FLUKE
83,85,87
Multimeters

Service Manual

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FLUKE®

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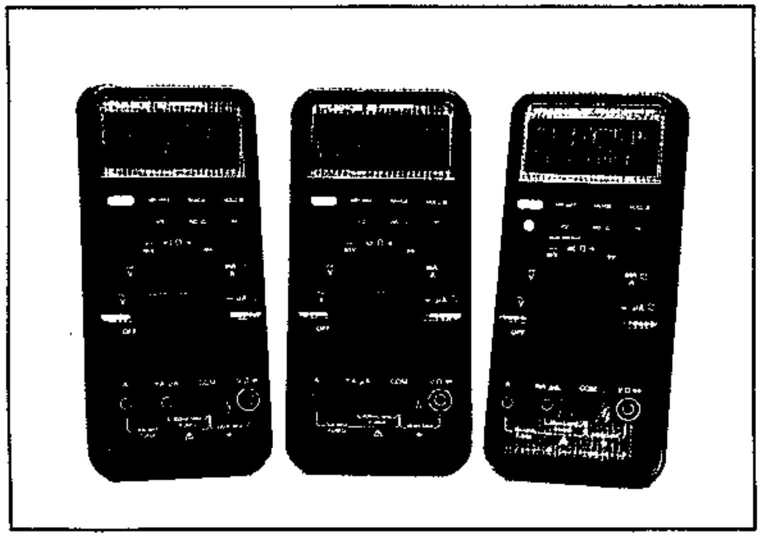

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Section 1
Introduction and Specifications

1-1. INTRODUCTION

This manual covers servicing information for Fluke multimeter Models 83, 85, and 87. This service manual will prove useful for tasks ranging from routine maintenance to troubleshooting and repair. Specifications, theory of operation, calibration routines, testing and troubleshooting procedures, parts replacement information, and schematic diagrams are provided.

A meter under warranty will be promptly repaired or replaced (at Fluke's option) and returned at no charge. See the registration card for warranty terms. If the warranty has lapsed, the meter will be repaired and returned for a fixed fee. Contact the nearest Service Center for information and prices. A list of U.S. and International Service Centers is included at the end of Section 4 of this manual.

1-2. ORGANIZATION OF THE SERVICE MANUAL

The following descriptions for the various sections serve to introduce the manual.

SECTION 1. INTRODUCTION AND SPECIFICATIONS

This section describes both use of the Service Manual and application of special terminology (conventions) to describe the meter's circuitry. A complete set of specifications appears at the end of this section.

SECTION 2. THEORY OF OPERATION

This section first categorizes instrument circuitry into functional blocks, with a description of each block's role in overall operation. A detailed circuit description is then given for each block. These descriptions explore operation to the component level and fully support troubleshooting and repair procedures defined in Section 3.

SECTION 3. MAINTENANCE

Provides complete maintenance information, from general maintenance and cleaning instructions to detailed troubleshooting and repair procedures to the component level. Troubleshooting and repair procedures rely closely on both the Theory of Operation presented in Section 2 and the Schematic Diagrams shown in Section 5.

SECTION 4. LIST OF REPLACEABLE PARTS

Includes parts lists for all standard assemblies. Information on how and where to order parts is also provided.

SECTION 5. SCHEMATIC DIAGRAMS

Includes schematic diagrams for all assemblies. A list of mnemonic definitions is also included to aid in identifying signal name abbreviations.

1-3. CONVENTIONS

Throughout the manual, certain notational conventions are used. A summary of these conventions follows:

- Instrument Reference

  When the discussion involves common features of the Fluke 80 Series multimeters, the term multimeter is used, and the model number is not used. Where features differ among models, further identification is made by model number (Model 83, 85, or 87).

- Printed Circuit Assembly

  The term pca is used to represent a printed circuit board and its attached parts.

- Signal Logic Polarity

  Signal names followed by a - are active (or asserted) low. Signals not so marked are active high.

- Circuit Nodes

  Individual pins or connections on a component are specified with a dash (-) following the component reference designator. For example, pin 19 of U30 would be U30-19.

- User Notation

  Generally, buttons to be pressed, function positions to select, input terminals to use, and display notation to be read are presented in this manual as they are seen on the multimeter. However, one button on the Model 83/85 and two buttons on the Model 87 use no terminology and are identified by color (blue or yellow) in this manual.

Special terms (mnemonics) used in text descriptions of multimeter circuitry correspond to terms used on the schematic diagrams in Section 5.

1-4. SPECIFICATIONS

Specifications for Models 83 and 85 are presented in Table 1-1. Model 87 specifications are presented in Table 2-2.

Table 1-1. Specifications, Models 83 and 85

FUNCTION	RANGE	RESOLUTION	ACCURACY[1]*			
$\tilde{V}$			50 Hz to 60 Hz	45 Hz to 1 kHz	1 KHz - 5 kHZ	
(Fluke 83)	400.0 mV	0.1 mV	±(1.0% + 4)	±(1.5% + 4)	±(2.0% + 4)	
	4.000V	0.001V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)	
	40.00V	0.01V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)	
	400.0V	0.1V	±(1.0% + 3)	±(1.5% + 3)	±(2.0% + 3)	
	1000V	1V	±(1.0% + 3)	±(2.5% + 3)	±(2.5% + 3)	
$\tilde{V}$			50 Hz to 60 Hz	45 Hz to 1 kHz	1 kHz - 5 kHz	5 kHz to 20 kHz
(Fluke 85)	400.0 mV	0.1 mV	±(0.5% + 4)	±(1.0% + 4)	±(2.0% + 4)	±(3.0% + 4)
	4.000V	0.001V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)	±4.0% + 4)
	40.00V	0.01V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)	±(4.0% + 4)
	400.0V	0.1V	±(0.5% + 2)	±(1.0% + 2)	±(2.0% + 2)	±(4.0% + 4)
	1000V	1V	±(0.5% + 2)	±(2.0% + 2)	±(2.0% + 2)	unspecified
$\overline{V}$			Fluke 83		Fluke 85	
	4.000V	0.001V	±(0.3% + 1)		±(0.1% + 1)	
	40.00V	0.01V	±(0.3% + 1)		±(0.1% + 1)	
	400.0V	0.1V	±(0.3% + 1)		±(0.1% + 1)	
	1000V	1V	±(0.3% + 1)		±(0.1% + 1)	
$\overline{mV}$	400.0 mV	0.1 mV	±(0.3% + 1)		±(0.1% + 1)	
Ω	400.0Ω	0.1Ω	±(0.4% + 1)		±(0.2% + 1)	
	4.000 kΩ	0.001 kΩ	±(0.4% + 1)		±(0.2% + 1)	
	40.00 kΩ	0.01 kΩ	±(0.4% + 1)		±(0.2% + 1)	
	400.0 kΩ	0.1 kΩ	±(0.4% + 1)		±(0.2% + 1)	
	4.000 MΩ	0.001 MΩ	±(0.4% + 1)		±(0.2% + 1)	
	40.00 MΩ	0.01 MΩ	±(1% + 3)		±(1% + 3)	
(nS)	40.00 nS	0.01 nS	±(1% +10)		±(1% + 10)	

TYPICAL OHMS SHORT CIRCUIT CURRENT

Range	400	4k	40k	400k	4M	40M
Current	700 μA	170 μA	20 μA	2 μA	.2 μA	.2 μA

1 Accuracy is given as ±([% of reading] + [number of least significant digits]) at 18° C to 28° C with relative humidity up to 90%, for a period of one year after calibration. AC conversions are ac-coupled, average responding, and calibrated to the rms value of a sine wave input.

** Below a reading of 200 counts, add 10 digits.*

Table 1-1. Specifications, Models 83 and 85 (cont)

FUNCTION	RANGE	RESOLUTION	ACCURACY[2]
Capacitance	5.00 nF	0.01 nF	±(1% + 3)
	0.0500 μF	0.0001 μF	±(1% + 3)
	0.500 μF	0.001 μF	±(1% + 3)
	5.00 μF	0.01 μF	±(1% + 3)
Diode Test	3.000V	0.001V	±(2% + 1)

FUNCTION	RANGE	RESOLUTION	ACCURACY		BURDEN VOLTAGE
			Fluke 83	Fluke 85	TYPICAL
mA A ~ (45 Hz to 2 kHz)	40.00 mA	0.01 mA	±(1.2% + 2)*	±(0.6% + 2)*	1.6 mV/mA
	400.0 mA	0.1 mA	±(1.2% + 2)*	±(0.6% + 2)*	1.6 mV/mA
	4000 mA	1 mA	±(1.2% + 2)*	±(0.6% + 2)*	0.03 V/A
	10.00A[3]	0.01A	±(1.2% + 2)*	±(0.6% + 2)*	0.03 V/A
mA A ⎓	40.00 mA	0.01 mA	±(0.4% + 2)	±(0.2% + 2)	1.6 mV/mA
	400.0 mA	0.1 mA	±(0.4% + 2)	±(0.2% + 2)	1.6 mV/mA
	4000 mA	1 mA	±(0.4% + 2)	±(0.2% + 2)	0.03 V/A
	10.00A[3]	0.01A	±(0.4% + 2)	±(0.2% + 2)	0.03 V/A
μA ~ (45 Hz to 2 kHz)	400.0 μA	0.1 μA	±(1.2% + 2)*	±(0.6% + 2)*	100 μV/μA
	4000 μA	1 μA	±(1.2% + 2)*	±(0.6% + 2)*	100 μV/μA
μA ⎓	400.0 μA	0.1 μA	±(0.4% + 3)	±(0.2% + 3)	100 μV/μA
	4000 μA	1 μA	±(0.4% + 2)	±(0.2% + 2)	100 μV/μA

FUNCTION	RANGE	RESOLUTION	ACCURACY
Frequency (0.5 Hz to 200 kHz, pulse width >2 μs)	199.99	0.01 Hz	±(0.005% + 1)
	1999.9	0.1 Hz	±(0.005% + 1)
	19.999 kHz	0.001 kHz	±(0.005% + 1)
	199.99 kHz	0.01 kHz	±(0.005% + 1)
	>200 kHz	0.1 kHz	Unspecified

2 With film capacitor or better using Relative mode to zero residual

3 10A continuous, 20A for 30 seconds maximum

Table 1-1. Specifications, Models 83 and 85 (cont)

FREQUENCY COUNTER SENSITIVITY AND TRIGGER LEVEL			
INPUT RANGE	MINIMUM SENSITIVITY (RMS SINEWAVE)		APPROXIMATE TRIGGER LEVEL (DC VOLTAGE FUNCTION)
(Maximum input for specified accuracy = 10X Range or 1000V)	5 Hz-20 kHz	0.5 Hz-200 kHz	
400 mV dc	70 mV (to 400 Hz)	70 mV (to 400 Hz)	40 mV
400 mV ac	150 mV	150 mV	—
4V	0.3V	0.7V	1.7V
40V	3V	7V	4V
400V	30V	70V (≤140 kHz)	40V
1000V	300V	700V (≤14 kHz)	400V

Duty Cycle 0.1 to 99.9% (0.5 Hz to 200 kHz, pulse width >2 μs)

Accuracy: Within ±(0.05% per kHz + 0.1%) of full scale for a 5V logic family input on the 4V dc range.

Within ± ((0.06 x Voltage Range / Input Voltage) X 100%) of full scale for sine wave inputs on ac voltage ranges.

FUNCTION	OVERLOAD PROTECTION[6]	INPUT IMPEDANCE (nominal)	COMMON MODE REJECTION RATIO (1 kΩ unbalance)	NORMAL MODE REJECTION RATIO
V ⎓	1000V rms	10 MΩ<100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
mV ⎓	1000V rms	10 MΩ<100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
V ~	1000V rms	10 MΩ<100 pF (ac-coupled)	>60 dB, dc to 60 Hz	

FUNCTION	OVERLOAD PROTECTION	OPEN CIRCUIT TEST VOLTAGE	FULL SCALE VOLTAGE		SHORT CIRCUIT CURRENT
			To 4.0 MΩ	40 MΩ or nS	
Ω	1000V rms[6]	<1.3V dc	<450 mV dc	<1.3V dc	<500 μA
Diode Test	1000V rms[6]	<3.9V dc	3.000V dc		1.0 mA typical

5 10^7 V Hz max

6 For circuits < 0.3A short circuit, 660V for high energy circuits.

Table 1-1. Specifications, Models 83 and 85 (cont)

	NOMINAL RESPONSE	ACCURACY (5% to 100% of range)
MIN MAX Recording	100 ms to 80%	Specified accuracy ±12 digits for changes >200 ms in duration (±40 digits in AC with beeper on)
	1 s	Same as specified accuracy for changes >2 seconds in duration (±40 digits in AC with beeper on)

FUSE PROTECTION	
mA or µA	1A 600V FAST Fuse
A	15A 600V FAST Fuse

MAXIMUM VOLTAGE BETWEEN ANY TERMINAL AND EARTH GROUND
1000 Volts

Display	Digital: 4000 counts, updates 4/sec Analog: 43 segments, updates 40/sec Frequency: 19,999 counts, updates 3/sec @ > 10 Hz
Operating Temperature	-20°C to 55°C
Storage Temperature	-40°C to 60°C
Temperature Coefficient	0.05 x (specified accuracy)/°C (<18°C or >28°C)
Electromagnetic Compatibility	In an RF field of 1 V/m on all ranges and functions: Total Accuracy = Specified Accuracy + 0.5% of range. Performance above 1 V/m is not specified.
Relative Humidity	0% to 90% (0°C to 35°C) 0% to 70% (35°C to 55°C)
Battery Type	9V, NEDA 1604 or 6F22 or 006P
Battery Life	500 hrs typical with alkaline
Shock, Vibration	Per MIL-T-28800 for a Class 2 Instrument
Size (HxWxL)	1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)
With Holster and Flex-Stand:	2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)
Weight	12.5 oz (355g)
With Holster and Flex-Stand:	22.0 oz (624g)
Safety	Designed to Protection Class II per IEC 348, ISA-DS82, and UL1244

Table 1-2. Specifications, Model 87

FUNCTION	RANGE	RESOLUTION	ACCURACY[1]			
			50 Hz to 60 Hz	45 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 20 kHz[2]
V~	400.0 mV	0.1 mV	±(0.7% + 4)	±(1.0% + 4)	±(2.0% + 4)	±(2.0% + 20)
	4.000V	0.001V	±(0.7% + 2)	±(1.0% + 4)	±(2.0% + 4)	±(2.0% + 20)
	40.00V	0.01V	±(0.7% + 2)	±(1.0% + 4)	±(2.0% + 4)	±(2.0% + 20)
	400.0V	0.1V	±(0.7% + 2)	±(1.0% +4	±(2.0% + 4)	±(2.0% + 20)
	1000V	1V	±(0.7% + 2)	±(1.0% + 4)[2]	±(2.0% + 4)[2]	unspecified
V⎓	4.000V	0.001V	±(0.1% + 1)			
	40.00V	0.01V	±(0.1% + 1)			
	400.0V	0.1V	±(0.1% + 1)			
	1000V	1V	±(0.1% + 1)			
mV⎓	400.0 mV	0.1 mV	±(0.1% + 1)			
Ω	400.0Ω	0.1Ω	±(0.2% + 1)			
	4.000 kΩ	0.001 kΩ	±(0.2% + 1)			
	40.00 kΩ	0.01 kΩ	±(0.2% + 1)			
	400.0 kΩ	0.1 kΩ	±(0.2% + 1)			
	4.000 MΩ	0.001 MΩ	±(0.2% + 1)			
	40.00 MΩ	0.01 MΩ	±(1% + 3)			
(nS)	40.00 nS	0.01 nS	±(1% + 10)			

FUNCTION	RANGE	RESOLUTION	ACCURACY[3]
Capacitance	5.00 nF	0.01 nF	±(1% + 3)
	0.0500 µF	0.0001 µF	±(1% + 3)
	0.500 µF	0.001 µF	±(1% + 3)
	5.00 µF	0.01 µF	±(1% + 3)
Diode Test	3.000V	0.001V	±(2% + 1)

FUNCTION	RANGE	RESOLUTION	ACCURACY	BURDEN VOLTAGE TYPICAL
mA A ~ (45 Hz to 2 kHz)	40.00 mA	0.01 mA	±(1.0% + 2)	1.6 mV/mA
	400.0 mA	0.1 mA	±(1.0% + 2)	1.6 mV/mA
	4000 mA	1 mA	±(1.0% + 2)	0.03 V/A
	10.00A[4]	0.01A	±(1.0% + 2)	0.03 V/A
mA A ⎓	40.00 mA	0.01 mA	±(0.2% + 2)	1.6 mV/mA
	400.0 mA	0.1 mA	±(0.2% + 2)	1.6 mV/mA
	4000 mA	1 mA	±(0.2% + 2)	0.03 V/A
	10.00A[4]	0.01A	±(0.2% + 2)	0.03 V/A

TYPICAL OHMS SHORT CIRCUIT CURRENT

Range	400	4k	40k	400k	4M	40M
Current	700 µA	170 µA	20 µA	2 µA	.2 µA	.2 µA

1 *Accuracy is given as ±([% of reading]+[number of least significant digits]) at 18°C to 28°C, with relative humidity up to 90%, for a period of one year after calibration. In the 4½-digit mode, multiply the number of least significant digits (counts) by 10. AC conversions are ac-coupled, true rms responding, calibrated to the rms value of a sine wave input, and valid from 5% to 100% of range. AC crest factor can be up to 3 at full scale, 6 at half scale. For non-sinusoidal wave forms add -(2% Rdg x 2% Fs) typical, for a crest factor up to 3.*

2 *Below 10% of range, add 6 digits.*

3 *With film capacitor or better using Relative mode to zero residual.*

4 *10A continuous, 20A for 30 seconds maximum.*

Table 1-2. Specifications, Model 87 (cont)

FUNCTION	RANGE	RESOLUTION	ACCURACY	BURDEN VOLTAGE TYPICAL
$\widetilde{\mu A}$ (45 Hz to 2 kHz)	400.0 μA	0.1 μA	±(1.0% + 2)	100 μV/μA
	4000 μA	1 μA	±(1.0% + 2)	100 μV/μA
$\overline{\mu A}$	400.0 μA	0.1 μA	±(0.2% + 3)	100 μV/μA
	4000 μA	1 μA	±(0.2% + 2)	100 μV/μA

FUNCTION	RANGE	RESOLUTION	ACCURACY
Frequency (0.5 Hz to 200 kHz, pulse width >2 μs)	199.99	0.01 Hz	±(0.005% + 1)
	1999.9	0.1 Hz	±(0.005% + 1)
	19.999 kHz	0.001 kHz	±(0.005% + 1)
	199.99 kHz	0.01 kHz	±(0.005% + 1)
	>200 kHz	0.1 kHz	Unspecified

FREQUENCY COUNTER SENSITIVITY AND TRIGGER LEVEL

INPUT RANGE (Maximum input for specified accuracy = 10X Range or 1000V)	MINIMUM SENSITIVITY (RMS SINEWAVE) 5 Hz-20 kHz	MINIMUM SENSITIVITY (RMS SINEWAVE) 0.5 Hz-200 kHz	APPROXIMATE TRIGGER LEVEL (DC VOLTAGE FUNCTION)
400 mV dc	70 mV (to 400 Hz)	70 mV (to 400 Hz)	40 mV
400 mV ac	150 mV	150 mV	—
4V	0.3V	0.7V	1.7V
40V	3V	7V	4V
400V	30V	70V (≤140 kHz)	40V
1000V	300V	700V (≤14 kHz)	400V

Duty Cycle 0.0 to 99.9% (0.5 Hz to 200 kHz, pulse width >2 μs)

Accuracy: Within ±(0.05% per kHz + 0.1%) of full scale for a 5V logic family input on the 4V dc range.

Within ±((0.06 x Voltage Range/Input Voltage) x 100%) of full scale for sine wave inputs on ac voltage ranges.

Table 1-2. Specifications, Model 87 (cont)

FUNCTION	OVERLOAD PROTECTION[6]	INPUT IMPEDANCE (nominal)	COMMON MODE REJECTION RATIO (1 kΩ unbalance)	NORMAL MODE REJECTION
$\overline{V}$	1000V rms	10 MΩ<100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\overline{mV}$	1000V rms	10 MΩ<100 pF	>120 dB at dc, 50 Hz or 60 Hz	>60 dB at 50 Hz or 60 Hz
$\widetilde{V}$	1000V rms	10 MΩ<100 pF (ac-coupled)	>60 dB, dc to 60 Hz	

FUNCTION	OVERLOAD PROTECTION	OPEN CIRCUIT TEST VOLTAGE	FULL SCALE VOLTAGE To 4.0 MΩ	FULL SCALE VOLTAGE 40 MΩ or nS	SHORT CIRCUIT CURRENT
Ω	1000V rms[7]	<1.3V dc	<450 mV dc	<1.3V dc	<500 μA
Diode Test	1000V rms[7]	<3.9V dc	3.000V dc		1.0 mA typical

	NOMINAL RESPONSE	ACCURACY (5% to 100% of range)
MIN MAX Recording	100 ms to 80% (DC Functions)	Specified accuracy ±12 digits for changes >200 ms in duration
	120 ms to 80% (AC Functions)	Specified accuracy ±40 digits for changes >350 ms and inputs >25% of range.
	1 s	Same as specified accuracy for changes >2 seconds in duration
	1 ms	Specified accuracy ±40 digits for changes >1 ms in duration. (±100 digits typical for mV, 400 μA dc, 40 mA dc, 400 mA dc).

FUSE PROTECTION	
mA or μA	1A 600V FAST Fuse
A	15A 600V FAST Fuse

MAXIMUM VOLTAGE BETWEEN ANY TERMINAL AND EARTH GROUND
1000 Volts

6 10^7 V Hz max

7 For circuits < 0.3A short circuit, 660V for high energy circuits

Table 1-2. Specifications, Model 87 (cont)

Display	Digital: 4000 counts, updates 4/sec 19,999 counts (4 ½-digit mode), updates 1/sec Analog: 4 x 32 segments (equivalent to 128), updates 40/sec Frequency: 19,999 counts, updates 3/sec @ > 10 Hz Backlight: On for 68 seconds when selected.
Operating Temperature	-20°C to 55°C
Storage Temperature	-40°C to 60°C
Temperature Coefficient	0.05 x (specified accuracy)/°C (<18°C or >28°C)
Relative Humidity	0% to 90% (0°C to 35°C) 0% to 70% (35°C to 55°C)
Electromagnetic Compatibility	In an RF field of 1 V/m on all ranges and functions: Total Accuracy = Specified Accuracy + 0.5% of range. Performance above 1 V/m is not specified.
Battery Type	9V, NEDA 1604 or 6F22 or 006P
Battery Life	400 hrs typical with alkaline
Shock, Vibration	Per MIL-T-28800 for a Class 2 Instrument
Size (HxWxL)	1.25 in x 3.41 in x 7.35 in (3.1 cm x 8.6 cm x 18.6 cm)
With Holster and Flex-Stand:	2.06 in x 3.86 in x 7.93 in (5.2 cm x 9.8 cm x 20.1 cm)
Weight	12.5 oz (355g)
With Holster and Flex-Stand:	22.0 oz (624g)
Safety	Designed to Protection Class II per IEC 348, ISA-DS82, and UL1244

Section 2
Theory of Operation

2-1. INTRODUCTION

This section describes the theory of operation for the Fluke 83, Fluke 85, and Fluke 87. Unless otherwise specified, the descriptions apply to all three instruments.

Functional block descriptions present an initial overview of circuit operation. Detailed circuit descriptions then cover the major circuit functions in more detail. For reference, detailed schematic diagrams are included in Section 5.

2-2. FUNCTIONAL BLOCK DESCRIPTION

Refer to Figure 2-1 for a block diagram of the Fluke 80 Series Multimeters. The instrument is partitioned into analog and digital sections. The integrated multimeter chip (U4) performs both analog and digital functions. Also, note that the Fluke 87 incorporates additional analog circuits.

The analog section of U4 contains the a/d converter, active filter, ac converter (for Models 83 and 85), frequency comparator, analog signal routing, range switching, and power supply functions.

The digital logic portion of U4 provides the state machine for synchronous a/d converter control and the 16-bit counter used for a/d converter counts and frequency measurements. Also, the digital logic section contains bus and interrupt control circuits (to facilitate the microcomputer interface) and registers for analog switch drive.

The microcomputer section of U4 executes software functions, formats data for the display, drives the display, and controls most analog and digital logic functions. The mode switch push buttons initiate various operating modes for the microcomputer. Output from the microcomputer can be presented visually on the liquid crystal display (LCD) and audibly on the beeper.

2-3. DETAILED CIRCUIT DESCRIPTION

Each of the functional blocks in Figure 2-1 is discussed in greater detail in the following paragraphs. The schematic diagrams located at the end of this manual can be consulted for details not portrayed in the figures in this section.

2-4. Input Overload Protection

Overload protection for the VΩ⊣⊢ input is provided by a network of two metal-oxide varistors (RV1 and RV2), three current-limiting resistors (R1, R2, and RT1), and spark gap E1. The 1 kΩ, 2W fusible resistor R1 opens when an extremely high energy signal is present. Thermistor RT1 rises to a high impedance during a sustained voltage overload in the millivolts dc, ohms, or diode test mode. A voltage clamp network is formed by transistors Q1, Q2, and Q6, diodes CR7 and CR8, and resistor R58. During ohms and diode test overloads, this clamp circuit limits the overload current to U4 at 10 mA. Power supply regulation and system operation is maintained during any of these overloads.

Overload protection for the mA µA input is provided by F1, rated at 1A/600V. The A input is protected by F2, rated at 15A/600V. In addition, the microamp shunt resistors (R4 and R43) are protected from overload currents below the F1 fusing level by the U1 and CR1 diode network.

The 83/85/87 Input-Alert feature provides a beeper warning signal when an input jack is connected to a current input and a non-current function is selected with the rotary switch. The meter detects the presence of an input connection by using split jacks at the mA µA and A inputs. One side of the jack is connected to an overload protection resistor (R7 for mA µA , R10 for A). In turn, R7 and R10 are connected to U4 sense lines AP4 and AP5 (pins 89 and 88). Resistors R8 and R48

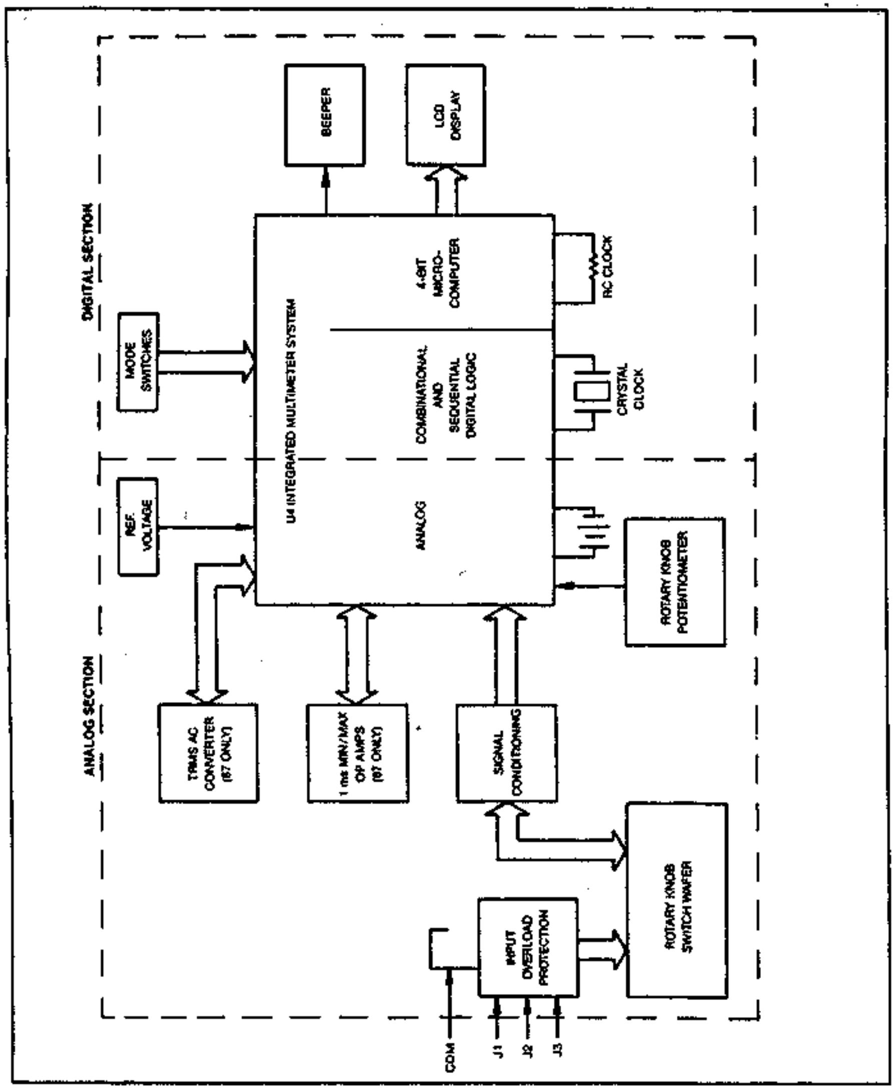


Figure 2-1. Overall Functional Block Diagram

provide Vdd pull up for AP4, and R11 is the pull up resistor for AP5. When a connection is made at mA µA or A, the sense side of the jack is pulled to COM. This condition is detected and compared with the selected function by U4. If a conflict exists, the beeper warning is activated.

2-5. Rotary Knob Switch and Potentiometer

Input signals are routed from the overload protection circuits to a double-sided switch wafer, which provides the necessary switching to implement the various signal conditioning. The function-encoding potentiometer is attached to the associated rotary switch shaft. After turn on, or a knob position change, U4 performs a voltage ratio measurement on this potentiometer to determine the new function.

2-6. Input Signal Conditioning Circuits

Each input signal is routed through signal conditioning circuitry before reaching U4. Input signals received through the VΩ▶| input are routed through Z1, a precision resistor network. This input divider network provides precise input scaling for the various voltage ranges and precision reference resistors for the ohms and capacitance functions. The capacitors in parallel with the various resistors in Z1 are used for high frequency compensation.

The input divider is used in two modes. In volts functions, a series mode is used to provide four divider ratios. In the ohms function, a parallel mode provides five reference resistors. During the following discussion, refer to the schematic and signal flow diagrams in Section 5.

2-7. VOLTS

In Volts functions, signal flow for input divider Z1 begins with the unknown voltage at the VΩ▶| input, which is connected to the high end of the 9.996 MΩ resistor (pin 1 of Z1) through R1 and RT1. In AC volts, C1 is also connected in series. In DC volts, C1 is shorted by S1 (contacts 3 and 4). Internal switches connect the 9.996 MΩ and 1.1111 MΩ resistors (pin 2 to pin 3 of Z1). The low end of the 1.1111 MΩ resistor (pin 7 of Z1) is connected to COM through S1 contacts 1 and 2, producing the divide-by-10 ratio used in the 400 mV ac, 4V ac, and 4V dc ranges.

For the 40V range, internal switches connect a 101.01 kΩ resistor to provide a divide-by-100 ratio. In the 400V range, 10.01 kΩ is used for a divide-by-1000 ratio. And a 1.0001 kΩ resistor is used in the 1000V range to provide a divide-by-10000 ratio.

The internal switch resistance connecting the 1.1111 MΩ and 9.996 MΩ with the other resistors is approximately 4 kΩ. Since the A/D senses the voltage at APV1 of U4 (pin 3 of Z1), the internal switch resistance adds to the 9.996 MΩ resistor, making for a circuit total of 10 MΩ.

2-8. OHMS

In the 400 ohm range the internal switches connect the 9.996 MΩ resistor (pin 2 of Z1) to the 1.0001 kΩ resistor (pin 6 of Z1); contacts 5 and 3 of S1 connect the remaining ends to of these resistors, making a reference resistor of 1 kΩ. Again, the 4 kΩ internal switch resistance adds to the 9.996 MΩ.

The source voltage is connected internally at both APV0 and APV4 of U4. The current is routed through the 1.0001 kΩ and 9.996 MΩ resistors, into S1 at contacts 3 and 5, out of S1 at contact 4, through R1 and RT1, out the VΩ▶| input, through the unknown resistance, and back to COM. The same current flows through the unknown resistance and the reference resistor. The voltage dropped across the unknown resistance is sensed from the VΩ▶| input jack through R2 and S1 (contacts 11 and 12) to AP1 of U4.

The A/D senses the voltage drop across the 1K reference resistor through the low (AP2 of U4 through R13) and high (APV0 and APV4) points. These two voltages are used by the A/D Converter to perform a ratiometric measurement.

For the 4 KΩ range, the 10.010 kΩ resistor used in parallel with the 9.996 MΩ resistor forms a 10 kΩ reference resistor. In the 40 kΩ range, 101.01 kΩ and 9.996 MΩ form a 100 kΩ reference resistor. And in the 400 kΩ range, 1.1111 MΩ and 9.996 MΩ provide a 1 MΩ reference resistor. The 4 MΩ and 40 MΩ use only the 9.996 MΩ resistor.

2-9. Analog Section of Integrated Multimeter IC (U4)

The analog-to-digital converter, autorange switching, frequency comparator, and most of the remaining analog circuitry are contained in the analog section of U4. Peripherals to this U4 analog section include the crystal clock, the system reference voltage, and some filter and amplifier resistors and capacitors. Included in the Fluke 87 only is a peripheral 1 ms MIN/MAX circuit and a true rms (root-mean-square) ac-to-dc converter.

Analog-to-digital conversion is accomplished within U4 using the dual-rate, dual-slope a/d converter circuit shown in Figure 2-2. For most measurements, the basic a/d rate cycle lasts 25 ms, for 40 measurements-per second. A single conversion at this rate is called a minor cycle sample. Each minor cycle sample is used to provide 40 updates-per-second for the fast response bar graph display, fast MIN/MAX recording, and fast autoranging.

