. Woonsocket, RI
12443 Budd Co.,The Plastics Products Div. Phoenixville, PA	13764 Micro Plastics Flippin, AZ	15636 Elec-Trol Inc. Saugus, CA	17338 High Pressure Eng. Co. Inc. OK City, OK
12581 Hitachi Metals International Ltd. Hitachi Magna-Lock Div. Big Rapids, MO	13919 Burr-Brown Research Corp. Tucson, AZ	15782 Bausch & Lomb Inc. Graphics & Control Div. Austin, TX	17504 Aluminum Filter Co. Carpinteria, CA
12615 US Terminals Inc. Cincinnati, OH	14099 Semtech Corp. Newbury Park, CA	15801 Fenwal Eletronics Inc. Div. of Kidde Inc. Framingham, MA	17545 Atlantic Semiconductors Inc. Asbury Park, NJ
12617 Hamlin Inc. LaKe Mills, WI	14140 McGray-Edison Co. Commercial Development Div. Manchester, NH	15818 Teledyne Inc. Co. Teledyne Semiconductor Div. Mountain View, CA	17745 Angstrom Precision, Inc. Hagerstown, MD
12673 Wesco Electrical Greenfield, MA	14189 Ortronics, Inc. Orlando, FL	15849 Useco Inc. (Now 88245)	17856 Siliconix Inc. Santa Clara, CA
12697 Clarostat Mfg. Co. Inc. Dover, NH	14193 Cal-R-Inc. Santa Monica, CA	15898 International Business Machines Corp. Essex Junction, VT	18178 E G & Gvactee Inc. St. Louis, MO
12749 James Electronic Inc. Chicago, IL	14301 Anderson Electronics Hollidaysburg, PA	16068 International Diode Div. Harrison, NJ	18235 KRL/Bantry Components Inc. Manchester, NH
12856 MicroMetals Inc. Anaheim, CA	14329 Wells Electronics Inc. South Bend, IN	16162 MMI Southfield, MI	18310 Concord Electronics New York, NY
12881 Metex Corp. Edison, NJ	14482 Watkins-Johnson Co. Palo Alto, CA	16245 Conap Inc. Olean, NY	18324 Signetics Corp. Sacramento, CA
12895 Cleveland Electric Motor Co. Cleveland, OH	14552 Microsemi Corp. (Formerly Micro-Semiconductor) Santa Ana, CA	16258 Space-Lok Inc. Burbank, CA	18377 Parlex Corp. Methuen, MA
12954 Microsemi Corp. Components Group Scottsdale, AZ	14604 Elmwood Sensors, Inc Pawtucket, RI	16352 Codi Corp. Linden, NJ	18520 Sharp Electronics Corp. Paramus, NJ
12969 Unitrode Corp. Lexington, MA	14655 Cornell-Dublier Electronics Div. of Federal Pacific Electric Co. Govt Cont Dept. Newark, NJ	16469 MCL Inc. LaGrange, IL	18542 Wabash Inc. Wabash Relay & Electronics Div. Wabash, IN

Federal Supply Codes for Manufacturers (cont)

18565 Chomerics Inc. Woburn, MA	2Y384 North American Philips Lighting Corp. Van Wert, OH	23732 Tracor Applied Sciences Inc. Rockville, MD	26402 Lumex, Inc. Bayshore, NY
18612 Vishay Intertechnology Inc. Vishay Resistor Products Group Malvern, PA	20584 Enochs Mfg. Inc. INpolis, IN	23880 Stanford Applied Engineering Santa Clara, CA	26629 Frequency Sources Inc. Sources Div. Chelmsford, MA
18632 Norton-Chemplast Santa Monica, CA	20891 Cosar Corp. Dallas, TX	23936 William J. Purdy Co. Pamotor Div. Burlingame, CA	26806 American Zenier Inc. Irvine, CA
18677 Scanbe Mfg. Co. Div. of Zero Corp. El Monte, CA	21317 Electronics Applications Co. El Monte, CA	24347 Penn Engineering Co. S. El Monte, CA	27014 National Semiconductor Corp. Santa Clara, CA
18736 Voltronics Corp. East Hanover, NJ	21604 Buckeye Stamping Co. Columbus, OH	24355 Analog Devices Inc. Norwood, MA	27167 Corning Glass Works Corning Electronics Wilmington, NC
18786 Micro-Power Long Island City, NY	21845 Solitron Devices Inc. Semiconductor Group Riviera Beach, FL	24444 General Semiconductor Industries, Inc. Tempe, AZ	27264 Molex Inc. Lisle, IL
18927 GTE Products Corp. Precision Material Products Business Parts Div. Titusville, PA	21847 Aertech Now TRW Microwave Inc. Sunnyvale, CA	24546 Bradford Electronics Bradford, PA	27440 Industrial Screw Products Los Angeles, CA
19080 Robinson Electronics Inc. San Luis Obispo, CA	21962 Vectron Corp. Replaced by: S.W. Electronics	24618 Transcon Mfg. Now: D.J. Associates Inc.	27494 Staffall, Inc. Providence, RI
19112 Garry Corp. Langhorne, PA	22526 DuPont, El DeNemours & Co. Inc. DuPont Connector Systems Advanced Products Div. New Cumberland, PA	24655 Genrad Inc. (Replaced General Radio 05173) Concord, MA	27745 Associated Spring Bames Group Inc. Syracuse, NY
19315 Bendix Corp., The Navigation & Control Group Terboro, NJ	22626 Micro Semiconductor (Now 14552)	24759 Lenox-Fugle Electronics Inc. South Plainfield, NJ	27918 Component Parts Corp. Bellmore, NY
19451 Perine Machine Tool Corp. Kent, WA	22670 GM Nameplate Seattle, WA	24796 AMF Inc. Potter & Brumfield Div. San Juan Capistrano, CA	27956 Relcom (Now 14482)
19482 Delta Electronics Alexandria, VA	22767 ITT Semiconductors Palo Alto, CA	24931 Specialty Connector Co. Greenwood, IN	28175 Alpha Metals Chicago, IL
19613 MN Mining & Mfg. Co. Textool Products Dept. Electronic Product Div. Irving, TX	22784 Palmer Inc. Cleveland, OH	24995 ECS Grants Pass, OR	28198 Positronic Industries Springfield, MO
19647 Caddock Electronics Inc. Riverside, CA	23050 Product Comp. Corp. Mount Vernon, NY	25088 Siemen Corp. Isilen, NJ	28213 MN Mining & Mfg. Co. Consumer Products Div. 3M Center Saint Paul, MN
19701 Mepco/Centralab Inc. A N. American Philips Co. Mineral Wells, TX	23223 CTS Microelectronics Lafayette, NY	25099 Cascade Gasket Kent, WA	28309 Kaiser Minette, AL
2B178 Wire Products Cleveland, OH	23237 I.R.C., Inc. Microcircuits Division Philadelphia, PA	25403 Amperex Electronic Corp. Semiconductor & Micro-Circuit Div. Slatersville, RI	28425 Serv-O-Link Eulless, TX
2K262 Boyd Corporation Portland, OR	23302 S.W. Electronics & Mfg. Corp. Cherry Hill, NJ	25435 Moldtronics, Inc Downers Grove, IL	28478 Deltrol Corporation Deltrol Controls Div. Milwaukee, WI
	23730 Mark Eyelet and Stamping Inc. Wolcott, CT	25706 Dabum Electronic & Cable Corp. Norwood, NJ	28480 Hewlett Packard Co. Corporate HQ Palo Alto, CA

Federal Supply Codes for Manufacturers (cont)

28484 Emerson Electric Co. Gearmaster Div. McHenry, IL	31433 Kernet Eleetronics Corp. Simpsonville, NC	33246 Epoxy Technology Inc. Billerica, MA	36701 Van Waters & Rogers Valley Field, Quebec, Canada
28520 Heyco Molded Products Kenilworth, NJ	31448 Army Safeguard Logistics Command Huntsville, AL	33292 Pioneer Sterilized Wiping Cloth Co. Portland, OR	37942 Mallory Capacitor Corp. Sub of Emhart Industries INpolis, IN
28932 Lumax Industrial, Inc Altoona, PA	31471 Gould Inc Semiconductor Div Santa Clara, CA	33297 NEC Electronics USA Inc. Electronic Arrays Inc. Div. Mountain View, CA	39003 Maxim Industries Middleboro, MA
29083 Monsanto Co. Santa Clara, CA	31522 Metal Masters Inc. Baldwin, MS	33919 Nortek Inc. Cranston, RI	4F434 Plastic Sales Los Angeles, CA
29604 Stackpole Components Co. Raleigh, NC	31746 Cannon Electric Woodbury, TN	34114 Oak Industries Rancho Bernardo, CA	40402 Roderstein Electronics Inc. Statesville, NC
29907 Omega Engineering Inc. Stamford, CT	31827 Budwig Ramona, CA	34263 CTS Electronics Corp. Brownsville, TX	42498 National Radio Melrose, MA
3D536 Aimco Inc. Seattle, WA	31918 FIT-Schadow Eden Prairie, MN	34333 Silicon General Inc. Garden Grove, CA	43543 Nytronics Inc. (Now 53342)
30035 Jolo Industries Inc. Garden Grove, CA	32293 Intersil Cupertino, CA	34335 Advanced Micro Devices (AMD) Sunnyvale, CA	43744 Panasonic Industrial Co. San Antonio, TX
30045 Solid Power Corp. Farmingdale, NY	32539 Mura Corp. Westbury, Long Island, N.Y.	34359 MN Mining & Mfg. Co. Commercial Office Supply Div. Saint Paul, MN	43791 Datron Systems Wilkes Barre, PA
30146 Symbex Corp. Painesville, OH	32559 Bivar Santa Ana, CA	34371 Harris Corp. Harris Semiconductor Products Group Melbourne, FL	44655 Ohmite Mfg. Co. Skokie, IL
30148 AB Enterprise Inc. Ahoskie, NC	32719 Siltronics Santa Ana, CA	34576 Rockwell International Corp. Newport Beach, CA	47001 Lumberg Inc. Richmond, VA
30161 Aavid Engineering Inc. Laconia, NH	32767 Griffith Plastics Corp. Burlingame, CA	34641 Instrument Specialties Euless, TX	47379 ISOCOM Campbell, CA
30315 Itron Corp. San Diego, CA	32879 Advanced Mechanical Components Northridge, CA	34649 Intel Corp. Santa Clara, CA	49569 IDT (International Development & Trade) Dallas, TX
30323 IL Tool Works Inc. Chicago, IL	32897 Murata Erie North America Inc. Carlisle Operations Carlisle, Pennsylvania	34802 Electromotive Inc. Kenilworth, NJ	49671 RCA Corp. New York, NY
30800 General Instrument Corp. Capacitor Div. Hicksville, NY	32997 Bourns Inc. Trimpot Div. Riverside, CA	34848 Hartwell Special Products Placentia, CA	49956 Raytheon Company Executive Offices Lexington, MA
30838 Fastec Chicago, ILL.	33025 M/A ComOmni Spectra, Inc. (Replacing Omni Spectra) Microwave Subsystems Div. Tempe, AZ	35009 Renfrew Electric Co. Ltd. IRC Div. Toronto, Ontario, Canada	5D590 Mostek Corp. Replaced by: SGS Thompson Microelec- tronics
31019 Solid State Scientific Inc. Willow Grove, PA	33096 CO Crystal Corp. Loveland, CO	35986 Amaad Melrose Park, IL	5F520 Panel Components Corp. Santa Rosa, CA
31091 Alpha Industries Inc. Microelectronics Div. Hatfield, PA	33173 General Electric Co. Owensboro, KY	36665 Mitel Corp. Kanata, Ontario, Canada	5P575 Nobel Electronics Suffern, NY
31323 Metro Supply Company Sacramento, CA			5W664 NDK Div. of Nihon Dempa Kogyo LTD Lynchburg, VA

Federal Supply Codes for Manufacturers (cont)

5U802 Dennison Mfg. Co. Framingham, MA	51499 Amtron Corp. Boston, MA	52840 Western Digital Corp. Costa Mesa, CA	54937 DeYoung Mfg. Bellevue, WA
50088 SGS - Thomson Microelectronics Inc. Carrollton, TX	51506 Accurate Screw Machine Co. (ASMCO) Nutley, NJ	53021 Sangamo Weston Inc. (Sec 06141)	54590 RCA Corp. Electronic Components Div. Cherry Hill, NJ
50120 Eagle-Picher Industries Inc. Electronics Div. CO Springs, CO	51605 CODI Semiconductor Inc. Kenilworth, NJ	53036 Textool Co. Houston, TX	55026 American Gage & Machine Co. Simpson Electric Co. Div. Elgin, IL
50157 Midwest Components Inc. Muskegon, MS	51642 Centre Engineering Inc. State College, PA	53184 Xciton Corp. Lathan, NY	55112 Plessey Capacitors Inc. (Now 60935)
50356 Teac Corp. of America Industrial Products Div Montebello, CA	51705 ICO/Rally Palo alto, CA	53217 Technical Wire Products Inc. Santa Barbara, CA	55261 LSI Computer Systems Inc. Melville, NY
50364 MMI, Inc.(Monolithic Memories Inc) Military Products Div. Santa Clara, CA	51791 Statek Corp. Orange, CA	53342 Opt Industries Inc. Phillipsburg, NJ	55285 Berequist Co. Minneapolis, MN
50472 Metal Masters, Inc. City of Industry, CA	51984 NEC America Inc. Falls Church, VA	53673 Thompson CSF Components Corp. (Semiconductor Div) Conaga Park, CA	55322 Samtech Inc. New Albany, IN
50541 Hypertronics Corp. Hudson, MA	52063 Exar Integrated Systems Sunnyvale, CA	53718 Airmold/W. R. Grese & Co. Roanoke Rapids, NC	55408 STI-CO Industries Co Buffalo, NY
50558 Electronic Concepts, Inc. Eatontown, NJ	52072 Circuit Assembly Corp. Irvine, CA	53848 Standard Microsystems Hauppauge, NY	55464 Central Semiconductor Corp. Hauppauge, NY
50579 Litronix Inc. Cupertino, CA	52152 MN Mining & Mfg. Saint Paul, MN	53894 ALLAM Inc. RanchoCA, CA	55557 Microwave Diode Corp. W.Stewartstown, NH
50891 Semiconductor Technology Stuart, FL	52333 API Electronics Hauppauge,Long Island,NY	53944 Glow-Lite Pauls Valley, OK	55566 R A F Electronic Hardware Inc. Seymour, CT
50934 Tran-Tec Corp Columbus, NE	52361 Communication Systems Piscataway, NJ	54178 Plasmetex Industries Inc. San Marcos, CA	55576 Synertek Santa Clara, CA
51167 Aries Electronics Inc. Frenchtown, NJ	52500 Amphenol, RF Operations Burlington, MA	54294 Shallcross Inc. Smithfield, NC	55680 Nichicon/America/Corp. Schaumburg, IL
51284 Mos Technology Norristown, PA	52525 Space-Lok Inc. Lerco Div. Burbank, CA	54453 Sullins Electronic Corp. San Marcos, CA	55943 D J Associates, Inc (Replaced Transcon Mfg.-24618) Fort Smith, AZ
51249 Heyman Mfg. Co. Cleveland, OH	52531 Hitachi Magnetics Edmore, MO	54473 Matsushita Electric Corp. (Panasonic) Secaucus, NJ	56282 Utek Systems Inc. Olathe, KS
51372 Verbatim Corp. Sunnyvale, CA	52745 Timco Los Angeles, CA	54492 Cinch Clamp Co., Inc. Santa Rosa, CA	56289 Sprague Electric Co. North Adams, MA
51398 MUPAC Corp. Brockton, MA	52763 Stettner-Electronics Inc. Chattanooga, TN	54583 TDK Garden City, NY	56365 Square D Co. Corporate Offices Palatine, IL
51406 Murata Erie, No. America Inc. (Also see 72982) Marietta, GA	52769 Sprague-Goodman Electronics Inc. Garden City Park, NY	54590 RCA Corp Distribution & Special Products Cherry Hill, NY	56375 WESCORP Div. Dai Industries Inc Mountain View, CA
	52771 Monitern Corp. Amatrom Div. Santa Clara, CA	54869 Piber International Corp. Arlington Heights, IL	

Federal Supply Codes for Manufacturers (cont)