Eight minor cycle samples are necessary to accumulate data for displaying a full-resolution (4000 count full scale)

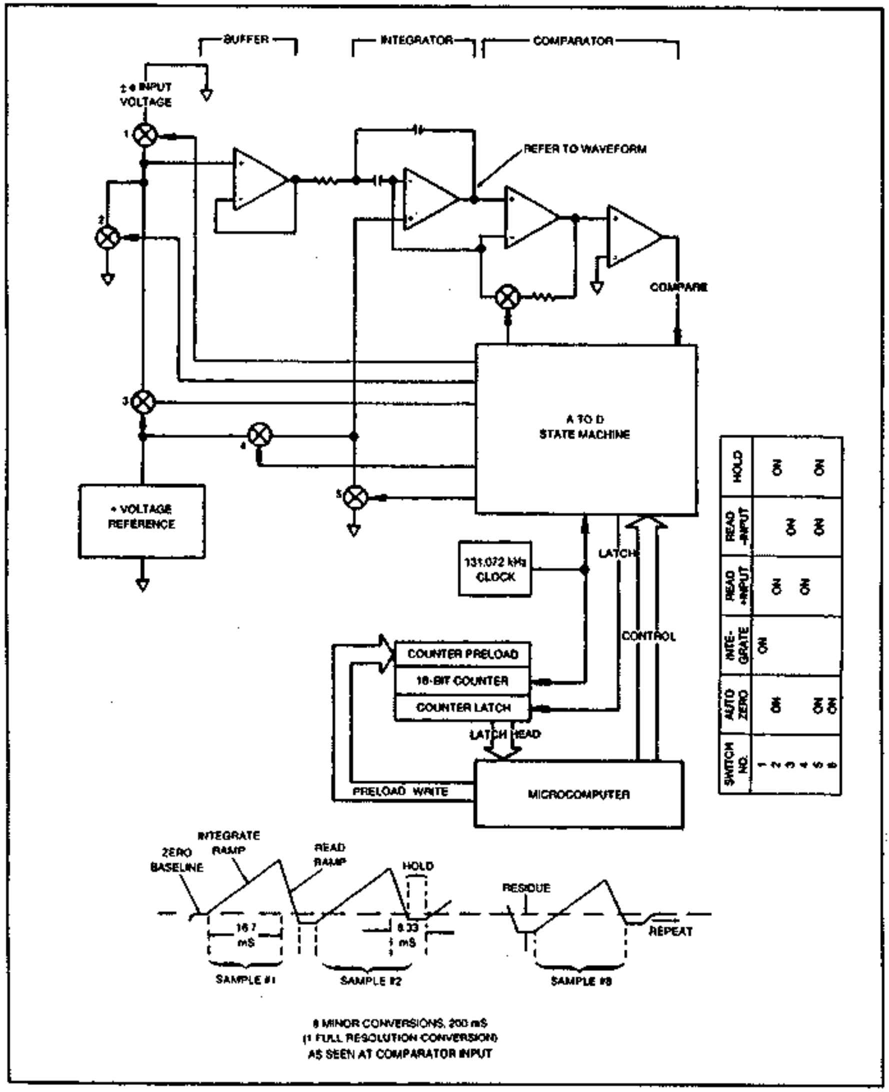


Figure 2-2. A/D Conversion

measurement on the digital display. A 40 ms autozero phase occurs following every eight-sample sequence. Therefore, each digital display update requires 240 ms, approximating 4 updates-per-second.

Basic a/d conversion elements and waveforms are illustrated in Figure 2-2. As this figure shows, a residual charge is retained by the integrator capacitor due to the overshoot past the true-zero base line. In the absence of an autozero phase, the residual charge would normally produce a significant error in the sample taken next. However, a digital algorithm eliminates the error and accounts for the residual as it propagates through all eight samples.

Basic timing for the a/d converter is defined as a series of eight integrate read cycles, followed by a 40 ms autozero phase. However, the 40 MΩ, capacitance, overload recovery, autoranging, Touch-Hold, 100 ms Min/Max, 1 ms Min/Max (Fluke 87 only), and rotary knob potentiometer modes all require variations from the basic timing.

Capacitance measurements to 5.0 μF are made by measuring the charge required to change the voltage across the unknown capacitor from zero to the system reference voltage. This technique is referred to as a ballistic type of measurement, the elements of which are shown in Figure 2-3. The unknown capacitor is fully charged from zero during the a/d converter integrate cycle. The signal integrated by the a/d converter constitutes the voltage drop across one or more precision resistors (Z1). The reference voltage is the de-integration signal for the a/d. Cx is discharged during de-integrate, hold, and autozero. The microcomputer calculates a display value from the latched count, which is proportional to the unknown capacitance. Capacitance mode uses two samples per display update.

A voltage comparator, with microcomputer configurable offsets, is used for both signal detection in frequency and duty cycle modes and threshold detection in continuity mode. In frequency and duty cycle modes, digital pulses from the voltage comparator are routed to the 16-bit counter.

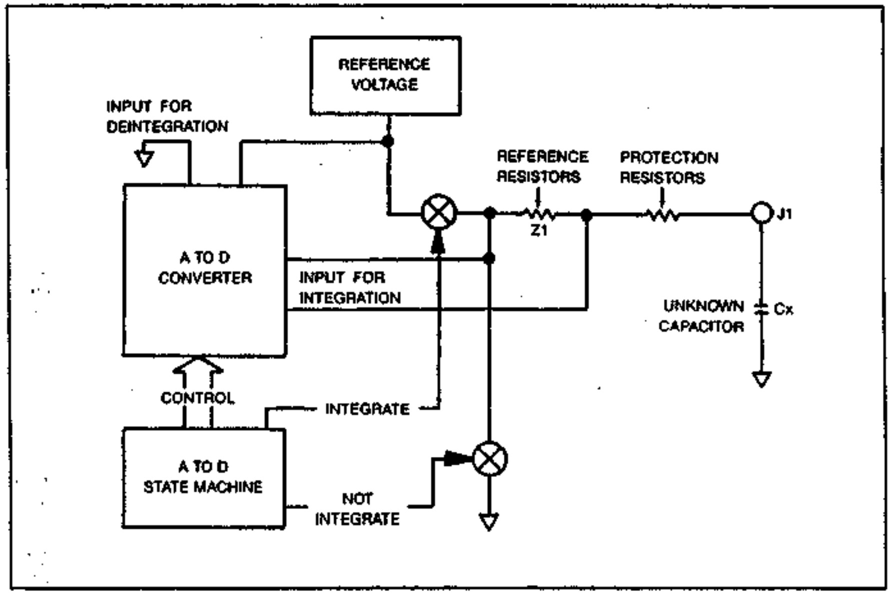


Figure 2-3. Capacitance Measurement Elements

2-10. Digital Section of Integrated Multimeter IC (U4)

Digital circuitry in U4 (excluding the microcomputer) is partitioned into five functional blocks, as shown in Figure 2-4.

- A bus control cell performs address decoding and manages selective power down, split jack sense, and low battery signals.
- The interrupt control cell manages and multiplexes four interrupts to the microcomputer. These interrupts are for 16-bit and 8-bit counter carries and voltage comparator transitions.
- A 48-bit write-only register latches microcomputer data for analog switch drive.
- A 16-bit counter (with parallel preload and latch registers) is used as a read counter for a/d conversions and as a pulse counter for frequency and duty-cycle measurements.
- The a/d converter is controlled by a 4-bit state machine with output decoding ROM.

Figure 2-5 is a block diagram of frequency counter components. For frequency and duty cycle measurements, the 16-bit counter in the digital section of U4 is partitioned into two 8-bit counters. Each of these counters is then extended to 20 bits using microcomputer software and hardware. The gating logic controls the start and stop of each reading. In frequency mode, signal A is the unknown frequency, and signal B is the crystal clock signal. After enough counts have been accumulated in each 20-bit register, the microcomputer calculates the unknown frequency from the ratio of the counter values.

In making a duty cycle measurement, signal A (Figure 2-5) is again the unknown signal, but signal B is the logical AND of the unknown and reference signals. As with frequency measurement, the microcomputer controls the start and stop of a measurement cycle via the gating logic. The ratio of the counter values yields the duty cycle value.

2-11. Microcomputer Control

A 4-bit microcomputer, integrated within U4, controls the various instrument functions and drives the display. A/D converter and counter measurements are controlled via the microcomputer interface lines shown in Figure 2-4. Min/Max, Touch-Hold, and REL (relative) modes involve additional data processing by the microcomputer to generate the display value.

The microcomputer/digital logic interface consists of both RAM that has been mapped into the digital logic and an interrupt line back to the microcomputer. The four interrupts are maskable, readable, and resettable. Note that the microcomputer runs on its own RC clock at a frequency of 525 to 800 kHz and is asynchronous from the crystal clock.

The microcomputer exercises direct control over the ranging and signal routing analog switches. A specific word is written to the switch drive register for each function/range selection. In autoranging (default) mode, the microcomputer determines the correct range based on the input. In addition, for autoranging during voltage, ohms, or current measurements, the active filter fast mode is enabled for quick response. In frequency or duty cycle mode, pushing the range button causes a range change in the primary function (volts, amps, etc.) that may change the sensitivity or offset.

The microcomputer sets the required a/d converter mode, which determines the on-chip analog signal ports to be used for the integrate and de-integrate signals. The microcomputer also selects one of the three available gain resistors in Z1 for integrate and de-integrate. All voltage and current conversions use either a 400 mV or a 40 mV full scale mode. Other modes are used for ohms, hiohms, 40 MΩ, nS, and capacitance. Since the a/d state machine timing is under direct software control, a mode invoked in another function or range can use different timing.

Frequency measurements are also controlled by the microcomputer section of U4. The microcomputer initializes the counters, monitors the count accumulation, arms and disarms the logic signal gating, and calculates the display value from the counter values.

Min/Max Record (1s and 100 ms), Touch-Hold, and Relative are secondary software functions. This means that the microcomputer performs either a different control algorithm or a different math routine on the data, as explained below.

- In Min/Max Record mode, the maximum and minimum readings after initialization are stored in memory, and a true running average is calculated after each reading. The running average is updated for a maximum of 36 hours. The MIN MAX button allows the user to scroll through the min, max, average, and present readings. In 100 ms Min/Max a single sample is used to calculate the display value, while in 1s Min/Max a full resolution conversion is used. Note that 1 ms Peak Min/Max (Fluke 87 only) requires additional analog peak hold amplifiers external to U4.

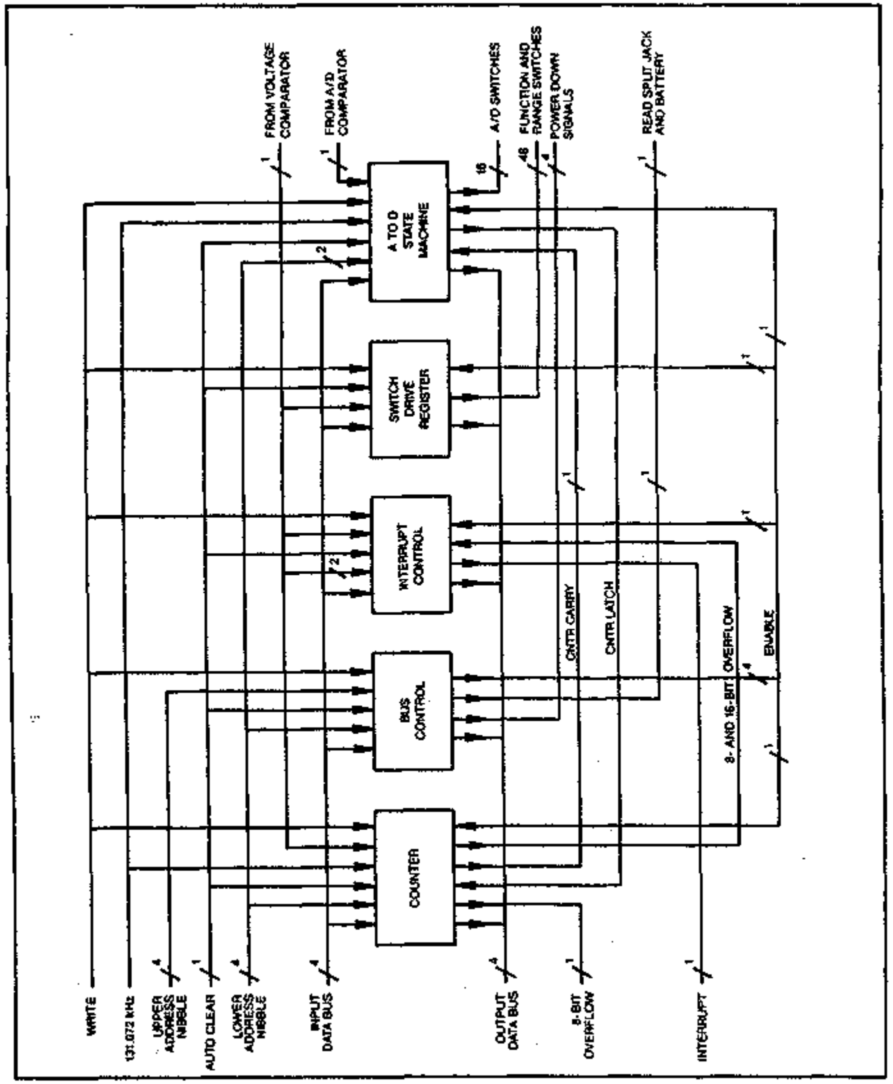


Figure 2-4. Digital Circuitry Within U4

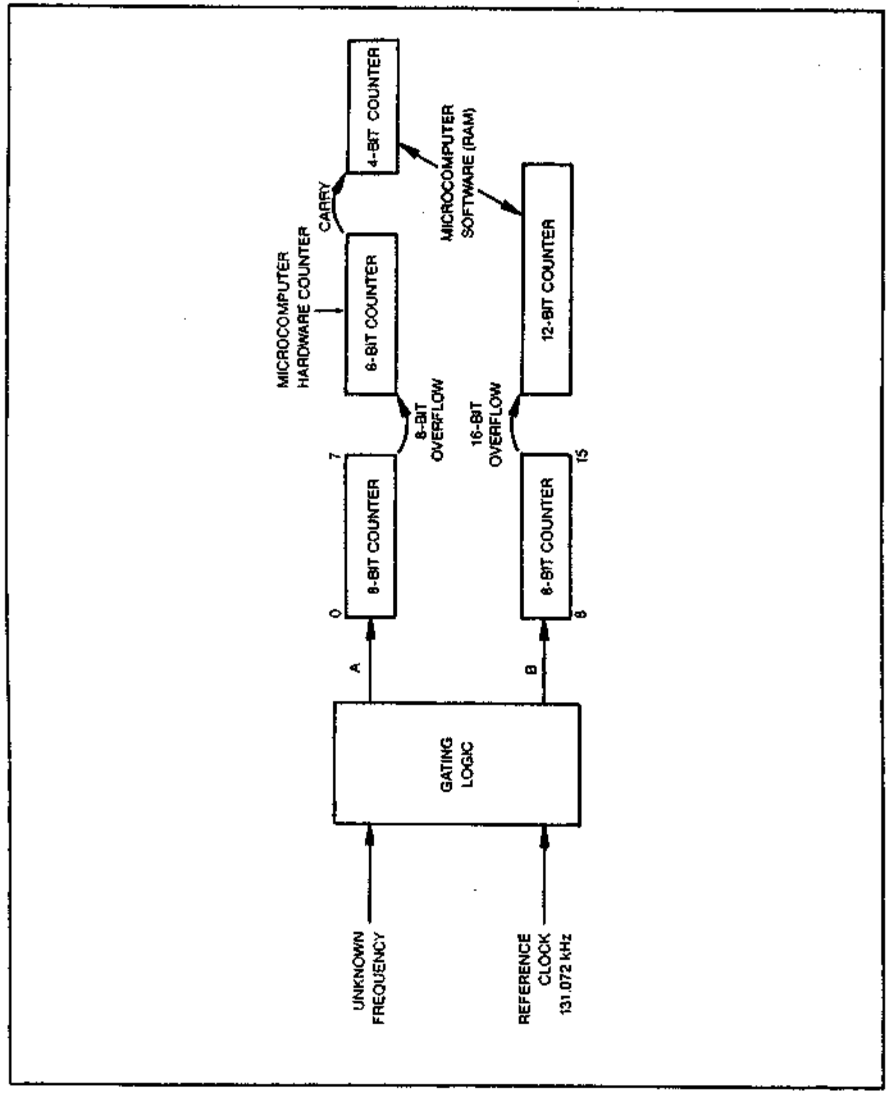


Figure 2-5. Frequency Counter Elements

- When Touch-Hold is selected, the microcomputer does not allow a full resolution conversion to be completed unless the input signal is stable. When a stable reading occurs, the conversion is completed, and the microcomputer generates and freezes the corresponding display. The microcomputer now waits for a change in the signal to exceed a certain threshold, then begins watching for a stable reading again. Note that a reading is forced when Touch Hold is first selected. Also, open test lead signals do not update the display.
- With the REL button (relative) selected, the microcomputer stores the present reading as an offset. This value is subtracted from all subsequent readings (provided that they are on scale) to give the display value.

2-12. Peripherals to U4

In addition to input overload protection and input signal conditioning circuits, other devices peripheral to U4 are needed to support 80 series features. The ac converter, active filter, and a/d converter circuits require off-chip resistors and capacitors. Digital drive and level-shifting circuits are needed for the beeper drive, quick turn off, true RMS converter power down (Fluke 87 only), and LCD back light (also Fluke 87 only) features. A voltage reference is generated separate from U4, and some discrete resistors and transistors support the power supply. The Fluke 87 also uses two analog peak hold circuits (1 ms Min/Max).

2-13. AC BUFFER

The ac buffer circuit differs between the Fluke 83/85 and the Fluke 87. On the Fluke 83/85, R14, R15, C5, and C27 are part of the ac buffer circuit that drives the ac converter and guard. The Fluke 83/85 ac buffer can be configured for an ac gain of 1 or 10. For the Fluke 87, R14, R15, R46, C5, and C27 support the ac buffer. This buffer can be configured for an ac gain of ½, 1, 5, or 10. The gains of ½ and 5 are needed for the true rms converter, which uses a 200 mV full scale input. In the Fluke 87, the ac buffer drives the rms ac converter, guard, and peak hold amplifiers.

2-14. AC CONVERTER

The Fluke 83/85 average ac converter uses off-chip components R30, R31, R34, R40, C24, C28, and C29. This ac converter is a full-wave rectifying converter with a differential output and gain selected to give a dc output equal to the rms value for a sine wave input. Filtering is provided by C28 and C29.

2-15. RMS CONVERTER

The Fluke 87 uses an integrated rms-to-dc converter (U2). Devices R34, R45, C6, and C7 support U2, while Q4, R32, and R39 drive the power on/off pin.

2-16. ACTIVE FILTER

On all models, the active filter uses off-chip passive components R17, R18, C8, and C9. The active filter is a second order low pass filter with two poles at 5.9 Hz in normal mode. It filters input signal noise and ac ripple from the ac converter, yielding stable a/d converter readings. The microcomputer can disable the filter completely or enable the filter fast response mode.

2-17. A/D CONVERTER

Pins 8, 9, and 10 on precision resistor network Z1 connect to the three a/d converter gain resistors. Pin 8 connects to 190 kΩ for a gain of 0.87. Pin 9 connects to 160 kΩ for a gain of 1, and pin 10 connects to 16 kΩ for a gain of 10. Pin 11 is the common connection. The autozero capacitor (C10) stores op amp and comparator offsets. The integration capacitor is C11.

2-18. BEEPER

Devices Q9, Q11, R56, R57 and CMOS hex inverter U6 make up the double-ended beeper drive circuit. Transistor Q12 is connected to provide quick microcomputer power down when the instrument is turned off.

2-19. SYSTEM REFERENCE

The system reference voltage (1.235V) is generated by VR1 and R44. The 1.000V reference voltage for the a/d converter is supplied through U4-1 (REF1). This voltage is adjusted by R21, the dc calibration potentiometer. In addition to generating the a/d reference, the VR1 voltage is used for power supply reference, voltage comparator selectable offset generation, and the ohms source level.

2-20. POWER SUPPLY

The power supply consists of two regulators, one shunt and one series, which set Vdd at +3.0V and Vss at -3.2V for all battery voltages down to 6.7V. The shunt (common) regulator sets Vdgnd - Vss (Vdgnd = COM = 0V) and consists of an uncompensated op amp and large current shunt devices integrated on U4. Resistors R37 and R38 provide voltage division. The series (Vdd) regulator, which sets Vdd - Vdgnd, is made up of another on-chip, uncompensated op amp, along with devices Q3, R24, and R25. Q3 is the series regulator element, and R24 and R25 are for voltage sensing. Capacitors C14 and C21 provide circuit compensation and power supply decoupling for the shunt and series regulators, respectively. Voltage level information is presented in Table 2-1.

Table 2-1. Typical Voltage Levels and Tolerance

VDD	3.0 ±0.3
VSS	-3.2 ±0.3
VBT+	3.5 ±0.3
VBT-	5.5 (battery at full 9V charge) 5.0 (battery at low charge of 6.5V)
REFH	1.235 ±0.012
PS0	1.235 ±0.15
PS1	0 ±0.15
AP6	-0.5 to -0.15
VOA	2.2 to 1.7 (referenced from VSS)
VOB	1.07 to .91 (referenced from VSS)

2-21. PEAK HOLD

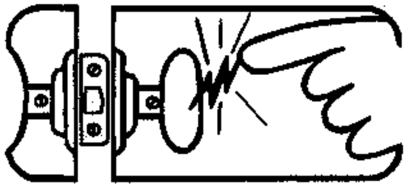
The 1ms Min/Max mode on the Fluke 87 is implemented using the peak hold circuit consisting of the dual op amp package AR1, diodes CR2 and CR3, C12, C13, R22, and R23. The op amp connected to CR2 charges C12 to the most positive voltage at its input after initialization (which can be positive or negative in amplitude.) CR2 prevents C12 from being discharged after the peak input is no longer present. The op amp connected to CR3 works in a similar fashion, but captures negative peaks. Upon selection of 1ms Min/Max, U4 initializes the circuit by connecting AP7 (pin 86) to Vss and AP8 (pin 85) to Vdd via on-chip switches. Leakage currents are controlled so that the voltages on C12 and C13 drift towards the AR1 op amp input level. The voltages stored on C12 and C13 are read, in a single sample, to give the display minimum and maximum values.

2-22. Display

The liquid-crystal display (LCD) operates under direct control of the microcomputer. Characters are generated by the computer and displayed on the LCD. Both digital readings and an analog bar-graph (or pointer for Fluke 87) display are presented, in conjunction with annunciators and decimal points. The Fluke 87 features a transflective LCD with a light-emitting diode (LED) back light. Refer to the Fluke 83/85 or 87 Operator's Manual for a more detailed description of the display.

static awareness

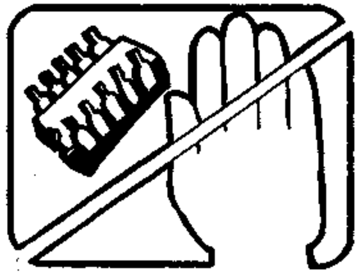
A Message From
Fluke Corporation



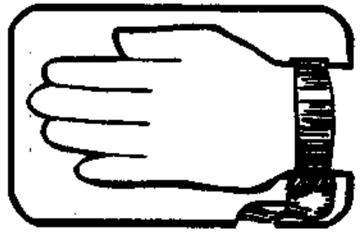
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

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

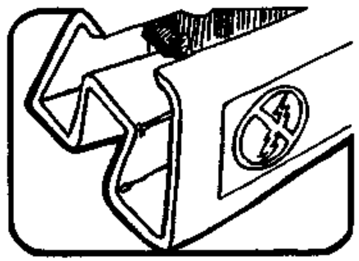
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



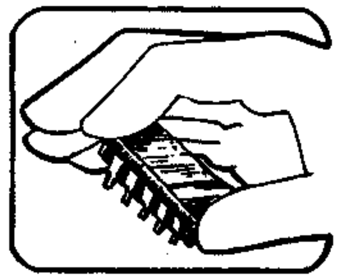
1. MINIMIZE HANDLING



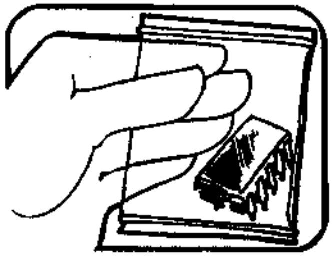
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



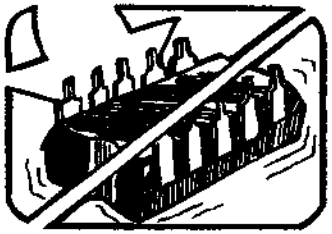
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



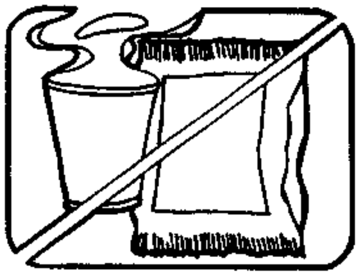
4. HANDLE S.S. DEVICES BY THE BODY.



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.

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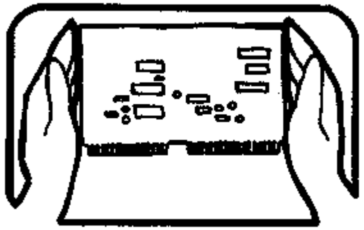
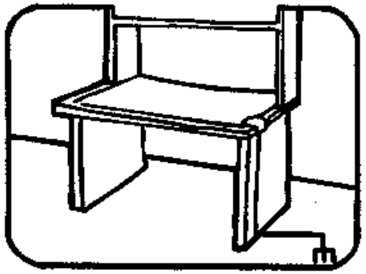


8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



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.

Section 3
Maintenance

WARNING

SERVICING DESCRIBED IN THIS SECTION IS TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.

3-1. INTRODUCTION

This section of the 80 Series Service Manual provides procedures in the following areas:

- Routine and preventive maintenance.
- Performance verifications.
- Calibration.
- Troubleshooting (to the component level.)

3-2. REQUIRED TOOLS AND EQUIPMENT

Required equipment is listed in Table 3-1. If the recommended models are not available, equipment with equivalent specifications may be used. Repairs or servicing should be performed only by qualified personnel.

3-3. OPERATOR MAINTENANCE

WARNING

TO AVOID ELECTRICAL SHOCK, REMOVE THE TEST LEADS AND ANY INPUT SIGNALS BEFORE REPLACING THE BATTERY OR FUSES. TO PREVENT DAMAGE OR INJURY, INSTALL ONLY QUICK ACTING FUSES WITH THE AMP/VOLT RATINGS SHOWN IN FIGURE 3-1.

3-4. Case Disassembly

Use the following procedure to disassemble the Multimeter.

1. Disconnect test leads from any live source, turn the rotary switch to OFF, and remove the test leads from the front terminals.

2. The case rear is secured to the case front by three screws and two internal snaps (at the LCD end). Using a Phillips-head screwdriver, remove the three screws from the case rear.

NOTE

The gasket between the two case halves is sealed to, and must remain with, the lower case half. The upper case half lifts away from the gasket easily. Do not damage the gasket or attempt to separate the lower case half from the gasket.

3. Now turn the case over (display side up), and, lifting up on the input terminal end, disengage the upper case half from the gasket. Gently unsnap the upper case half at the display end. See Figure 3-2.

CAUTION

With its case removed, the Multimeter presents exposed circuit connections. To avoid unintended circuit shorting, always place the uncovered multimeter assembly on a protective surface.

3-5. Circuit Assembly Removal and Installation

Once the outer case has been removed, the circuit assembly can be disconnected from its covering shields with the following procedure:

EQUIPMENT	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
DMM Calibrator	AC Voltage Range: 0-1000V ac Accuracy: ±0.175% Frequency Range: 60-20000 Hz Frequency Accuracy: ±3% DC Voltage Range: 0-1000V dc Accuracy: ±0.035% Current Range: 350 µA-2A Accuracy: AC (60 Hz to 1 kHz): ±0.3% DC: ±0.063% Current Range: 10A Accuracy: AC (60 Hz to 1 kHz): ±0.3% DC: ±0.1% Frequency Source: 19.999 kHz - 199.99 kHz Accuracy: ±0.0025% Amplitude: 150 mV to 6V RMS Accuracy: ±5%	Fluke 5500A or equivalent
Resistance Calibrator	Range: 1Ω-100 MΩ Accuracy: 0.065%	Fluke 5450A
Decade Capacitor	Range: 5 nF to 1 µF Accuracy: ±0.35%	Genrad 1413 or 1423
Transconductance Amplifier	Current Range: 10A Accuracy: AC (60 Hz to1 kHz): ±0.3% DC: ±0.1%	Fluke 5220A

EQUIPMENT USAGE IN PERFORMANCE TESTS

	CALIBRATOR	RESISTANCE CALIBRATOR	DECADE CAPACITOR
AC Voltage	X		
Frequency	X		
Trigger Level	X		
DC Voltage	X		
1-Ms IN MAX	X		
mV DC	X		
Ohms		X	
Capacitance			X
Diode	X		
mA	X		
µA	X		
A	X		

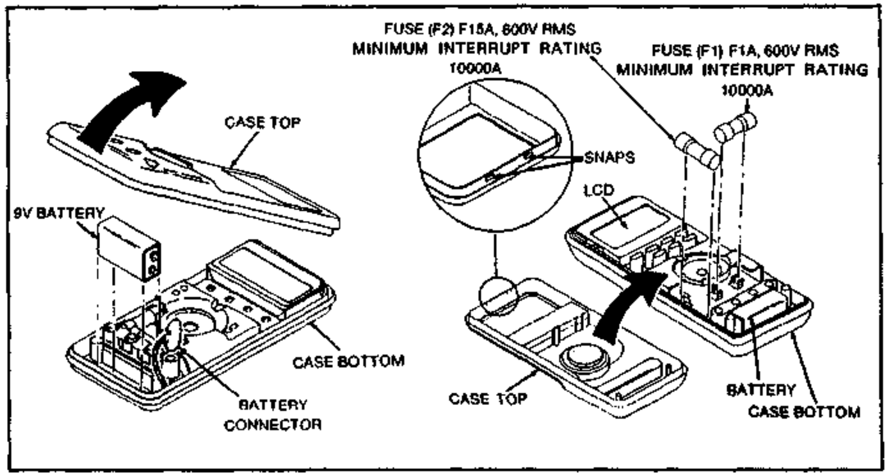


Figure 3-1. Battery and Fuse Replacement

1. Remove the one Phillips-head screw securing the back shield to the circuit assembly. Then remove the back shield.

2. The front shield can now be disconnected from the circuit assembly by detaching the four snaps (one at a time) found on the top-front.

CAUTION

Be gentle when detaching or attaching the four securing snaps. Excessive force can deform or fracture the snaps.

3. To reattach the circuit assembly, push the front shield on so that the four clips engage gently and simultaneously. Then turn the assembly over, and replace the Phillips-head screw and back shield.

NOTE

Ensure that the shields are tightly attached. Accurate multimeter operation relies on properly fitted shields.

3-6. Case Reassembly

Use the following procedure to reassemble the Multimeter.

1. Check that the case top rotary switch and circuit board switch are in the OFF position.

2. Ensure that the gasket remains secured to the lower case half. Then, starting with the two snaps at the display end and finishing at the terminal end, cradle the upper case half into the gasket.

3. Reinstall the three screws from the lower case half.

4. Repeat the Performance Test (found in this section of the manual) after reassembly.

3-7. Battery Replacement

The meter is powered by a single 9V battery (NEDA 1604, 6F22, or 006P). Referring to Figure 3-1, use the following procedure to replace the battery:

1. Remove the multimeter case as described under Case Disassembly.

2. Lift the battery from the case bottom, and carefully disconnect the battery connector leads.

3. Snap the battery connector leads to the terminals of a new battery and reinsert the battery into the case bottom. Dress the battery leads so that they will not be pinched between the case bottom and case top.

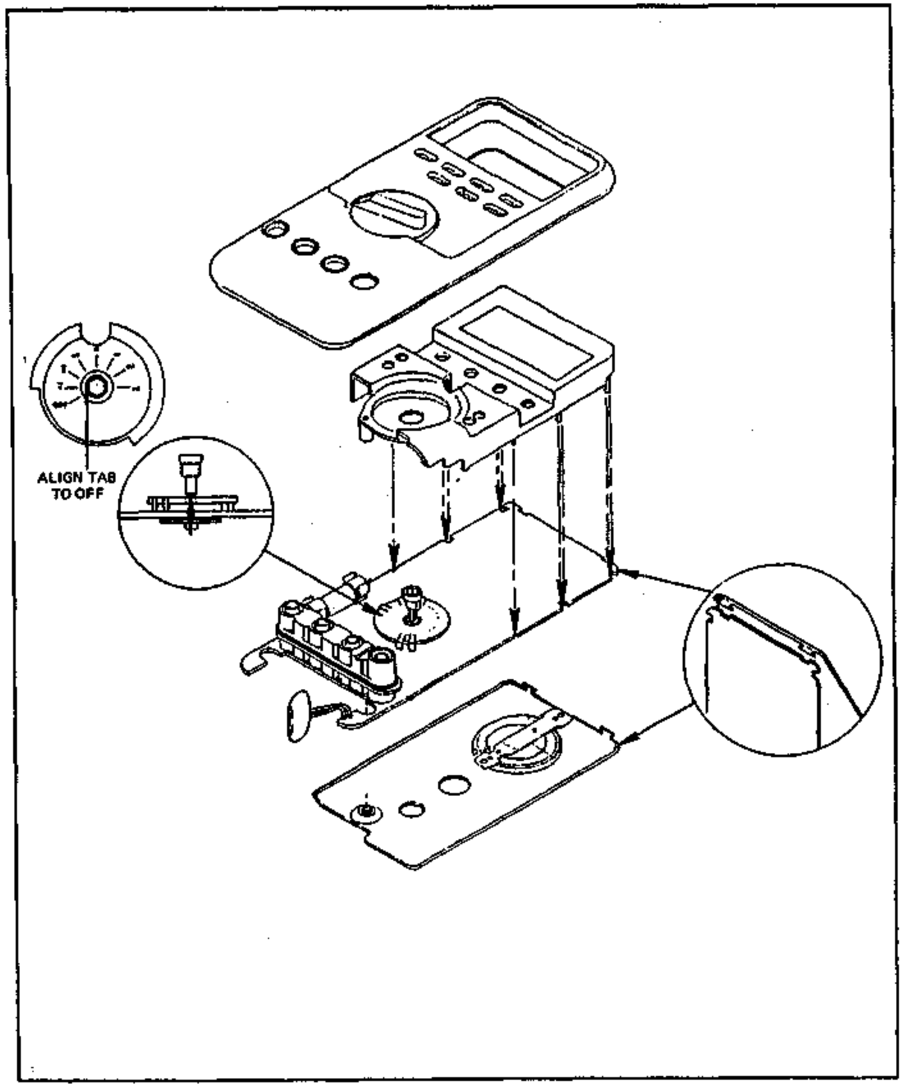


Figure 3-2. Assembly Details

4. Reassemble the Multimeter as described under Case Reassembly.

3-8. Fuse Test

Use the following procedure to test the internal fuses of the meter.

1. Turn the rotary selector switch to the ·))) Ω ⊣⊢ position.
2. Plug a test lead into the VΩ⊣⊢ input terminal, and touch the probe to the [A] input terminal. Because the receptacles of the input terminals contain split contacts, be sure that you touch the probe to the half of the receptacle contact that is nearest the LCD.
3. The display should indicate between 00.0 and 00.5 ohms. This tests F2 (15A, 600V). If the display reads OL (overload), replace the fuse and test again. If the display reads any other value, further servicing is required.
4. Move the probe from the A input terminal to the mA µA input terminal.
5. The display should read between 0.995 kilohms and 1.005 kilohms. This procedure tests F1 (1A, 600V). If the display reads a high resistance or OL (overload), replace the fuse and test again. If the display reads any other value, further servicing is required.