56481 Shugart Associates Sub of Xerox Corp. Sunnyvale, CA	59610 Souriau Inc Valencia, CA	60911 Inmos Corp. CO Springs, CO	64537 KDI Electronics Whippany, NJ
56637 RCD Components Inc. Manchester, NH	59635 HV Component Associates Howell, NJ	60935 Westlake Capacitor Inc. Tantalum Div. Greencastle, IN	64782 Precision Control Mfg. Inc. Bellevue, WA
56708 Zilog Inc. Campbell, CA	59640 Supertex Inc. Sunnyvale, CA	60958 ACIC Intercomp Wire & Cable Div. Hayesville, NC	64834 West M G Co. San Francisco, CA
56856 Vamistor Corp. of TN Sevierville, TN	59660 Tusonix Inc. Tucson, AZ	61271 Fujitsu Microelectronics Inc San Jose, CA	64961 Electronic Hardware LTD North Hollywood, CA
56880 Magnetics Inc. Baltimore, MD	59730 Thomas and Betts Corp. IA City, IA	61394 SEEQ Technology Inc. San Jose, CA	65092 Sangamo Weston Inc. Weston Instruments Div. Newark, NJ
57026 Endicott Coil Co. Inc. Binghamton, NY	59831 Semtronics Corp. Watchung, NJ	61429 Fox Electronics Cape Coral, FL	65786 Cypress Semi San Jose, CA
57053 Gates Energy Products Denver, CO	61053: American Components Inc. an Insilco Co. RPC Div. Hayesville, NC	61529 Aromat Corp. New Providence, NJ	65940 Rohm Corp & Whatney Irvine, CA
57170 Cambridge Thermionic Cambridge, MA Replaced by: 71279 Interconnection Products Inc.	6L611 Allen, Robert G. Inc. Van Nuys, CA	61752 IR-ONICS Inc Warwick, RI	65964 Evox Inc. Bannockburn, IL
57668 R-ohm Corp Irvine, CA	6U850 Burgess Switch Co., Inc Northbrook, IL	61772 Integrated Device Technology Santa Clara, CA	66150 Entron Inc. Winslow Teltronics Div. Glendale, NY
57962 SGS - Thomson Microelectronics Inc Montgomeryville, PA	6U095 AMD Enterprises, Inc. Roswell, GA	61802 Toshiba Houston, TX	66302 VLSI Technology Inc. San Jose, CA
58014 Hitachi Magnalock Corp. (Now 12581)	6X403 SGS/ATES Semiconductor Corp. Indianapolis, IN	61857 SAN-O Industrial Corp. Bohemia, Long Island, NY	66419 Exel San Jose, CA
58104 Simco Atlanta, GA	6Y440 Micron Technology Inc. Boise, ID	61935 Schurter Inc. Petaluma, CA	66450 Dyna-Tech Electronics, Inc Walled Lake, MI
58364 BYCAP Inc. Chicago, IL	60046 Power Dynamics Inc West Orange, NJ	62351 Apple Rubber Lancaster, NY	66608 Bering Industries Freemont, CA
58451 Precision Lamp Cotat, CA	60197 Precicontact Inc. Langhorne, PA	62643 United Chemicon Rosemont, IL	66891 BKC International Electronics Lawrence, MA
58474 Superior Electric Co. Bristol, CT	60386 Squires Electronics Inc Cornelius, OR	62712 Seiko Instruments Torrance, CA	66958 SGS Semiconductor Corp. Phoenix, AZ
58614 Communications Instruments Inc. Fairview, NC	60395 Xicor Inc. Milpitas, CA	62793 Lear Siegler Inc. Energy Products Div. Santa Ana, CA	66967 Powerex Inc Auburn, NY
59124 KOA-Speer Electronics Inc. Bradford, PA	60399 Torin Engineered Blowers Div. of Clevepak Corp. Torrington, CT	63743 Ward Leonard Electric Co. Inc. Mount Vernon, NY	67183 Altra Santa Clara, CA
59422 Holmberg Electronics Irvine, CA	60496 Micrel Inc. Sunnyvale, CA	64154 Lamb Industries Portland, OR	68919 WIMA % Harry Levinson Co. Seattle, WA
	60705 Cera-Mite Corp. (formerly Sprague) Grafton, WI	64155 Linear Technology Milpitas, CA	

Federal Supply Codes for Manufacturers (cont)

7F361 Richmond-Division of Dixico % Zellerbach Paper Co. Seattle, WA	71468 ITT Cannon Div. of ITT Fountain Valley, CA	73138 Beckman Industrial corp. Helipot Div. Fullerton, CA	75042 TRW Inc. IRC Fixed Resistors Philadelphia, PA
7F844 Moore Business Forms, Inc Seattle, WA	71482 General Instrument Corp. Clarc Div. Chicago, IL	73168 Fenwal Inc. Ashland, MA	75297 Kester Solder Div. Litton Systems, Inc Des Plaines, IL
7G902 Textron Inc. Camcar Div. Rockford, IL	71590 Mepco/Centralab A North American Philips Co. Fort Dodge, IA	73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, CA	75376 Kurz-Kasch Inc. Dayton, OH
7I395 Universal Plastics Welshpool, WA	71707 Coto Corp. Providence, RI	73445 Amperex Electronic Corp. Hicksville, NY	75378 CTS Knights Inc. Sandwich, IL
7J696 AMD Plastics East Lake, OH	71744 General Instrument Corp. Lamp Div/Worldwide Chicago, IL.	73559 Carlingswitch Inc. Hartford, CT	75382 Kulka Electric Corp. (Now 83330) Mount Vernon, NY
7K354 Omni Spectra Inc Los Altos, CA	71785 TRW Inc. Cinch Connector Div. Elk Grove Village, IL	73586 Circle F Industries Trenton, NJ	75569 Performance Semiconductor Corp. Sunnyvale, CA
7Z884 ALPS Seattle, WA	71984 Dow Corning Corp. Midland, MI	73734 Federal Screw Products Inc. Chicago, IL	75915 Litelfuse Tracor (Formerly: Tracor-Litelfuse) Des Plaines, IL
7X634 Duracell USA Div. of Dart & Kraft Inc. Valdese, NC	72005 AMAX Specialty Metals Corp. Newark, NJ	73743 Fischer Special Mfg. Co. Cold Spring, KY	76854 Oak Switch Systems Inc. Crystal Lake, IL
70290 Almetal Universal Joint Co. Cleveland, OH	72136 Electro Motive Mfg. Corp. Florence, NC	73893 Microdot Mt. Clemens, MS	77122 TRW Assemblies & Fasteners Group Fastener Div. Moutainside, NJ
70485 Atlantic India Rubber Works Inc. Chicago, IL	72228 AMCA International Corp. Continental Screw Div. New Bedford, MA	73899 JFD Electronic Components Div. of Murata Eric Oceanside, NY	77342 AMF Inc. Potter & Brumfield Div. Princeton, IN
70563 Amperite Company Union City, NJ	72259 Nytronics Inc. New York, NY	73905 FL Industries Inc. San Jose, CA	77542 Ray-O-Vac Corp Madison, WI
70903 Cooper-Belden Corp. Geneva, IL	72619 Amperex Electronic Corp. Dialight Div. Brooklyn, NY	73949 Guardian Electric Mfg. Co. Chicago, IL	77638 General Instrument Corp. Rectifier Div. Brooklyn, NY
71002 Bimbach Co. Inc. Farmingdale, NY	72653 G C Electronics Co. Div. of Hydrometals Inc. Rockford, IL	74199 Quam Nichols Co. Chicago, IL	77900 Shakeproof Lock Washer Co. (Now 78189)
71034 Bliley Electric Co. Erie, PA	72794 Dzus Fastner Co. Inc. West Islip, NY	74217 Radio Switch Co. Marlboro, NJ	77969 Rubbercraft Corp. of CA Ltd. Torrance, CA
71183 Westinghouse Electric Corp. Bryant Div. Bridgeport, CT	72928 Gulton Industries Inc. Gudeman Div. Chicago, IL	74306 Piezo Crystal Co. Div. of PPA Industries Inc. Carlisle, PA	78189 IL Tool Works Inc. Shakeproof Div. Elgin, IL
71279 Interconnection Products Inc. Formerly Midland-Ross Cambion Div. Santa Ana, CA	72962 Elastic Stop Nut Div. of Harrard Industries Union, NJ	74445 Holo-Krome Co. Elmwood, CT	78277 Sigma Instruments Inc. South Braintree, MA
71400 Bussman Manufacturing Div. McGraw-Edison Co. St. Louis, MO	72982 Erie Specialty Products, Inc Formerly: Murata Erie Erie, PA	74542 Hoyt Elect.Instr. Works Inc. Penacook, NH	78290 Struthers Dunn Inc. Pitman, NJ
71450 CTS Corp. Elkhart, IN		74840 IL Capacitor Inc. Lincolnwood, IL	78553 Eaton Corp. Engineered Fastener Div. Cleveland, OH

Federal Supply Codes for Manufacturers (cont)

78592 Stoeger Industries South Hackensack, NJ	81439 Therm-O-Disc Inc. Mansfield, OH	83315 Hubbell Corp. Mundelein, IL	87034 Illuminated Products Inc. (Now 76854)
79497 Western Rubber Co. Goshen, IN	81483 International Rectifier Corp. Los Angeles, CA	83330 Kulka Smith Inc. A North American Philips Co. Manasquan, NJ	87516 Standard Crystal KS City, KS
79727 C - W Industries Southampton, PA	81590 Korry Electronics Inc. Seattle, WA	83478 Rubbercraft Corp. of America West Haven, CT	88044 Aeronautical Standards Group Dept. of Navy & Air Force
79963 Zierick Mfg. Corp. Mount Kisco, NY	81741 Chicago Lock Co. Chicago, IL	83553 Associated Spring Barnes Group Gardena, CA	88219 GNB Inc. Industrial Battery Div. Langhorne, PA
8C798 Ken-Tronics, Inc. Milan, IL	82227 Airpax Corp. Cheshire Div. Cheshire, CT	83740 Union Carbide Corp. Battery Products Div. Danbury, CT	88245 Winchester Electronics Litton Systems-Useco Div. Van Nuys, CA
8D528 Baumgartens Atlanta, GA	82240 Simmons Fastener Corp. Albany, NY	84171 Arco Electronics Commack, NY	88486 Triangle PWC Inc. Jewitt City, CT
8F330 Eaton Corp. Cutler Hammer Product Sales Office Mountain View, CA	82305 Palmer Electronics Corp. South Gate, CA	84411 American Shizuki TRW Capacitors Div. Ogallala, NE	88690 Essex Group Inc. Wire Assembly Div. Dearborn, MI
8T100 Tellabs Inc. Naperville, IL	82389 Switchcraft Inc. Sub of Raytheon Co. Chicago, IL	84613 FIC Corp. Rockville, MD	88786 Atlantic India Rubber Co. Goshen, IN
80009 Tektronix Beaverton, OR	82415 Airpax Corp Frederick Div. Frederick, MD	84682 Essex Group Inc. Peabody, MA	88978 Philips (Now Fluke) Mahwah, NJ
80031 Mepco/Electra Inc. Morristown, NJ	82872 Roanwell Corp. New York, NY	84830 Lee Spring Co. Inc Brooklyn, NY	89020 Amerace Corp. Buchanan Cromptool Products Div. Union, NJ
80032 Ford Aerospace & Communications Corp. Western Development Laboratories Div. Palo Alto, CA	82877 Rotron Inc. Custom Div. Woodstock, NY	85367 Bearing Distributing Co. San Fransisco, CA	89265 Potter-Brumfield (See 77342)
80145 LFE Corp. Process Control Div. Clinton, OH	82879 ITT Royal Electric Div. Pawtucket, RI	85372 Bearing Sales Co. Los Angeles, CA	89462 Waldes Truarc, Inc. Long Island, NY
80183 Sprague Products (Now 56289)	83003 Varo Inc. Garland, TX	85480 W. H. Brady Co. Industrial Product Milwaukee, WI	89536 John Fluke Mfg. Co., Inc. Everett, WA
80294 Boums Instruments Inc. Riverside, CA	83014 Hartwell Corp. Placentia, CA	85840 Brady WH Co Industrial Products Div Milwaukee, WI	89597 Fredericks Co. Huntingdon Valley, PA
80583 Hammerlund Mfg. Co. Inc. Paramus, NJ	83055 Signalite Fuse Co. (Now 71744)	85932 Electro Film Inc. Valencia, CA	89709 Bunker Ramo-Eltra Corp. Amphenol Div. Broadview, IL
80640 Computer Products Inc. Stevens-Arnold Div. South Boston, MA	83058 TRW Assemblies & Fasteners Group Fasteners Div. Cambridge, MA	86577 Precision Metal Products Co. Peabody, MA	89730 General Electric Lamp Div. Newark, NJ
81073 Grayhill Inc. La Grange, IL	83259 Parker-Hannifin Corp. O-Seal Div. Culver City, CA	86684 Radio Corp. of America (Now 54590)	9R216 Data Composition Svc, Inc Laurel, MD
81312 Litton Systems Inc. Winchester Electronics Div. Watertown, CT	83298 Bendix Corp. Electric & Fluid Power Div. Eatonville, NJ	86928 Seastrom Mfg. Co. Inc. Glendale, CA	9S171 Port Plastics Tukwila, WA

Federal Supply Codes for Manufacturers (cont)

9W423 Amatom El Mont, CA	91934 Miller Electric Co. Woonsocket, RI	95573 Campion Laboratories Inc. Detroit, MI	98278 Malco A Microdot Co. South Pasadena, CA
90201 Mallory Capacitor Co. Sub of Emhart Industries Inc. Indianapolis, IN	91967 National Tel-Tronics Div. of electro Audio Dynamics Inc Meadville, PA	95712 Bendix Corp. Electrical Comp. Div. Franklin, IN	98291 Sealectro Corp. BICC Electronics Trumbull, CT
90215 Best Stamp & Mfg. Co. KS City, MO	91984 Maida Development Co. Hampton, VA	95987 Weckesser Co. Inc. (Now 85480)	98372 Royal Industries Inc. (Now 62793)
90303 Duracell Inc. Technical Sales & Marketing Bethel, CT	91985 Norwalk Valve Co. S. Norwalk, CT	96733 SFE Technologies San Fernando, CA	98388 Lear Siegler Inc. Accurate Products Div. San Deigo, CA
91094 Essex Group Inc. Suflex/AWP Div. Newmarket, NH	92218 Wakefield Corp., The Wakefield, ME	96853 Gulton Industries Inc. Measurement & Controls Div. Manchester, NH	98978 IERC (International Electronic Research Corp.) Burbank, CA
91247 H. Transformer Co. Chicago, IL	92527 VTC Inc. Bloomington, MN	96881 Thomson Industries Inc. Port WA, NY	99120 Plastic Capacitors Inc. Chicago, IL
91293 Johanson Mfg. Co. Boonton, NJ	92607 Tensolite Co. Div. of Carlisle Corp. Buchanan, NY	97464 Industrial Retainer Ring Irvington, NJ	99217 Bell Industries Inc. Elect. Distributor Div. Sunnyvale, CA
91462 Alpha Industries Inc. Logansport, IN	92914 Alpha Wire Corp. Elizabeth, NJ	97525 EECO Inc. Santa Ana, CA	99378 ATLEE of DE Inc. N. Andover, MA
91502 Associated Machine Santa Clara, CA	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, MA	97540 Whitehall Electronics Corp. Master Mobile Mounts Div. Fort Meyers, FL	99392 Mepco/Electra Inc. Roxboro Div. Roxboro, NC
91506 Augat Alcoswitch N. Andover, MA	94144 Raytheon Co. Microwave & Power Tube Div. Quincy, MA	97913 Industrial Electronic Hardware Corp. NY, NY	99515 Electron Products Inc. Div. of American Capacitors Duarte, CA
91507 Froeliger Machine Tool Co. Stockton, CA	94222 Southco Inc. Concordville, PA	97945 Pennwalt Corp. SS White Industrial Products Piscataway, NJ	99779 Bunker Ramo- Eltra Corp. Bames Div. Lansdown, PA
91637 Dale Electronics Inc. Columbus, NE	94988 Wagner Electric Corp. Sub of Megraw-Edison Co. Whippany, NJ	97966 CBS Electronic Div. Danvers, MA	99800 American Precision Industries Delevan Div. East Aurora, NY
91662 Elco Corp. A Gulf Western Mfg. Co. Connector Div. Huntingdon, PA	95146 Alco Electronic Products Inc. Switch Div. North Andover, MA	98094 Machlett Laboratories Inc. Santa Barbara, CA	99942 Mepco/Centralab A North American Philips Co. Milwaukee, WI
91737 ITT Cannon/Gremar (Now 08718)	95263 Leecraft Mfg. Co. Long Island City, NY	98159 Rubber-Teck Inc. Gardena, CA	
91802 Industrial Devices Inc. Edgewater, NJ	95275 Vitramon Inc. Bridgeport, CT		
91833 Keystone Electronics Corp. NY, NY	95303 RCA Corp. Receiving Tube Div. Cincinnati, OH		
91836 King's Electronics Co. Inc. Tuckahoe, NY	95348 Gordo's Corp. Bloomfield, NJ		
91929 Honeywell Inc. Micro Switch Div. Freeport, IL	95354 Methode Mfg. Corp. Rolling Meadows, IL		