3-9. Fuse Replacement

Referring to Figure 3-1, use the following procedure to examine or replace the meter's fuses:

1. Perform steps 1 through 3 of the battery replacement procedure.
2. Remove the defective fuse by gently prying one end of the fuse loose and sliding the fuse out of the fuse bracket.
3. Install a new fuse of the same size and rating. Make sure the new fuse is centered in the fuse holder.
4. Ensure that the case top rotary switch and circuit board switch are in the OFF position.
5. Ensure that the gasket remains secured to the lower case half. Then, starting with the two snaps at the display end and finishing at the terminal end, cradle the upper case half into the gasket.
6. Reinstall the three screws from the lower case half.

3-10. Cleaning

WARNING

TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE METER, NEVER ALLOW WATER INSIDE THE CASE. TO AVOID DAMAGING THE METER'S HOUSING, NEVER APPLY SOLVENTS TO THE METER.

If the meter requires cleaning, wipe it down with a cloth that is lightly dampened with water or a mild detergent. Do not use aromatic hydrocarbons, chlorinated solvents, or methanol-based fluids when wiping down the meter.

3-11. INPUT TERMINALS

Water, dirt, or other contamination in the A or mA µA terminals may activate the Input Alert (beeper) feature even though test leads are not inserted. With all test leads removed, such contamination might be dislodged by turning the multimeter over and gently tapping on the case. However, the following procedure is recommended as a much more effective treatment:

1. Turn the multimeter off and remove all test leads.
2. Use a clean swab in each of the four terminals to dislodge and clean out the contamination.
3. Moisten a new swab with a cleaning and oiling agent (such as WD40). Work this swab around in each of the four terminals. Since the oiling agent insulates the terminals from moisture-related shorting, this preventive treatment ensures against future erroneous Input Alerts.

3-12. ROTARY SWITCH

Clean the rotary knob potentiometer used by function selector switch S2 with the following procedure:

1. Remove the circuit assembly as described earlier in this section (Circuit Assembly Removal and Installation).
2. From the back of the circuit assembly, push the switch shaft in, and remove the polymer thick film (ptf) contact assembly.
3. Clean the ptf contact assembly and the potentiometer on the circuit assembly with alcohol. Blow these parts dry with clean, dry air.
4. Using a Q-tip, apply a thin film of W.F.Nye Gel Lubricant, #813S (Fluke PN 926084), to the entire surface of the ptf pattern and the hole in the center of the pattern. It is important that the grease be applied in a consistent manner, using only enough grease so that it does not accumulate on the ptf wiper contacts. Remove excess grease with a dry Q-tip. No portion of the ptf pattern should be left unlubricated.

5. Push and secure the ptf contact assembly back on the switch shaft.
6. Reassemble the circuit assembly, shields, and case parts as described earlier in the section (Case Reassembly).
7. Repeat the Performance Test after reassembly.

3-13. PERFORMANCE TEST

Basic operability of an 80 Series Multimeter can be checked by turning the rotary switch to Ω and connecting a test lead from the VΩ⊣⊢ input to the mA µA input. (If you are using a test probe, touch the half of the input contact nearest the LCD.) The display should read 1.000 kΩ ± 5 digits. With the rotary switch still at Ω, test the A fuse (15A) by inserting the plug end of the test lead into the A input; then test the mA µA fuse (1A) by inserting the plug end of the test lead into the mA µA input. The beeper emits an Input Alert if the fuses are good.

A more involved operability and accuracy check is detailed in the following paragraphs. Each function is checked for accuracy to the specifications listed in Section 1 of this manual. Note that for performance verification purposes, the case covers do not need to be removed and no adjustments are necessary. Merely make the input connections called for, and check the display for accuracy.

3-14. Setup

Equipment setup is defined for each accuracy verification procedure. Equipment requirements are presented in Table 3-1. Accuracy figures are valid for a period of one year after calibration, when measured at an operating temperature of 18 to 28 degrees C and at a maximum of 90% relative humidity.

3-15. Display Test

Switch the meter on and compare the display with the appropriate example in Figure 3-3. Hold any button down to hold the instrument in Display Test.

3-16. Rotary Switch Test

This test verifies correct operation of the rotary function selector switch. Internally, the selector circuit relies on the interface between a ptf region on the circuit assembly and a rotating contact assembly on the switch shaft. The rotary switch test exercises this interface by checking the various range codes and displaying their representative numbers.

To enter the rotary switch test mode, hold down the RANGE button while turning the rotary switch from OFF to V⎓. Normal meter functions are now disabled, and a number appears in the display. Refer to Table 3-2. Continue rotating the switch one function at a time, checking for appropriate number displays. To exit the Rotary Switch mode, turn the rotary switch first to OFF, then (without holding down the RANGE button) back to any function selection.

Table 3-2. Rotary Switch Test

FUNCTION	DISPLAY (±12)	FUNCTION	DISPLAY (±12)
OFF	n/a	OHMS	-96
ACV	0	DIODE	-128
DCV	-32	mA/A	-160
mV DC	-64	µA	-192

3-17. AC Voltage Test

Use the following procedure to verify accuracy in the ac voltage ranges.

1. Connect the Calibrator to the VΩ⊣⊢ and COM inputs on the Multimeter.
2. Set the Calibrator for the voltage and frequency called for in step 1 of Table 3-3. Check that the multimeter display is within the limits shown for your 80 Series Multimeter (Model 83, 85, or 87).

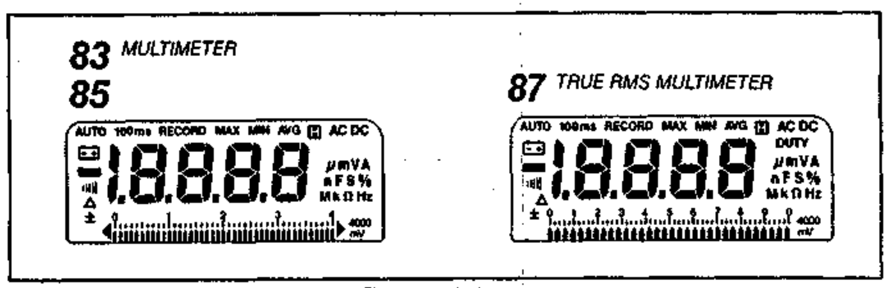


Figure 3-3. Display Test

Table 3-3. AC Voltage Test

Step	INPUT		DISPLAY READING		
	VOLTAGE	FREQUENCY	83	85	87
1	350.0 mV	60 Hz	346.1 to 353.9	347.8 to 352.2	347.1 to 352.9
2	350.0 mV	1 kHz	344.3 to 355.7	346.1 to 353.9	346.1 to 353.9
3	350.0 mV	5 kHz	342.6 to 357.4	342.6 to 357.4	342.6 to 357.4
4	350.0 mV	20 kHz	NA	339.1 to 360.9	341.0 to 359.0
5	3.500V	60 Hz	3.462 to 3.538	3.480 to 3.520	3.473 to 3.527
6	3.500V	1 kHz	3.444 to 3.556	3.463 to 3.537	3.461 to 3.539
7	3.500V	5 kHz	3.427 to 3.573	3.428 to 3.572	3.426 to 3.574
8	3.500V	20 kHz	NA	3.356 to 3.644	3.410 to 3.590
9	35.00V	60 Hz	34.62 to 35.38	34.80 to 35.20	34.73 to 35.27
10	35.00V	1 kHz	34.44 to 35.56	34.63 to 35.37	34.61 to 35.39
11	35.00V	5 kHz	34.27 to 35.73	34.28 to 35.72	34.26 to 35.74
12	35.00V	20 kHz	NA	33.56 to 36.44	34.10 to 35.90
13	350.0V	60 Hz	346.2 to 353.8	348.0 to 352.0	347.3 to 352.7
14	350.0V	1 kHz	344.4 to 355.6	346.3 to 353.7	346.1 to 353.9
15	350.0V	5 kHz	342.7 to 357.3	342.8 to 357.2	342.6 to 357.4
16	100.0V	20 kHz	NA	95.6 to 104.4	96.0 to 104.0
17	200.0V	20 kHz	NA	191.6 to 208.4	194.0 to 206.0
18	300.0V	20 kHz	NA	287.6 to 312.4	292.0 to 308.0
19	900V	60 Hz	888 to 912	893 to 907	892 to 908
20	900V	1 kHz	874 to 926	880 to 920	887 to 913
21	900V	5 kHz	874 to 926	880 to 920	878 to 922

Table 3-4. Frequency Test

STEP	SINE WAVE INPUT		DISPLAY READING 83/85/87
	VOLTAGE	FREQUENCY	
1	150 mV rms	19.000 kHz	18.998 to 19.002
2	150 mV rms	190.00 kHz	189.98 to 190.02

3. Repeat this procedure for steps 2 through 21 of Table 3-3.

3-18. Frequency Test

The following procedure verifies Multimeter accuracy in Frequency mode.

1. Connect the Calibrator to the VΩ→+ and COM inputs on the Multimeter. Note that the frequency accuracy of the Calibrator used must be appropriate for the specified accuracy fo the Multimeter.
2. With the Multimeter in the 400 mV ac range, press the HZ button to enter the Frequency Counter mode.
3. Set the Calibrator for the sine wave voltage and frequency called for in step 1 of Table 3-4. Check for a reading within the limits shown.

3-19. Frequency Sensitivity and Trigger Level Test

The following procedure verifies the counter sensitivity and trigger levels for all frequency modes and ranges. For any function and range, the sensitivity and trigger level is the same in both frequency and duty cycle modes.

1. Connect the meter calibrator to the V Ω →+ and COM inputs on the Multimeter.
2. Select the 4V ac range, and press the Hz button to choose the Frequency mode.
3. Apply the input from step 1 of Table 3-5, and check for the called-for response.
4. Select the 4V dc range, and press the Hz button to select Frequency mode.
5. Apply the input from step 2 and step 3 of Table 3-5, and check for the called-for responses.
6. On the Multimeter, press the RANGE button to enter the 40V dc range.
7. Apply the step 4 and step 5 input and check for the called-for responses on the Multimeter.

3-20. DC Voltage Test

Use this procedure to verify accuracy in the dc voltage function. Note that a separate verification procedure for dc millivolts (mV) is provided later in this section.

1. Connect the Calibrator to the VΩ→+ and COM inputs on the Multimeter.
2. Rotate the multimeter function control to V⎓ .
3. Check for the multimeter response called for in each step of Table 3-6.

Table 3-5. Frequency Counter Sensitivity and Trigger Level Tests

STEP	RANGE	AMPLITUDE (RMS)	FREQUENCY	DISPLAY READING
1	4V ac	300 mV ac	1 kHz	999.8 - 1000.2
2	4V dc	1.7V ac	1 kHz	999.8 - 1000.2
3	4V dc	1.0V ac	1 kHz	000.0
4	40V dc	6.0V ac	1 kHz	999.8 - 1000.2
5	40V dc	2.0V ac	1 kHz	000.0

Table 3-6. DC Voltage Test

STEP	DC INPUT VOLTAGE	DISPLAY READING		
		83	85	87
1	3.500V	3.488 to 3.512	3.495 to 3.505	3.495 to 3.505
2	35.00V	34.88 to 35.12	34.95 to 35.05	34.95 to 35.05
3	-35.00V	-34.88 to -35.12	-34.95 to -35.05	-34.95 to -35.05
4	350.0V	348.8 to 351.2	349.5 to 350.5	349.5 to 350.5
5	1000V	996 to 1004	998 to 1002	998 to 1002

3-21. 1-MS MIN MAX Test (Model 87 only)

The following procedure checks the minimum/maximum hold feature of the Model 87 Multimeter.

1. Apply 2.0V ac at 60 Hz (step 1, Table 3-7) from the Calibrator to the VΩ-→+ and COM inputs of the Multimeter. Prior to entering the MIN MAX mode, rotate the function selector knob to either dc volts (for dc coupling of the input) or ac volts (for capacitive coupling of the input).

NOTE

The rms converter is not used in Peak mode. The digital display represents the actual peak value of the input.

2. Press the MIN MAX button to enter the Min/Max mode.
3. Press the beeper button to both enter the 1-millisecond mode and begin display of maximum values.
4. Check for the maximum reading called for in step 1 of Table 3-7.
5. Press the MIN MAX button to begin display of minimum values.
6. Check for the minimum reading called for in step 2 of Table 3-7.

3-22. mV DC Tests

The following test verifies accuracy in the dc millivolt ranges.

1. Connect the Calibrator to the VΩ-→+ and COM inputs on the Multimeter.
2. Set the Multimeter to the mV⎓ function.
3. Apply 350.0 mV and check for the appropriate multimeter display, as follows:

Model 83	348.8 to 351.2
Model 85	349.5 to 350.5
Model 87	349.5 to 350.5

3-23. Ohms Tests

Use the following procedure to verify resistance measurement accuracy.

1. Connect the Resistance Calibrator to VΩ-→+ and COM on the Multimeter.
2. Rotate the multimeter function selector to Ω.
3. Check for the required display for each input called for in steps 1 through 4 of Table 3-8.
4. Press the RANGE button on the Multimeter to enter the 40-nanosiemen range, used for conductance tests of high resistances. Then proceed with step 5 of Table 3-8.

3-24. Capacitance Tests

The Multimeter measures capacitance by charging the capacitor with a known direct current, measuring the resultant voltage, and calculating the capacitance. If the same capacitance is measured on an impedance bridge, a different reading may result. This variance is likely to be greater at higher frequencies.

Table 3-7. 1-MS MIN MAX Test

STEP	AC INPUT		DISPLAY READING		
	VOLTAGE	FREQUENCY	83	85	87
1	2.0V	60 Hz	n/a	n/a	2.765 to 2.890
2	2.0V	60 Hz	n/a	n/a	-2.765 to -2.890

Table 3-8. Ohms Tests

STEP	RESISTANCE	DISPLAY READING		
		83	85	87
1	190.0Ω	189.1 to 190.9	189.5 to 190.5	189.5 to 190.5
2	19.00 kΩ	18.91 to 19.09	18.95 to 19.05	18.95 to 19.05
3	1.900 MΩ	1.891 to 1.909	1.895 to 1.905	1.895 to 1.905
4	19.00 MΩ	18.78 to 19.22	18.78 to 19.22	18.78 to 19.22
5	100.0 MΩ	9.80 to 10.20	9.80 to 10.20	9.80 to 10.20

The following procedure verifies the capacitance measuring accuracy of your Multimeter.

1. Connect the Calibrator to the VΩ-→+ and COM inputs on the Multimeter.
2. For steps 1 through 3 in Table 3-9, turn the rotary switch to ·))) Ω ⊣⊢, press the blue button, connect the test leads to the capacitor, and check for the appropriate display on your Multimeter. The meter selects the proper range automatically. Each measurement takes about one second per range.
3. For step 4, first use the Relative mode (REL) to zero the display and automatically subtract the residual meter and test lead capacitance. Note that the Relative mode puts the multimeter into manual ranging.

3-25. Diode Test

Use the following procedure to check the diode function:

1. Rotate the multimeter function selector to →+.
2. Connect the Calibrator to the VΩ-→+ and COM inputs on the Multimeter.

NOTE

On Fluke 5100 series calibrators, activate the 50Ω divider override.

3. Apply 3.000V, and look for a display response of 3.000 ± 0.061V dc.

3-26. mA Tests

The following procedure verifies accuracy of both ac and dc current measurement when the multimeter function selector is set to mA/A ⎓.

1. Connect the Calibrator to the mA µA and COM inputs on the Multimeter.
2. Set the multimeter function to mA/A ⎓.
3. Perform steps 1 and 2 in Table 3-10, checking for the appropriate multimeter display for each input.
4. Press the blue button on the Multimeter to toggle to ac current measurement.
5. Perform steps 3 through 6 in Table 3-10, checking for the appropriate multimeter display for each input.

Table 3-9. Capacitance Tests

STEP	CAPPACITANCE	DISPLAY READING		
		83	85	87
1	1.0 µF	0.96 to 1.04	0.96 to 1.04	0.96 to 1.04
2	0.470 µF	0.462 to 0.478	0.462 to 0.478	0.462 to 0.478
3	0.0470 µF	0.0462 to 0.0478	0.0462 to 0.0478	0.0462 to 0.0478
4	4.70 µF	4.62 to 4.78	4.62 to 4.78	4.62 to 4.78

Table 3-10. mA Tests

STEP	DC CURRENT		DISPLAY READING		
			83	85	87
1	35.00 mA		34.84 to 35.16	34.91 to 35.09	34.91 to 35.09
2	350.0 mA		348.4 to 351.6	349.1 to 350.9	349.1 to 350.9
	AC CURRENT	FREQ	83	85	87
3	35.00 mA	60 Hz	34.56 to 35.44	34.77 to 35.23	34.63 to 35.37
4	35.00 mA	1.0 kHz	34.56 to 35.44	34.77 to 35.23	34.63 to 35.37
5	350.0 mA	60 Hz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
6	350.0 mA	1.0 kHz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7

3-27. μA Tests

The following test verifies accuracy in the microamp (μA) measurement mode.

1. Connect the Calibrator to the mA μA and COM inputs on the Multimeter.
2. Rotate the multimeter function selector to μA ⎓.
3. Verify correct display readings for the given dc inputs in steps 1 and 2 of Table 3-11.
4. Press the blue button on the Multimeter to enable ac measurements.
5. Check for the appropriate multimeter readings for steps 3 through 6 of Table 3-11.

3-28. A Tests

Use the following procedure to verify measurement accuracy in the ampere (A) mode.

1. If necessary, set the calibrator output to 0.
2. Rotate the multimeter function selector to mA/A ⎓.
3. Connect the Calibrator to the A and COM inputs of the Multimeter.
4. Perform steps 1 and 2 in Table 3-12. For each input, check that a display appropriate for your Multimeter is obtained.
5. Set the calibrator output to 0. Now press the blue button on the Multimeter to toggle to ac current measurement once again.
6. Perform steps 3 through 6 in Table 3-12.

3-29. CALIBRATION

Calibrate the meter once a year to ensure that it performs according to specifications. Connect the Calibrator to the VΩ-⊣⊢ and COM inputs on the Multimeter. Calibration adjustment points are identified in Figure 3-4. The slightly different routines required for each model of the 80 Series are presented in the following paragraphs.

3-30. Models 83 and 85 Calibration

Calibrate the Fluke 83 or 85 with the following procedure:

1. Set the source for VDC, 0V.
2. On the multimeter, select the V⎓ function.

Table 3-11. μA Tests

STEP	DC CURRENT		DISPLAY READING		
			83	85	87
1	350.0 μA		348.3 to 351.7	349.0 to 351.0	349.0 to 351.0
2	3500 μA		3484 to 3516	3491 to 3509	3491 to 3509
	AC CURRENT	FREQ	83	85	87
3	350.0 μA	60 Hz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
4	350.0 μA	1.0 kHz	345.6 to 354.4	347.7 to 352.3	346.3 to 353.7
5	3500 μA	60 Hz	3456 to 3544	3477 to 3523	3463 to 3537
6	3500 μA	1.0 kHz	3456 to 3544	3477 to 3523	3463 to 3537

Table 3-12. A Tests

STEP	DC CURRENT		DISPLAY READING		
			83	85	87
1	3500 mA		3484 to 3516	3491 to 3509	3491 to 3509
2	10.00A		9.94 to 10.06	9.96 to 10.04	9.96 to 10.04
	AC CURRENT	FREQ	83	85	87
3	3500 mA	60 Hz	3456 to 3544	3477 to 3523	3463 to 3537
4	3500 mA	1.0 kHz	3456 to 3544	3477 to 3523	3463 to 3537
5	10.00A	60 Hz	9.86 to 10.14	9.92 to 10.08	9.88 to 10.12
6	10.00A	1.0 kHz	9.86 to 10.14	9.92 to 10.08	9.88 to 10.12

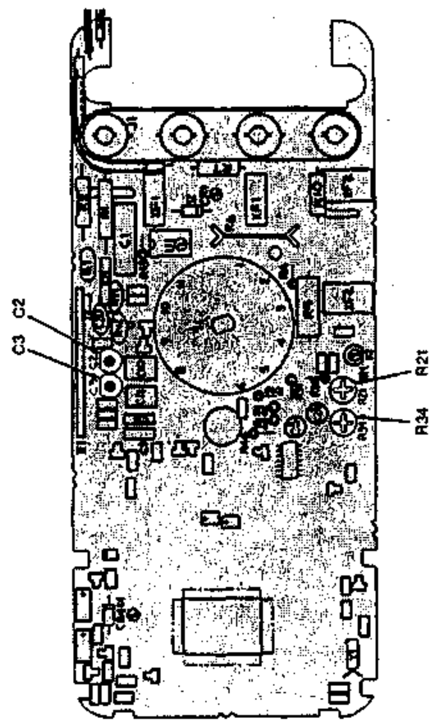


Figure 3-4. Calibration Adjustment Points

3. Connect the source to the VΩ-⊣◄ and COM inputs on the multimeter.
4. Set the source for 3.500V dc output.
5. The multimeter should now display 3.500 ±0.001. If necessary, adjust R21 to obtain the proper display.
6. Now set the multimeter to the V~ function, then set the source for an output of 3.500V at 100 Hz.
7. The multimeter should now display 3.500 ±0.002. If necessary, adjust R34 to obtain the proper display.

NOTE

For the Fluke 85, set the source for 100V at 20 kHz. The Fluke 85 should now display 100.0 ± 0.2. If necessary, adjust C37 to obtain the proper display.

8. Set the source for an output of 3.500V at 10 kHz.
9. The multimeter should now display 3.500 ±0.004. If necessary, adjust C2 to obtain the proper display.
10. Set the source for an output of 35.00V at 10 kHz.
11. The multimeter should now display 35.00±0.04. If necessary, adjust C3 to obtain the proper display.

3-31. Model 87 Calibration

Calibrate the Fluke 87 with the following procedure:

1. Set the source for VDC, 0V.
2. On the Model 87, select the V⎓ function.
3. Connect the source to the Model 87 VΩ-⊣◄ and COM inputs.
4. Set the source for 3.500V dc output.
5. The Model 87 should now display 3.500 ±0.001. If necessary, adjust R21 to obtain the proper display.
6. Now set the Model 87 to the V~ function, then set the source for an output of 3.513V at 50 Hz.

NOTE

The disparity of 3.513 in step 6, and display of 3.500 in step 7, is due to compensation for the RMS coverter linearity.

7. The Model 87 should now display 3.500 ± 0.002. If necessary, adjust R34 to obtain the proper display.
8. Set the source for 100V at 20 kHz.
9. The Model 87 should now display 100.0 ± 0.2. If necessary, adjust C37 to obtain the proper display.
10. Set the source for an output of 3.500V at 10 kHz.
11. The Model 87 should now display 3.500 +/-0.004. If necessary, adjust C2 to obtain the proper display.
12. Set the source for an output of 35.00V at 10 kHz.
13. The Model 87 should now display 35.00 +/-0.04. If necessary, adjust C3 to obtain the proper display.

3-32. TROUBLESHOOTING

If the meter fails, check the battery and fuses and replace as needed. If problems persist, verify that you are operating the meter correctly by reviewing the operating instructions found in the User's Manual. If these measures suggest a fault with the multimeter, consult the power supply troubleshooting procedures in this section and the signal flow diagrams in Section 5 of this manual.

3-33. Servicing Surface-Mount Assemblies

The 80 Series multimeters incorporate Surface-Mount Technology (SMT) for printed circuit assemblies (pca's). Surface-mount components are much smaller than their predecessors, with leads soldered directly to the surface of a circuit board; no plated through-holes are used. Unique servicing, troubleshooting, and repair techniques are required to support this technology. The information offered in the following paragraphs serves only as an introduction to SMT. It is not recommended that repair be attempted based only on the information presented here. Refer to the Fluke Surface Mount Device Soldering Kit for a complete demonstration and discussion of these techniques (call 1-800-526-4731 to order).

Since sockets are seldom used with SMT, shotgun troubleshooting cannot be used; a fault should be isolated to the component level before a part is replaced. Surface-mount assemblies are probed from the component side. The special probes make contact only with the pads in front of the component leads. With the close spacing involved, ordinary test probes can easily short two adjacent pins on an SMT IC.

This Service Manual is a vital source for component locations and values. With limited space on the circuit board, chip component locations are seldom labeled. Figures provided in Section 4 of this manual provide this information. Also, remember that chip components are not individually labeled; keep any new or removed component in a labeled package.

Surface-mount components are removed and replaced by reflowing all the solder connections at the same time. Special considerations are required.

Table 3-13. Functional Description of Power Supply Components

COMPONENT	FUNCTION
R24, R25	Vdd Regulator series regulator device
Q8	Power on/off device
Q10	Power supply startup device. Q10 provides Q3 base startup current. Q10 is always off during meter operation.
CR5	CR5 is in the power supply series loop, allowing for generation of Vbt=+3.6V for diode test.
VR1	VR1 provides the system reference voltage. It is used for the A/D Converter reference and as a reference for both power supply regulators.
C14	Vdd regulator compensation and bypass.
C21	Common regulator compensation and bypass.
C35	Battery and CR5 bypass.
C32	Q8 gate bypass.
R24, R25	Vdd regulator voltage sensing resistors.
R37, R38	Common regulator voltage sensing resistors.
R44	Supplies bias current to VR1.
R54	Q8 gate pull-up resistor.

- The solder tool uses regulated hot air to melt the solder; there is no direct contact between the tool and the component.
- Surface-mount assemblies require rework with wire solder rather than with solder paste. A 0.025 inch diameter wire solder composed of 63% tin and 37% lead is recommended. A 60/40 solder is also acceptable.
- A good connection with SMT requires only enough solder to make a positive metallic contact. Too much solder causes bridging, while too little solder can cause weak or open solder joints. With SMT, the anchoring effect of the through-holes is missing; solder provides the only means of mechanical fastening. Therefore, the pca must be especially clean to ensure a strong connection. An oxidized pca pad causes the solder to wick up the component lead, leaving little solder on the pad itself.

Refer to the Fluke Surface Mount Device Soldering Kit for a complete discussion of these techniques.

3-34. TROUBLESHOOTING - POWER SUPPLY

The two regulator circuits are interrelated; a malfunction in either the common regulator or the Vdd regulator may cause a problem in the other. Refer to Tables 3-13 and 3-14 for descriptions of power supply components and voltage levels, respectively. To isolate the problem regulator circuit, disconnect the battery, and drive Vdd - Vss = 6.2V with a power supply. This procedure tests the common regulator independently of the Vdd regulator.

Table 3-14. Voltage Levels

VDD	3.0 ±0.3
VSS	-3.2 ±0.3
VBT+	3.5 ±0.3
VBT-	-5.6 (battery at full 9V charge) -3.0 (battery at low charge of 6.5V)
REFH	1.235 ±0.012
PS0	1.235 ±0.15
PS1	0 ±0.15
AP6	-0.5 to -0.15
VOA	2.2 to 1.7 (referenced from VSS)
VOB	1.07 to .91 (referenced from VSS)

Now check for Vdgnd - Vss = -3.2V ±0.3V. If this test is successful, the problem lies with the Vdd regulator; refer to Vdd Regulator Troubleshooting later in this section. If this test is not successful, the problem lies with the common regulator; continue with the Common Regulator Troubleshooting below.

Note that if the common regulator works or has been repaired, check both supplies with the 9V battery supply.

3-35. Common (Shunt) Regulator Troubleshooting

To troubleshoot the common regulator, connect the power supply so that Vdd, Vss, and DGND (digital ground) are supplied from an external power supply. This procedure over-drives the large on-chip shunt transistors; the bias current from the power supply ranges from 10 mA to 100 mA. Refer to Figure 3-5 for a simplified diagram of the common regulator. Make the following tests:

1. Check for +1.235V ±20 mV (Vrefh) at the cathode of VR1. If Vrefh is not correct, check VR1, R19, R20, and R44 and the traces to these parts carefully. If Vrefh is still incorrect, U4 is bad.

2. If Vrefh is correct, measure the voltage at U4 pin 6 (PS1). If Vps1 is not equal to 0V ±0.15V, check R37 and R38 and their associated traces. If Vps1 is still at an incorrect voltage, U4 is bad.

3. A DGND and Vss current much larger than 100 mA may indicate a problem with Q12 (Vdgnd-to -Vss quick turn-off clamp) or its base drive signal from U6. The Q12 clamp is off when the instrument is on and on when the instrument is off.

4. Check the bias generator circuit. With the exception of resistor R35 (620 kΩ), the bias generator (which sets the bias level for all U4 analog circuitry) is internal to U4. A problem with this circuit could cause the on-chip power supply op amps to not work. Measure the dc voltage between U4 pin 8 (Vbias) and DGND. If -0.2V < Vbias > +0.2V the bias generator is okay. If Vbias is not correct, check R35. If Vbias is still wrong, replace U4.

5. Measure the ac voltage between Vdgnd and Vss. If it is greater than 10 mV ac, check C21. (An open C21 causes common regulator instability.) The dc level may also be incorrect.

6. If the common regulator still does not work, circuitry internal to U4 is bad. Replace U4.

3-36. Vdd (Series) Regulator Troubleshooting

If a problem still exists after the common regulator troubleshooting, continue on with the following Vdd regulator troubleshooting. Often, a short or sneak current path causes power supply problems. Refer to Figure 3-5 for a simplified diagram of the Vdd (Series) Regulator. Make the following tests:

1. Measure the dc operating current from the 9V battery. If it is greater than 1.2 mA for an 83/85 or greater than 1.4 mA for an 87, a sneak current path exists. A sneak current path can be very difficult to find.

2. First, visually check for both solder bridges on U4 pins and other circuit board shorts.

Isolate the current path at the negative battery terminal (Vbt-). The components connected to Vbt- are C35, CR4, R56, U6, Q8, and the rotary knob fingers. Remove these parts one at a time (except Q8). Measure I(bat) after each removal to isolate the problem.

1. If the excess battery current stops after removing R56, either R56, R57, Q9, or Q11 may be bad. If one of these four parts is bad a problem may not be noticed until U6 is removed.

2. If the extra current is still present with all parts except Q8 removed, remove Q10 and check for excess battery current. If I(bat) is now correct, Q10 is bad. If I(bat) is still excessive, U4 is probably at fault.

If the power supply is not working, but battery current is normal, perform the following tests.

1. With the 9V battery attached, cycle the unit off and on. If both supplies are less than 1.0V, a problem probably exists with the on/off circuit. Check Q8, R54, and C32.

2. Check the rotary knob wiper contacts; verify that the Q8 gate voltage is close to Vbt+.

3. If Vdd - Vss is low, a problem may exist with start up device Q10. Check Q10 by momentarily connecting Vss to Vbt-. If both Vss and Vbt- now start up and operate correctly, check Q10 for an open.

4. Measure the ac voltage between Vdd and Vss. An unstable Vdd regulator can be caused by an open C14. If it is greater than 10 mV ac, check C14. The dc level may also be incorrect.

For a final check of U4, remove the battery and supply Vdd = +3.0V, Vdgnd = 0, and Vss = -3.2V from an external power supply. Measure the voltage at U4 pin 7 (Vps0). If it does not equal 1.235V ±0.15V then check R24 and R25 carefully. If Vps0 is still incorrect, U4 is bad.

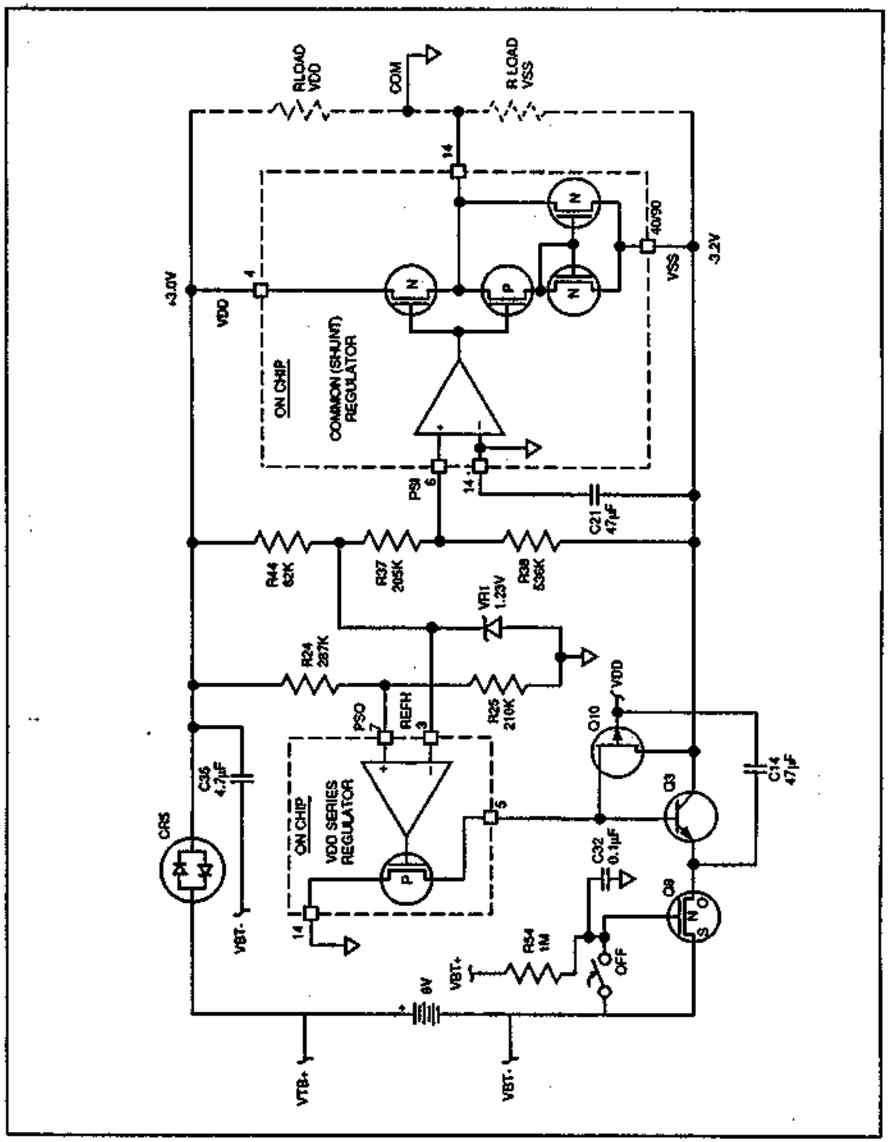


Figure 3-5. Simplified Power Supply Schematic

Section 4
List of Replaceable Parts

TABLE OF CONTENTS

4-1. INTRODUCTION

This section contains an illustrated list of replaceable parts for the 83, 85, and 87 Multimeters. Parts are listed by assembly; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge.
- Description
- Fluke stock number
- Manufacturers supply code
- Manufacturers part number or generic type
- Total quantity
- Any special notes (i.e., factory-selected part)

CAUTION

A ⚡ symbol indicates a device that may be damaged by static discharge.