TECHNICAL SERVICE CENTERS

U.S. Service Locations

California

Fluke Technical Center
16969 Von Karman Avenue
Suite 100
Irvine, CA 92714
Tel: (714) 863-9031

Fluke Technical Center
46610 Landing Parkway
Fremont, CA 94538
Tel: (415) 651-5112

Colorado

Fluke Technical Center
14180 East Evans Avenue
Aurora, CO 80014
Tel: (303) 695-1171

Florida

Fluke Technical Center
940 N. Fern Creek Avenue
Orlando, FL 32803
Tel: (407) 896-4881

Illinois

Fluke Technical Center
1150 W. Euclid Ave.
Palatine, IL 60067
Tel: (312) 705-0500

Maryland

Fluke Technical Center
5640 Fishers Lane
Rockville, MD 20852
Tel: (301) 770-1576

New Jersey

Fluke Technical Center
East 66 Midland Avenue
Paramus, NJ 07652-0930
Tel: (201) 599-9500

Texas

Fluke Technical Center
1801 Royal Lane, Suite 307
Dallas, TX 75229
Tel: (214) 869-2848

Washington

Fluke Technical Center
John Fluke Mfg. Co., Inc.
1420 75th St. S.W.
M/S 6-30
Everett, WA 98203
Tel: (206) 356-5560

International

Argentina

Coasin S.A.
Virrey del Pino 4071 DPTO E-65
1430 CAP FED
Buenos Aires
Tel: 54 1 522-5248

Australia

Philips Customer Support
Scientific and Industrial
23 Lakeside Drive
Tally Ho Technology Park
East Burwood
Victoria 3151

Australia

Philips Customer Support
Scientific & Industrial
25-27 Paul St. North
North Ryde N.S.W. 2113
Tel: 61 02 888 8222

Austria

Oesterreichische Philips Industrie
Unternehmensbereich Prof. Systeme
Triesterstrasse 66
Postfach 217
A-1101 Wein
Tel: 43 222-60101, x1388

Belgium

Philips & MBLE Associated S.A.
Scientific & Industrial Equip. Div
Service Department.
80 Rue des deux Gares B-1070
Brussels
Tel: 32 2 525 6111

Brazil

Hi-Tek Electronica Ltda.
Al. Amazonas 422, Alphaville
CEP 06400 Barueri
Sao Paulo
Tel: 55 11 421-5477

Canada

Fluke Electronics Canada Inc.
400 Britannia Rd. East, Unit #1
Mississauga
Ontario L4Z 1X9
Tel: 416-890-7600

Chile

Intronica Chile Ltda.
Casilla 16228
Santiago 9
Tel: 56 2 2321886, 2324308

China

Fluke International Corp.
P.O. Box 9085
Beijing
Tel: 86 01 512-3436

Colombia

Sistemas E Instrumentacion, Ltda.
Carrera 13, No. 37-43, Of. 401
Ap. Aereo 29583
Bogota DE
Tel: 57 232-4532

Denmark

Philips A/S
Technical Service I & E
Strandlodsvej 1A
PO Box 1919
DK-2300
Copenhagen S
Tel: 45 1 572222

Ecuador

Proteco Coasin Cia., Ltda.
P.O. Box 228-A
Ave. 12 de Octubre
2285 y Orellana
Quito
Tel: 593 2 529684

Egypt

Philips Egypt
10, Abdel Rahman el Rafei st.
el. Mohandessin
P.O. Box 242
Dokki Cairo
Tel: 20-2-490922

England

Philips Scientific
Test & Measuring Division
Colonial Way
Watford
Hertfordshire WD2 4TT
Tel: 44 923-40511

Finland

Oy Philips AB
Central Service
Sinikalliontie 1-3
P.O. Box 11
SF-02630 ESPOO
Tel: 358-0-52572

France

S.A. Philips Industrielle
et Commerciale,
Science et Industry
105 Rue de Paris Bp 62
93002 Bobigny, Cedex
Tel: 33-1-4942-8040

Germany (F.R.G.)

Philips GmbH
Service fuer FLUKE - Produkte
Department VSF
Oskar-Messter-Strasse 18
D-8045 Ismaning/Munich,
West Germany
Tel: 49 089 9605-239

Greece

Philips S.A. Hellenique
15, 25th March Street
177 78 Tavros
10210 Athens
Tel: 30 1 4894911

Hong Kong

Schmidt & Co (H.K.) Ltd.
18/FL., Great Eagle Centre
23 Harbour Road
Wanchai
Tel: 852 5 8330222

India

Hinditron Services Pvt. Ltd
1st Floor, 17-B,
Mahal Industrial Estate
Mahakali Road, Andheri East
Bombay 400 093
Tel: 91 22 6300043

Hinditron Services Pvt. Inc.
33/44A Raj Mahal Villas Extn.
8th Main Road
Bangalore 560 080
Tel: 91 812 363139

Hinditron Services Pvt. Ltd.
Field Service Center
Emerald Complex 1-7-264
5th Floor
114 Sarojini Devi Road
Secunderabad 500 003
Tel: 08 42-821117

Hinditron Services Pvt. Ltd.
15 Community Centre
Panchshila Park
New Delhi 110 017
Tel: 011-6433675

Indonesia

P.T. Lamda Triguna
P.O. Box 6/JATJG
Jakarta 13001
Tel: (021) 8195365

Israel

R.D.T. Electronics Engineering, Ltd.
P.O. Box 43137
Tel Aviv 61430
Tel: 972 3 483211

Italy

Philips S.p.A.
Sezione I&E / T&M
Viale Elvezia 2
2005 Monza
Tel: 39 39 3635342

Japan

John Fluke Mfg. Co., Inc.
Japan Branch
Sumitomo Higashi Shinbashi Bldg.
1-1-11 Hamamatsucho
Minato-ku
Tokyo 105
Tel: 81 3 434-0181

Korea

Myoung Corporation
Yeo Eui Do P.O. Box 14
Seoul 150
Tel: 82 2 784-9942

Malaysia

Mecomb Malaysia Sdn. Bhd.
P.O. Box 24
46700 Petaling Jaya
Selangor
Tel: 60 3 774-3422

Mexico

Mexel Servicios en Computacion
Instrumentacion y Perifericos
Blvd. Adolfo Lopez Mateos No. 163
Col. Mixcoac
Mexico D.F.
Tel: 52-5-563-5411

Netherlands

Philips Nederland
Test & Meetapparaten Div.
Postbus 115
5000 AC Tilburg
Tel: 31-13-352445

New Zealand

Philips Customer Support
Scientific & Industrial Division
2 Wagener Place
Mt. Albert
Auckland
Tel: 64 9 894-160

Norway

Morgenstjerne & Co. A/S
Konghellegate 3
P.O. Box 6688, Rodelokka
Oslo 5
Tel: 47 2 356110

Pakistan

International Operations (PAK) Ltd.
505 Muhammadi House
I.I. Chundrigar Road
P.O. Box 5323
Karachi
Tel: 92 21 221127, 239052

Peru

Importaciones & Representaciones
Electronicas S.A.
Avad Franklin D. Roosevelt 105
Lima 1
Tel: 51 14 288650

Philippines

Spark Radio & ElectronicS Inc.
Greenhills, P.O. Box 610
San Juan, Metro-Manila Zip 3113
Tel: 63-2-775192

Portugal

Decada Espectral
Equipmentos de Elec. e Cientificos
Av. Bomberos Voluntarios
Lote 102B, Miraflores/Alges
1495 Lisboa
Tel: 351 1 410-3420

Singapore

Rank O'Connor's Singapore (PTE) Ltd.
98 Pasir Panjang Road
Singapore 0511
Tel: 65 4737944

South Africa

South African Philips (Pty) Ltd.
Service Department
195 Main Rd
Martindale, Johannesburg, 2092
Tel: 27 11 470-5255

Spain

Philips Iberica S.A.E.
Depto. Tecnico Instrumentacion
c/Martinez Villergas 2
28027 Madrid
Tel: 34 1 4042200

Sweden

Philips Kistaindustrier AB
Customer Support
Borgarfjordsgatan 16
S-16493 Kista

Switzerland

Philips A.G.
Technischer Kundendienst
Postfach 670
Allmendstrasse 140
CH-8027 Zurich
Tel: 41 1 482211

Taiwan

Schmidt Electronics Corp.
5th Floor, Cathay Min Sheng
Commercial Building,
344 Min Sheng East Road
Taipei
Tel: 886 2501-3468

Thailand

Measuretronix Ltd.
2102/63 Ramkamhaeng Rd.
Bangkok 10240
Tel: 66 2 374-2516, 374-1632

Turkey

Turk Philips Ticaret A.S.
Inonu Caddesi 78/80
Posta Kutusu 504-Beyoglu
Istanbul
Tel: 90 1 1435891

Uruguay

Coasin Uruguay S.A
Casilla de Correo 1400
Libertad 2525
Montevideo
Tel: 598-2-789015

Venezuela

Coasin C.A.
Calle 9 Con Calle 4, Edif. Edinurbi
Apartado de Correos Nr-70-136
Los Ruices
Caracas 1070-A
Tel: 58 2 241-0309, 241-1248

West Germany

Philips GmbH
Department VSF
Service fuer FLUKE - Produkte
Oskar - Messter - Strasse 18
D-8045 Ismaning / Munich
Tel: 49 089 9605-260

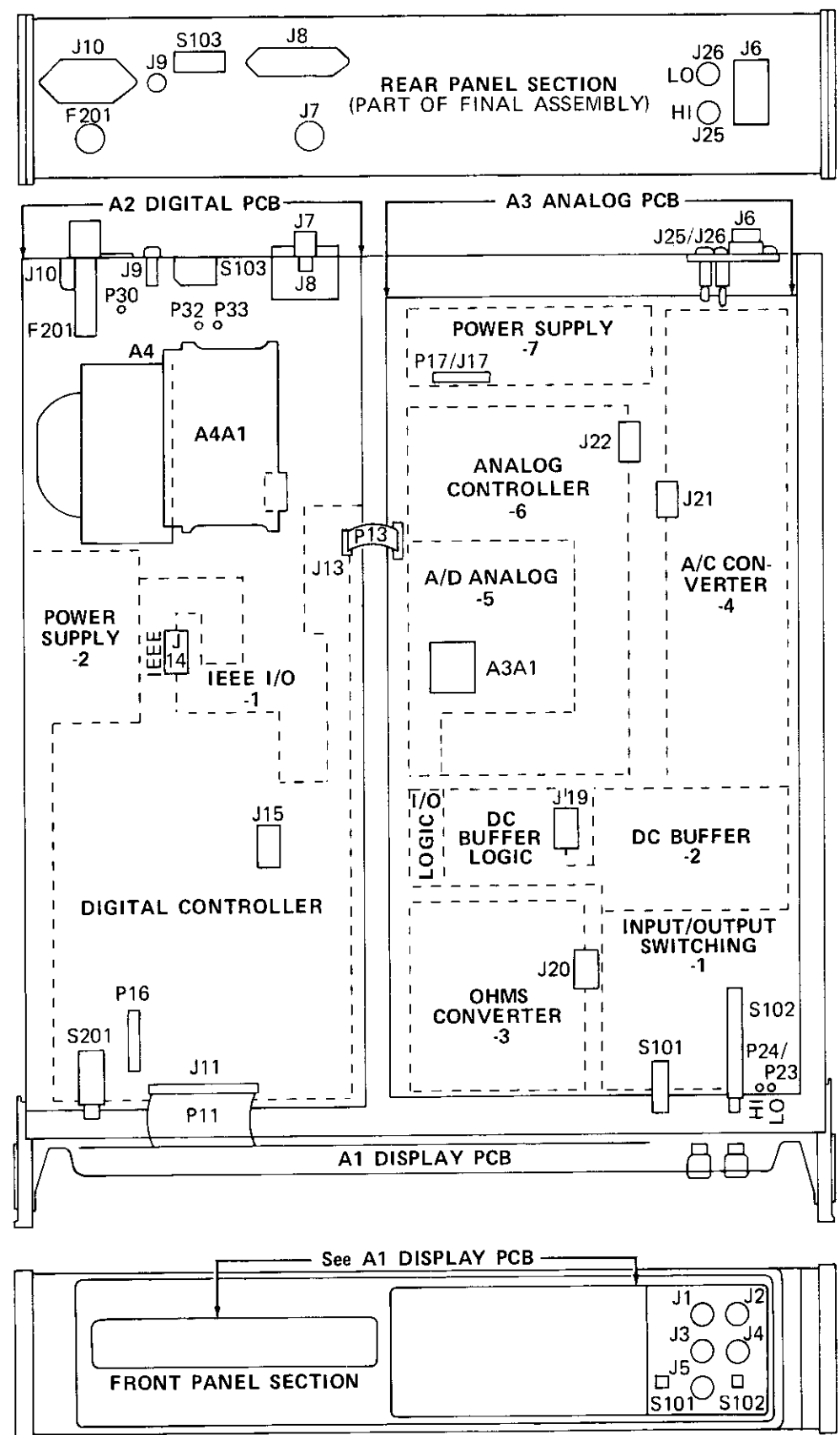
Section 8

Schematic Diagrams

TABLE OF CONTENTS

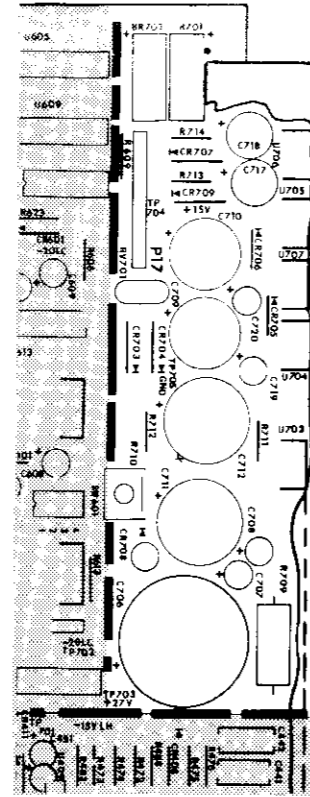
FIGURE	TITLE	DRAWING NO.	PAGE
8-1.	Assembly Placement	8520A-1303	8-3
8-2.	Power Supply	8520A-1023	8-4
8-3.	Display	8520A-1011	8-6
8-4.	Digital Controller	8520A-1021	8-8
8-5.	IEEE-488 Interface	8520A-1022	8-14
8-6.	Input/Output SW	8520A-1031	8-16
8-7.	DC Buffer	8520A-1032	8-18
8-8.	Ohms Converter	8520A-1033	8-20
8-9.	A/C Converter	8520A-1034	8-22
8-10.	A/D Analog	8520A-1035	8-24
8-11.	Analog Controller	8520A-1036	8-26
8-12.	Reference Module	8520A-1045	8-30

NOTES

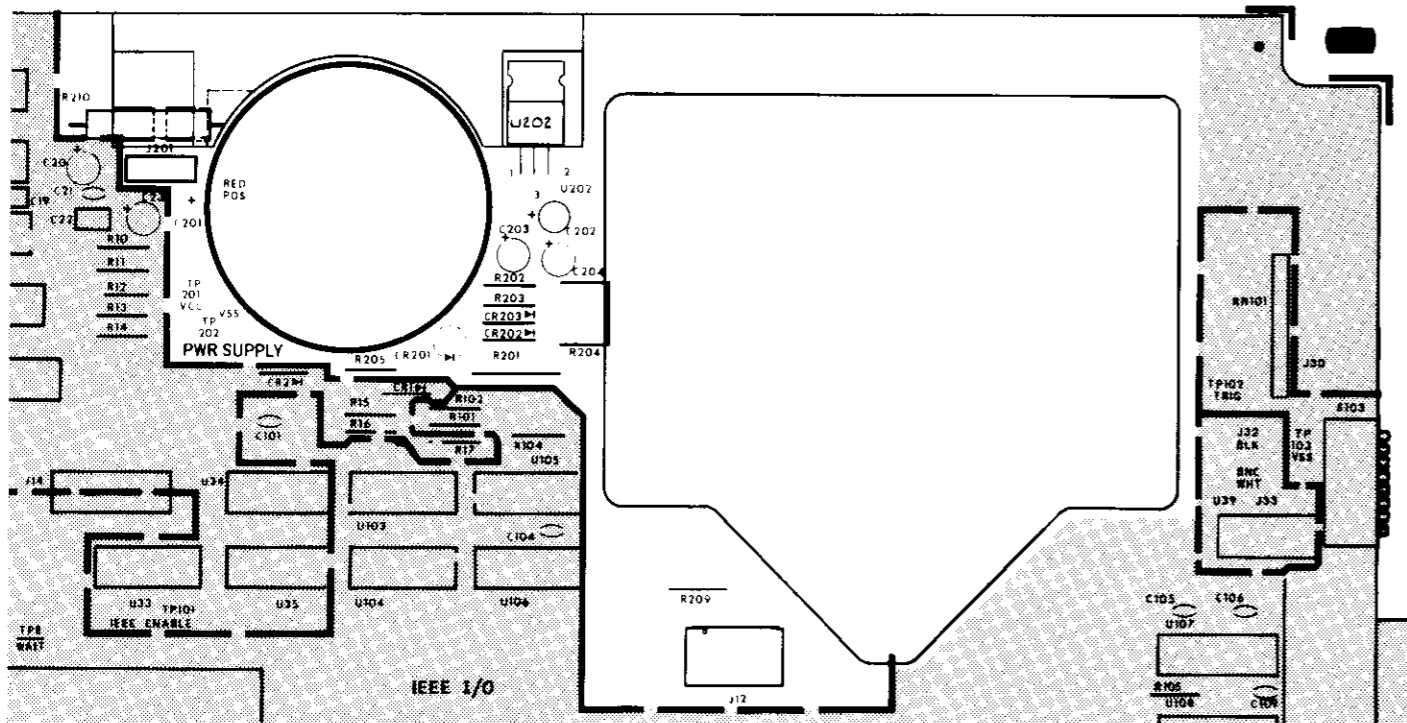


8520A-1303

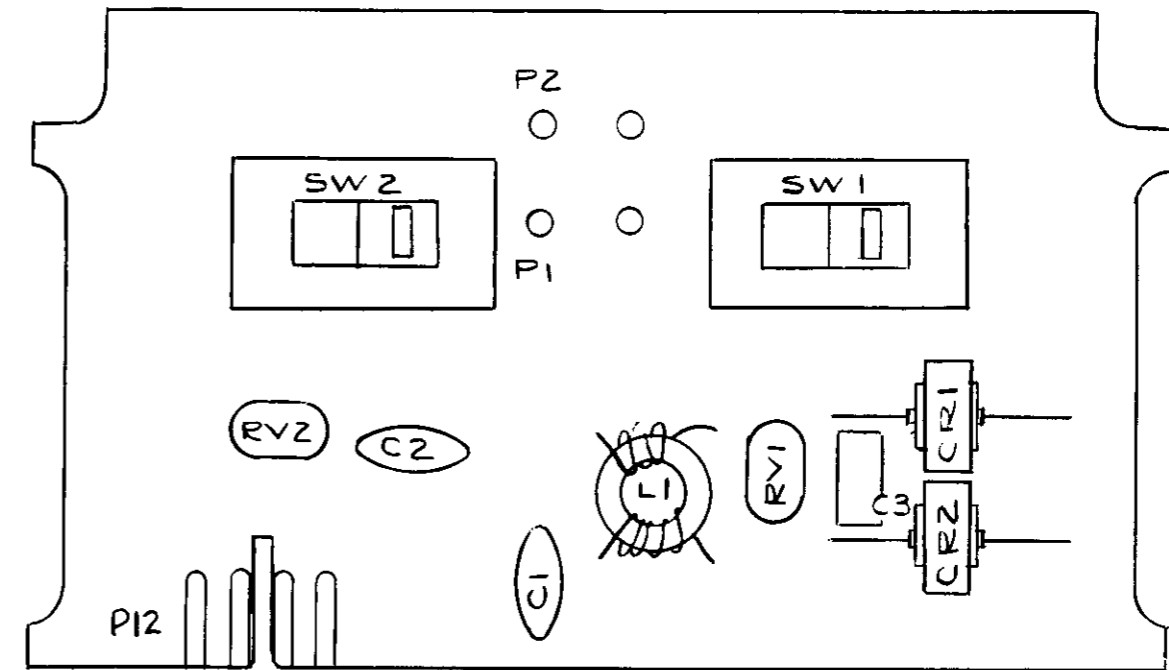
Figure 8-1. Assembly Placement



Part of
8520A-1630

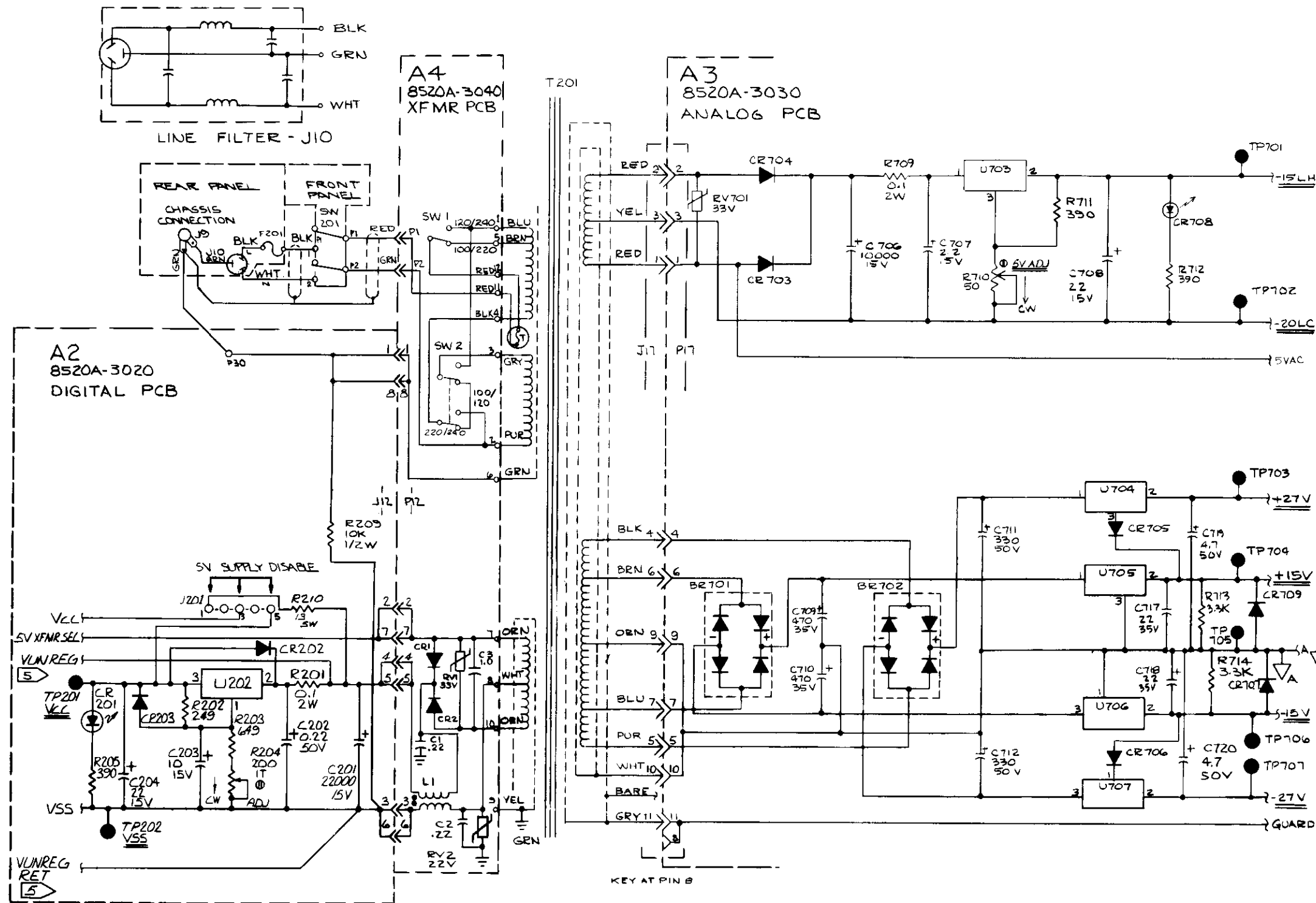


Part of
8520A-1620



8520A-1640

Figure 8-2. Power Supply



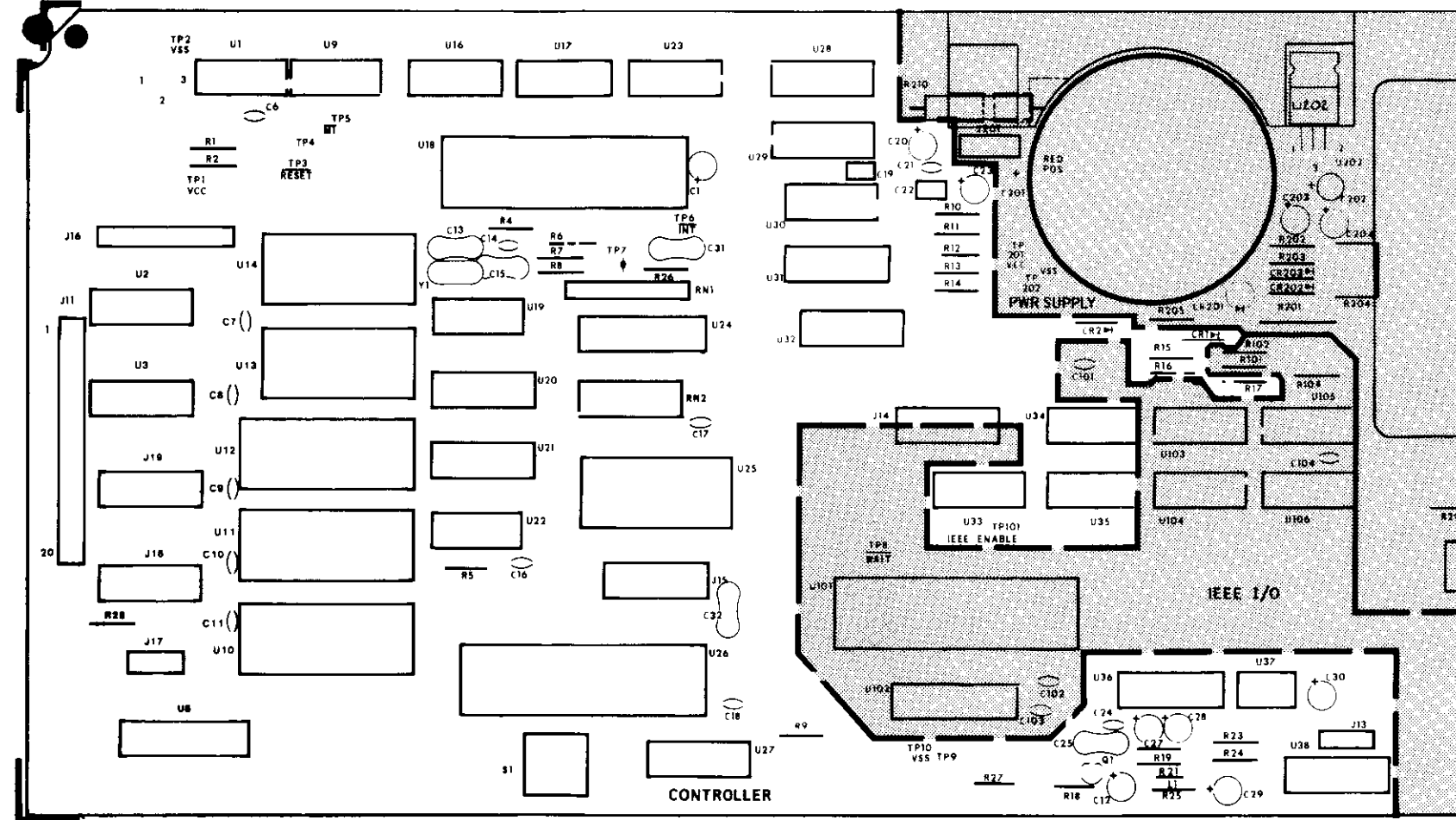
NOTES: UNLESS OTHERWISE SPECIFIED:
 1. ALL RESISTANCE VALUES IN OHMS.
 2. ALL CAPACITANCE VALUES IN MICRO-FARADS.

5 ONLY TO FRONT PANEL.

ANALOG CONTROLLER				
A.C. CONVERTER				
OHMS				
DC BUFFER/I/O SW.				
	J19	J20	J21	J22
+27V	7	7	8	7
+15V	6	6	9	6
-15V	5	5	10	5
-15LH	4	4	11	4
-20LC	3	3	12	3
-27V	2	2	13	2
VOLTAGE	INPUT NO.			

8520A-1023

Figure 8-2. Power Supply (cont)