4-2. HOW TO OBTAIN PARTS

Electrical components may be ordered directly from the manufacturer by using the manufacturers part number, or from the John Fluke Mfg. Co., Inc. and its authorized representatives by using the part number under the heading FLUKE STOCK NO. In the U.S., order directly from the Fluke Parts Dept. by calling 1-800-526-4731. 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.

In the event that the part ordered has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Fluke stock number
- Description (as given under the DESCRIPTION heading)
- Quantity
- Reference designator
- Part number and revision level of the pca containing the part.
- Instrument model and serial number

4-3. MANUAL STATUS INFORMATION

The Manual Status Information table that precedes the parts list defines the assembly revision levels that are documented in the manual. Revision levels are printed on the component side of each pca.

4-4. NEWER INSTRUMENTS

Changes and improvements made to the instrument are identified by incrementing the revision letter marked on the affected pca. These changes are documented on a supplemental change/errata sheet which, when applicable, is included with the manual.

4-5. SERVICE CENTERS

A list of service centers is located at the end of this section.

NOTE

This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.

WARNING

THIS INSTRUMENT CONTAINS A FUSIBLE RESISTOR (PN 832550). TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

MANUAL STATUS INFORMATION

REF. DES.	ASSEMBLY NAME	FLUKE PART NO.	REVISION LEVEL
A1	Main PCA (83)	819284	T
A1	Main PCA (85)	819276	Y
A1	Main PCA (87)	819268	AD

Table 4-1. Fluke 83 Final Assembly

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A 1	‡ MAIN PCA	657070	89536	657070	1	
BT 1	BATTERY,PRIMARY,ALKALINE,9V,0-500MA	614487	73434	MN1604	1	
E 1	CONTACT,PTF	822676	1CG66	822676	1	
E 2	CONTACT,ANNUNCIATOR	832791	0K393	832791	1	
F 1	FUSE,.406X1.375,1A,600V,FAST	830828	71400	BBS-1	1	
F 2	FUSE,.406X1.5, 15A, 600V, FAST	820829	71400	KTK-15	1	
H 1	SCREW,PH,P,THD FORM,STL,4-24,.562	832326		COMMERCIAL	1	
H 2- 4	SCREW,PH,P,THD FORM,STL,5-24,.750	832346		COMMERCIAL	3	
J 1, 2	CONN,ELASTOMERIC,LCD TO PWB,1.580 L	817460	6X392	817460	2	
MP 1	MASK,LCD	830364	89536	830364	1	
MP 2	SHIELD,TOP	824516	89536	824516	1	
MP 3	SHAFT,SWITCH	822635	89536	822635	1	
MP 4	SHIELD,BOTTOM	824524	89536	824524	1	
MP 5	CASE TOP (PAD XPRT)	857260	89536	857266	1	1
MP 6	CASE & GASKET ASSY, BOTTOM	819350	89536	819350	1	
MP 8	KNOB,SWITCH (PAD XPRT)	857271	89536	857271	1	
MP 9	SPRING,DETENT	833643	89536	833643	1	
MP 10, 11	FOOT,NON SKID	824466	30045	824466	2	
MP 13	SHOCK ABSORBER	836641	30045	836641	1	
MP 14	O-RING,SYN RUBBER,1.474 ID,0.067 WIDE	831933	3R160	6-143N674-70	1	
MP 15	HOLSTER&FLEXSTAND ASSY (YELLOW)	833809	28405	833809	1	
MP 16	CONTAINER,BOTTOM	833033	89536	833033	1	
MP 17	CONTAINER,TOP	833767	89536	833767	1	
MP 19	TEST LEADS	855742	89536	855742	1	
MP 20	LABEL, WINDOW FLUKE-PHILIPS	844337	22670	844337	1	
S 2	SWITCH PAD, MOMENTARY	809988	89536	809988	1	
TM 1	83/85 USER'S MANUAL (ENGLISH)	834218	89536	834218	1	
TM 2	83/85 USER'S MANUAL (INTERNATIONAL)	834226	89536	834226	1	
TM 3	83/85/87 SERVICE MANUAL	834168	89536	834168	1	
U 5	LCD,4.5 DIGIT,BAR GRAPH,MULTIPLEXED	782763	13901	L6393C	1	
NOTES:	‡ Static sensitive part. 1. MP5 includes MP8 and MP9.					

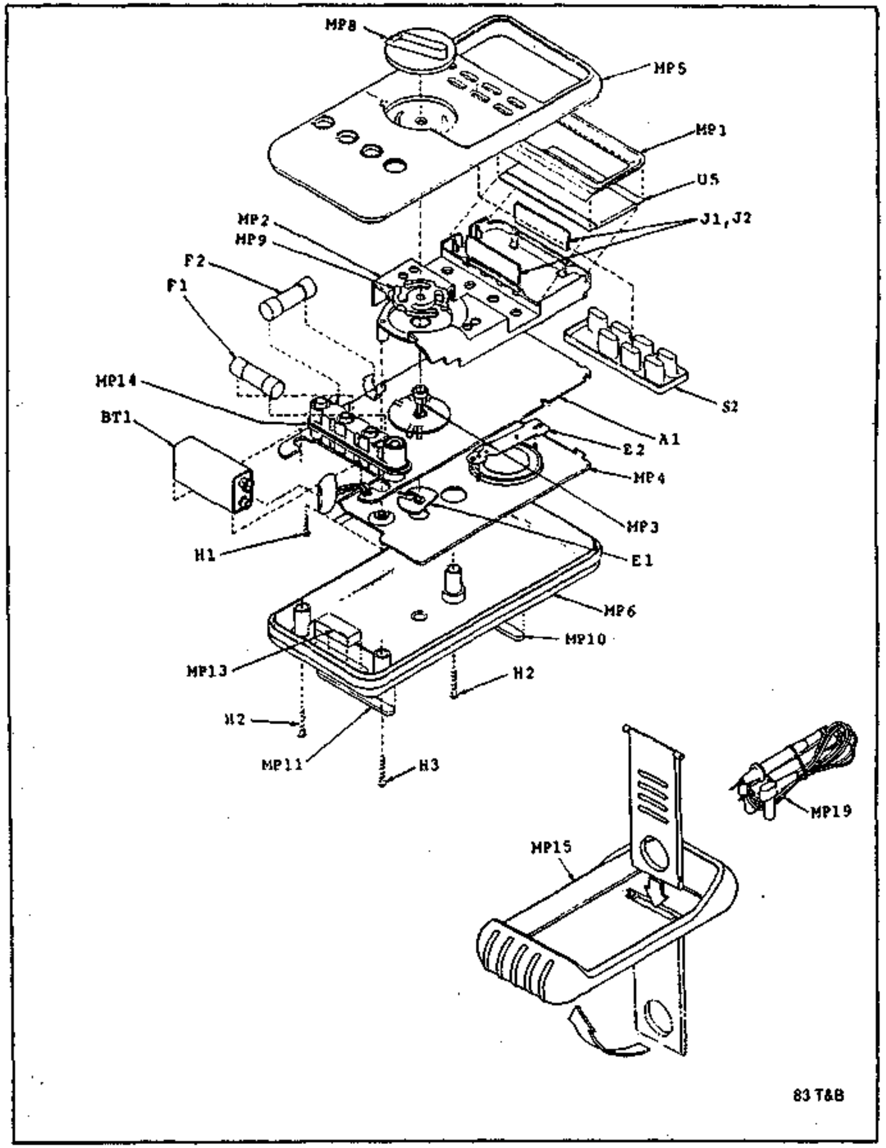


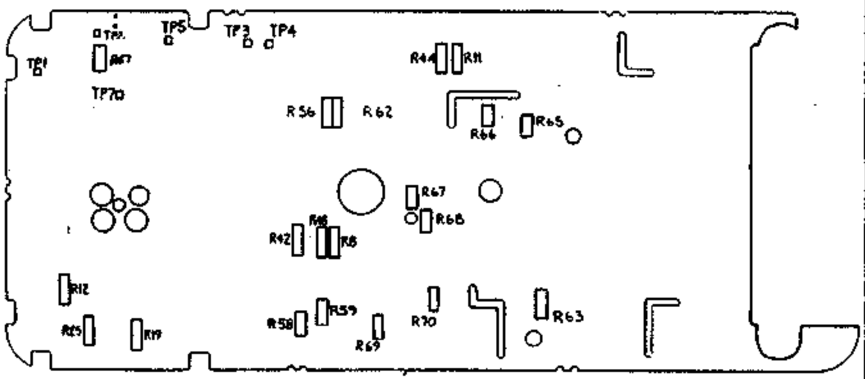
Figure 4-1. Fluke 83 Final Assembly

Table 4-2. Fluke 83 A1 Main PCA

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
C 1	CAP,POLYES,0.01UF,+-10%,1000V	822361	37942	160103K1000F	1	
C 2	CAP,VAR,3-11PF,100V,CER	861713	51406	TZ03T110ER174	1	
C 3	CAP,VAR,9-50PF,50V,CER	643136	51406	TZ03R500ER174	1	
C 4	CAP,CER,470PF,+-5%,50V,C0G,1206	943365	89536	943365	1	
C 5	CAP,TA,15UF,+-20%,6.3V	867434	56289	199D156X06R3BA2	1	
C 6, 9	CAP,POLYCA,0.027UF,+-10%,63V	720979	68919	MKC1872R6J	2	
C 10	CAP,POLYES,0.47UF,+-10%,50V	697409	68919	MKS2474K50B	1	
C 11	CAP,POLYPR,0.022UF,+-10%,63V	821978	68919	MKP10-223-K-63V	1	
C 14, 22	CAP,TA,47UF,+-20%,10V,7343	867580	56289	293D476X0010D2T or W	2	
C 15, 16, 32	CAP,CER,0.1UF,+-10%,25V,X7R,1206	747287	04222	12065C104KATMA	3	
C 17, 18	CAP,CER,33PF,+-10%,50V,C0G,1206	740563	04222	12065A330KAT050R	2	
C 19	CAP,CER,13PF,+-10%,50V,C0G,1206	747329	89536	747329	1	
C 20	CAP,CER,3.6PF,+-0.25PF,1500V,C0G	851011	51964	4010C0H3R6C1.5KV14	1	
C 23	CAP,CER,1000PF,+-10%,50V,C0G,1206	747378	04222	12065A102KAT050R	1	
C 24	CAP,TA,10UF,+-20%,10V	714766	56289	199D106X0010BA2	1	
C 25, 31, 33, C 34	CAP,CER,0.01UF,+-10%,50V,X7R,1206	747261 747261	04222	12065C103KATMA	4	
C 27	CAP,CER,130PF,+-10%,50V,C0G,1206	911237	04222	12065A131KATMA	1	
C 28, 29	CAP,TA,0.47UF,+-20%,35V,3528	867259	56289	293D474X0035B2T or W	2	
C 30	CAP,CER,3200PF,+-10%,50V,C0G,1206	780070	04222	12065A322KAT050R	1	
C 35	CAP,TA,4.7UF,+-20%,10V,3528	867262	56289	293D475X0010B2T or W	1	
C 36	CAP,CER,68PF,+-10%,50V,C0G,1206	853861	04222	12065A680KAT050R	1	
C 39	CAP,CER,150PF,+-5%,50V,C0G,0805	866533	04222	08055A151JAT050R	1	
CR 1, 4	DIODE,SI,1K PIV,1.0 AMP	707075	30800	1N4007	2	
CR 5, 7, 8	† DIODE,SI,BV=70.0V,IO=50MA,DUAL,SOT23	742320	4R333	BAV99	3	
E 1	SURGE PROTECTOR,1500V,+-20%	683134	51964	100T1	1	
J 1	INPUT RCPT ASSY	836216	9F401	836216	1	
Q 1, 2, 6	† TRANSISTOR,SI,NPN,SELECT IEBO,SOT-23	821637	04713	SMBT1384LT1	3	
Q 3, 9, 12	† TRANSISTOR,SI,NPN,SMALL SIGNAL,SOT-23	742676	04713	MMBT3904T	3	
Q 8	† TRANSISTOR,SI,N-DMOS FET,SOT23	830961	17856	SSTVN0049-T1	1	
Q 10	† TRANSISTOR,SI,P-CHAN,SOT-23	832477	17856	SST4115T1	1	
Q 11	† TRANSISTOR,SI,PNP,SMALL SIGNAL,SOT-23	742684	04713	MMBT3906T	1	
Q 13,14	† TRANSISTOR,SI,NPN,SMALL SIGNAL,SOT-23	912469	89536	912469	2	
R 1	RES,MF,1K,+-1%,100PPM,FLMPRF,FUSIBLE	832580	91637	CMF-65 49 1K F T-1 BULK	1	3
R 2	† RES,CERM,909K,+-1%,1W	831984	33237	GS-3-909K-1%	1	
R 3	† RES,CERM,1.5K,+-5%,.125W,200PPM,1206	746438	91637	CRCW1206-1501JB	1	
R 4	RES,MF,110.1,+-0.1%,0.125W,100PPM	821728	59124	MF50D110R1B	1	
R 5	RES,WW,.991,+-.1%,2.5W	821468	91637	RS-2C 991ZF	1	
R 6	RES,WW,.010,+-.1%,1W,100PPM	867305	10235	R-2269010	1	
R 7, 10	† RES,CERM,1M,+-5%,1W	913509	33237	201/2-105M-5%	2	
R 8, 60	† RES,CERM,15M,+-5%,.125W,200PPM,1206	811208	91637	CRCW1206-1505JB	2	
R 9, 13, 29, R 61	† RES,CERM,100K,+-5%,.125W,200PPM,1206	740548 740548	91637	CRCW1206-1003JB	4	
R 11	† RES,CERM,10M,+-5%,.125W,200PPM,1206	783274	91637	CRCW1206-1005JB	1	
R 12, 64-70	† RES,CERM,10K,+-5%,.125W,200PPM,1206	746610	91637	CRCW1206-1002JB	8	
R 14	RES,MF,10K,+-0.1%,0.125W,100PPM	696955	59124	MF50D1002B	1	
R 15	RES,MF,50K,+-0.1%,0.125W,100PPM	689966	59124	MF50D5002B	1	
R 17, 19, 42, R 54	† RES,CERM,1M,+-5%,.125W,200PPM,1206	746926 746926	91637	CRCW1206-1004JB	4	
R 18	† RES,CERM,56.2K,+-1%,.125W,100PPM,1206	831305	91637	CRCW1206-5622FB	1	
R 20, 27	† RES,CERM,205K,+-1%,.125W,100PPM,1206	769935	91637	CRCW1206-2053FB	2	
R 21	RES,CERM,VAR,100K,+-20%,.3W	649937	51406	RVG-0707-V-100-3-104M	1	
R 24	† RES,CERM,324K,+-1%,.125W,100PPM,1206	911243	91637	CRCW1206-3243FB	1	
R 25	† RES,CERM,310K,+-1%,.125W,100PPM,1206	831560	91637	CRCW1206-3103FB	1	
R 30	RES,MF,30K,+-0.25%,0.125W,50PPM	715029	59124	MF50C3002C	1	
R 31, 40	RES,MF,22.6K,+-0.25%,0.125W,50PPM	715011	59124	MF50C2262C	2	
R 34	RES,CERM,VAR,1K,+-20%,.3W	831420	51406	RVG-0707-V-100-3-102M	1	
R 35	† RES,CERM,499K,+-1%,.125W,100PPM,1206	867460	89536	867460	1	
R 38	† RES,CERM,536K,+-1%,.125W,100PPM,1206	868620	91637	CRCW1206-5363FB	1	
R 41, 47	† RES,CERM,0,+.05 MAX,.125W,1206	810747	91637	CRCW1206-0R00D	2	
R 43	RES,MF,1K,+-0.1%,0.125W,100PPM	821694	59124	MF50D1001B	1	
R 44	† RES,CERM,82K,+-5%,.125W,200PPM,1206	811796	91637	CRCW1206-8202JB	1	
R 46	RES JUMPER,0.02,0.25W	602573	91637	FRJ-55	1	
R 56, 57	† RES,CERM,22K,+-5%,.125W,200PPM,1206	746651	91637	CRCW1206-2202JB	2	
R 58	† RES,CERM,130K,+-5%,.125W,200PPM,1206	746719	91637	CRCW1206-1303JB	1	
R 59	† RES,CERM,510,+-5%,.125W,200PPM,1206	746289	91637	CRCW1206-5100JB	1	
R 63	† RES,CERM,1K,+-5%,.125W,200PPM,1206	745992	91637	CRCW1206-1001JB	1	
RT 1	THERMISTOR,RECT,POS,1.5K,+-30%,25 C	822015	54393	511P84015Z013	1	
RV 1, 2	VARISTOR,910,+-10%,1.0MA	876193	09214	V910LEX1300	2	
S 1	SWITCH,ROTARY	819334	71590	819334	1	
U 1	DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	418582	14936	DF01M	1	
U 4	SMD2 OLY 83 IC	931601	89536	931601	1	
U 6	† IC,CMOS,HEX INVERTER,SOIC	830375	27014	MM74HC04M	1	
VR 1	† IC, 1.23V,150 PPM T.C.,BANDGAP V. REF	634451	27014	LM385M-1.2D26	1	
W 1	JUMPER WIRE NRO	834994	89536	834994	1	

Table 4-2. Fluke 83 A1 Main PCA (cont)

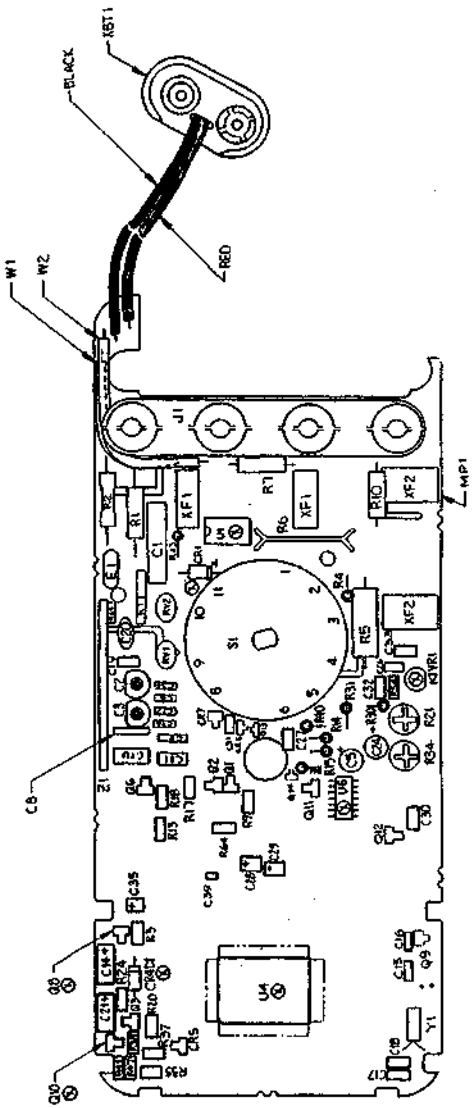
REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
W 2	JUMPER WIRE,POS	835049	89536	835049	1	
MBT 1	CONNECTOR,BATTERY	829974	89451	829974	1	
XF 1	CONTACT,600V,FUSE	659524	70970	659524	2	1
XF 2	600 VOLT FUSE CONTACT	707190	70970	707190	2	2
Y 1	CRYSTAL,131.072KHZ,0.003%,3X8MM	831453	0BZ74	ST6351030	1	
Z 1	RES NET THK FILM TESTED	820157	89536	820157	1	
NOTES:	† Static sensitive part. 1. Ref. Designator XF1 is two (2) parts. They are used with F1 on the Final Assembly. 2. Ref. Designator XF2 is two (2) parts. They are used with F2 on the Final Assembly. 3. This resistor is a fusible resistor. To ensure safety, use exact replacement only.					



BOTTOM SIDE

83-4001
(1 of 2)

Figure 4-2. Fluke 83 A1 Main PCA



TOP SIDE

83-4001
(2 of 2)

Figure 4-2. Fluke 83 A1 Main PCA (cont)

Table 4-3. Fluke 85 Final Assembly

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A 1	⚡ MAIN PCA	857867	89536	857867	1	
BT 1	BATTERY,PRIMARY,ALKALINE,9V,0-200MA	614487	72634	MN1604	1	
E 1	CONTACT,PTF	822676	1C066	822676	1	
E 2	CONTACT,ANNUNCIATOR	832791	0X392	832791	1	
F 1	FUSE,.406X1.375,1A,600V,FAST	830828	71400	BBS-1	1	
F 2	FUSE,.406X1.5, 15A, 600V, FAST	820829	71400	KTK-15	1	
H 1	SCREW,PH,P,THD FORM,STL,4-14,.562	832220		COMMERCIAL	1	
H 2- 4	SCREW,PH,P,THD FORM,STL,5-14,.750	832246		COMMERCIAL	3	
J 1, 2	CONN,ELASTOMERIC,LCD TO PWB,1.190 L	817460	0K382	817460	2	
MP 1	MASK,LCD	930276	89536	930276	1	
MP 2	SHIELD,TOP	834516	89536	834516	1	
MP 3	SHAFT,SWITCH	832638	89536	832638	1	
MP 4	SHIELD,BOTTOM	834524	89536	834524	1	
MP 5	CASE TOP (PAD XFER)	857260	89536	857260	1	1
MP 6	CASE & GASKET ASSY, BOTTOM	810250	89536	810250	1	
MP 8	KNOB,SWITCH (PAD XFER)	857271	89536	857271	1	
MP 9	SPRING,DETENT	832643	89536	832643	1	
MP 10, 11	FOOT,NON SKID	824466	20045	824466	2	
MP 13	SHOCK ABSORBER	828541	20045	828541	1	
MP 14	O-RING,SYN RUBBER,1.670 ID,0.047 WIDE	831933	2K140	9-1420474-70	1	
MP 15	HOLSTER&FLEXSTAND ASSY (YELLOW)	822809	86405	822809	1	
MP 16	CONTAINER,BOTTOM	822825	89536	822825	1	
MP 17	CONTAINER,TOP	822775	89536	822775	1	
MP 19	TEST LEADS	855742	89536	855742	1	
MP 20	LABEL, WINDOW FLUKE-PHILIPS	844337	22670	844337	1	
S 2	SWITCH PAD, MOMENTARY	809988	89536	809988	1	
TM 1	83/85 USER'S MANUAL (ENGLISH)	834218	89536	834218	1	
TM 2	83/85 USER'S MANUAL (INTERNATIONAL)	834226	89536	834226	1	
TM 3	83/85/87 SERVICE MANUAL	834168	89536	834168	1	
U 5	LCD,4.5 DIGIT,BAR GRAPH,MULTIPLEXED	783763	12581	L0282C	1	

NOTES:
⚡ Static sensitive part.
1. MP5 includes MP8 and MP9.

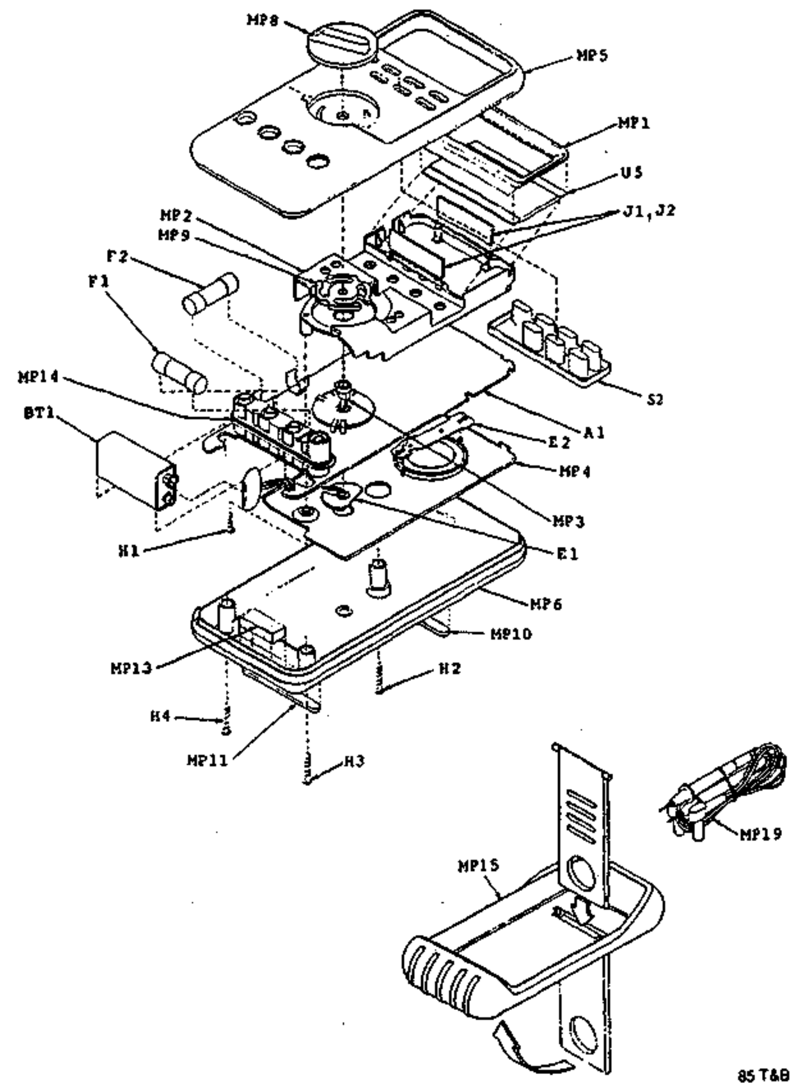


Figure 4-3. Fluke 85 Final Assembly

Table 4-4. Fluke 85 A1 Main PCA

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
C 1	CAP,POLYES,0.01UF,+-10%,1000V	822361	37942	160103K1000F	1	
C 2	CAP,VAR,2-11PF,100V,CER	641712	51406	TZ03T110FR174	1	
C 3	CAP,VAR,5-90PF,50V,CER	643130	51406	TZ03R900FR174	1	
C 4	CAP,CER,560PF,+-5%,50V,C0G,1206	943373	89536	943373	1	
C 5	CAP,TA,15UF,+-20%,6.3V	807534	56289	293D156X06R3B2T	1	
C 8, 9	CAP,POLYCA,0.027UF,+-10%,63V	720979	40919	MKC2273M63B	2	
C 10	CAP,POLYES,0.47UF,+-10%,50V	697409	40919	MKS2474K50B	1	
C 11	CAP,POLYPR,0.022UF,+-10%,63V	831879	40919	MKP20-223-K-63V	1	
C 14, 21	CAP,TA,47UF,+-20%,10V,7343	867580	56289	293D476X0010D2T or W	2	
C 15, 16, 32	CAP,CER,0.1UF,+-10%,25V,X7R,1206	747287	04222	12063C104KATMA	3	
C 17, 18, 19	CAP,CER,33PF,+-10%,50V,C0G,1206	740563	04222	12065A330KAT050R	3	
C 20	CAP,CER,3.6PF,+-0.25PF,1000V,C0J	851012	89536	851012	1	
C 22	CAP,CER,.47UF,+-5%,50V,X7R,1206	943368	89536	943368	1	
C 23	CAP,CER,.01UF,+-5%,50V	929364	89536	929364	1	
C 24	CAP,TA,10UF,+-20%,10V	714766	56289	199D106X0010BA1	1	
C 26, 31, 33, C 34	CAP,CER,0.01UF,+-10%,50V,X7R,1206	747261 747261	04222	12061C103KATMA	4	
C 27	CAP,CER,130PF,+-10%,50V,C0G,1206	911337	04222	12065A131KATMA	1	
C 28, 29	CAP,TA,0.47UF,+-20%,35V,3528	867358	56289	293D474X0035B2T or W	2	
C 36	CAP,CER,330PF,+-10%,50V,C0G,1206	758078	04222	12065A331KAT050R	1	
C 35	CAP,TA,4.7UF,+-20%,10V,3528	867343	56289	293D475X0010B2T or W	1	
C 36	CAP,CER,1000PF,+-1%,50V,C0G,1206	867466	04222	12065A102FAT050R	1	
C 37	CAP,VAR,0.35PF-1.0PF,1700V,TEFLON	910711	52769	ER-530-017	1	
C 39	CAP,CER,150PF,+-5%,50V,C0G,0805	866533	04222	08055A151JAT050R	1	
CR 1, 4	DIODE,SI,1K PIV,1.0 AMP	707075	28480	1N4007	2	
CR 5, 7, 8	† DIODE,SI,BV=70.0V,IO=50MA,DUAL,SOT23	742320	0A333	BAV99	3	
E 1	SURGE PROTECTOR,1500V,+-20%	655136	21964	160T1	1	
J 1	INPUT RCPT ASSY	836314	89401	836314	1	
Q 1, 3, 4	† TRANSISTOR,SI,NPN,SELECT ZERO,SOT-23	821637	04713	SMDT1308LT1	3	
Q 2, 9, 12	† TRANSISTOR,SI,NPN,SMALL SIGNAL,SOT-23	742676	04713	MMBT3904T	3	
Q 5	† TRANSISTOR,SI,N-DMOS FET,SOT23	836051	17856	SST VN50SP-T1	1	
Q 10	† TRANSISTOR,SI,P-CHAN,SOT-23	832477	17856	SST511BT1	1	
Q 11	† TRANSISTOR,SI,PNP,SMALL SIGNAL,SOT-23	742684	04713	MMBT3906T	1	
Q 13,14	† TRANSISTOR,SI,NPN,SMALL SIGNAL,SOT-23	912469	89536	912469	2	
R 1	RES,MF,1K,+-1%,100PPM,FLMPRF,FUSIBLE	832956	91637	CMF-65 69 1K F T-1 BULK	1	3
R 2	† RES,CERM,909K,+-1%,2W	851584	93237	HV-3-909K-1%	1	
R 3	† RES,CERM,1.5K,+-5%,.125W,200PPM,1206	746428	91637	CRCW1206-1501JB	1	
R 4	RES,MF,110.1,+-0.1%,0.125W,100PPM	821720	59124	MF50D110R1B	1	
R 5	RES,WW,.991,+-.1%,3.5W	821645	91637	RS-2C 9913F	1	
R 6	RES,WW,.010,+-.1%,1W,100PPM	207308	10125	R-3369010	1	
R 7, 10	† RES,CERM,2M,+-5%,1W	912509	23237	RG1/2-105M-5%	2	
R 8, 40	† RES,CERM,15M,+-5%,.125W,200PPM,1206	811968	91637	CRCW1206-1505JB	2	
R 9, 12, 20, R 52	† RES,CERM,100K,+-5%,.125W,200PPM,1206	740548 740548	91637	CRCW1206-1003JB	4	
R 11	† RES,CERM,10M,+-5%,.125W,200PPM,1206	783274	91637	CRCW1206-1005JB	1	
R 13, 64- 70	† RES,CERM,10K,+-5%,.125W,200PPM,1206	746610	91637	CRCW1206-1002JB	8	
R 14	RES,MF,10K,+-0.1%,0.125W,100PPM	650955	59124	MF50D1002B	1	
R 15	RES,MF,90K,+-0.1%,0.125W,100PPM	650906	59124	MF50D9002B	1	
R 17, 18, 42, R 54	† RES,CERM,1M,+-5%,.125W,200PPM,1206	746826 746826	91637	CRCW1206-1004JB	4	
R 19	† RES,CERM,107K,+-1%,.125W,100PPM,1206	876324	91637	CRCW1206-1073FB	1	
R 20	† RES,CERM,412K,+-1%,.125W,100PPM,1206	875339	91637	CRCW1206-4123FB	1	
R 21	RES,CERM,VAR,100K,+-20%,.2W	649897	51406	RVG-0707-V-100-3-104M	1	
R 24	† RES,CERM,234K,+-1%,.125W,100PPM,1206	911343	91637	CRCW1206-2343FB	1	
R 25	† RES,CERM,210K,+-1%,.125W,100PPM,1206	821660	91637	CRCW1206-2103FB	1	
R 28	RES,MF,20K,+-0.25%,0.125W,50PPM	715839	59124	MF50C2002C	1	
R 31, 44	RES,MF,21.6K,+-0.25%,0.125W,50PPM	719811	59124	MF50C2162C	2	
R 34	RES,CERM,VAR,1K,+-20%,.2W	851420	51406	RVG-0707-V-100-3-102M	1	
R 35	† RES,CERM,442K,+-1%,.125W,100PPM,1206	867460	89536	867460	1	
R 37	† RES,CERM,309K,+-1%,.125W,100PPM,1206	769836	91637	CRCW1206-3093FB	1	
R 38	† RES,CERM,536K,+-1%,.125W,100PPM,1206	865430	91637	CRCW1206-5363FB	1	
R 41, 47	† RES,CERM,0,+-.05 MAX,.125W,1206	810747	91637	CRCW1206-0R00B	2	
R 43	RES,MF,1K,+-0.1%,0.125W,100PPM	821694	59124	MF50D1001B	1	
R 44	† RES,CERM,33K,+-5%,.125W,200PPM,1206	811794	91637	CRCW1206-3303JB	1	
R 46	RES JUMPER,0.02,0.25W	682872	91637	FMJ-25	1	
R 56, 67	† RES,CERM,330,+-5%,.125W,200PPM,1206	746481	91637	CRCW1206-3301JB	2	
R 60	† RES,CERM,150K,+-5%,.125W,200PPM,1206	740719	91637	CRCW1206-1503JB	1	
R 59	† RES,CERM,510,+-5%,.125W,200PPM,1206	746263	91637	CRCW1206-5100JB	1	
R 63	† RES,CERM,1K,+-5%,.125W,200PPM,1206	745992	91637	CRCW1206-1001JB	1	
RT 1	THERMISTOR,RECT.POS.1.5K,+-30%,25 C	853019	56863	311P04X152M013	1	
RV 1, 2	VARISTOR,910,+-10%,1.0MA	876193	09214	V910LM1309	2	
S 1	SWITCH,ROTARY	819336	71590	819336	1	
U 1	DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	418582	14936	DF01M	1	
U 4	SMD1 QLF 85 IC	931681	89536	931681	1	
U 6	† IC,CMOS,HEX INVERTER,SOIC	838375	27014	MM1449TMX	1	

Table 4-4. Fluke 85 A1 Main PCA (cont)

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
VR 1	† IC,1.23V,50PPM TC,BAND-GAP REFERENCE	654787	27014	LM385BXS-1.2b1ds	1	
W 1	JUMPER WIRE NBO	834994	89536	834994	1	
W 2	JUMPER WIRE,PCB	835009	89536	835009	1	
XBT 1	CONNECTOR,BATTERY	835976	87461	835976	1	
XF 1	CONTACT,600V,FUSE	659524	70970	659524	2	1
XF 2	600 VOLT FUSE CONTACT	707150	70970	707150	2	2
Y 1	CRYSTAL,131.072KHZ,0.003%,2X6MM	831453	9ED74	1X6351020	1	
Z 1	RES NET TRM F TESTED	919871	89536	919871	1	
NOTES:	† Static sensitive part. 1. Ref. designator XF1 is two (2) parts. They are used with F1 on the Final Assembly. 2. Ref. designator XF2 is two (2) parts. They are used with F2 on the Final Assembly. 3. This resistor is a fusible resistor. To ensure safety, use exact replacement only.					