Part of
8520A-1620

Figure 8-4. Digital Controller

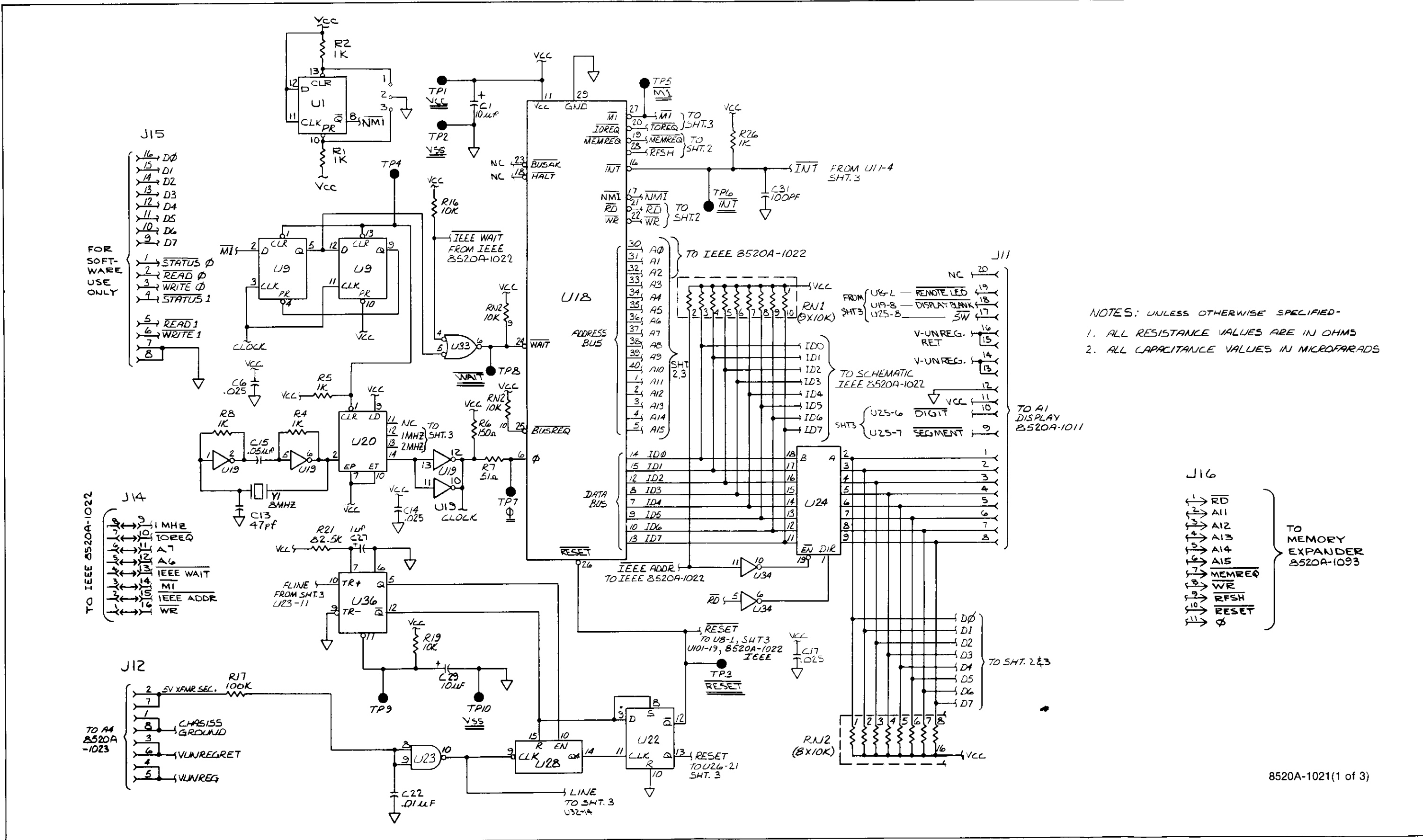
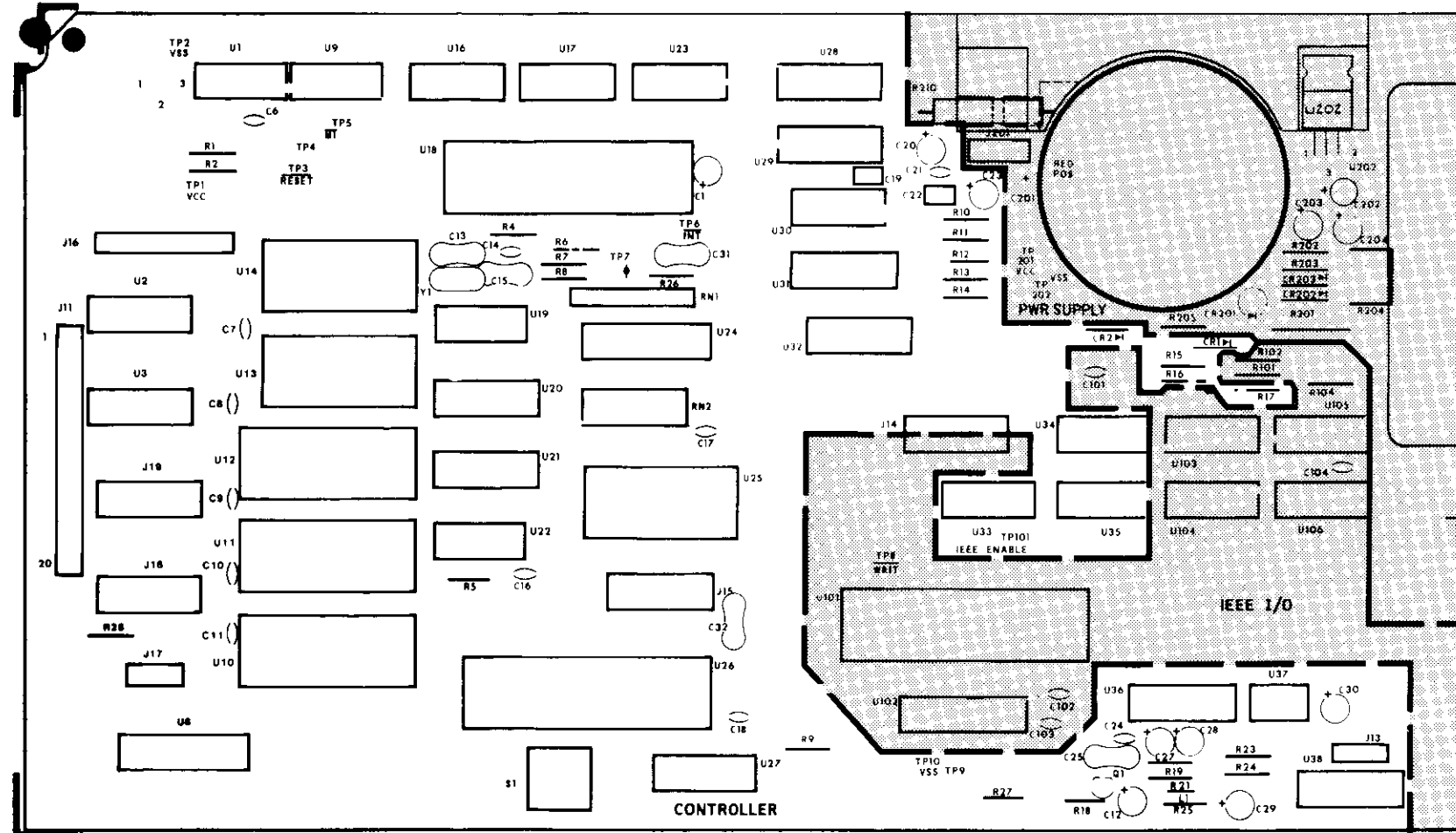
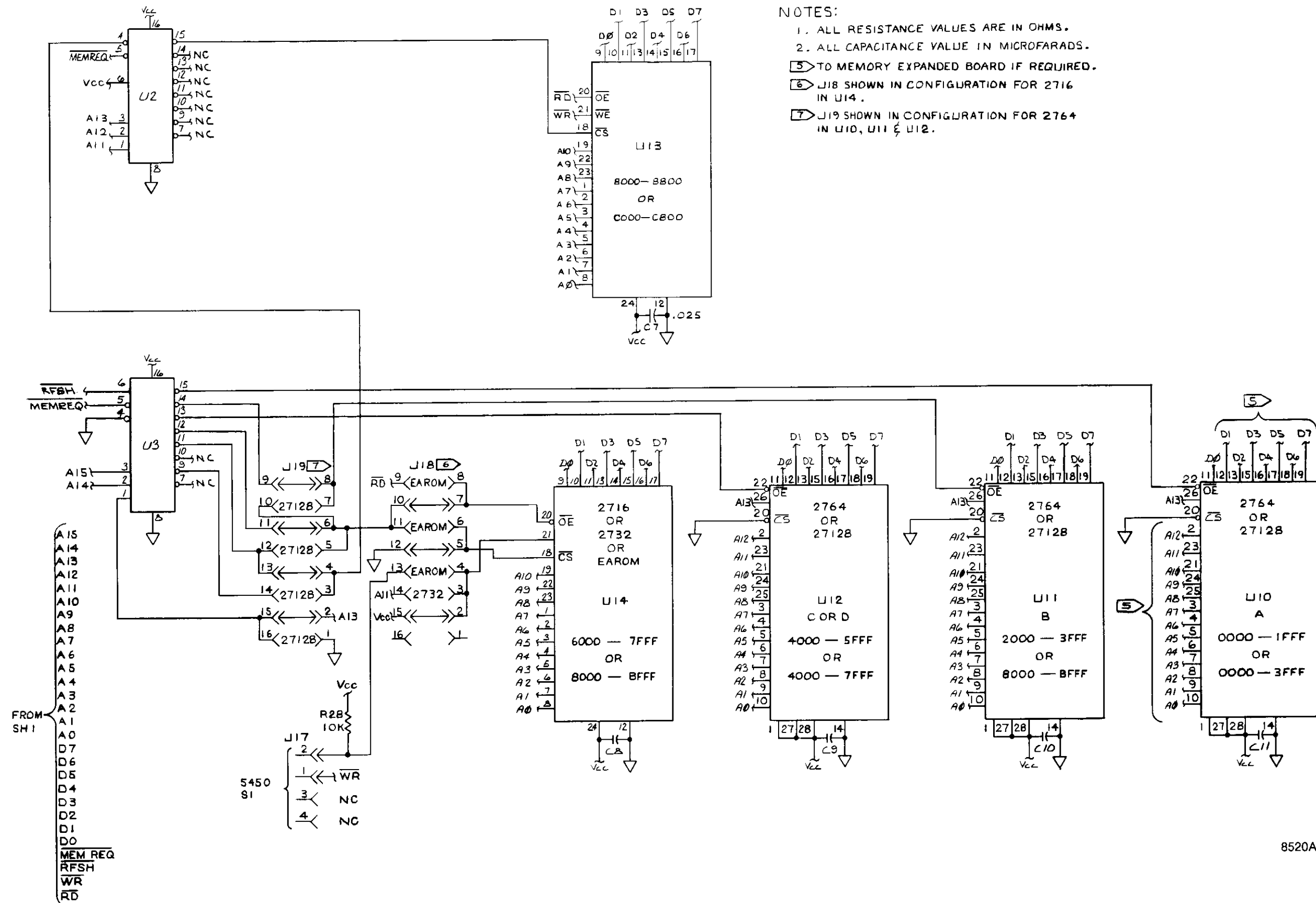


Figure 8-4. Digital Controller (cont)



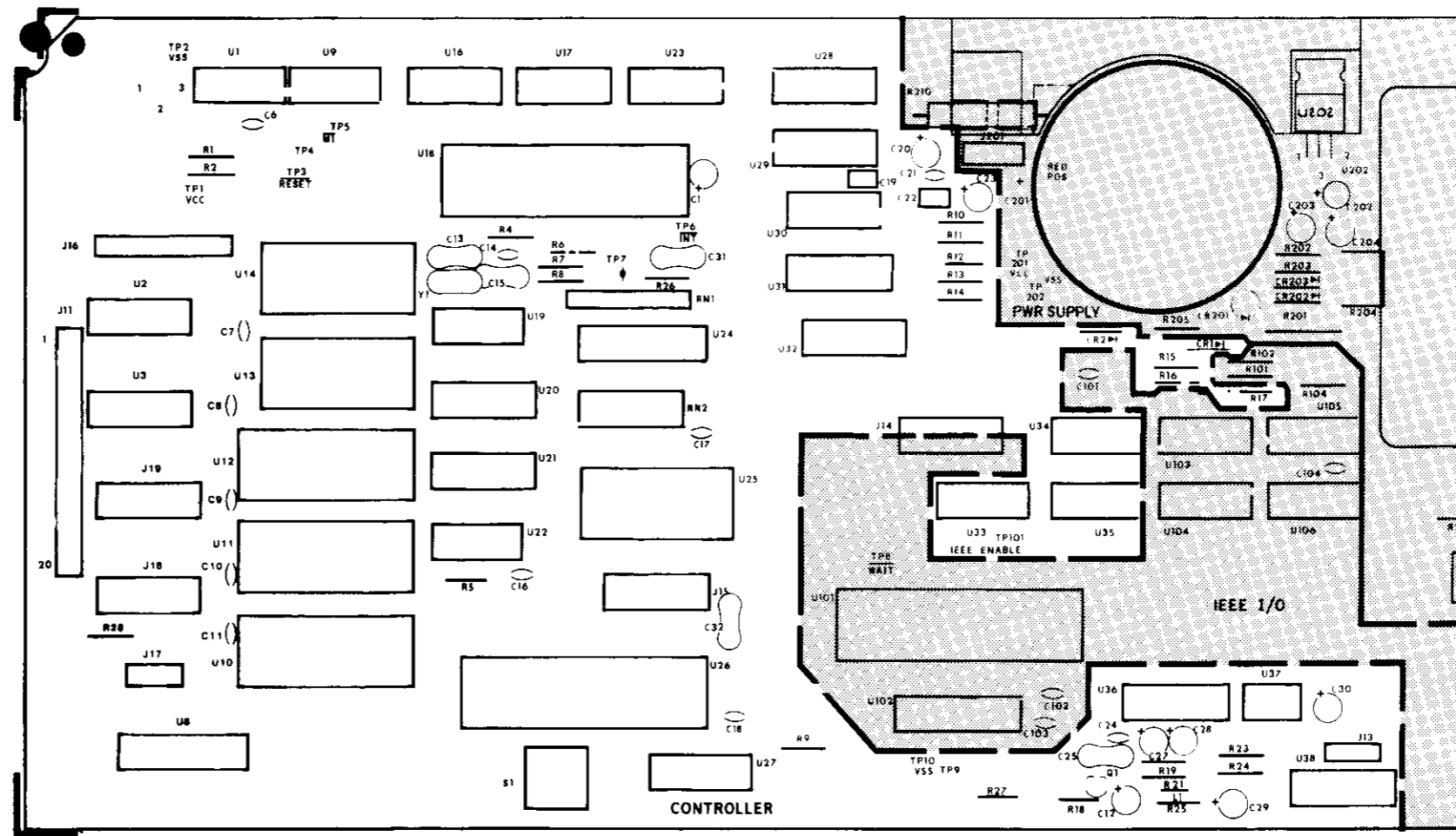
Part of
8520A-1620

Figure 8-4. Digital Controller (cont)



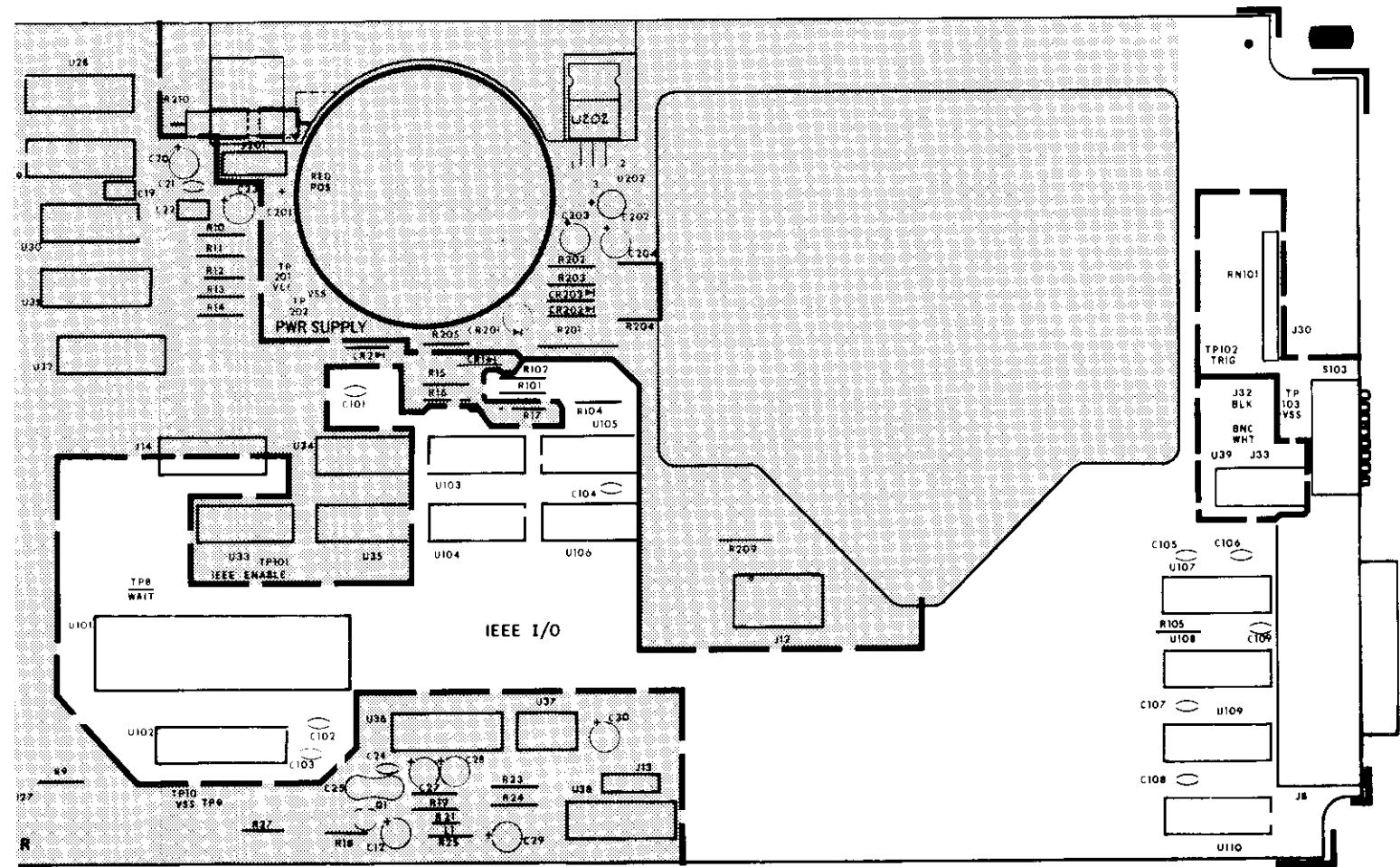
NOTES:
 1. ALL RESISTANCE VALUES ARE IN OHMS.
 2. ALL CAPACITANCE VALUE IN MICROFARADS.
 [5] TO MEMORY EXPANDED BOARD IF REQUIRED.
 [6] J18 SHOWN IN CONFIGURATION FOR 2716 IN U14.
 [7] J19 SHOWN IN CONFIGURATION FOR 2764 IN U10, U11 & U12.