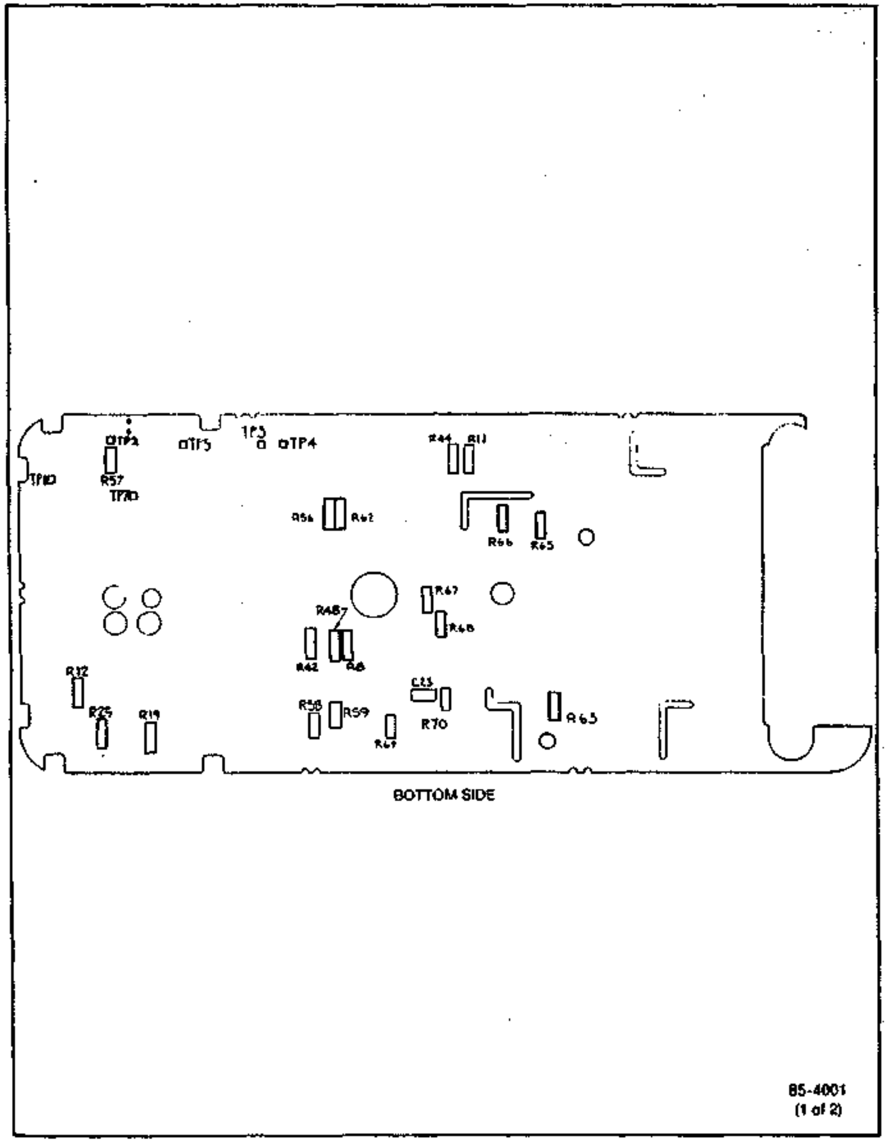


Figure 4-4. Fluke 85 A1 Main PCA

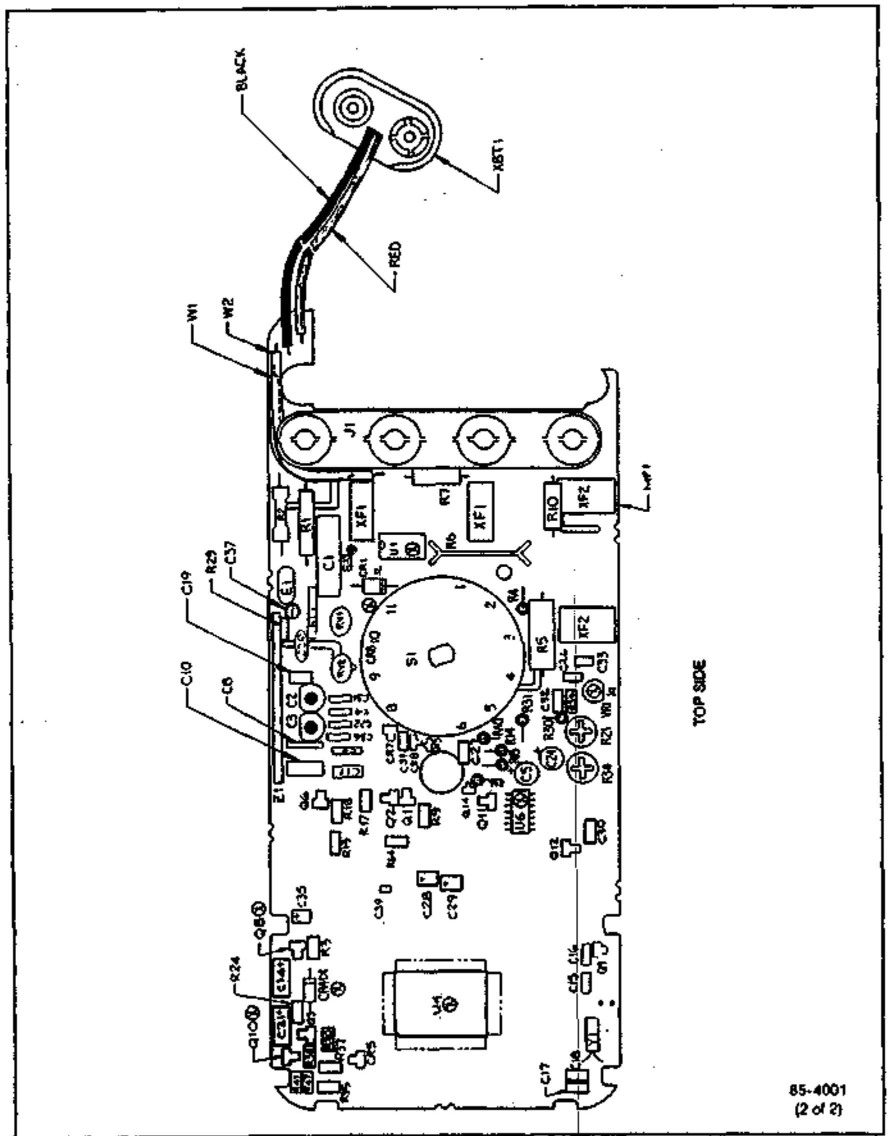


Figure 4-4. Fluke 85 A1 Main PCA (cont)

Table 4-5. Fluke 87 Final Assembly

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
A 1	† MAIN PCA	857862	89536	857862	1	
BT 1	BATTERY, PRIMARY, ALKALINE, 9V, 0-300MA	614487	72816	MN1604	1	
CR 6	BACKLIGHT	818342	3M818	818342	1	
E 1	CONTACT, PTF	822676	1C044	822676	1	
E 2	CONTACT, ANNUNCIATOR	822791	0K393	822791	1	
F 1	FUSE, .406X1.375, 1A, 600V, FAST	830828	71400	BBS-1	1	
F 2	FUSE, .406X1.5, 15A, 600V, FAST	820829	71400	KTK-15	1	
H 1	SCREW, PH, P, THD FORM, STL, 4-14, .343	832220		COMMERCIAL	1	
H 2- 4	SCREW, PH, P, THD FORM, STL, 5-14, .750	832246		COMMERCIAL	3	
J 1, 2	CONN, ELASTOMERIC, LCD TO PWB, 1.500 L	817460	0K392	817460	2	
MP 1	MASK, LCD	830371	89536	830371	1	
MP 2	SHIELD, TOP	824516	89536	824516	1	
MP 3	SHAFT, SWITCH	822635	89536	822635	1	
MP 4	SHIELD, BOTTOM	824524	89536	824524	1	
MP 5	CASE TOP (PAD XFER)	857263	89536	857263	1	1
MP 6	CASE & GASKET ASSY, BOTTOM	819409	89536	819409	1	
MP 8	KNOB, SWITCH (PAD XFER)	857271	89536	857271	1	
MP 9	SPRING, DETENT	822643	89536	822643	1	
MP 10, 11	FOOT, NON SKID	824466	30045	824466	2	
MP 13	SHOCK ABSORBER	828541	30045	828541	1	
MP 14	O-RING, EPM RUBBER, 1.470 ID, 0.047 WIDE	831933	2K160	5-1430874-70	1	
MP 15	HOLSTER/FLEXSTAND ASSY (YELLOW)	822809	28408	822809	1	
MP 16	CONTAINER, BOTTOM	832625	89536	832625	1	
MP 17	CONTAINER, TOP	832617	89536	832617	1	
MP 19	TEST LEADS	855742	89536	855742	1	
MP 20	LABEL, WINDOW FLUKE-PHILIPS	844337	22670	844337	1	
S 2	SWITCH PAD, MOMENTARY	869570	89536	869570	1	
TM 1	87 USER'S MANUAL (ENGLISH)	834192	89536	834192	1	
TM 2	87 USER'S MANUAL (INTERNATIONAL)	834200	89536	834200	1	
TM 3	83, 85, 87 SERVICE MANUAL	834168	89536	834168	1	
U 5	LCD, 4.5 DIGIT, BAR GRAPH, MULTIPLEXED	833108	12581	LC5948	1	

NOTES:
† Static sensitive part.
1. MP5 includes MP8 and MP9.

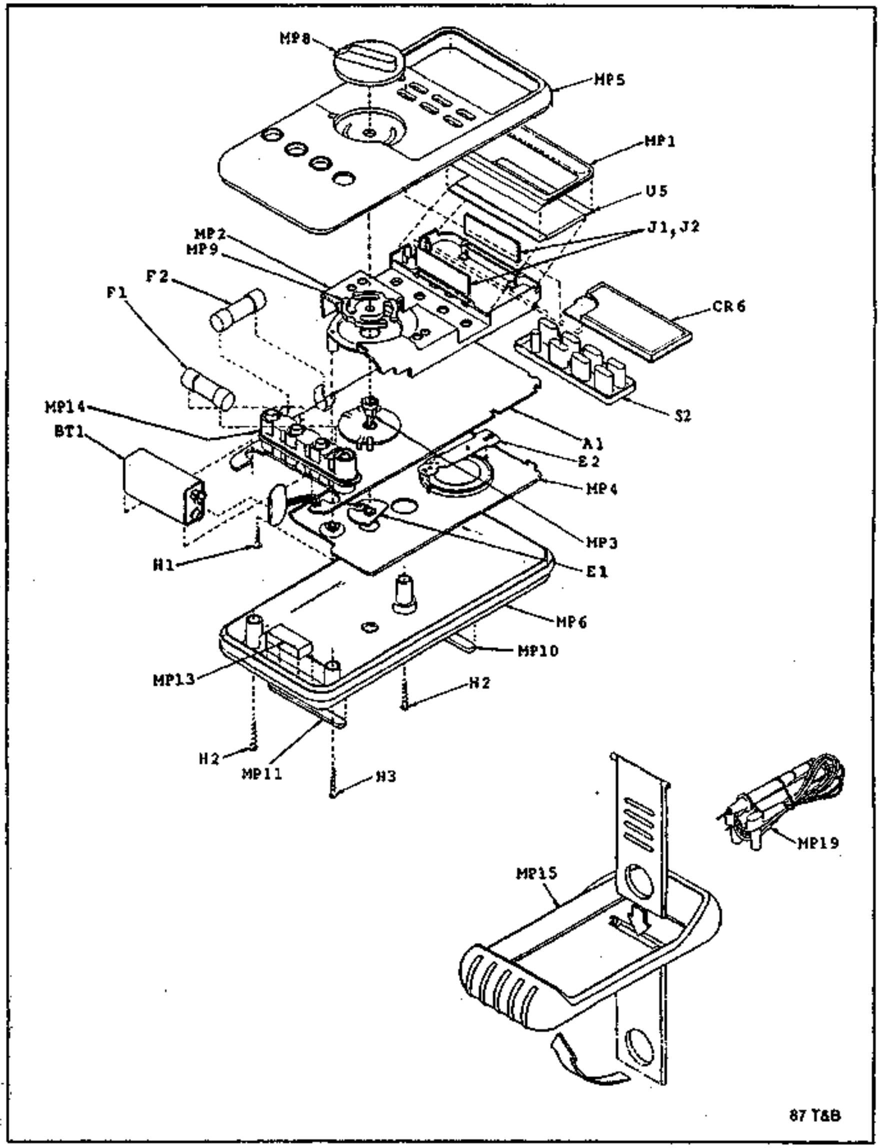


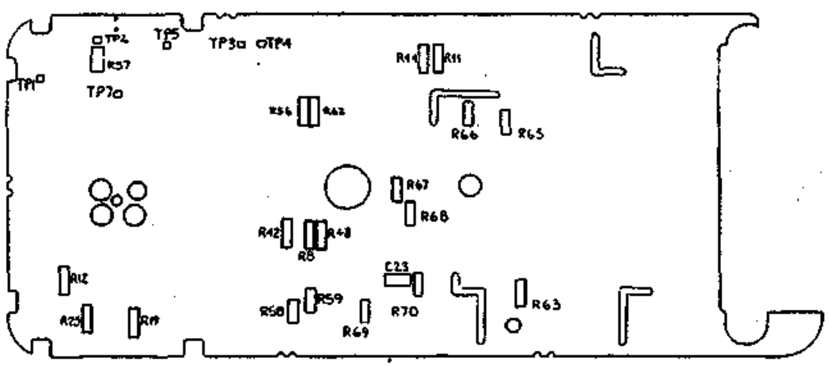
Figure 4-5. Fluke 87 Final Assembly

Table 4-6. Fluke 87 A1 Main PCA

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
AR 1	† IC,OP AMP,DUAL,PIX MED POWER,SOIC	930810	01295	TLC27M2IDR	1	
C 1	CAP,POLYES,0.01UF,+-10%,1000V	822361	37942	160103K1000F	1	
C 2	CAP,VAR,3-11PF,100V,CER	841712	51406	TZ03T110FR174	1	
C 3	CAP,VAR,5-30PF,50V,CER	843139	51406	TZ03R300ER174	1	
C 4	CAP,CER,560PF,+-2%,50V,C0G,1206	943373	89536	943373	1	
C 5	CAP,TA,10UF,+-20%,6.3V	807636	56289	199D106X06R3BG2	1	
C 6	CAP,TA,22UF,+-20%,10V	458971	56289	199D226X0010CG2	1	
C 7	CAP,TA,10UF,+-20%,10V	714766	56289	199D106X0010BG2	1	
C 8, 9	CAP,POLYCA,0.037UF,+-10%,63V	720979	60919	MKC1873K63	2	
C 10	CAP,POLYES,0.47UF,+-10%,50V	697409	60919	MKS2474K50	1	
C 11	CAP,POLYPR,0.033UF,+-10%,63V	821879	60919	MKP10-333-K-63V	1	
C 12, 13	CAP,POLYPR,0.068UF,+-20%,100V	822122	37942	MKP1.71	2	
C 14, 32	CAP,TA,47UF,+-20%,10V,7343	867580	56289	293D476X0010D2T or W	2	
C 15, 16, 22	CAP,CER,0.1UF,+-10%,25V,X7R,1206	747287	04222	12063C104KATMA	3	
C 17, 18, 19	CAP,CER,22PF,+-10%,50V,C0G,1206	740563	04222	1206SA220KAT050R	3	
C 19	CAP,CER,8.2PF,+-10%,50V,C0G,1206	747303	04222	1206SA8R2KAT050B	1	
C 20	CAP,CER,1.6PF,+-0.25PF,1500V,C0G	891811	89536	851811	1	
C 22	CAP,CER,4700PF,+-5%,50V,X7R,1206	943365	89536	943365	1	
C 23	CAP,CER,.01UF,+-5%,50V	939364	89536	939364	1	
C 26, 31, 33, C 34	CAP,CER,0.010UF,+-10%,50V,X7R,1206	747261 747261	04222	12061C103KATMA	4	
C 27	CAP,CER,100PF,+-10%,50V,C0G,1206	740571	04222	1206SA101KAT050R	1	
C 30	CAP,CER,220PF,+-10%,50V,C0G,1206	730070	04222	1206SA221KAT050R	1	
C 35	CAP,TA,4.7UF,+-20%,10V,3528	867262	56289	293D475X0010B2T or W	1	
C 36	CAP,CER,1000PF,+-1%,50V,C0G,1206	867660	04222	1206SA102FAT050R	1	
C 37	CAP,VAR,0.25PF-1.5PF,1700V,TEFLON	910711	53769	ER-530-017	1	
CR 1, 4	DIODE,SI,1K PIV,1.0 AMP	707075	30000	1N4007	2	
CR 2, 3	† DIODE,SI,BV= 30.0V,IO= 50MA,250 MW	830398	07263	MMBD7366,01	2	
CR 5, 7, 8	† DIODE,SI,BV=70.0V,IO=50MA,DUAL,SOT23	742320	0A333	BAV99	3	
E 1	SURGE PROTECTOR,1500V,+-20%	655134	91984	100T1	1	
J 1	INPUT RCPT ASSY	836214	9P481	836214	1	
J 2	SOCKET,1 ROW,PWB,0.100CTR,3 POS	832634	28213	929706-01-03	1	
Q 1, 2, 6	† TRANSISTOR,SI,NPN,SELECT IEBO,SOT-23	821637	04713	MMBT1380LT1	3	
Q 3, 4, 7, Q 9, 12	† TRANSISTOR,SI,NPN,SMALL SIGNAL,SOT-23	742676 742676	04713	MMBT3904T	5	
Q 5, 11	† TRANSISTOR,SI,PNP,SMALL SIGNAL,SOT-23	742684	04713	MMBT3906T	2	
Q 8	† TRANSISTOR,SI,N-DMOS FET,SOT23	830851	17856	SSTVN500S-T1	1	
Q 10	† TRANSISTOR,SI,P-CHAN,SOT-23	832477	17856	SSTJ19T1	1	
Q 13,14	† TRANSISTOR,SI,NPN,SMALL SIGNAL,SOT-23	912469	89536	912469	2	
R 1	RES,MF,1K,+-1%,100PPM,FLMPRF,FUSIBLE	832550	91637	CMF-65 69 1K F T-1 BULK	1	3
R 2	† RES,CERM,909K,+-1%,1W	831594	23237	OP-2-909K-1%	1	
R 3	† RES,CERM,1.5K,+-5%,.125W,200PPM,1206	746430	91637	CRCW1206-1501JB	1	
R 4	RES,MF,110.1,+-0.1%,0.125W,100PPM	821790	59124	MF50D110R1B	1	
R 5	RES,WW,.991,+-.1%,2.5W	821645	91637	RS-2C 9913F	1	
R 6	RES,WW,.010,+-.1%,1W,100PPM	807309	10135	R-3269010	1	
R 7, 10	† RES,CERM,1M,+-5%,1W	913988	23237	ROL/2-10M-5%	2	
R 8, 49	† RES,CERM,15M,+-5%,.125W,200PPM,1206	812960	91637	CRCW1206-1505JB	2	
R 9, 12, 23, R 53, 62	† RES,CERM,100K,+-5%,.125W,200PPM,1206	740548 740548	91637	CRCW1206-1003JB	5	
R 11	† RES,CERM,10M,+-5%,.125W,200PPM,1206	782274	91637	CRCW1206-1005JB	1	
R 13, 65- 70	† RES,CERM,10K,+-5%,.125W,200PPM,1206	746610	91637	CRCW1206-1002JB	7	
R 14	RES,MF,10K,+-0.1%,0.125W,100PPM	690955	59124	MF50D1002B	1	
R 15	RES,MF,40K,+-0.1%,0.125W,100PPM	851702	59124	MF50D4002B	1	
R 17, 18, 63, R 64	† RES,CERM,1M,+-5%,.125W,200PPM,1206	746826 746826	91637	CRCW1206-1004JB	4	
R 19	† RES,CERM,107K,+-1%,.125W,100PPM,1206	879234	91637	CRCW1206-1073FB	1	
R 20	† RES,CERM,412K,+-1%,.125W,100PPM,1206	875229	91637	CRCW1206-4123FB	1	
R 21	RES,CERM,VAR,100K,+-20%,.5W	649697	51406	RVG-0707-V-100-3-104M	1	
R 22, 29	† RES,CERM,2K,+-5%,.125W,200PPM,1206	746461	91637	CRCW1206-2001JB	2	
R 24	† RES,CERM,316K,+-1%,.125W,100PPM,1206	811263	91637	CRCW1206-3163FB	1	
R 25	† RES,CERM,210K,+-1%,.125W,100PPM,1206	871400	91637	CRCW1206-2103FB	1	
R 31	RES JUMPER,0.02,0.25W	682575	91637	FRJ-55	1	
R 32	† RES,CERM,75K,+-5%,.125W,200PPM,1206	811901	91637	CRCW1206-7502JB	1	
R 34	RES,VAR,CERM,200,+-20%,.5W	867945	51406	RVG-0707-V-100-3-201M	1	
R 35	† RES,CERM,665K,+-1%,.125W,100PPM,1206	867460	89536	867460	1	
R 37	† RES,CERM,309K,+-1%,.125W,100PPM,1206	769834	91637	CRCW1206-3093FB	1	
R 38	† RES,CERM,536K,+-1%,.125W,100PPM,1206	845420	91637	CRCW1206-5363FB	1	
R 39	† RES,CERM,56K,+-5%,.125W,200PPM,1206	746701	91637	CRCW1206-5602JB	1	
R 43	RES,MF,1K,+-0.1%,0.125W,100PPM	821694	59124	MF50D1001B	1	
R 44	† RES,CERM,82K,+-5%,.125W,200PPM,1206	811794	91637	CRCW1206-8202JB	1	
R 45, 50	† RES,CERM,0,+.05 MAX,.125W,1206	810747	91637	CRCW1206-0R00B	2	
R 46	RES,MF,50K,+-0.1%,0.125W,100PPM	821710	59124	MF50D5002B	1	
R 56, 57	† RES,CERM,22K,+-5%,.125W,200PPM,1206	746651	91637	CRCW1206-2202JB	2	
R 58	† RES,CERM,120K,+-5%,.125W,200PPM,1206	746719	91637	CRCW1206-1203JB	1	
R 59	† RES,CERM,510,+-5%,.125W,200PPM,1206	746180	91637	CRCW1206-5100JB	1	

Table 4-6. Fluke 87 A1 Main PCA (cont)

REFERENCE DESIGNATOR	DESCRIPTION	FLUKE STOCK NO	MFRS SPLY CODE	MANUFACTURERS PART NUMBER OR GENERIC TYPE	TOT QTY	NOTES
R 61	† RES,CERM,1.3M,+-5%,.125W,200PPM,1206	811778	91637	CRCW1206-1304JB	1	
R 63	† RES,CERM,1K,+-5%,.125W,200PPM,1206	745992	91637	CRCW1206-1001JB	1	
RT 1	THERMISTOR,RECT,POS,1.5K,+-20%,25 C	833015	56533	[illegible]	1	
RV 1, 2	VARISTOR,910,+-10%,1.0MA	876193	09214	V910LA81399	2	
S 1	SWITCH,ROTARY	819334	71880	819334	1	
U 1	DIODE,SI,RECT,BRIDGE,BV=50V,IO=1A	410849	14936	DF01M	1	
U 2	† IC,BPLR,TRUE RMS TO DC CONVERTER,SOIC	888040	24355	AD737JR-REEL	1	
U 3	MAIN OLY 87 IC	931604	89536	931604	1	
U 4	† IC,CMOS,HEX INVERTER,SOIC	838375	27014	MM74HC04M	1	
VR 1	† IC,1.23V,40PPM TC,BAND-GAP REFERENCE	694767	27014	LM385BXM-1.2	1	
W 1	JUMPER WIRE NON	834986	89536	834986	1	
W 2	JUMPER WIRE,PCB	835009	89536	835009	1	
XBT 1	CONNECTOR,BATTERY	835874	9Y451	835874	1	
XF 1	CONTACT,600V,FUSE	899534	76970	899534	2	1
XF 2	600 VOLT FUSE CONTACT	707190	76970	707190	2	2
Y 1	CRYSTAL,131,072KHZ,0.003%,3XXXX	831493	0ND74	TT4253436	1	
Z 1	RES NET THK F TESTED	919871	89536	919871	1	
NOTES:	† Static sensitive part. 1. Ref Designator XF 1 is two (2) parts. They are used with F1 on the Final Assembly. 2. Ref. Designator XF2 is two (2) parts. They are used with F2 on the Final Assembly. 3. This resistor is a fusible resistor. To ensure safety, use exact replacement only.					



BOTTOM SIDE

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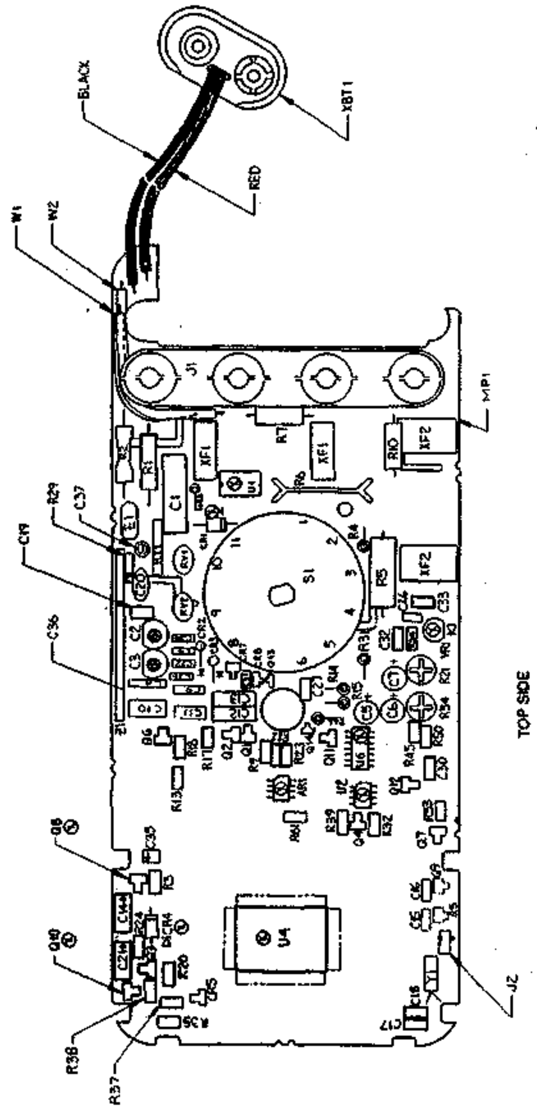
(1 of 2)

Figure 4-6. Fluke 87 A1 Main PCA



TOP SIDE

87-4001
(2 of 2)

Figure 4-6. Fluke 87 A1 Main PCA (cont)

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Texas Instruments Inc.
Semiconductor Group
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AVX Ceramics Div.
Myrtle Beach, SC

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Semiconductor Products Sector
Phoenix, AZ

05347
Ultronix Inc
(Tel Labs)
Grand Junction, CO

09214
General Electric Co.
Semiconductor Products Dept.
Auburn, NY

0K392
Shin-Etsu Silicones of America
(S P America)
Torrance, CA

14936
General Instrument Corp.
Power Semiconductor Div.
Hicksville, NY

17856
Siliconix Inc.
Santa Clara, CA

23237
I R C, Inc.
Microcircuits Div
Philadelphia, PA

25403
Philips Circuit Assemblies
Formerly Amperex Electronic Corp.
Statersville, RI

27014
National Semiconductor Corp.
Santa Clara, CA

32997
Bourns Inc.
Trimpot Div.
Riverside, CA

51406
Murata Erie, No. America Inc.
Symrna, GA

54583
TDK Electronics Corp.
Port Washington, NY

56289
Sprague Electric Co.
Nashua, NH

59124
KOA Speer Electronics Inc.
Bradford, PA

59717
Eveready Battery Co. Inc.
Asheboro, NC

61429
Fox Electronics
Fort Myers, FL

62786
Hitachi America Ltd.
Semiconductor & IC Div.
San Jose, CA

68919
Inter-Technical Group Inc., The
Wima Division
Elmsford, NY

71400
Bussman - Now Magnum
Div. of Cooper Industries Inc.
St. Louis, MO

83553
Associated Spring Barnes Group, Inc.
Gardena, CA

89536
John Fluke Mfg. Co., Inc.
Everett, WA

91637
Dale Electronics Inc.
Columbus, NE

91984
Maida Development Co.
Hampton, VA

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Fluke Calibration Center
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FAX: (714) 755-7332

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FAX: (214) 247-5642

Fluke Service Center
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Illinois
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Fluke Corporation
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FAX: 55-11-524-4873 (ID 2148)

Sigtron Instrumentos E. Servicos
Rua Alvaro Rodrigues
269 - Brooklin
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FAX: 49-89-9961-1270

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FAX: 91-33-247-6844

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N-0601 Oslo
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FAX: 47-22-653407

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FAX: 92-21-577-0348

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FAX: 51-14-31-0707

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FAX: 63-2-721-0491 or 700-709

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60 159 Poznan
TEL: 48-61-681998
FAX: 48-61-682256

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Sales Y Servicios Dept
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1700 Lisboa
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FAX: 351-1-795-1713

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Ronex S.R.L., Cust. Supp. Serv.
Str. Transilvaniei Nr. 24
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FAX: 40-1-659-4468

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UL. Petrovsko Razumovsky
Proezd. 29
103287 Moscow
TEL: 7-95-212-3833
FAX: 7-95-212-3838

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A. Rajab & Silsilah Co. S&S Dept.
P.O. Box 203
21411 Jeddah
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FAX: 966-2-661-0558

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Fluke ASEAN Regional Office
#27-03 PSA Building
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FAX: 65-*276-5929

South Africa
Spescom Measure. (PTY) Ltd.
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Halfway House, Midrand 1685
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FAX: 27-11-805-1192

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Centro Empresarial Euronora
c/Ronda de Poniente, 8
28760-Tres Cantos
Madrid, Spain
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FAX: 34-1-804-2496

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Fluke Sverige AB, (CSS)
P.O. Box 61
S-164 94 Kista
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FAX: 46-8-751-0480

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FAX: 886-2-767-8820

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FAX: 66-2-374-9965

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Pestas Prof. Elektr. Sist. Tic. V
Selcukler Caddesi
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FAX: 90-212-282-7839

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FAX: 971-4-281285

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FAX: 44-923-225067

Uruguay
Coasin Instrumentos S.A.
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Libertad 2529, Montevideo
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FAX: 598-2-492-659

Venezuela
Coasin C.A.
Calle 9 Con Calle 4, Edit. Edinurbi
Piso-3
La Urbina
Caracas 1070-A, Venezuela
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FAX: 58-2-241-1939

Vietnam
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Tu Liem, Hanoi
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West Indies
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Freeport Mission Road
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West Indies
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FAX: 809-673-0767

Yugoslavia
Jugoelektro Beograd
T & M Customer Support
Services
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11070 Novi
TEL: 38-11-182470
FAX: 38-11-638209

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Field Technical Sales
45, Kelvin Road North
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FAX: 263-4-729970

Section 5
Schematic Diagrams

TABLE OF CONTENTS

Table 5-1. Signal Abbreviations

ACBM	AC Buffer Minus (inverting input)	K1	Buffer output times 1
ACBO	AC Buffer Output	K2	Buffer output times 10
AFI	Active Filter Input	PDS	Power Down (off) Signal
AFO	Active Filter Output	P00	Port 00 (keypad)
AGND	Analog Ground	P01	Port 01 (keypad)
AP0	Analog Port 0 (guard)	P02	Port 02 (keypad)
AP1	Analog Port 1 (ohms, millivolts sense)	P03	Port 03 (PTF reference and position change sense)
AP2	Analog Port 2 (ohms reference sense)	P10	Port 10 (keypad)
AP3	Analog Port 3 (amps sense)	P11	Port 11 (keypad)
AP4	Analog Port 4 (milli/micro amps jack sense)	P12	Port 12 (keypad)
AP5	Analog Port 5 (amps jack sense)	P13	Port 13 (PW2, RMS power down drive)
AP6	Analog Port 6 (PTF position sense)	PS0	Power Supply 0 (feed back for VDD regulator)
AP7	Analog Port 7 (peak hold min sense)	PS1	Power Supply 1 (feed back for common regulator)
AP8	Analog Port 8 (peak hold max sense)	PS2	Power Supply 2 (output for common regulator)
APV0	Analog Port Voltage 0 (divider Input)	PW2	Power 2 (power down drive for RMS converter)
APV1	Analog Port Voltage 1 (divide by 10)	REFH	Reference High (1.23V)
APV2	Analog Port Voltage 2 (divide by 100)	REFI	Reference In (1.00V)
APV3	Analog Port Voltage 3 (divide by 1000)	RESET	Reset for μP
APV4	Analog Port Voltage 4 (divide by 10000)	S0	LCD Segment drive 0
APCC	Analog Port Compensation Capacitor	⋮	
AVAM	Absolute Value Amplifier Minus (inverting input)		
AVAOM	Absolute Value Amplifier Output Minus	S31	LCD Segment drive 31
AVAOP	Absolute Value Amplifier Output Positive	TEST	Factory Test
AZ	Auto Zero	VBT+	Plus battery voltage
CK1	Clock 1 (RC clock output)	VBT-	Minus battery voltage
CK2	Clock 2 (RC clock input)		
COM	Common	VDD	Plus system supply
FAI	Filter Active Input	VDGND	Digital Ground
FAO	Filter Active Output	VOA	2/3 voltage for LCD drive
H1	LCD backplane drive 1	VOB	1/3 voltage for LCD drive
H2	LCD backplane drive 2	VSS	Minus system supply
H3	LCD backplane drive 3		
H4	LCD backplane drive 4		
INT	Integrator output		
K0	Buffer output times .874		

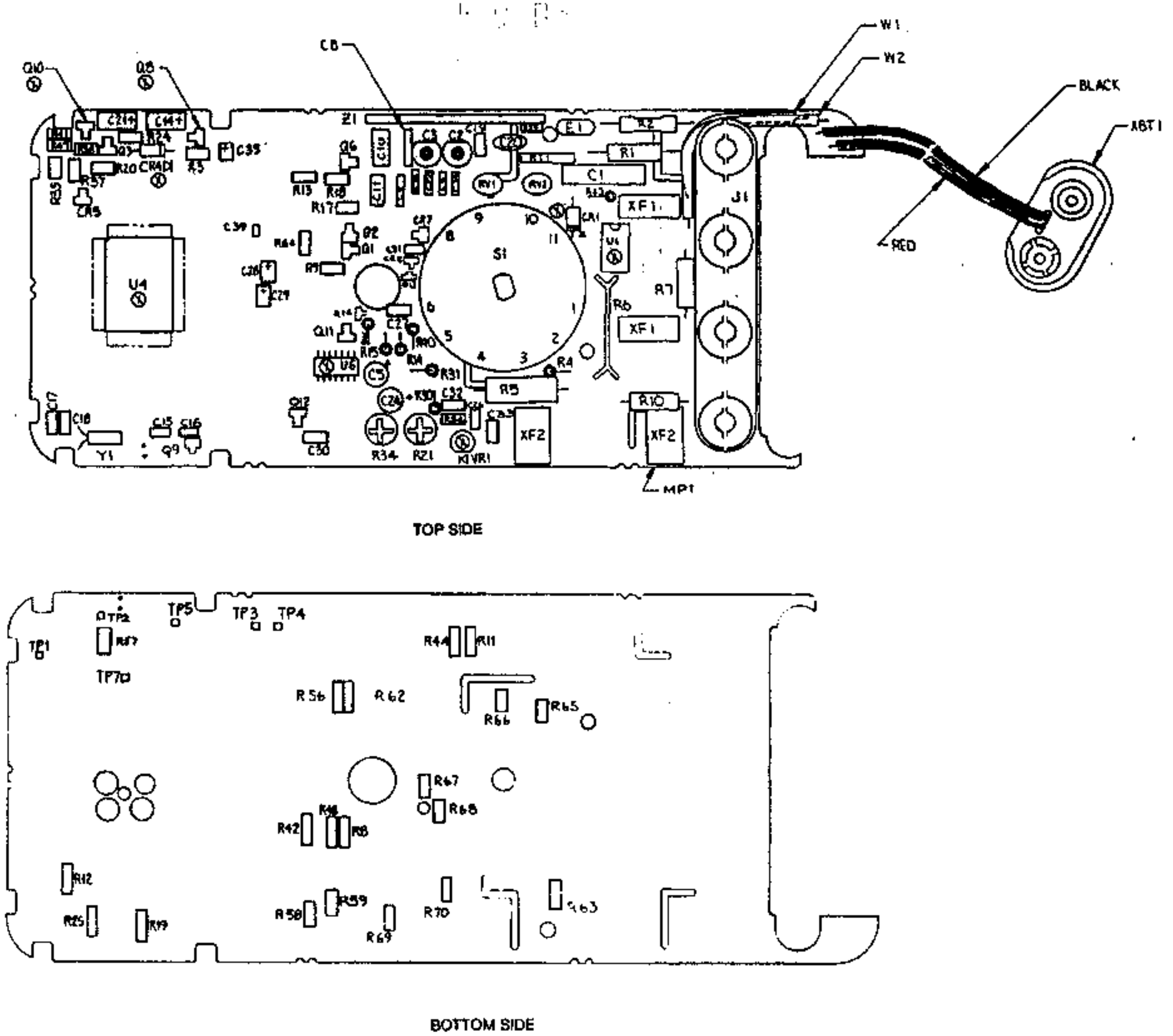


Figure 5-1. Fluke 83 A1 Main PCA

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITANCES ARE IN MICROFARADS. TANTALUMS ARE ±20%, ALL OTHERS ARE ±10%.
2. ALL RESISTANCES ARE IN OHMS. ALL RESISTORS ARE 1/8W,±5%, CERMET. ±.25% & ±1% RESISTORS ARE 1/8W.

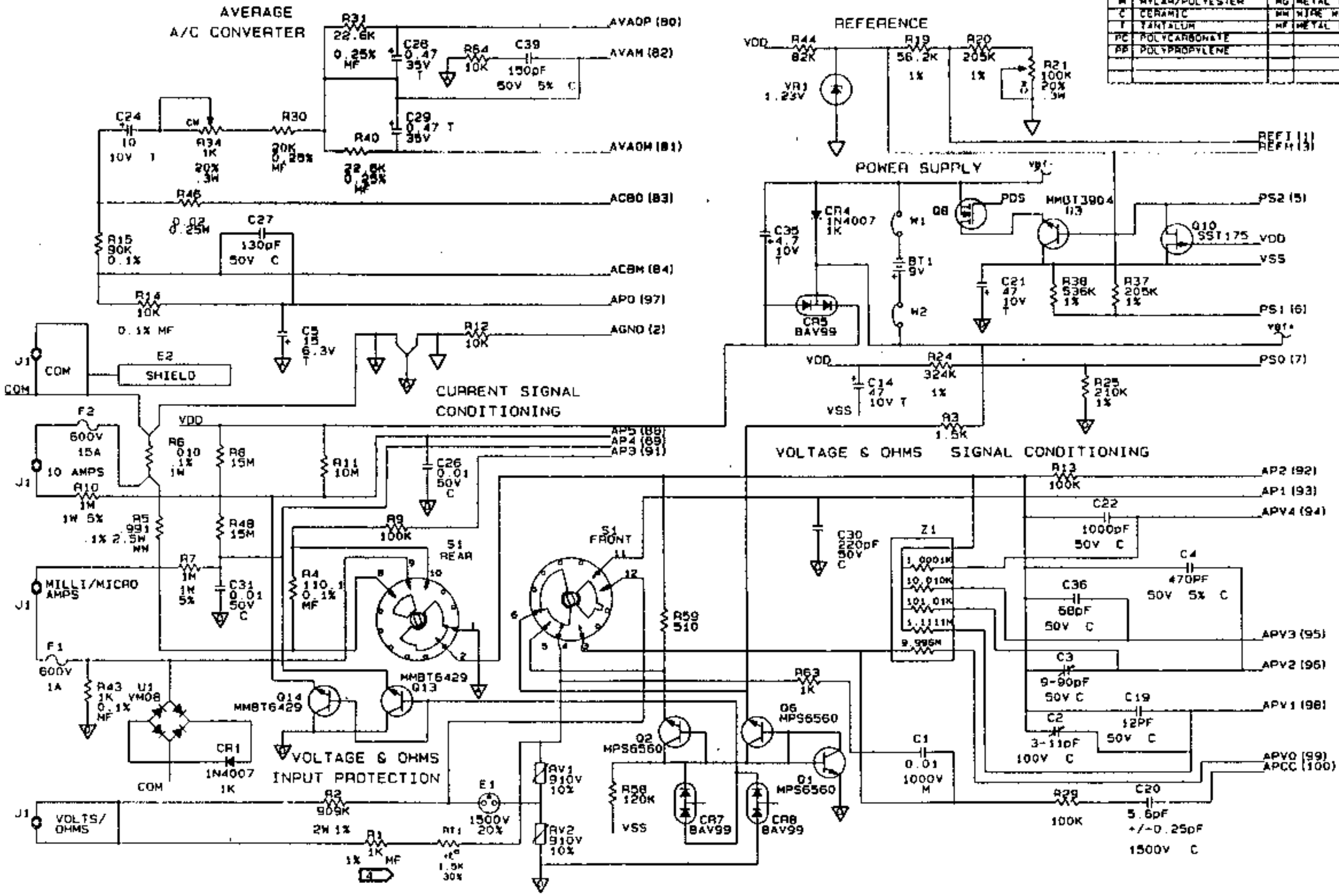
(4) R1 IS A FUSIBLE RESISTOR. TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

REFERENCE DESIGNATION			
LAST USED		NOT USED	
AR		AR	1
BT	1	BT	
C	39	C	6, 7, 12, 13, 23, 25, 37, 38, 40
CR	8	CR	2, 3, 6
E	2	E	
F	2	F	
J	1	J	
LS	1	LS	
Q	14	Q	4, 5, 7
R	70	R	16, 22, 23, 26, 27, 28, 32, 33, 36, 39, 45, 49, 50, 51, 52, 53, 60
RT	1	RT	
RV	2	RV	
S	9	S	
TP	7	TP	
U	6	U	2, 3
VR	1	VR	
Y	1	Y	
Z	1	Z	
H	2		

ROTARY SWITCH INFORMATION			
POSITION	FRONT	REAR	TEST ROTARY SWITCH** +/-12 COUNTS
OFF		1-2*	
ACV		1-2	0
DCV	3-4	1-2	32
mVDC	3-4 11-12		64
Ω	3-4-5 11-12		96
diode	4-6 11-12	1-2	128
mA/A		9-8	160
μA	3-4*	1-2* 10-9	192

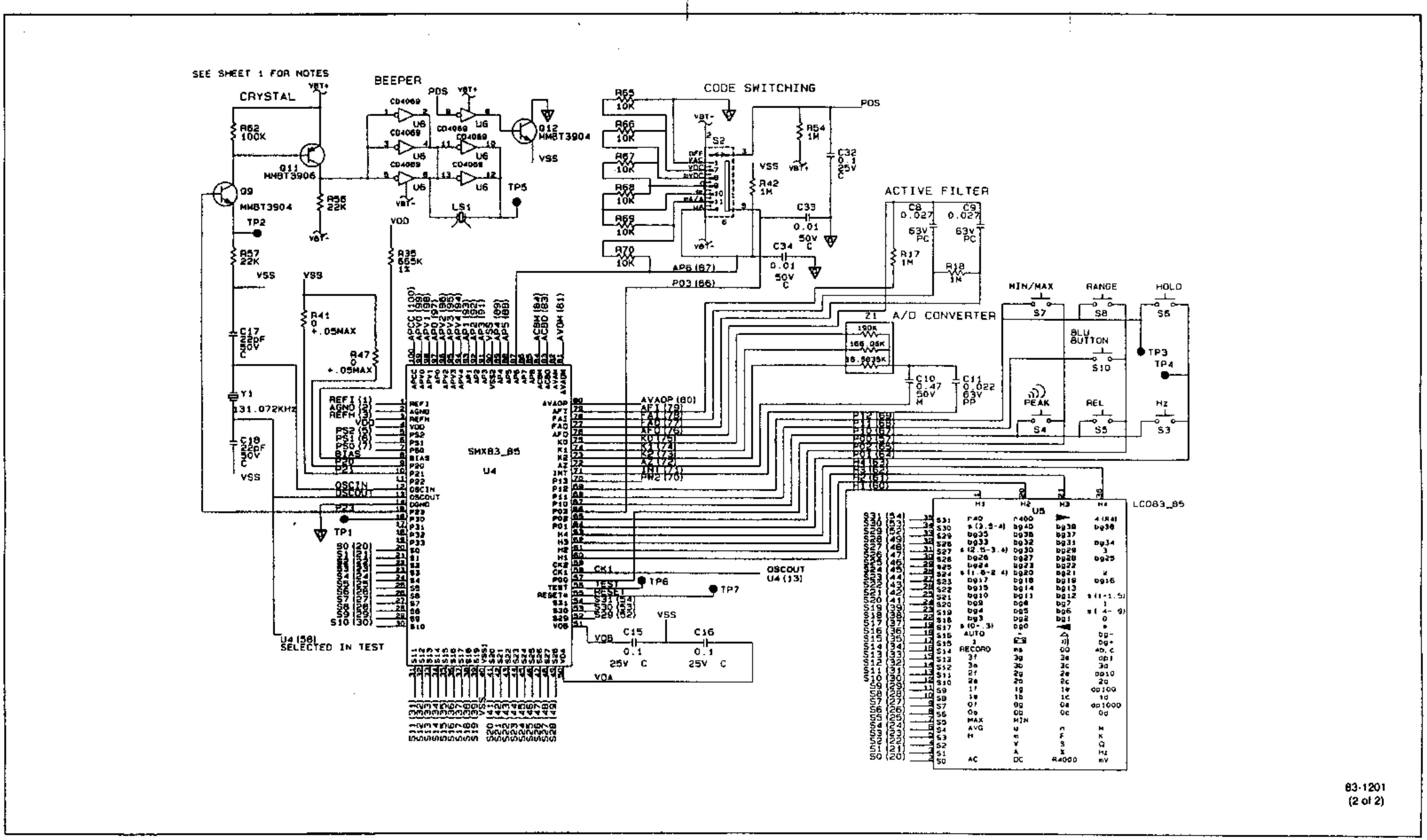
*CONNECTION NOT USED FOR OPERATION
**POWER UP OPTION
PRESS RANGE BUTTON DOWN FOR 2 SECS WHILE TURNING ON METER

COMPONENT TYPE ABBREVIATION CODE			
SYM	CAPACITOR	SYM	RESISTOR
M	MYLAR/POLYESTER	MG	METAL GLAZE
C	CERAMIC	WW	WIRE WOUND
T	TANTALUM	MF	METAL FILM
PC	POLYCARBONATE		
PP	POLYPROPYLENE		



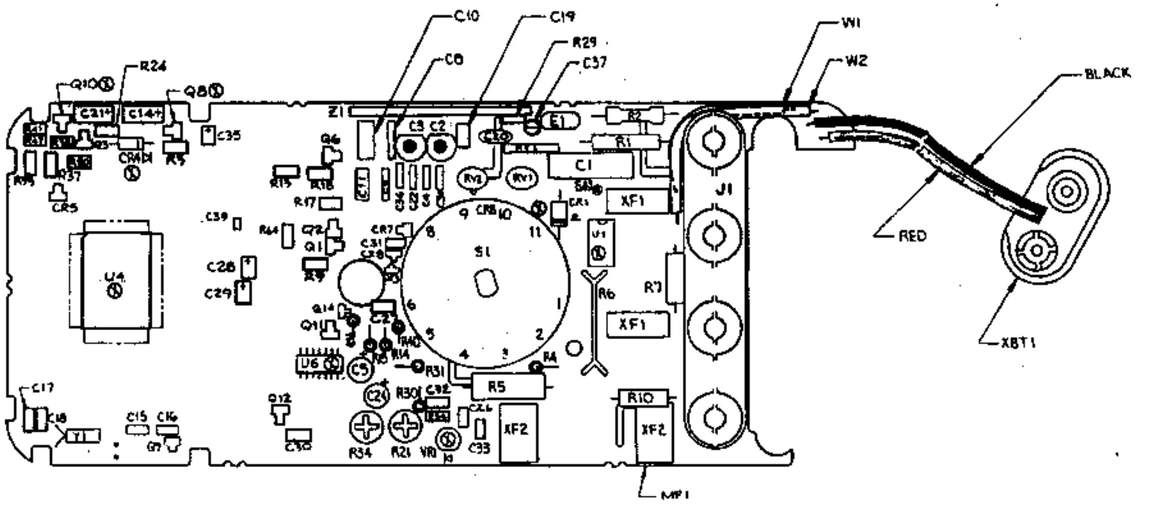
83-1201
(1 of 2)

Figure 5-1. Fluke 83 A1 Main PCA (cont)

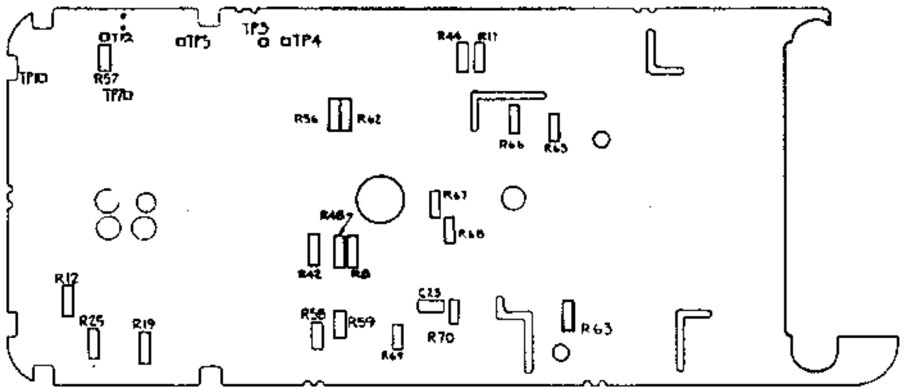


83-1201
(2 of 2)

Figure 5-1. Fluke 83 A1 Main PCA (cont)



TOP SIDE



BOTTOM SIDE

85-4001

Figure 5-2. Fluke 85 A1 Main PCA

NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL CAPACITANCES ARE IN MICROFARADS. TANTALUMS ARE ±20%. ALL OTHERS ARE ±10%.
2. ALL RESISTANCES ARE IN OHMS. ALL RESISTORS ARE 1/8W, ±5% CERMET. ±.25% & ±1% RESISTORS ARE 1/8W.

4 R1 IS A FUSIBLE RESISTOR. TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

COMPONENT TYPE ABBREVIATION CODE			
SYM	CAPACITOR	SYM	RESISTOR
M	MYLAR/POLYESTER	MG	METAL GLAZE
C	CERAMIC	WW	WIRE WOUND
T	TANTALUM	MF	METAL FILM
PC	POLYCARBONATE		
PP	POLYPROPYLENE		

ROTARY SWITCH INFORMATION

POSITION	FRONT	REAR	TEST ROTARY SWITCH** +/-12 COUNTS
OFF		1-2*	
ACV		1-2	0
DCV	3-4	1-2	32
mVDC	3-4 11-12		64
Ω	3-4-5 11-12		96
diode	4-6	1-2	128
mA/A		9-8 1-2*	160
µA	3-4*	10-9	192

*CONNECTION NOT USED FOR OPERATION
**POWER UP OPTION
PRESS RANGE BUTTON DOWN FOR 2 SECS WHILE TURNING ON METER

REFERENCE DESIGNATION			
LAST USED		NOT USED	
AR		AR	1
BT	1	BT	
C	39	C	6, 7, 12, 13, 25, 38, 40
CR	8	CR	2, 3, 4, 6
E	2	E	
F	2	F	
J	1	J	
LS	1	LS	
Q	14	Q	
R	70	R	16, 22, 23, 26, 27, 28, 32, 33, 36, 39, 45, 49, 50, 51, 52, 53, 55, 60
RT	1	RT	
RV	2	RV	
S	9	S	
TP	7	TP	
U	6	U	2, 3
VR	1	VR	
Y	1	Y	
Z	1	Z	
W	2		

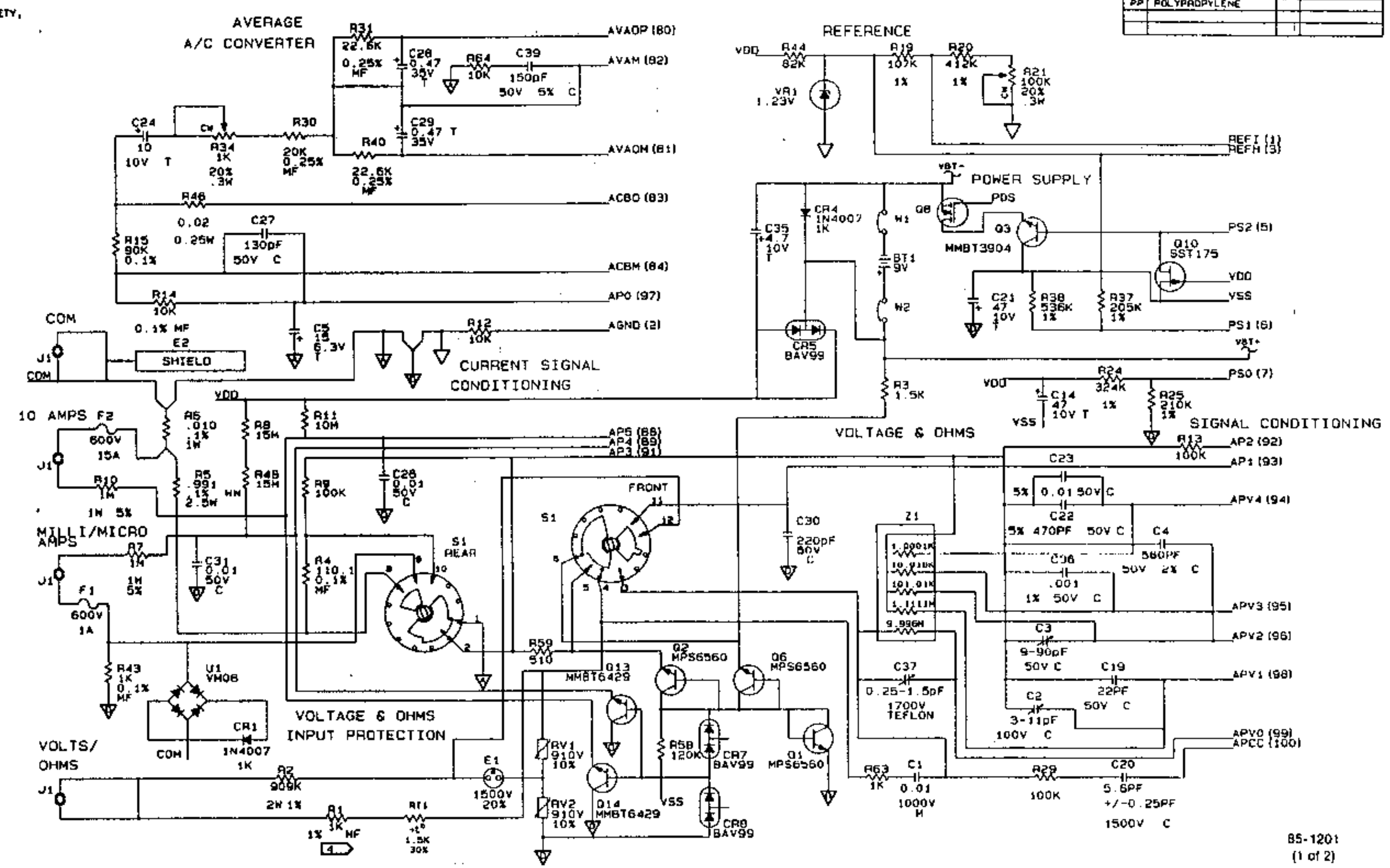
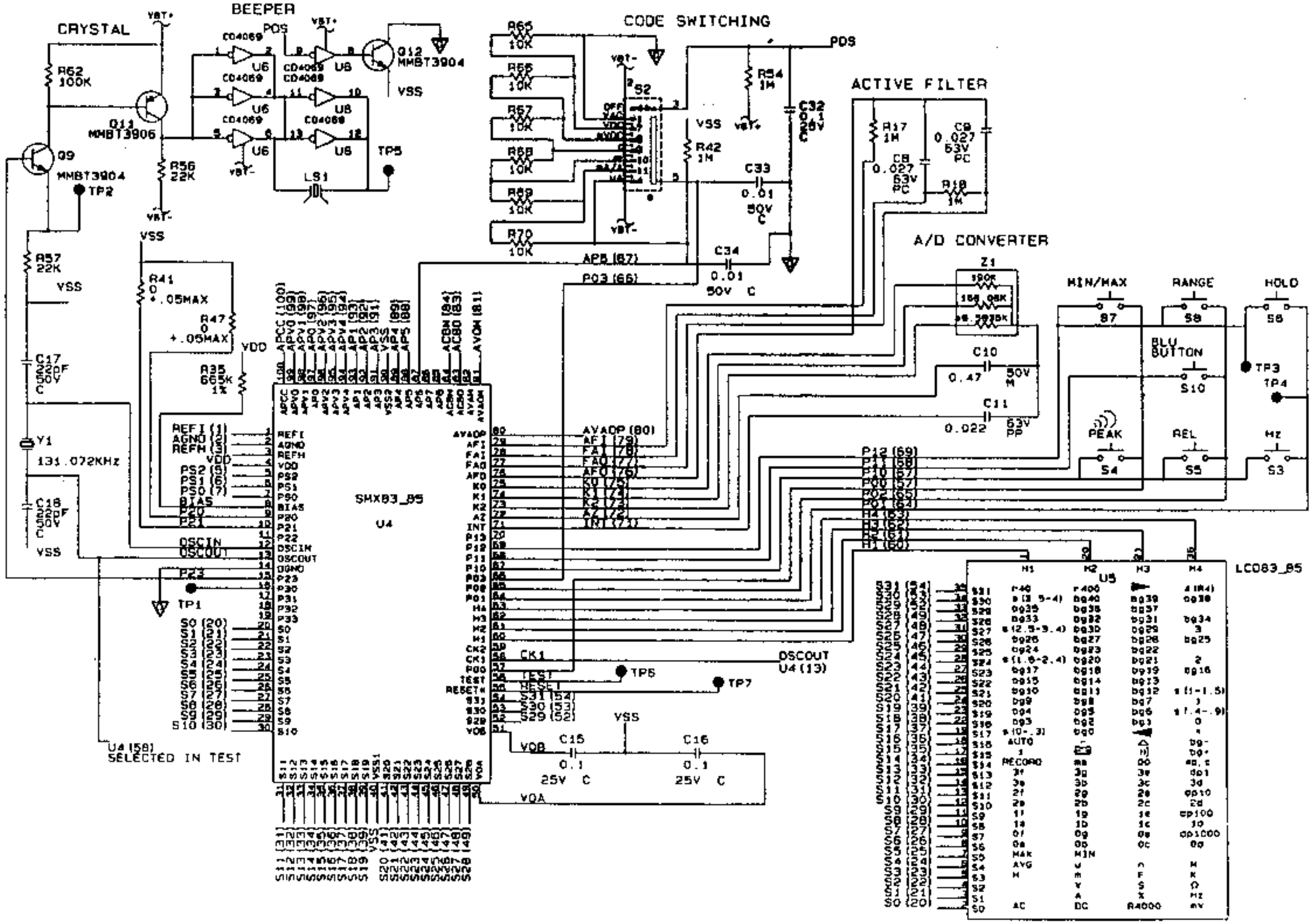
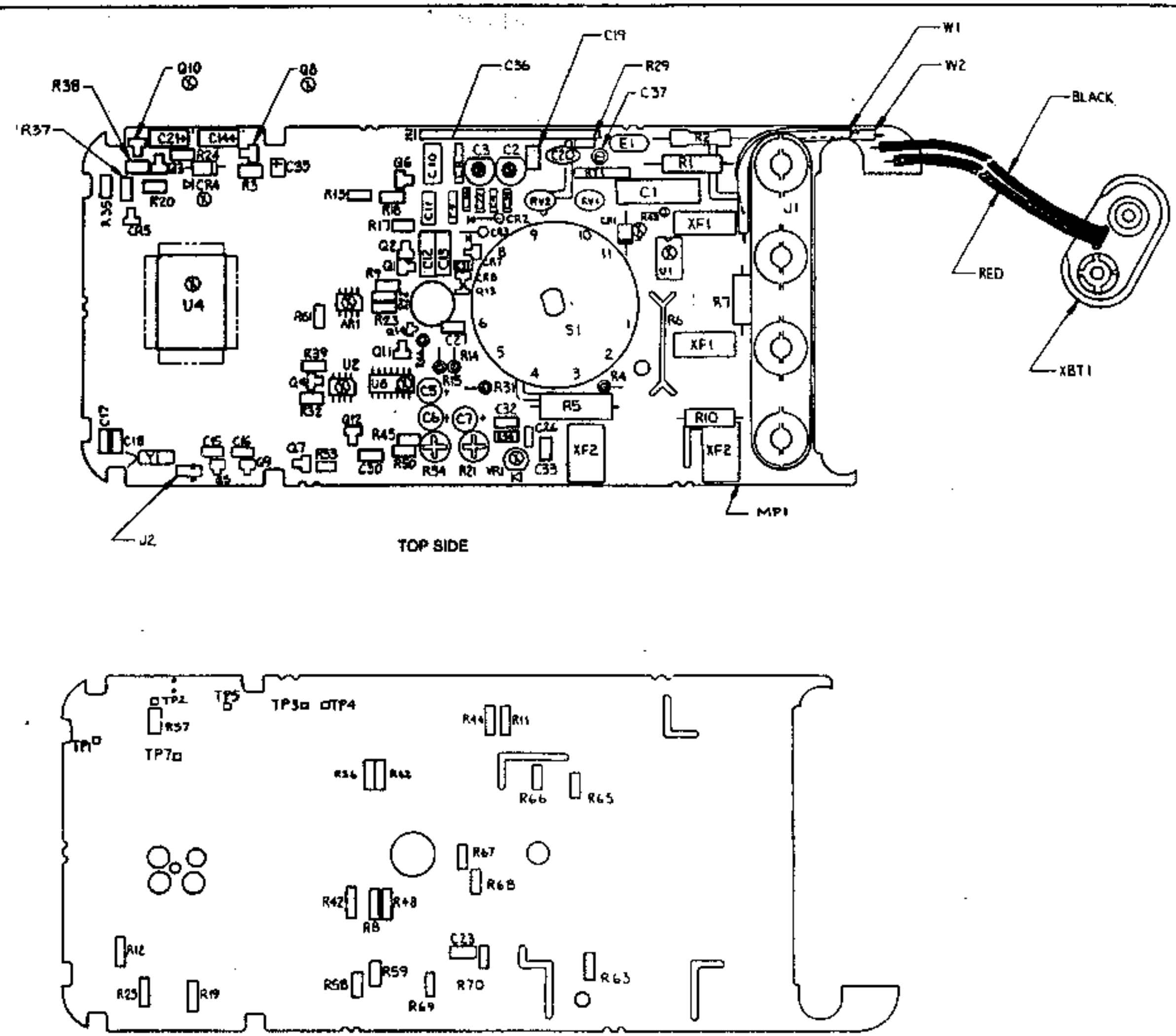


Figure 5-2. Fluke 85 A1 Main PCA (cont)



85-1201
(2 of 2)

Figure 5-2. Fluke 85 A1 Main PCA (cont)



87-4001

Figure 5-3. Fluke 87 A1 Main PCA

NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL CAPACITANCES ARE IN MICROFARADS. TANTALUMS ARE ±20%. ALL OTHERS ARE ±10%.
2. ALL RESISTANCES ARE IN OHMS. ALL RESISTORS ARE 1/8W, ±5% CERMET. ±.25% & ±1% RESISTORS ARE 1/8W.

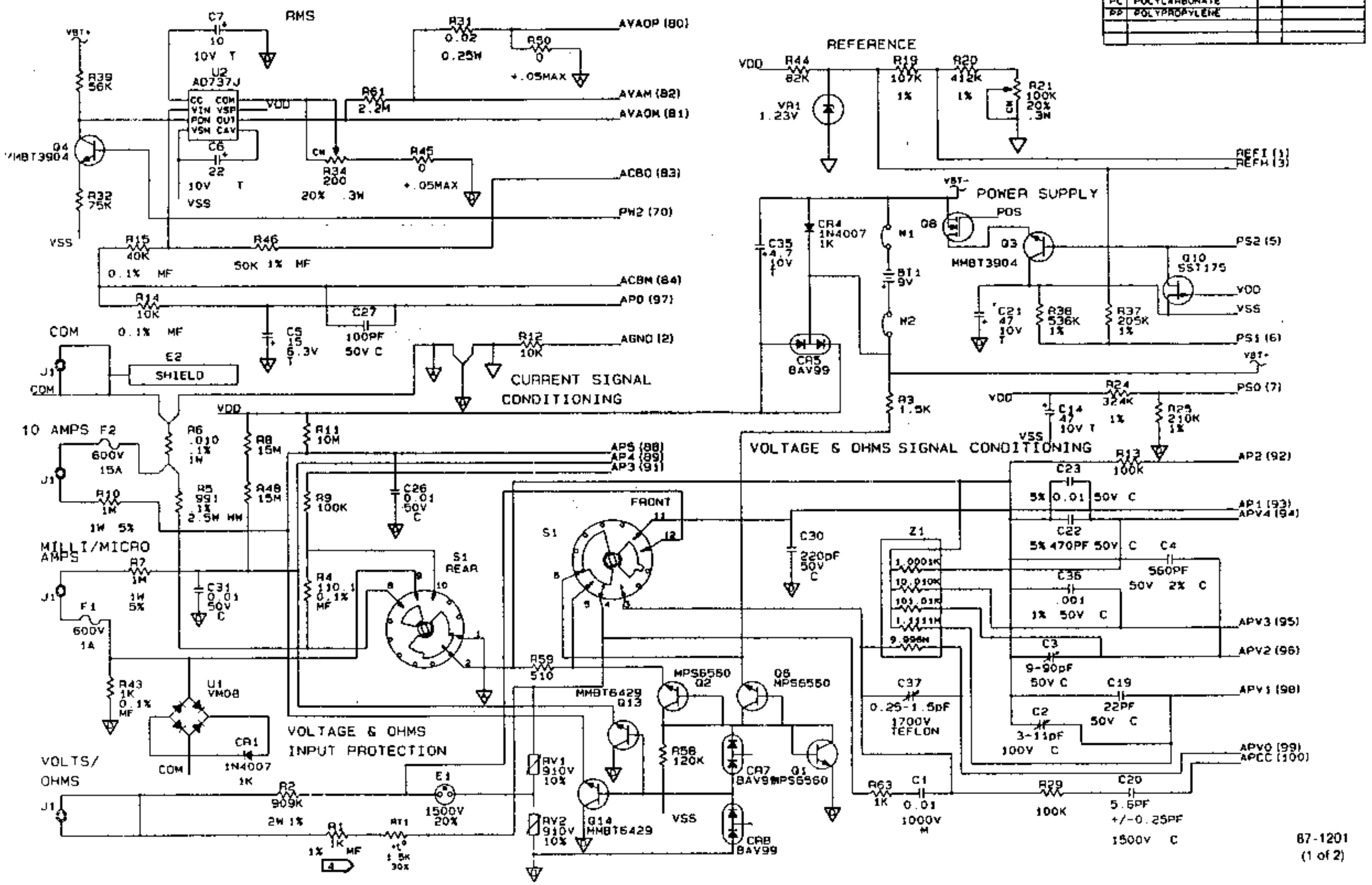
[4] R1 IS A FUSIBLE RESISTOR. TO ENSURE SAFETY, USE EXACT REPLACEMENT ONLY.