Figure 8-4. Digital Controller (cont)



Part of
8520A-1620

Figure 8-4. Digital Controller (cont)



Part of
8520A-1620

Figure 8-5. IEEE-488 Interface

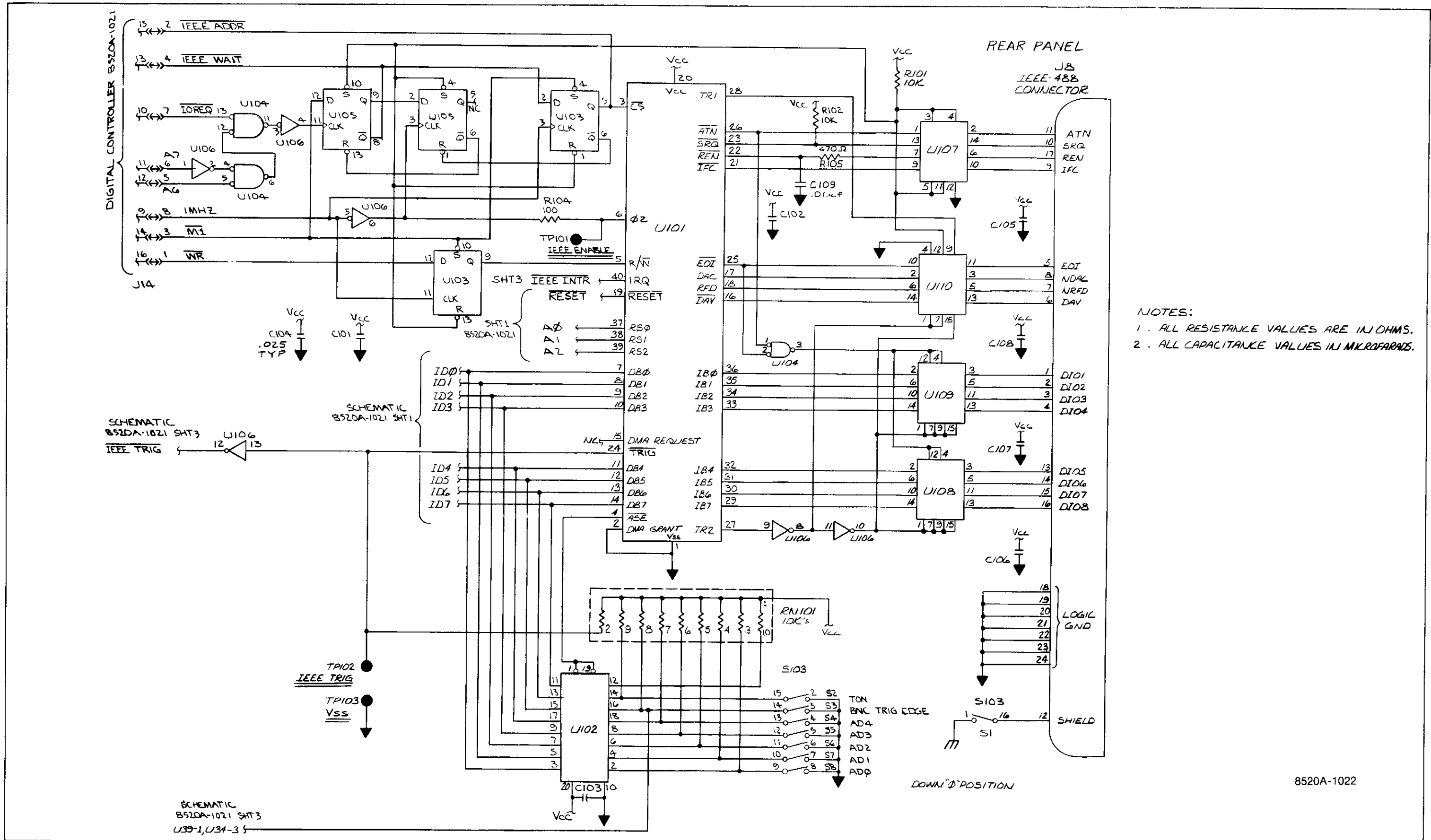
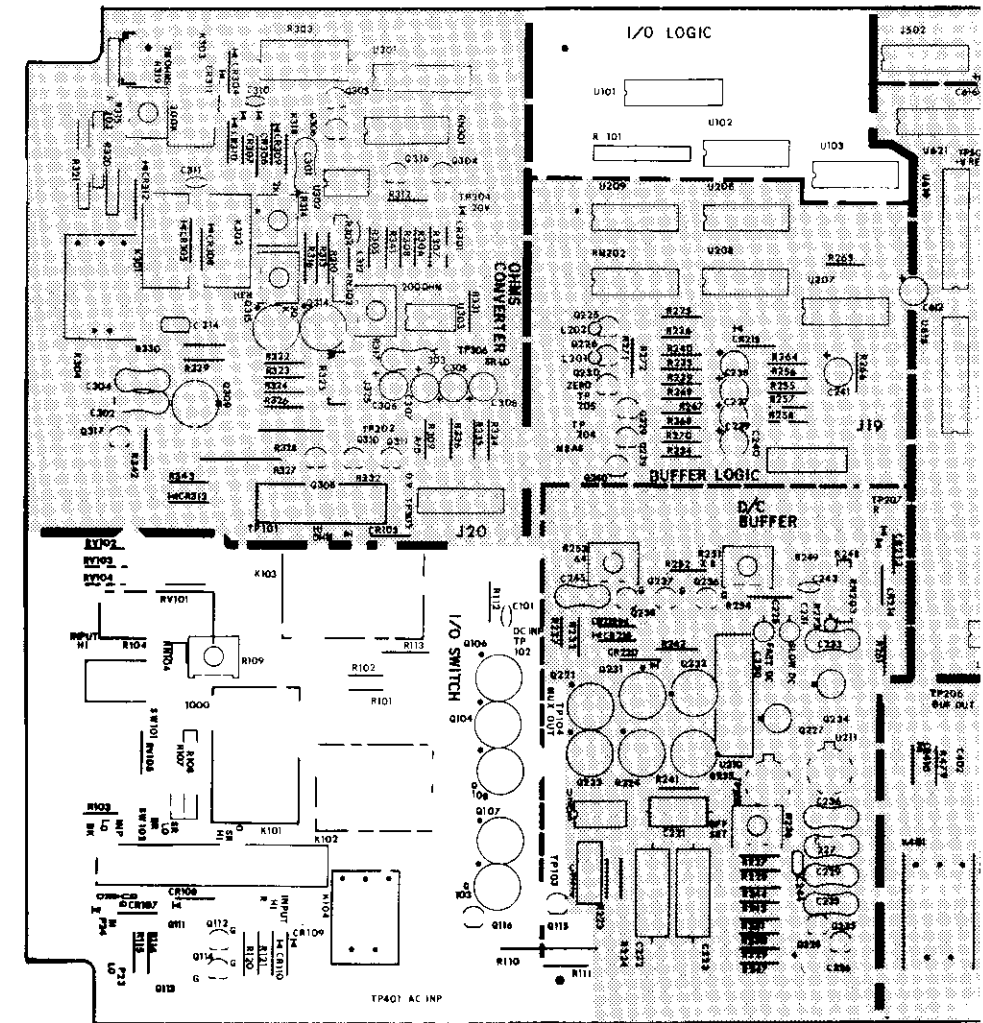


Figure 8-5. IEEE-488 Interface (cont)



Part of
8520A-1630

Figure 8-6. Input/Output SW

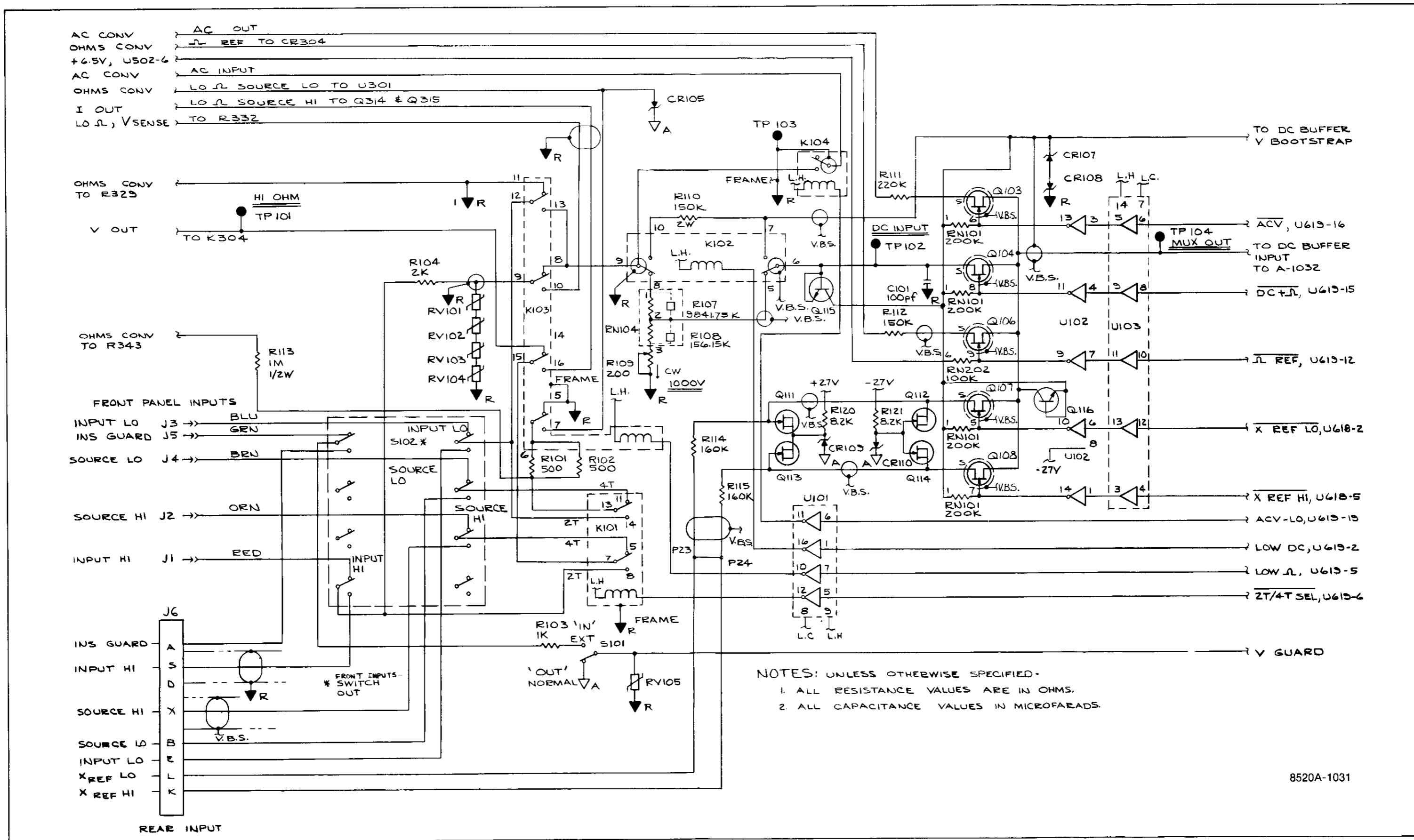
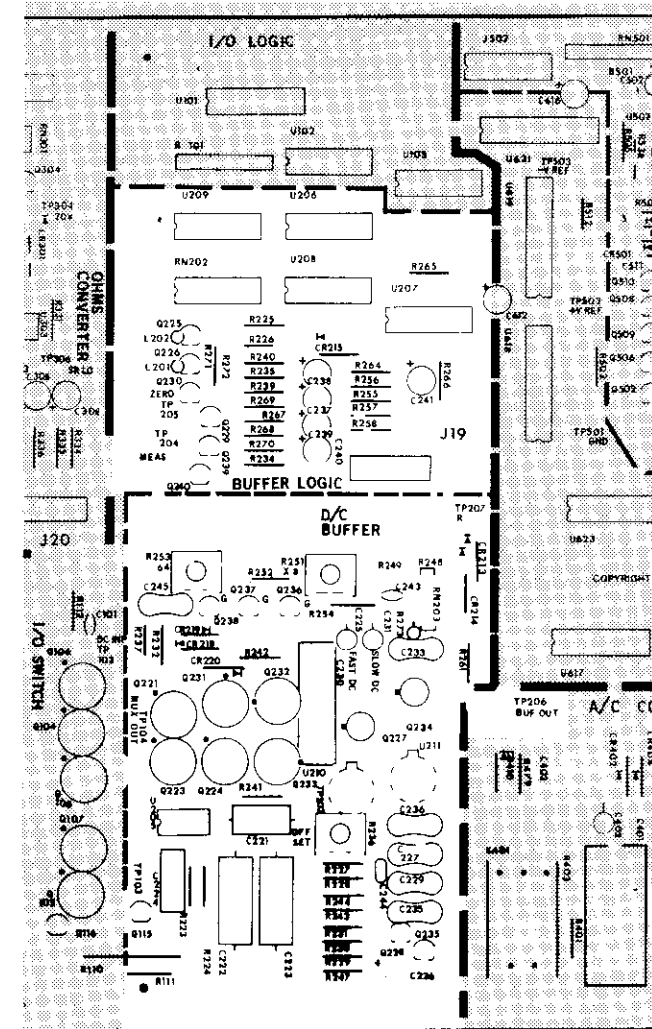
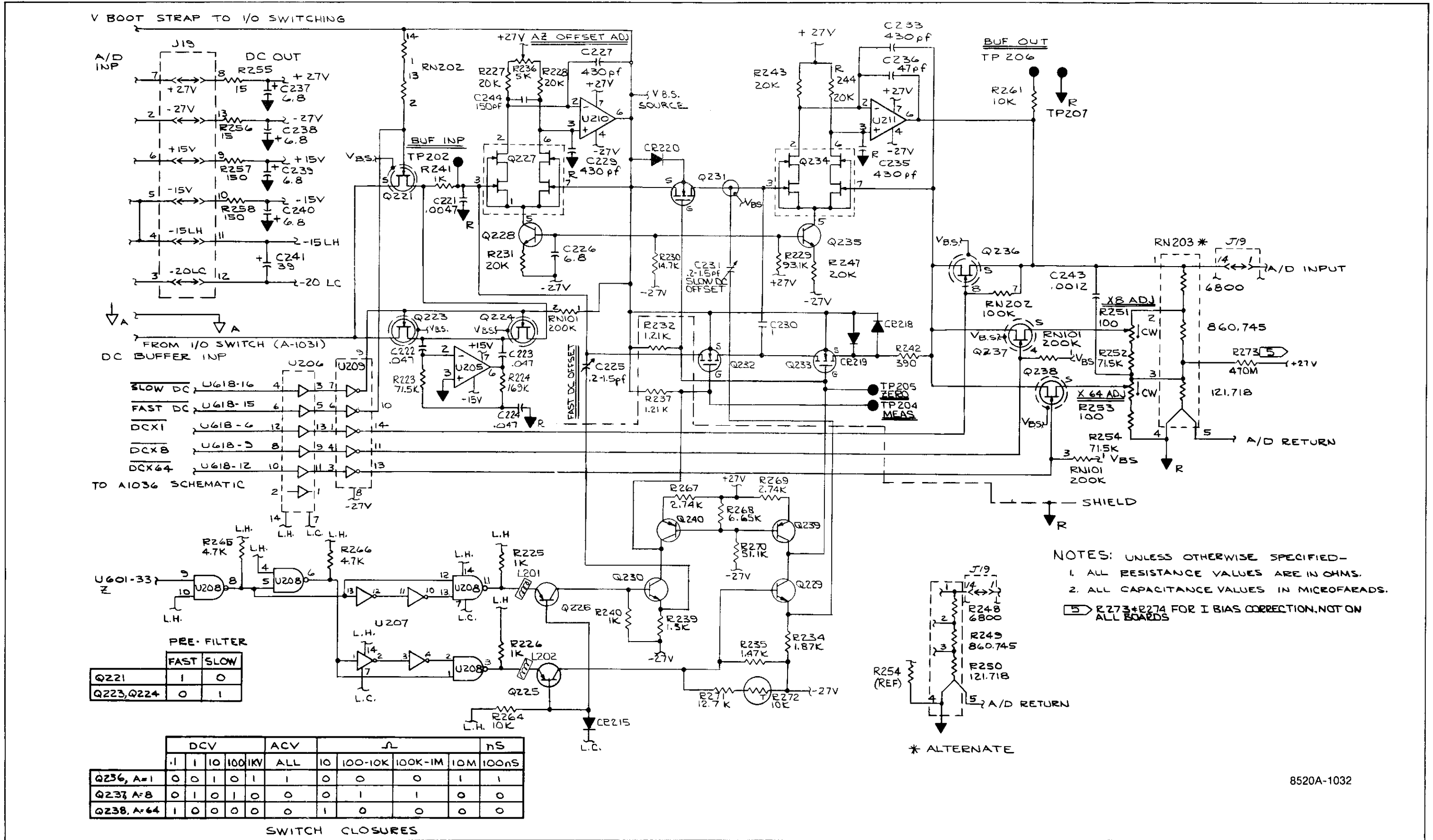


Figure 8-6. Input/Output SW (cont)