COMPONENT TYPE ABBREVIATION CODE			
SYM	CAPACITOR	SYM	RESISTOR
M	MYLAR/POLYESTER	MG	METAL GLAZE
C	CERAMIC	WW	WIRE WOUND
T	TANTALUM	MF	METAL FILM
PC	POLYCARBONATE		
PP	POLYPROPYLENE		

REFERENCE DESIGNATION			
LAST USED		NOT USED	
AR	1	AR	
BT	1	BT	
C	37	C	24, 25, 28, 29, 38, 39, 40
CR	8	CR	6
E	2	E	
F	2	F	
J	2	J	
LS	1	LS	
Q	14	Q	
R	70	R	18, 21, 26, 27, 28, 30, 33, 36, 40, 41, 47, 49, 51, 52, 54, 60, 64
RT	1	RT	
RV	2	RV	
S	10	S	
TP	7	TP	
U	6	U	3
VR	1	VR	
Y	1	Y	
Z	1	Z	
M	2		

ROTARY SWITCH INFORMATION			
POSITION	FRONT	REAR	TEST ROTARY SWITCH** +/-12 COUNTS
OFF		1-2*	
ACV		1-2	0
DCV	3-4	1-2	32
mVDC	3-4 11-12		64
Ω	3-4-5 11-12		96
→+	4-5 11-12	1-2	128
mA/A		9-8 1-2*	160
µA	3-4*	10-9	192

*CONNECTION NOT USED FOR OPERATION
**POWER UP OPTION
PRESS RANGE BUTTON DOWN FOR 2 SECS WHILE TURNING ON METER



87-1201
(1 of 2)

Figure 5-3. Fluke 87 A1 Main PCA (cont)

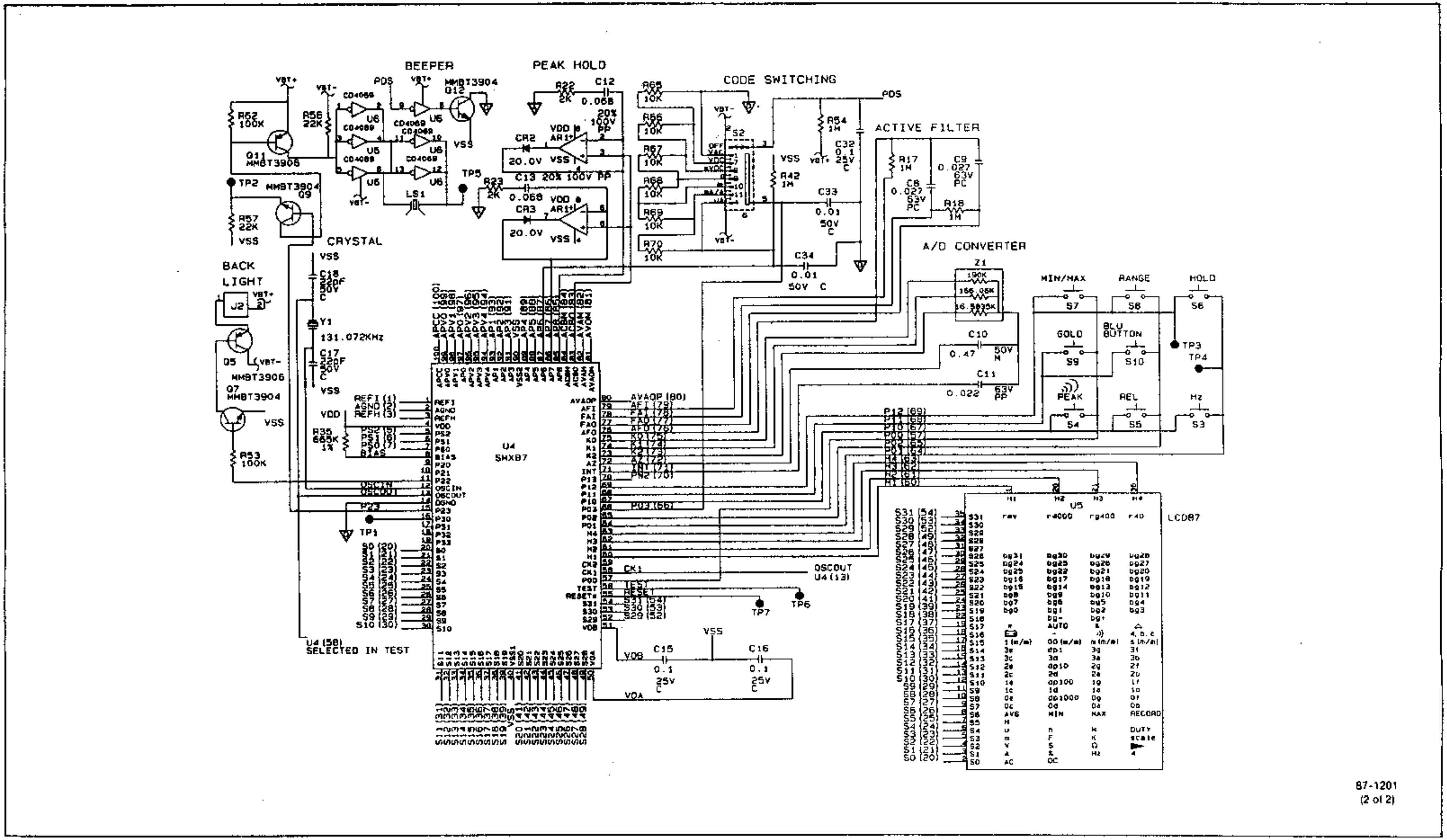


Figure 5-3. Fluke 87 A1 Main PCA (cont)

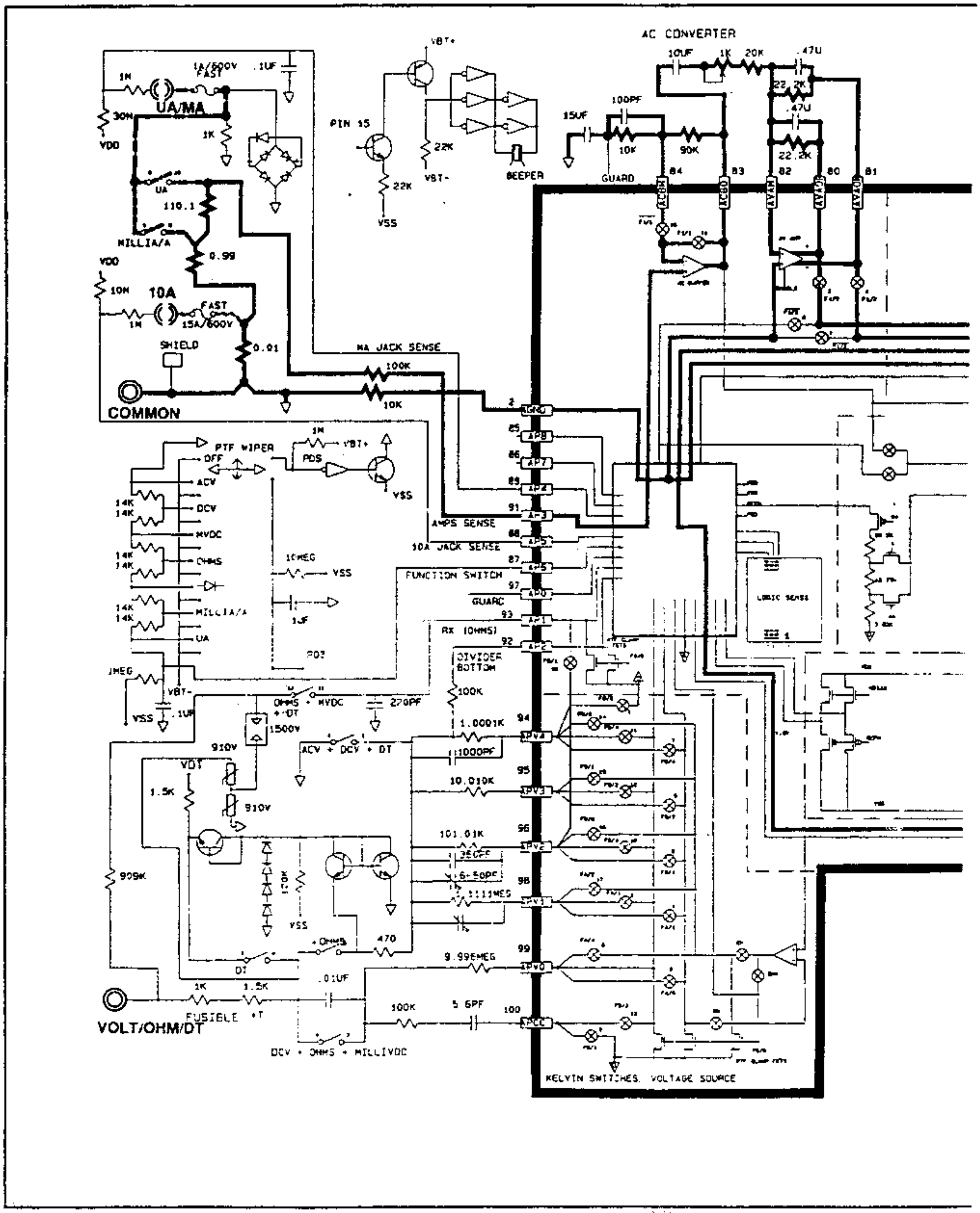
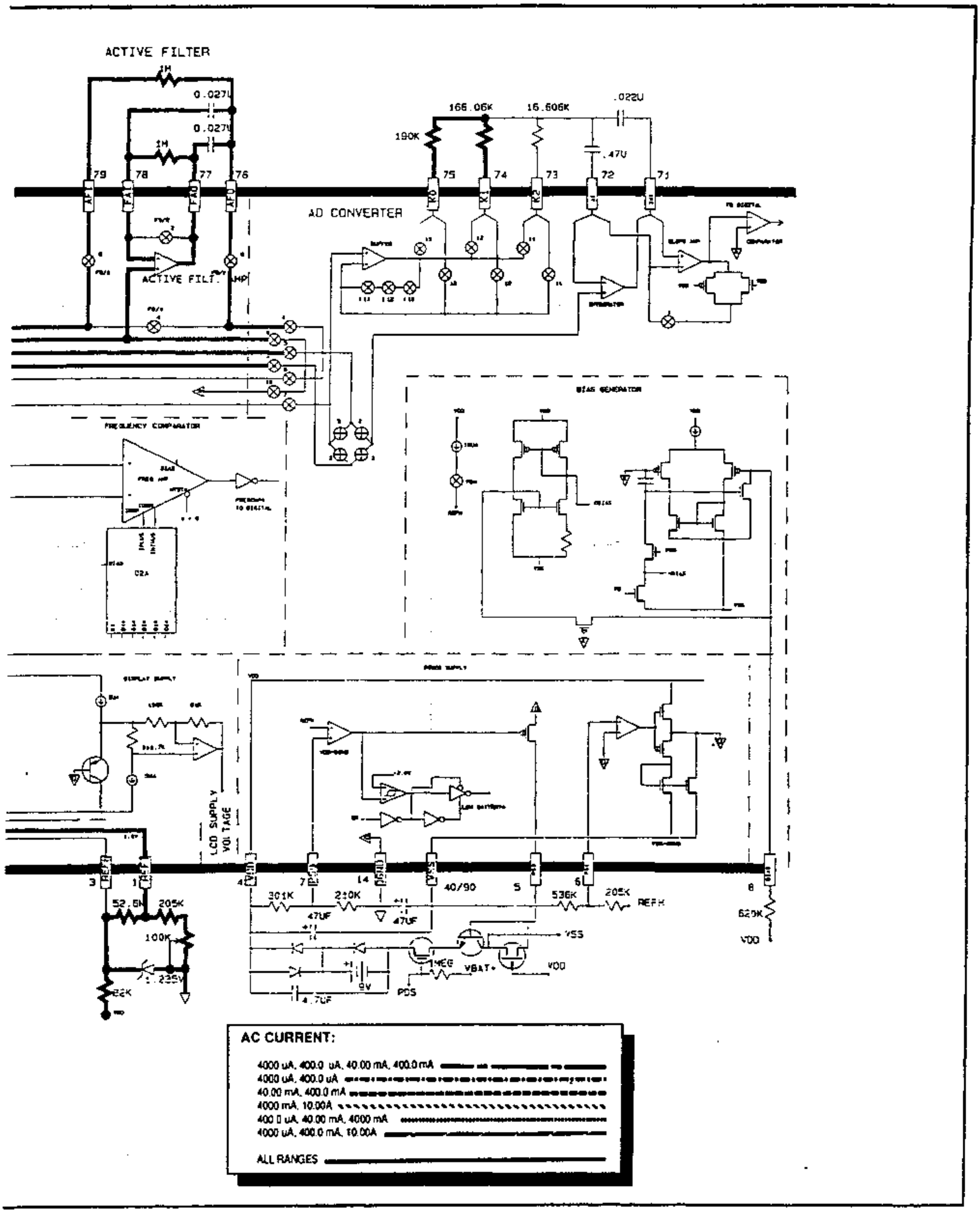


Figure 5-4. AC Current Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
AF1
FA1
FA0
AF0
ACTIVE FILT.
HP
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
AD CONVERTER
LCD SUPPLY VOLTAGE
3
1
4
7
14
40/90
5
6
8
52.6K
205K
100K
1.235V
22K
301K
210K
47UF
47UF
536K
205K
REFH
620K
VDD
VSS
1MEG
VBAT+
VDD
9V
PDS
4.7UF
AC CURRENT:
4000 uA, 400.0 uA, 40.00 mA, 400.0 mA
4000 uA, 400.0 uA
40.00 mA, 400.0 mA
4000 mA, 10.00A
400 0 uA, 40.00 mA, 4000 mA
4000 uA, 400.0 mA, 10.00A
ALL RANGES

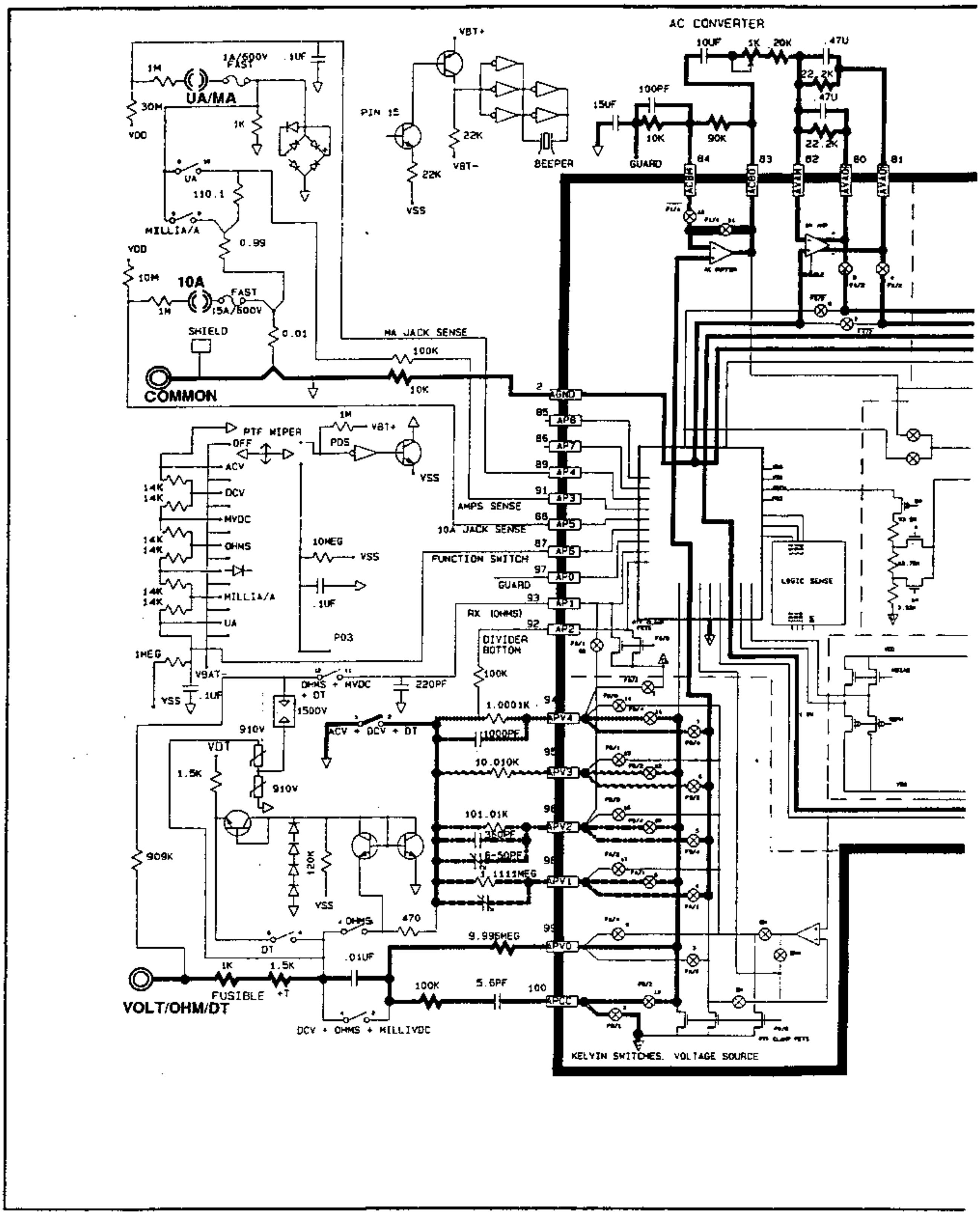
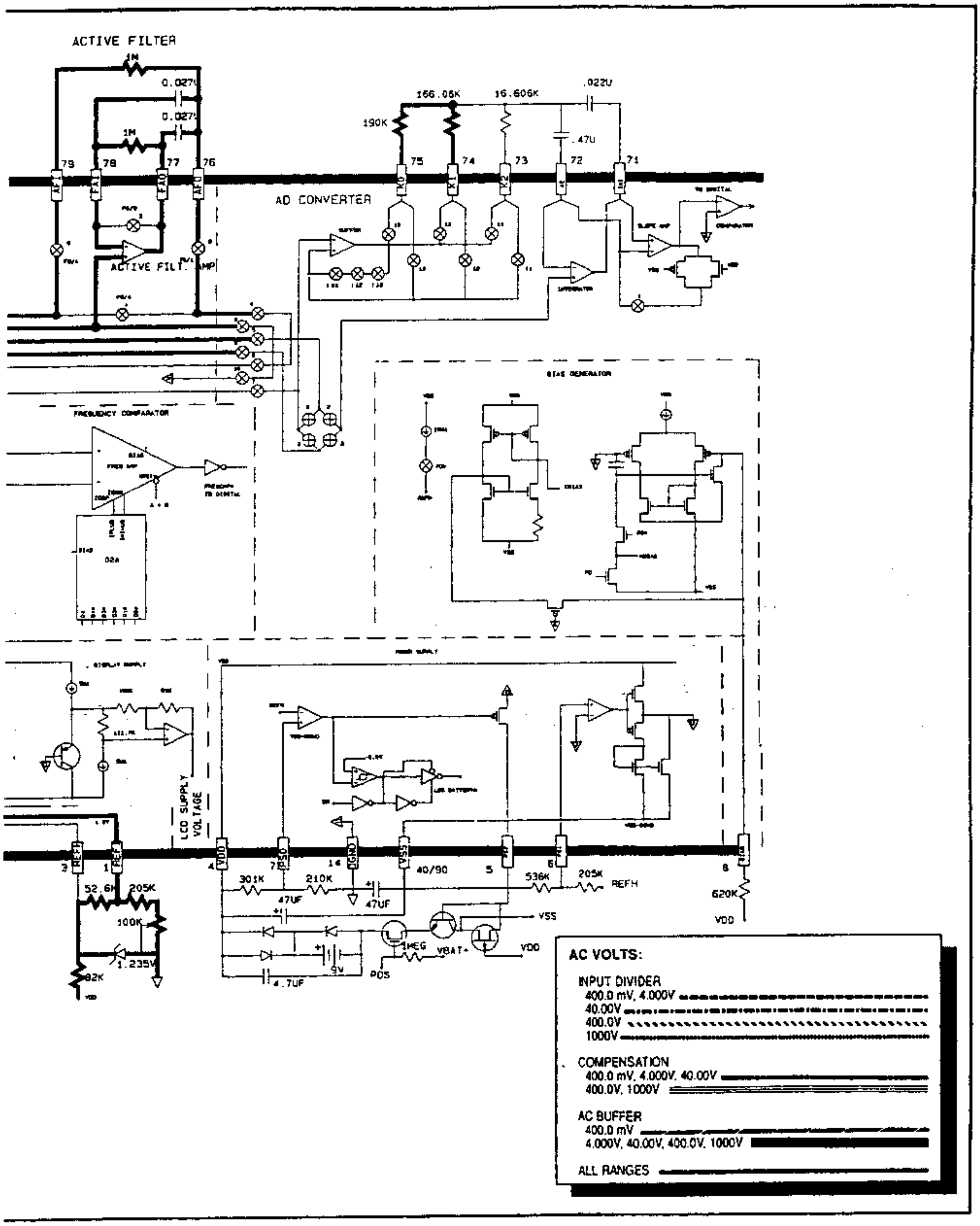


Figure 5-5. AC Volts Signal Flow (Models 83, 85)



ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
AD CONVERTER
ACTIVE FILT. AMP
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
LCD SUPPLY VOLTAGE
3
1
52.6K
205K
100K
1.235V
82K
4
7
14
40/90
5
6
8
301K
210K
47UF
47UF
536K
205K
REFH
620K
VDD
VSS
1MEG
VBAT+
VDD
9V
4.7UF
POS
AC VOLTS:
INPUT DIVIDER
400.0 mV, 4.000V
40.00V
400.0V
1000V
COMPENSATION
400.0 mV, 4.000V, 40.00V
400.0V, 1000V
AC BUFFER
400.0 mV
4.000V, 40.00V, 400.0V, 1000V
ALL RANGES

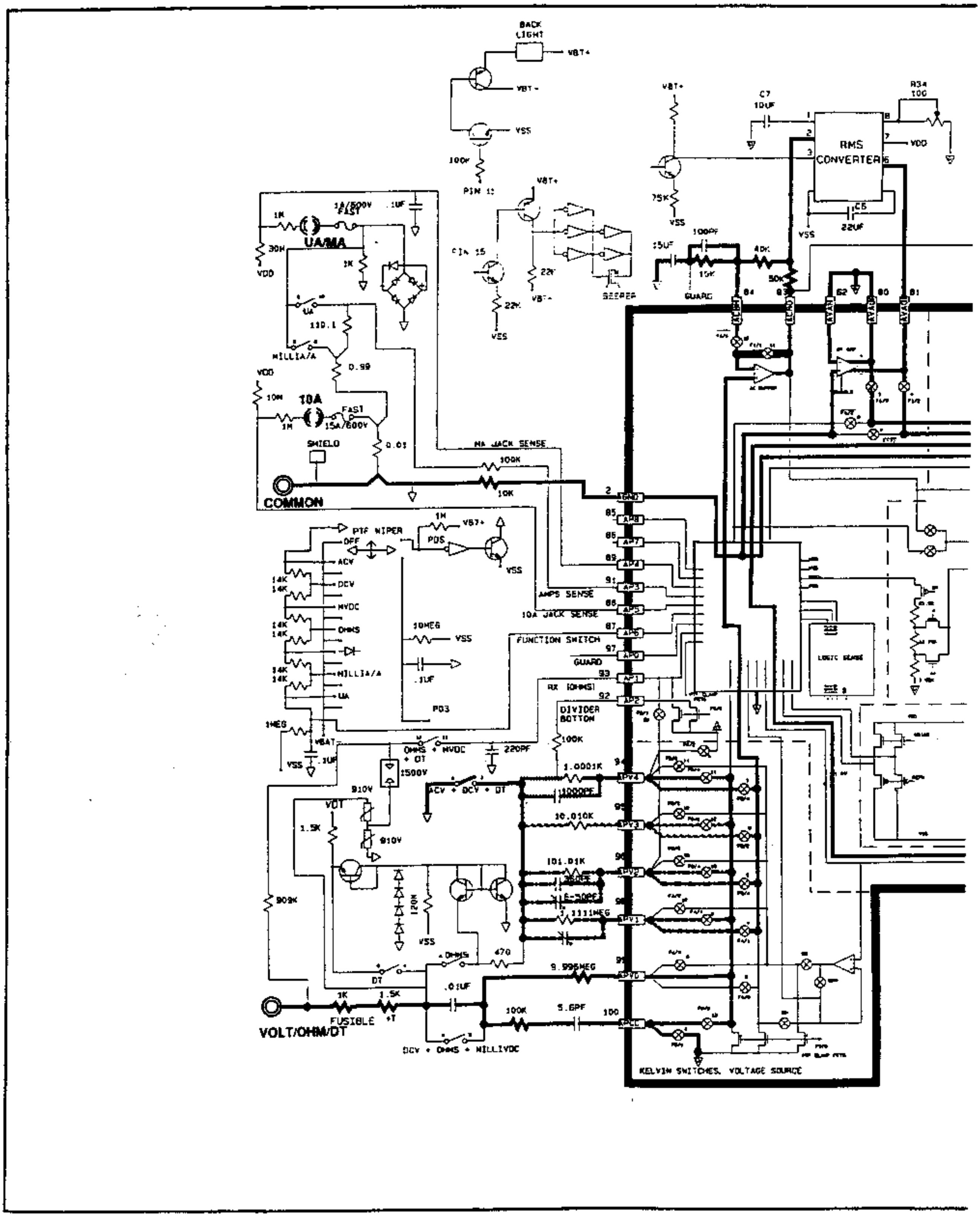
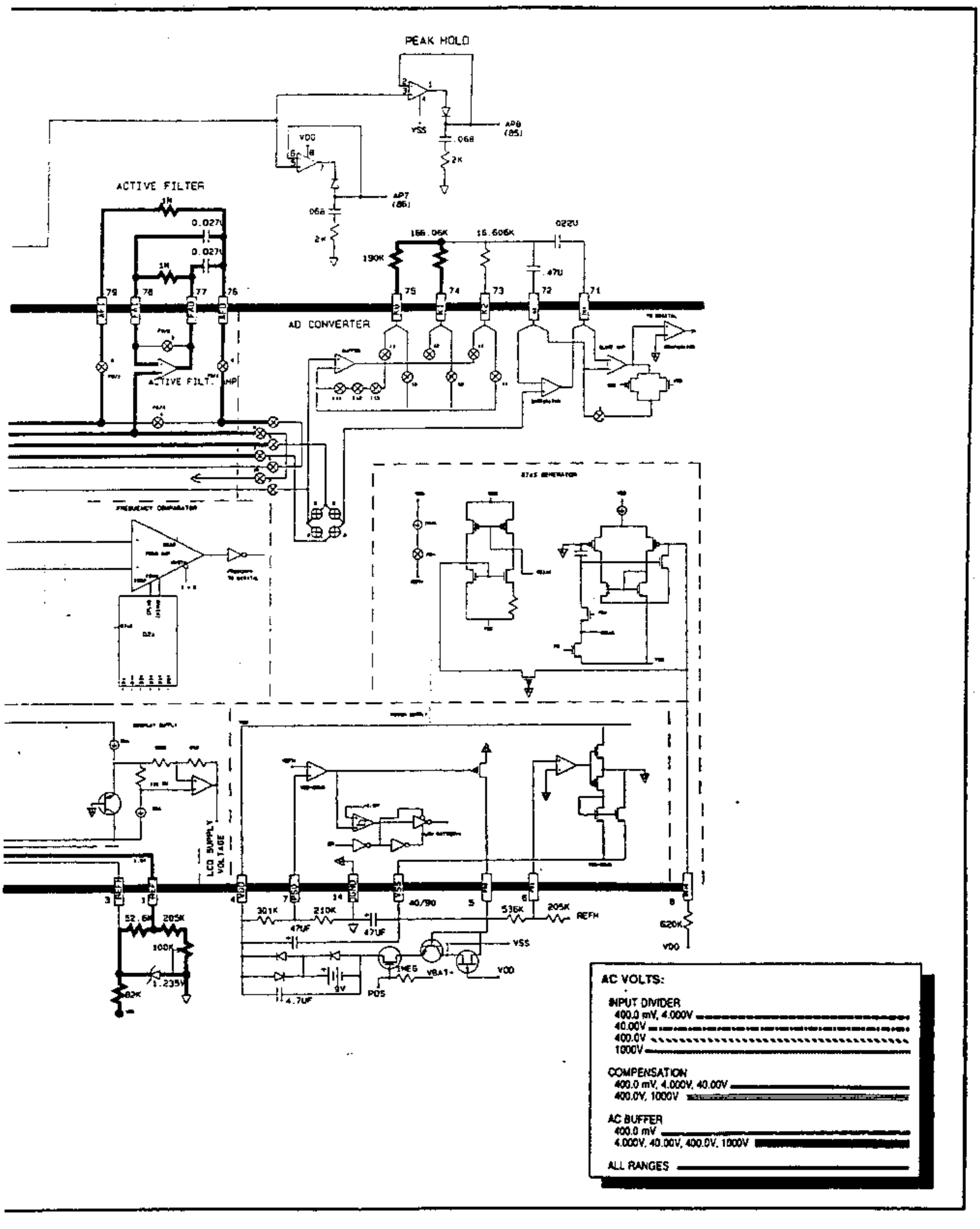


Figure 5-6. AC Volts Signal Flow (Model 87)


PEAK HOLD
VDD
VSS
.068
2K
AP8
(85)
AP7
(86)
ACTIVE FILTER
1M
0.027U
AD CONVERTER
ACTIVE FILT.
HP
190K
166.05K
16.606K
022U
.47U
79
78
77
76
75
74
73
72
71
LCD SUPPLY VOLTAGE
3
1
4
7
14
40/90
5
6
8
52.6K
205K
100K
82K
1.235V
301K
210K
47UF
536K
REFH
620K
1MEG
VBAT+
POS
9V
4.7UF
AC VOLTS:
INPUT DIVIDER
400.0 mV, 4.000V
40.00V
400.0V
1000V
COMPENSATION
400.0 mV, 4.000V, 40.00V
400.0V, 1000V
AC BUFFER
400.0 mV
4.000V, 40.00V, 400.0V, 1000V
ALL RANGES

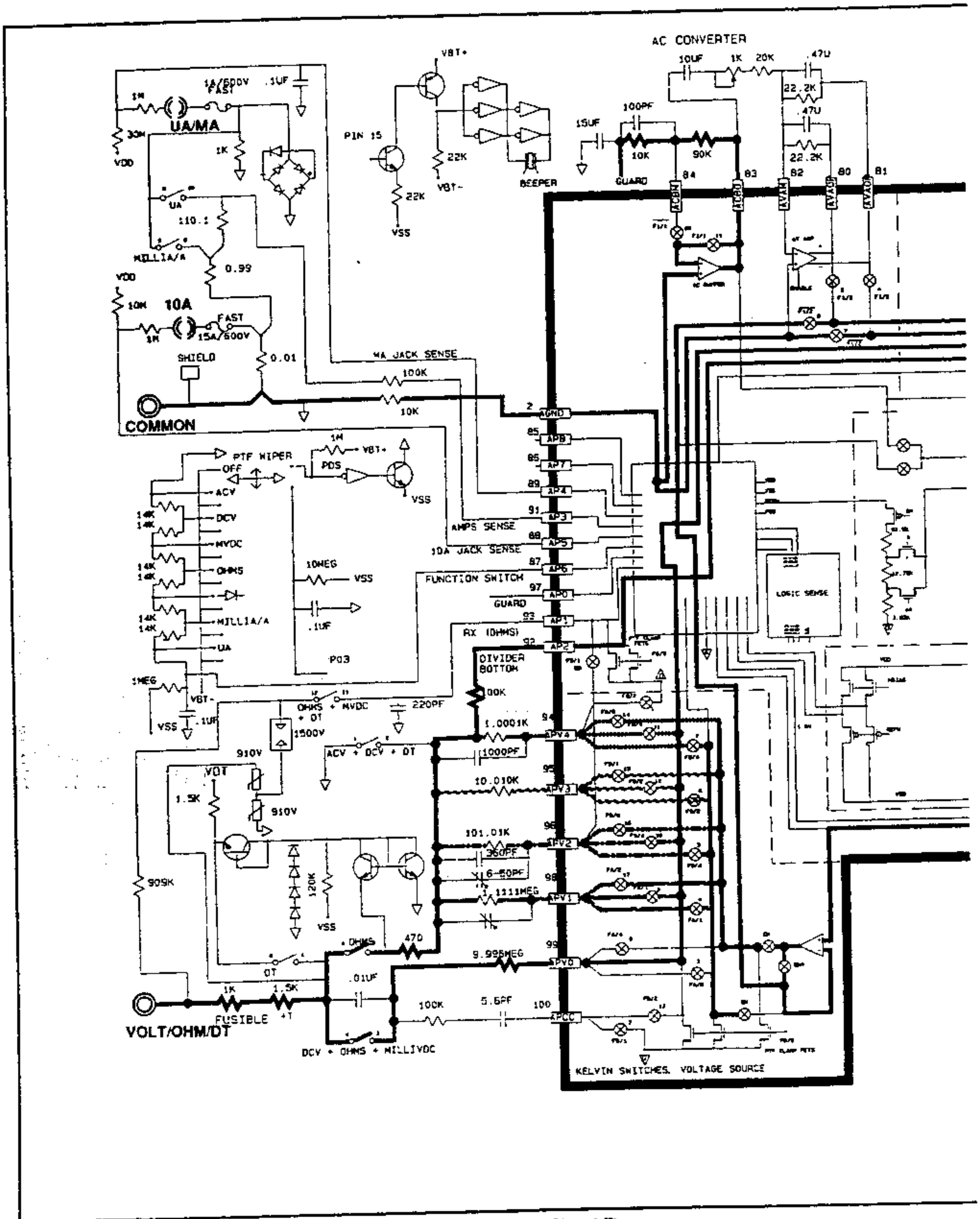
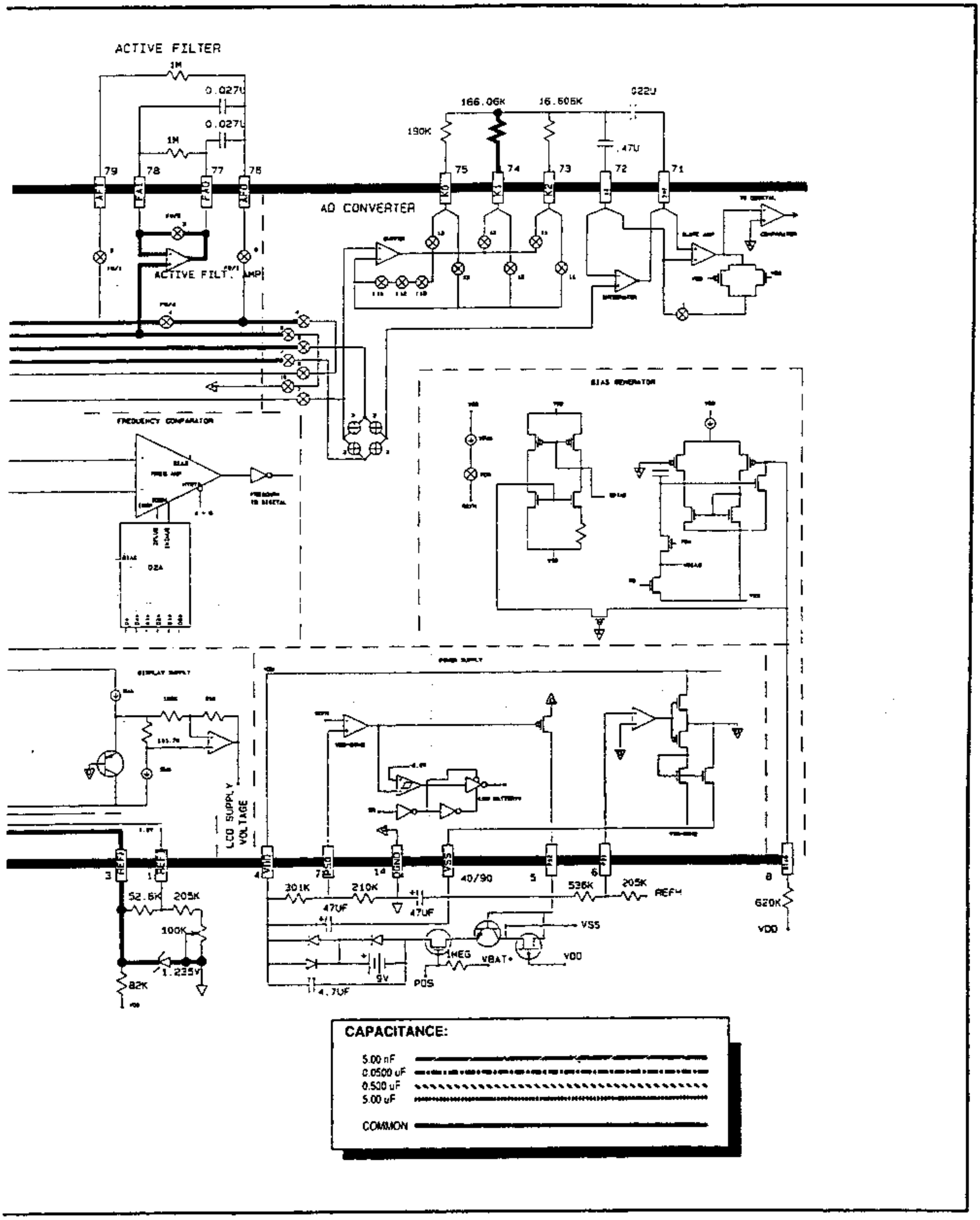