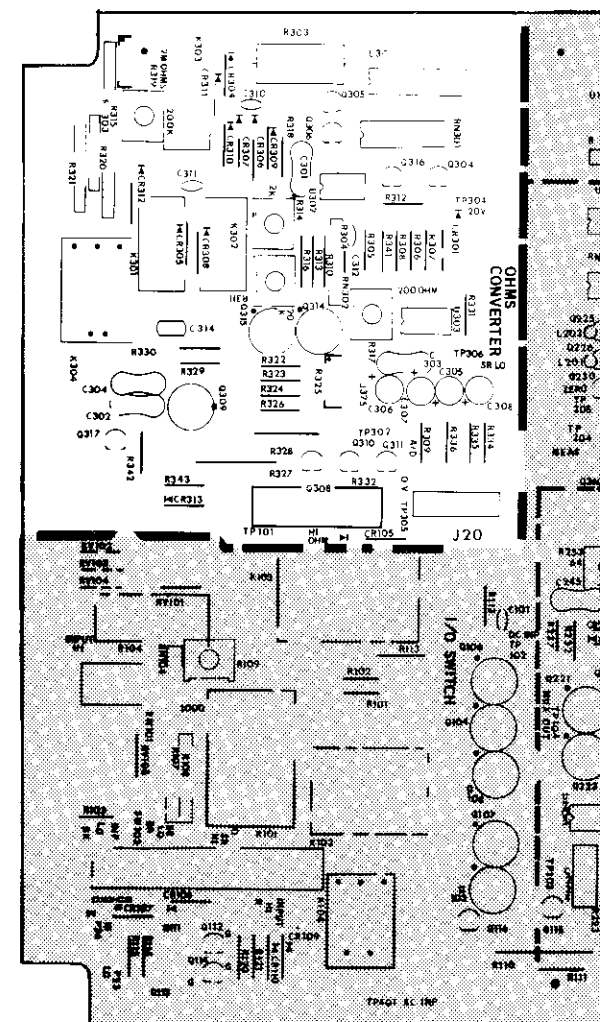
Part of
8520A-1630

Figure 8-7. DC Buffer



8520A-1032

Figure 8-7. DC Buffer (cont)



Part of
8520A-1630

Figure 8-8. Ohms Converter

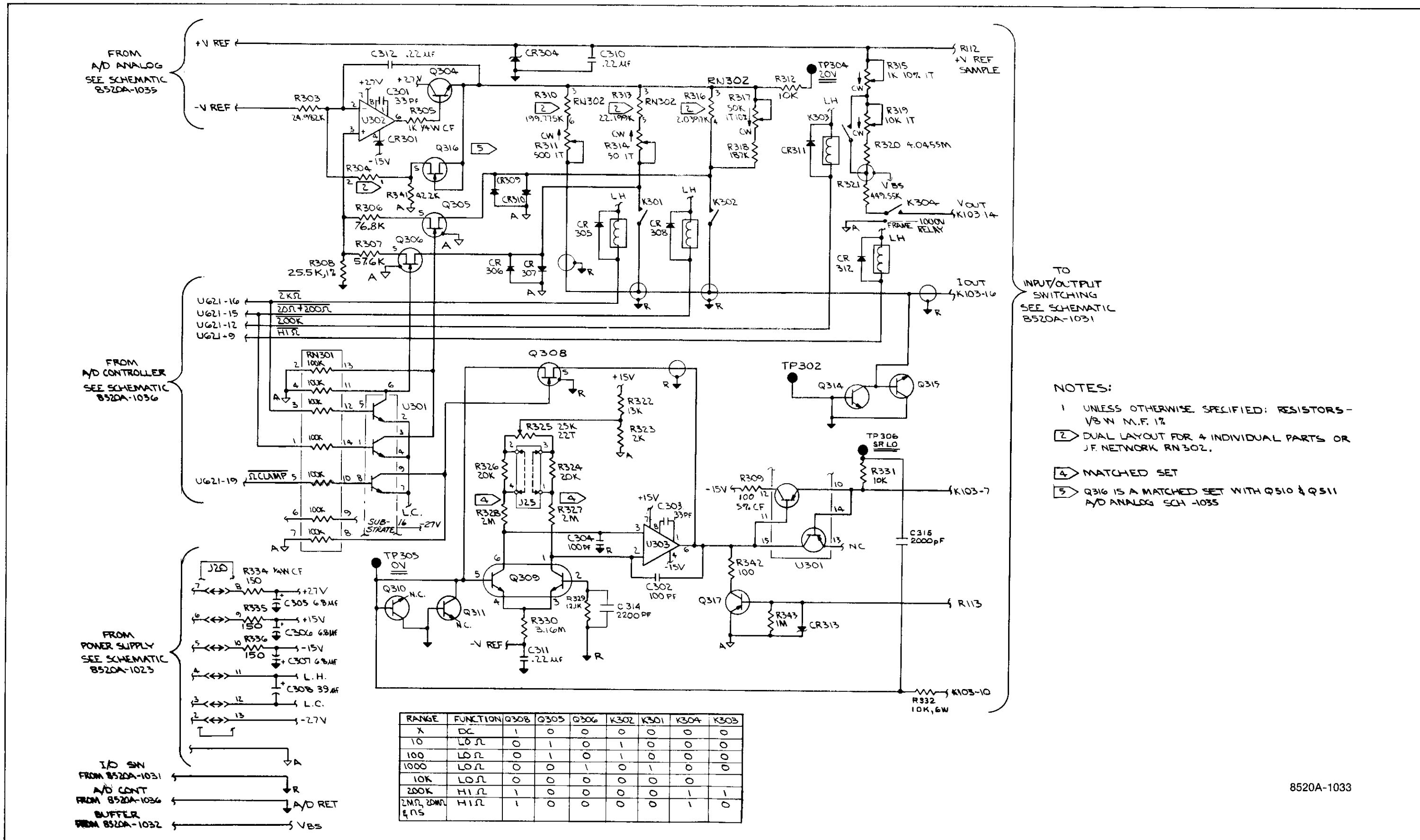
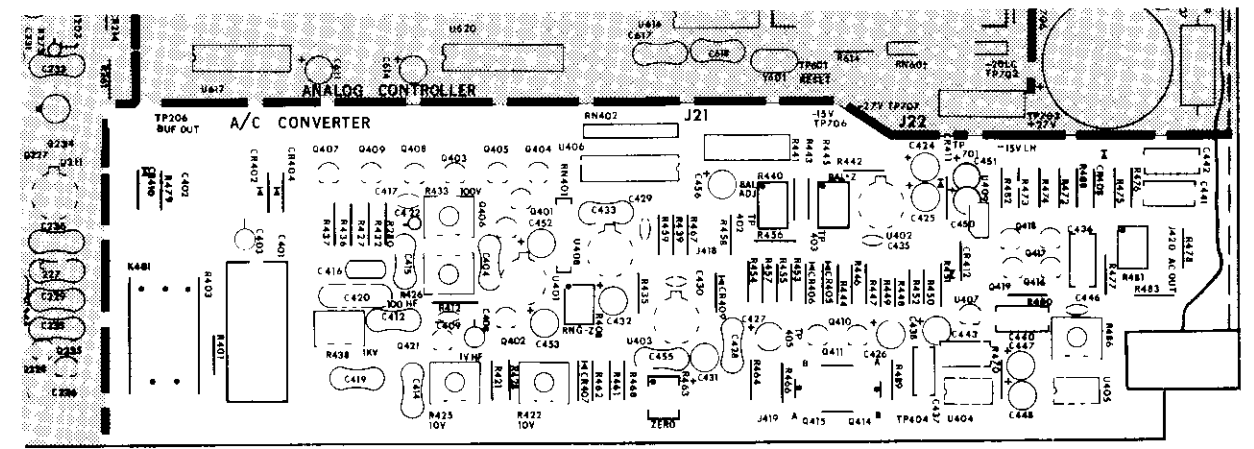
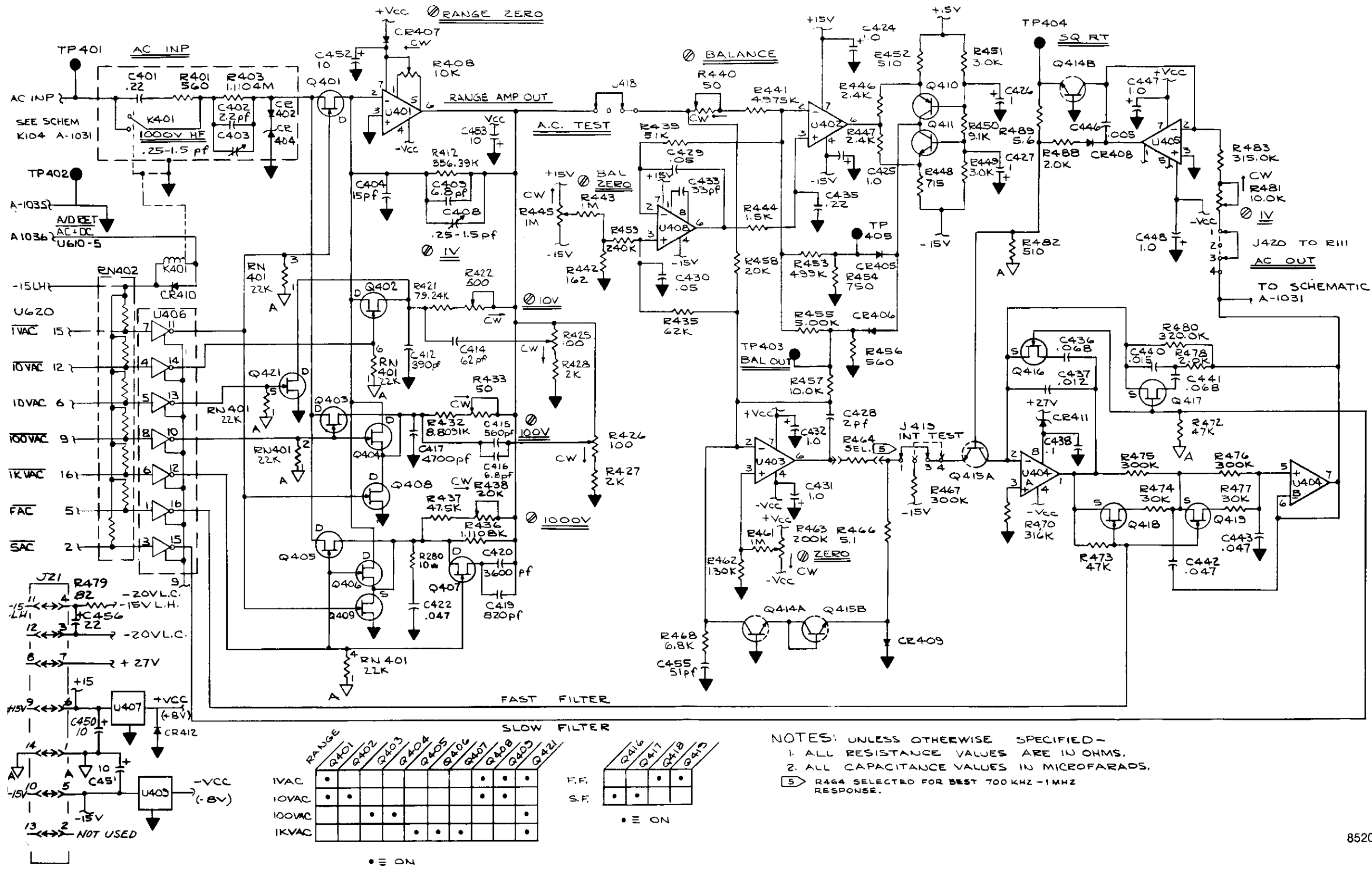


Figure 8-8. Ohms Converter (cont)



Part of
8520A-1630

Figure 8-9. AC Converter



RANGE

	Q401	Q402	Q403	Q404	Q405	Q406	Q407	Q408	Q409	Q421
1VAC	•									
10VAC	•	•								
100VAC			•							
1KVAC				•						

• = ON

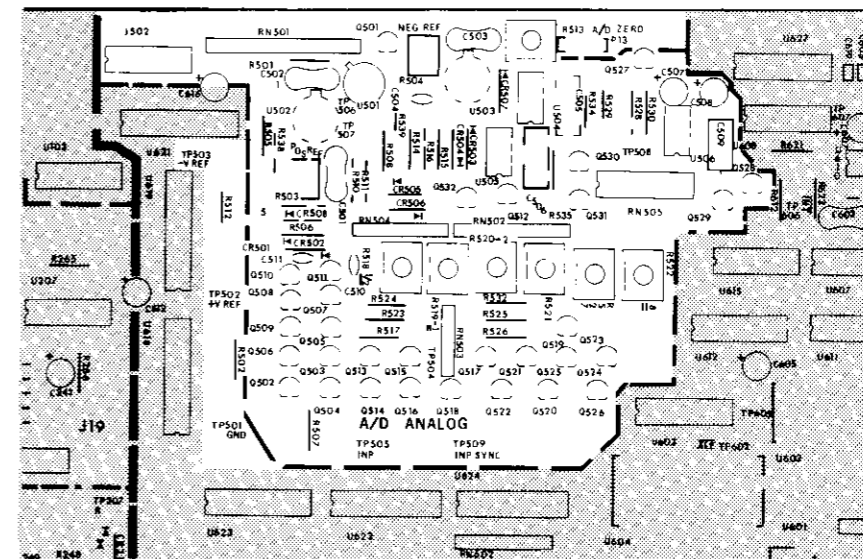
F.F.

	Q416	Q417	Q418	Q419
F.F.	•	•	•	•
S.F.				

• = ON

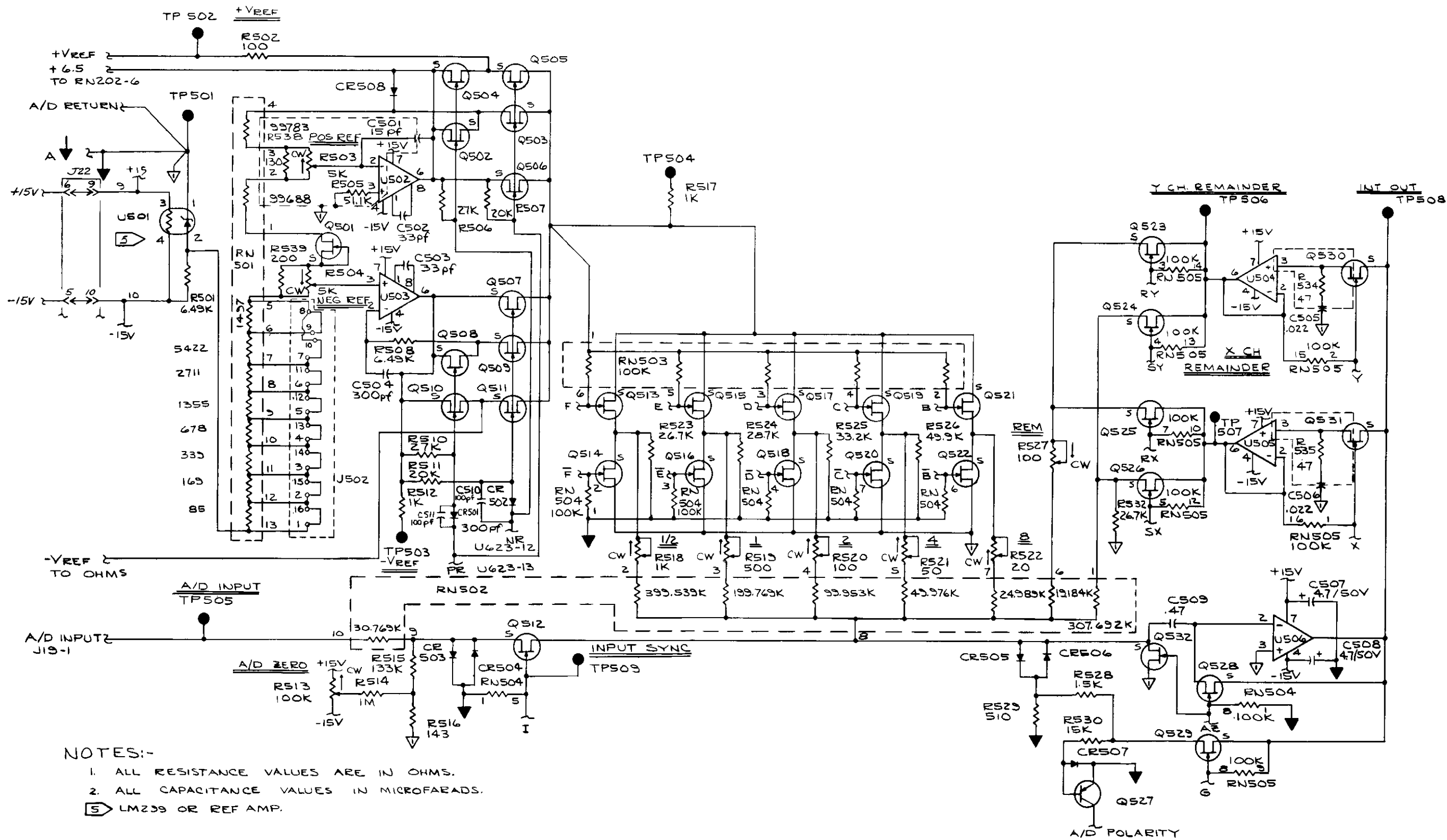
NOTES: UNLESS OTHERWISE SPECIFIED -
 1. ALL RESISTANCE VALUES ARE IN OHMS.
 2. ALL CAPACITANCE VALUES IN MICROFARADS.
 [S] R464 SELECTED FOR BEST 700 KHZ - 1MHZ RESPONSE.

Figure 8-9. AC Converter (cont)



Part of
8520A-1630

Figure 8-10. A/D Analog



- NOTES:-
1. ALL RESISTANCE VALUES ARE IN OHMS.
 2. ALL CAPACITANCE VALUES IN MICROFARADS.
 3. LM239 OR REF AMP.

8520A-1035

Figure 8-10. A/D Analog (cont)

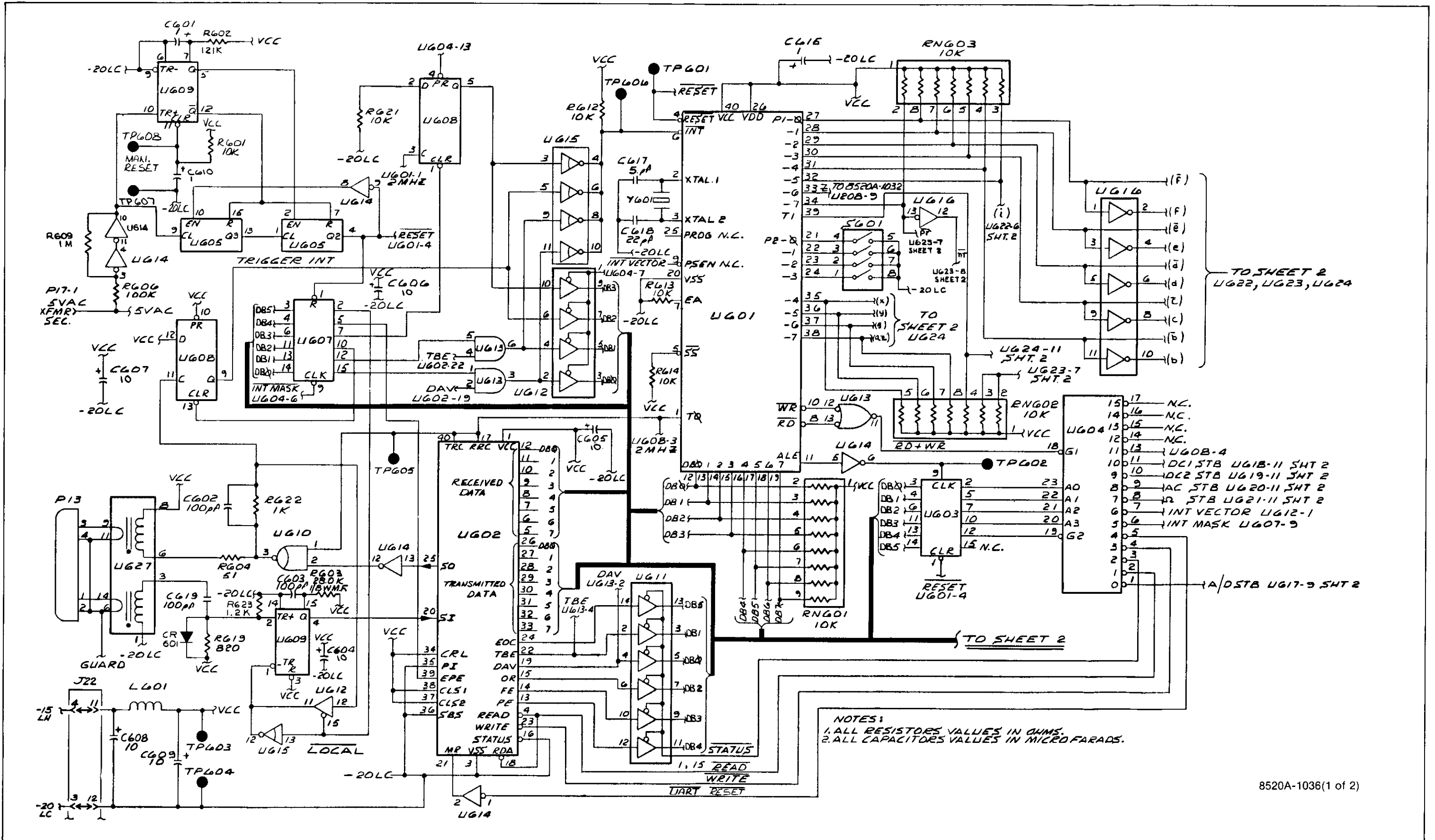
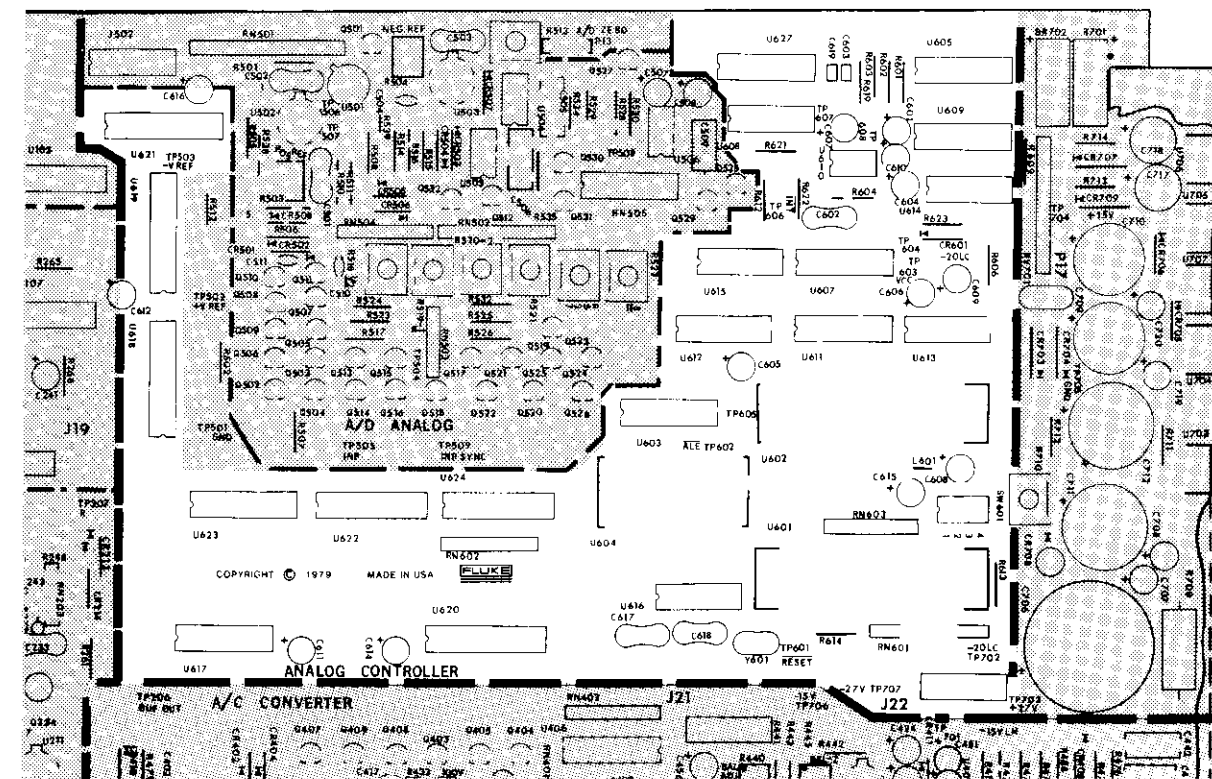


Figure 8-11. Analog Controller (cont)



Part of
8520A-1630

Figure 8-11. Analog Controller (cont)

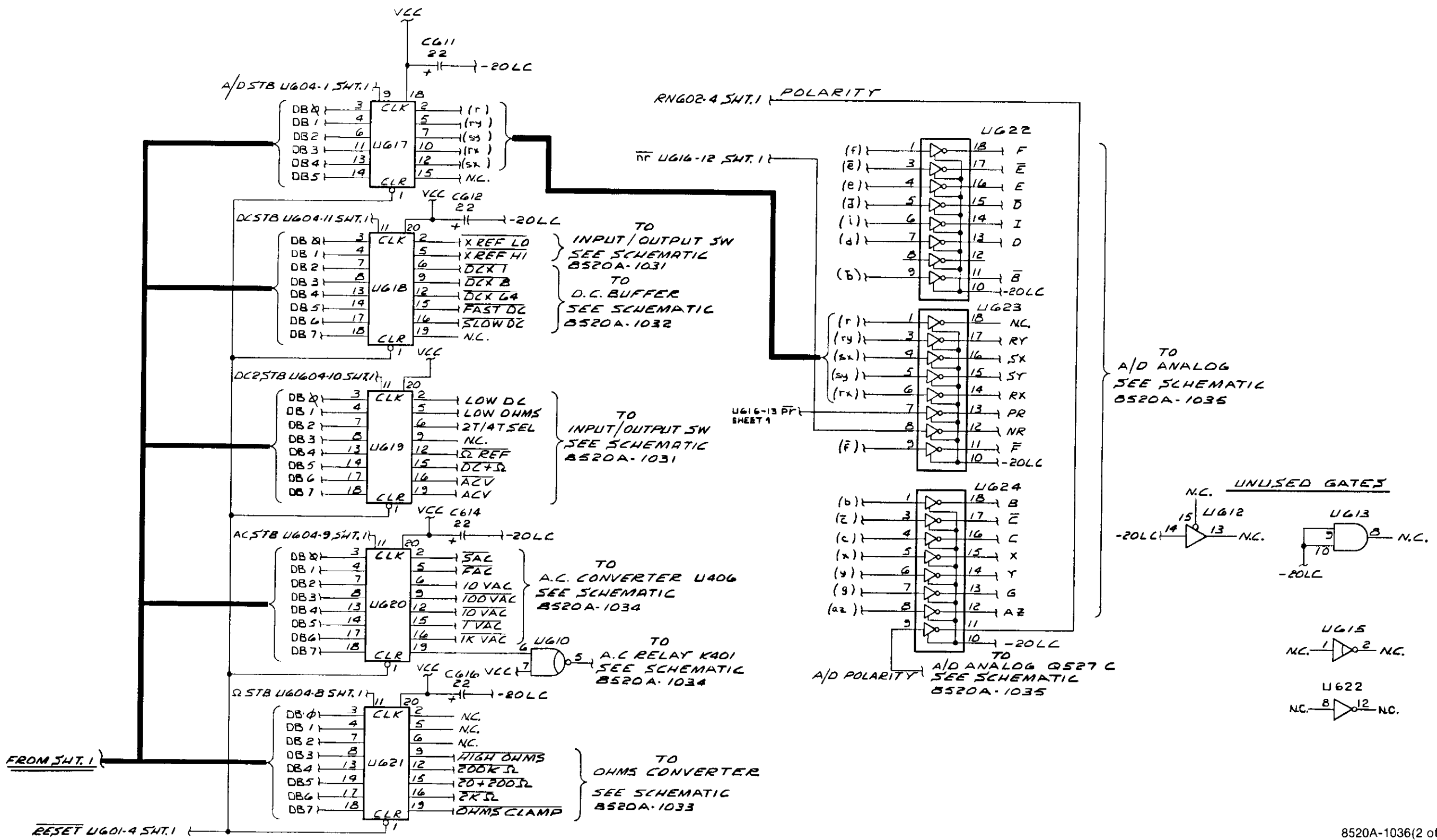
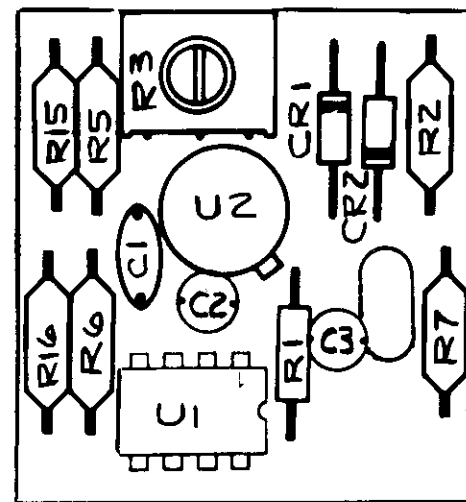
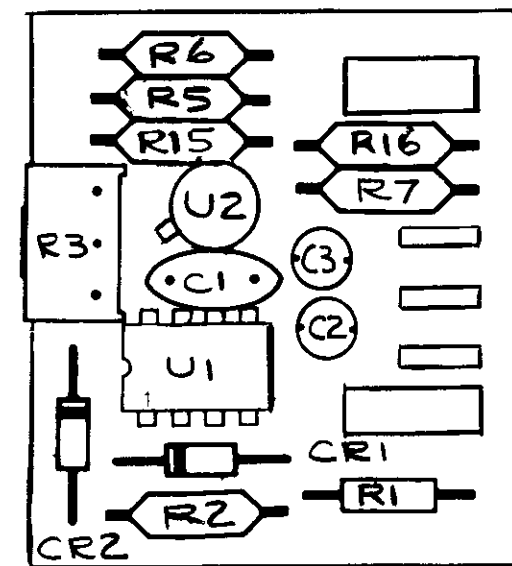


Figure 8-11. Analog Controller (cont)



HORIZONTAL

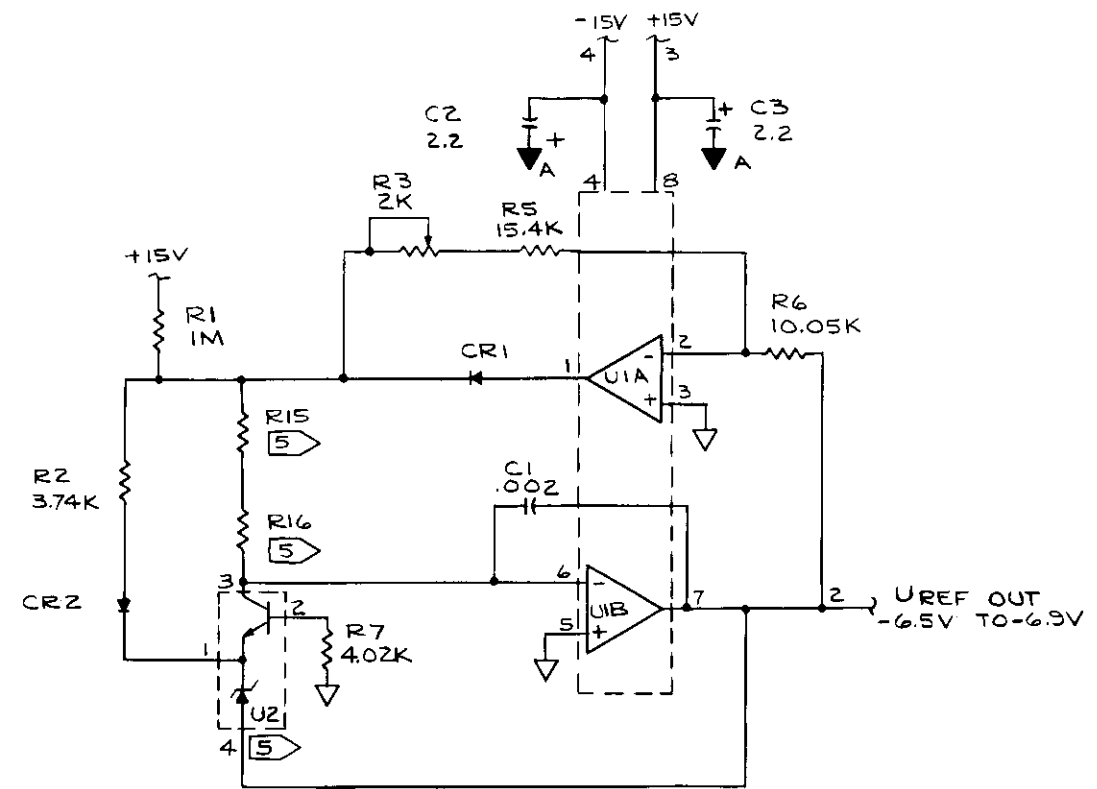
8520A-1645



VERTICAL

8520A-1646

Figure 8-12. Reference Module



NOTES:-

1. ALL RESISTANCE VALUES ARE IN OHMS.
 2. ALL CAPACITANCE VALUES IN MICROFARADS.
- 5 MATCHED SET JF P/N 523407 (8520A-451Z).

Figure 8-12. Reference Module (cont)