Figure 5-7. Capacitance Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
AF1
FA1
FA0
AF0
ACTIVE FILT. AMP
AD CONVERTER
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
K0
K1
K2
LCD SUPPLY VOLTAGE
REFI
REFL
VDIS
DSP
GND
VSS
52.6K
205K
100K
1.235V
82K
301K
210K
47UF
47UF
4.7UF
40/90
536K
205K
REFH
620K
VDD
VSS
1MEG
VBAT+
9V
POS
CAPACITANCE:
5.00 nF
0.0500 uF
0.500 uF
5.00 uF
COMMON

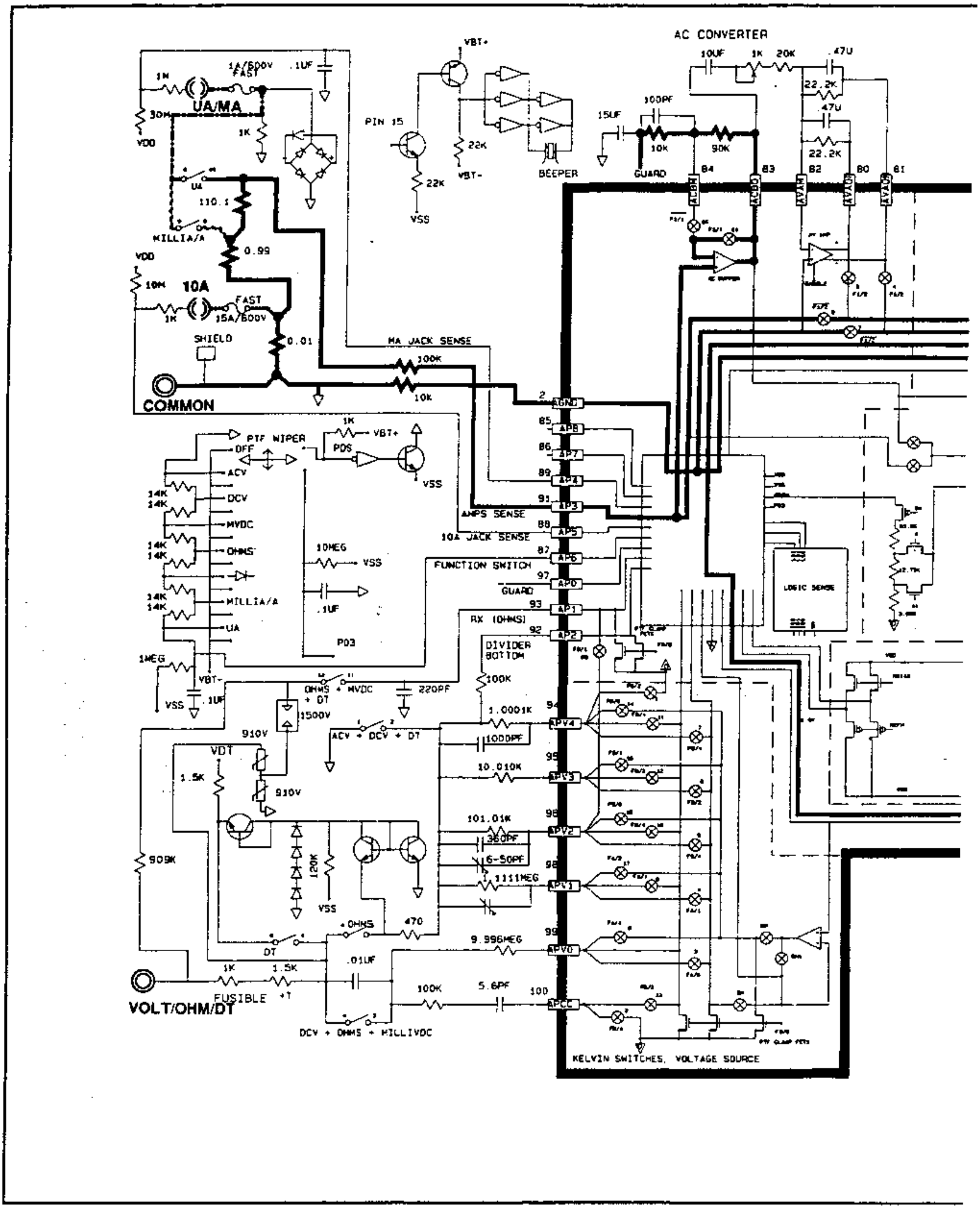
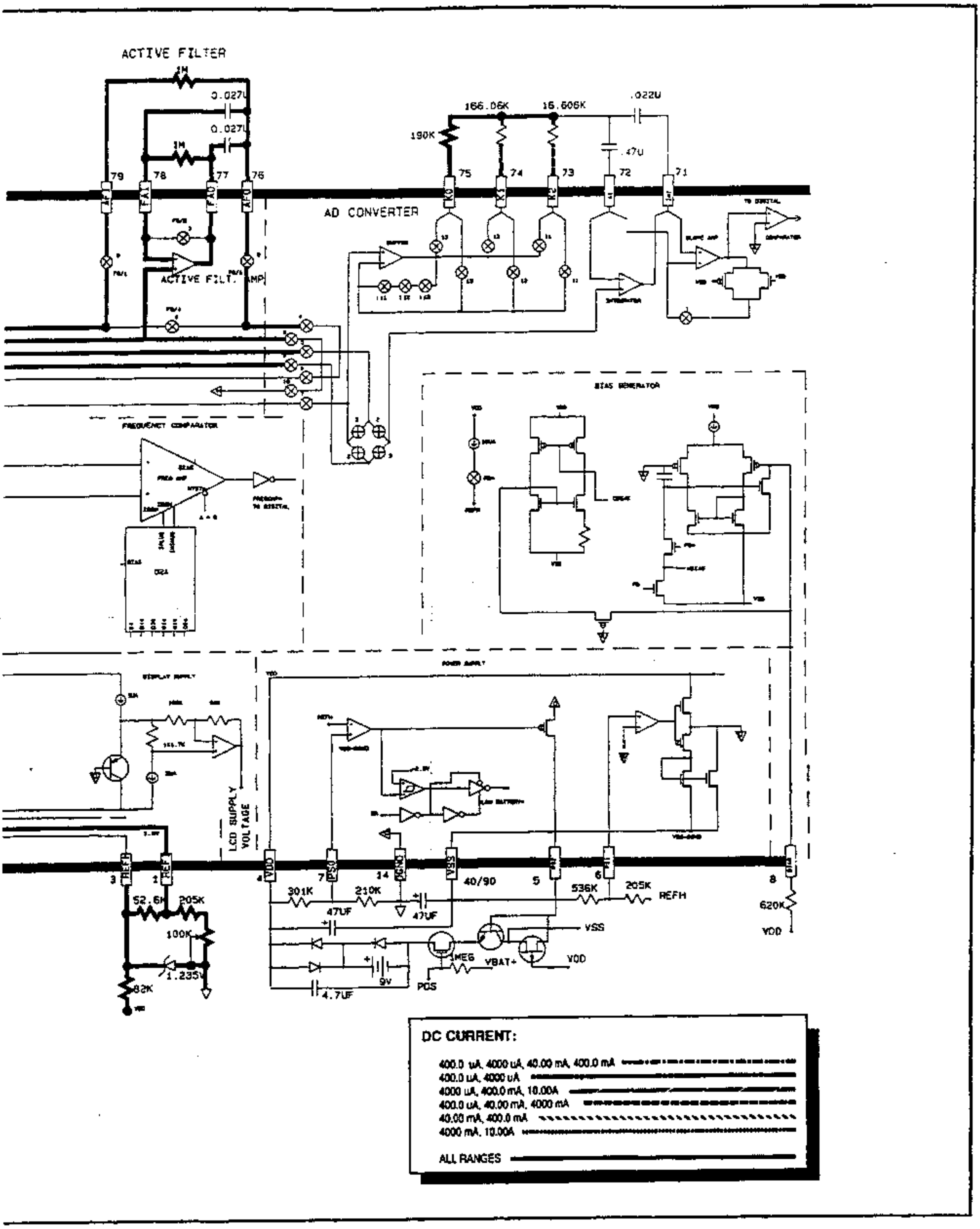


Figure 5-8. DC Current Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
ACTIVE FILT. AMP
AD CONVERTER
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
LCD SUPPLY VOLTAGE
VDD
PSO
VSS
40/90
301K
210K
47UF
47UF
536K
205K
REFH
620K
VDD
VSS
1MEG
VBAT+
9V
POS
4.7UF
52.6K
205K
100K
1.235V
82K
DC CURRENT:
400.0 uA, 4000 uA, 40.00 mA, 400.0 mA
400.0 uA, 4000 uA
4000 uA, 400.0 mA, 10.00A
400.0 uA, 40.00 mA, 4000 mA
40.00 mA, 400.0 mA
4000 mA, 10.00A
ALL RANGES

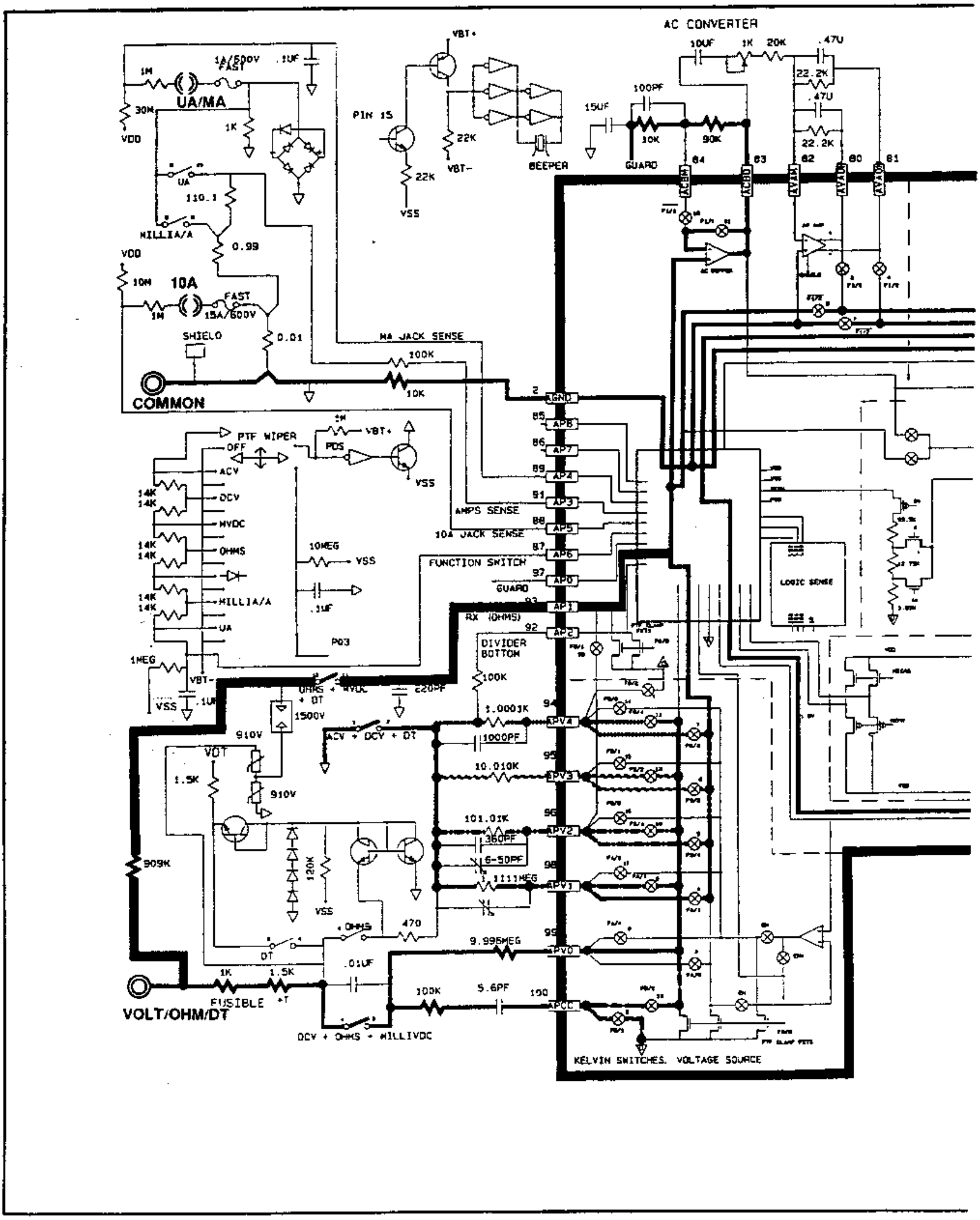
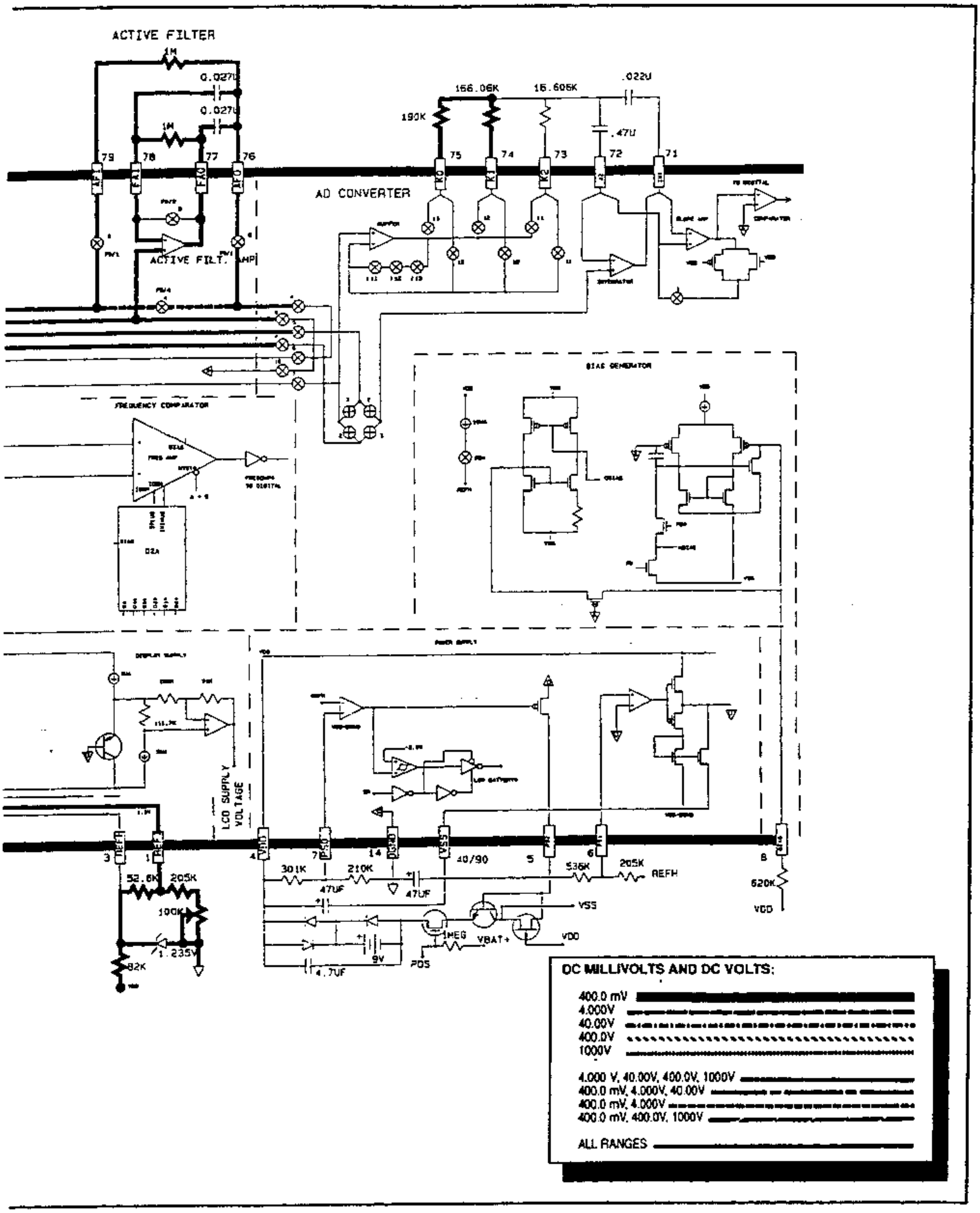


Figure 5-9. DC Millivolts and DC Volts Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
AF1
FA1
FA0
AF0
ACTIVE FILT.
AD CONVERTER
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
K0
K1
K2
LCD SUPPLY VOLTAGE
REFH
REFL
VDD
PSO
DGND
VSS
3
1
4
7
14
40/90
5
6
8
52.6K
205K
100K
1.235V
82K
301K
210K
47UF
47UF
4.7UF
9V
POS
1MEG
VBAT+
VSS
VDD
536K
205K
REFH
620K
VDD
DC MILLIVOLTS AND DC VOLTS:
400.0 mV
4.000V
40.00V
400.0V
1000V
4.000 V, 40.00V, 400.0V, 1000V
400.0 mV, 4.000V, 40.00V
400.0 mV, 4.000V
400.0 mV, 400.0V, 1000V
ALL RANGES

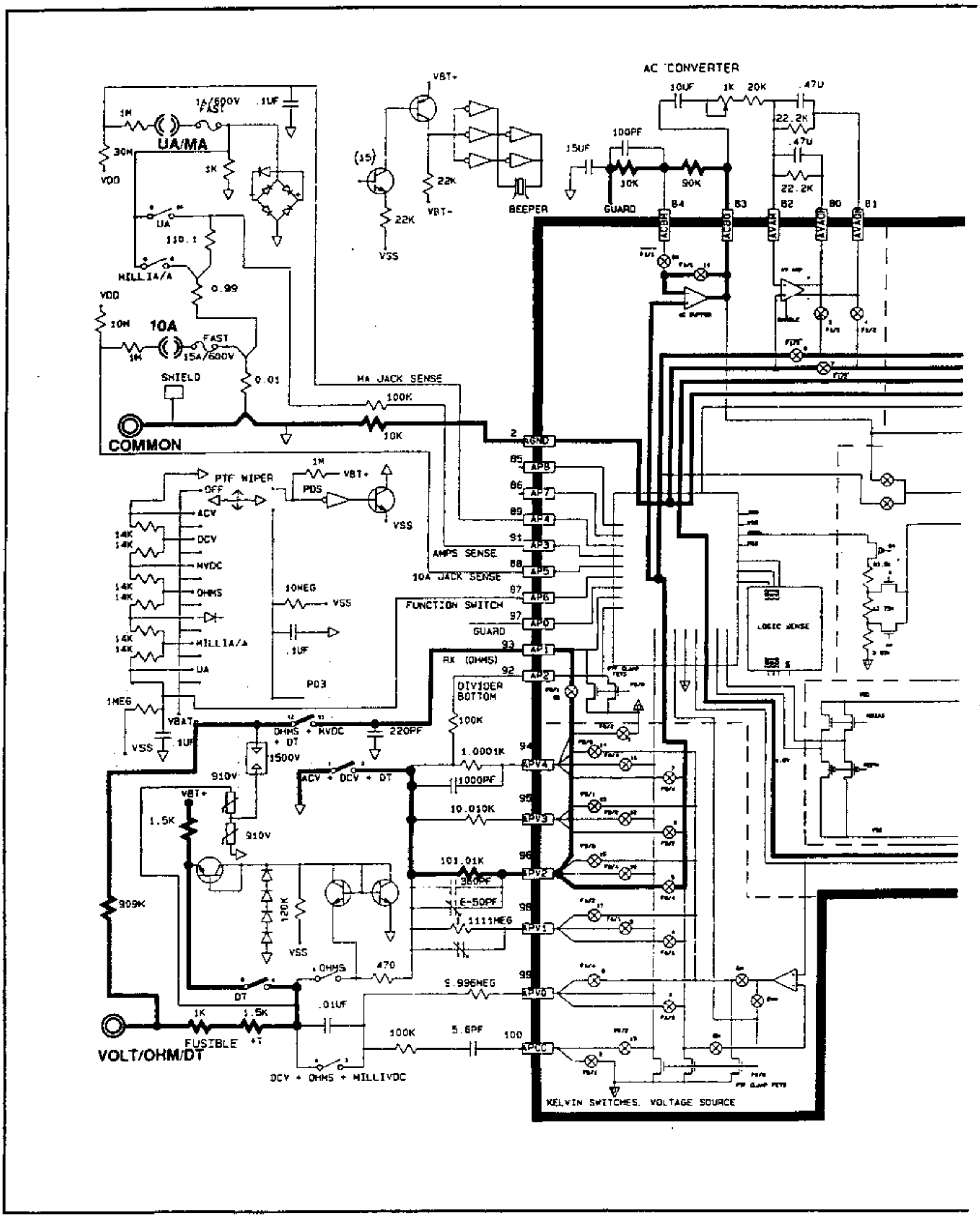
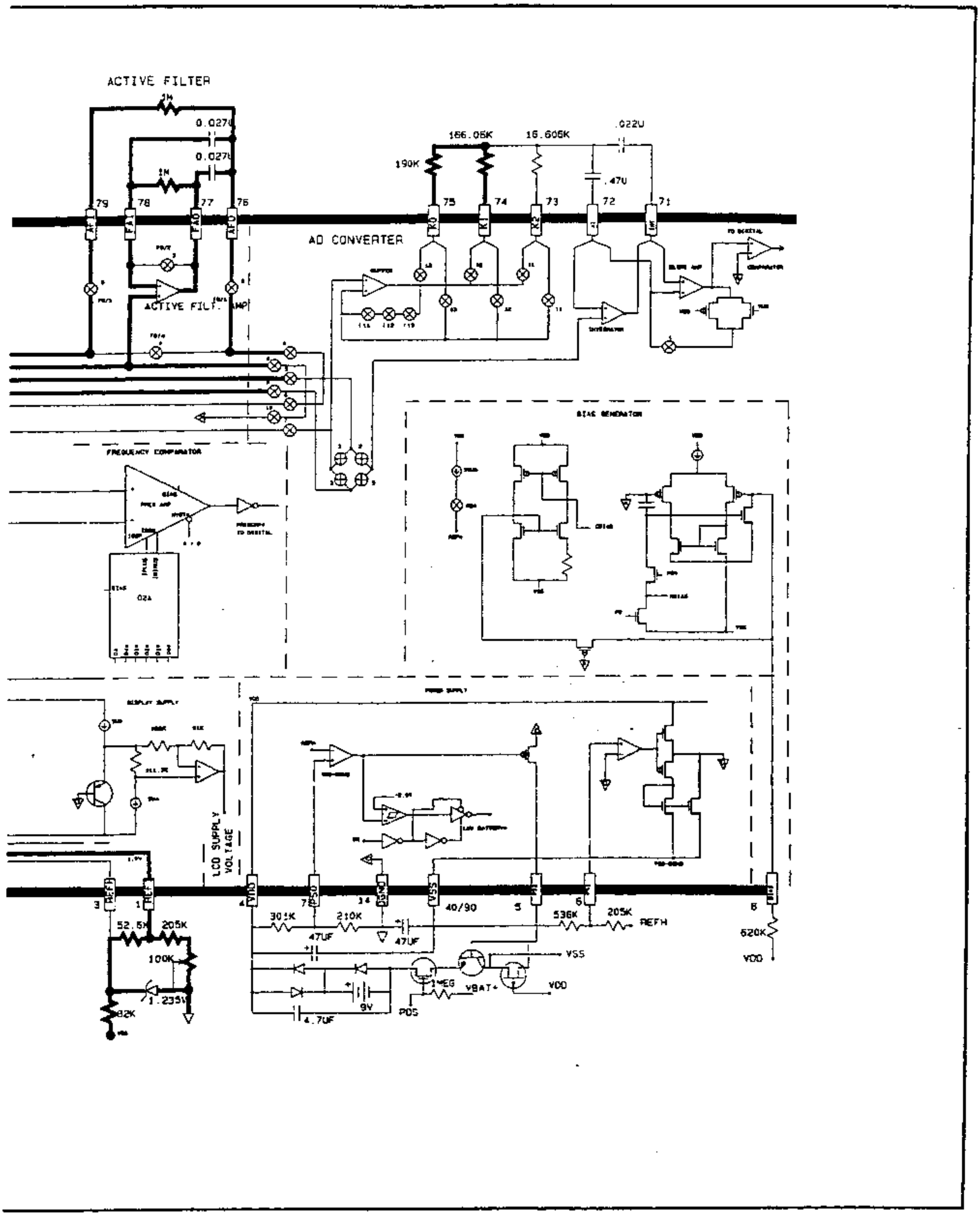


Figure 5-10. Diode Test Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
AF1
FA1
FA0
AF0
ACTIVE FILT. AMP
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
TK0
K1
K2
AD CONVERTER
LCD SUPPLY VOLTAGE
VDD
BSO
DGND
VSS
REFH
REF
3
1
4
7
14
40/90
5
6
8
52.5K
205K
100K
1.235V
82K
301K
210K
47UF
47UF
536K
205K
REFH
620K
VDD
VSS
1MEG
VBAT+
VDD
9V
POS
4.7UF

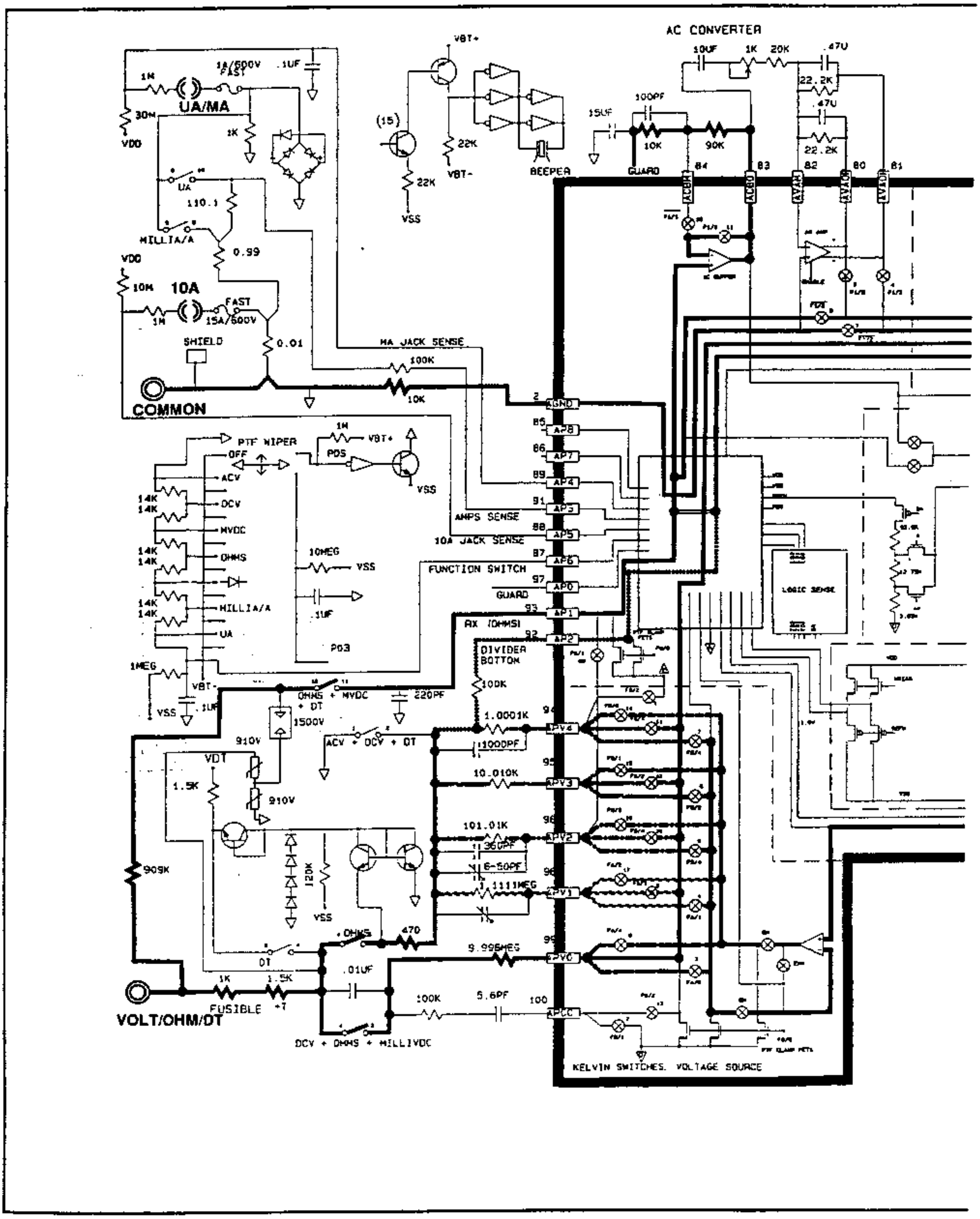
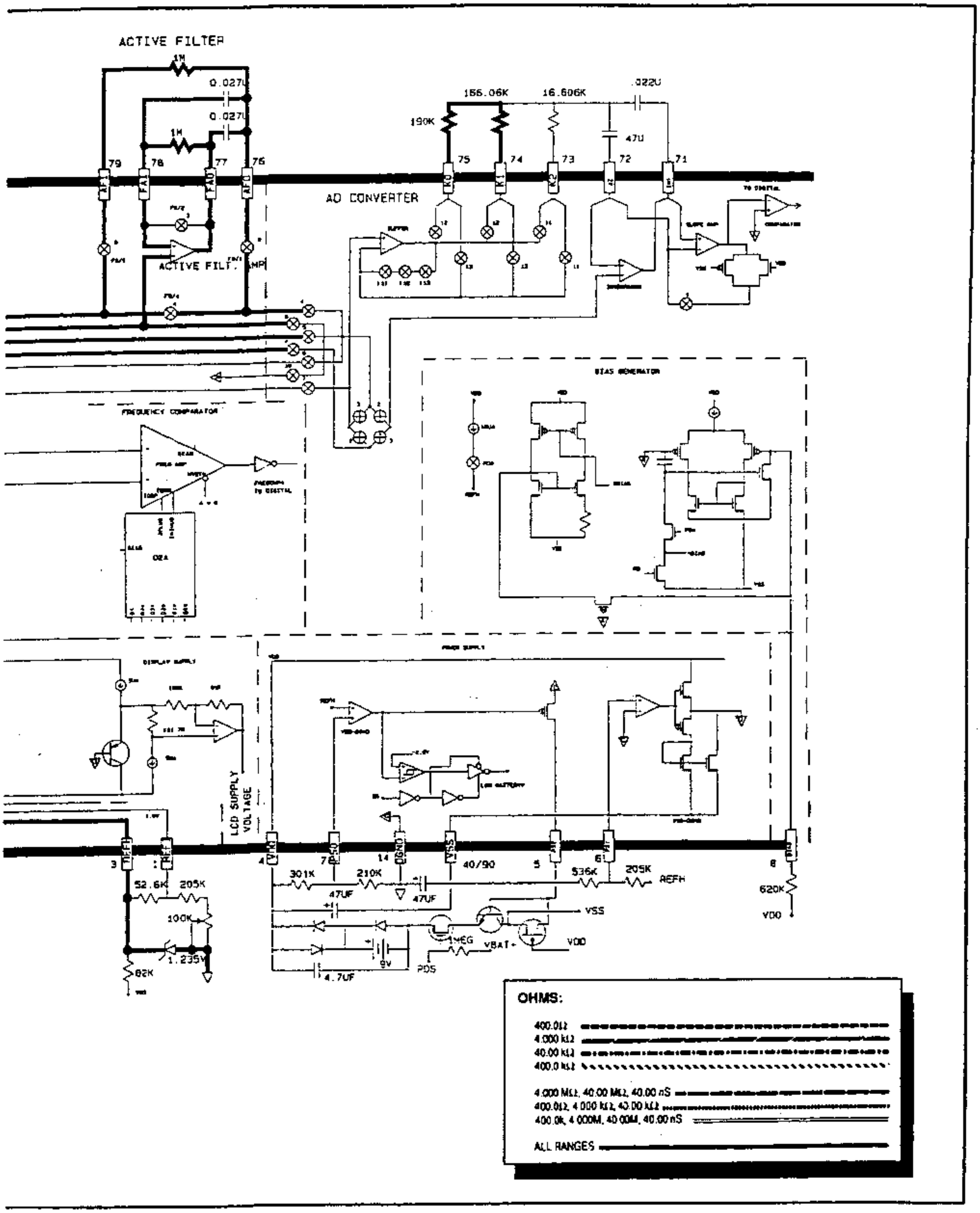


Figure 5-11. Ohms Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
ACTIVE FILT. AMP
AD CONVERTER
166.06K
16.606K
.022U
190K
47U
75
74
73
72
71
LCD SUPPLY VOLTAGE
3
4
7
14
40/90
5
61
8
52.6K
205K
100K
1.235V
82K
301K
210K
47UF
47UF
536K
205K
REFH
620K
VDD
VSS
1MEG
VBAT+
VDD
9V
4.7UF
PDS
OHMS:
400.0Ω
4.000 kΩ
40.00 kΩ
400.0 kΩ
4.000 MΩ, 40.00 MΩ, 40.00 nS
400.0Ω, 4.000 kΩ, 40.00 kΩ
400.0k, 4.000M, 40.00M, 40.00 nS
ALL RANGES

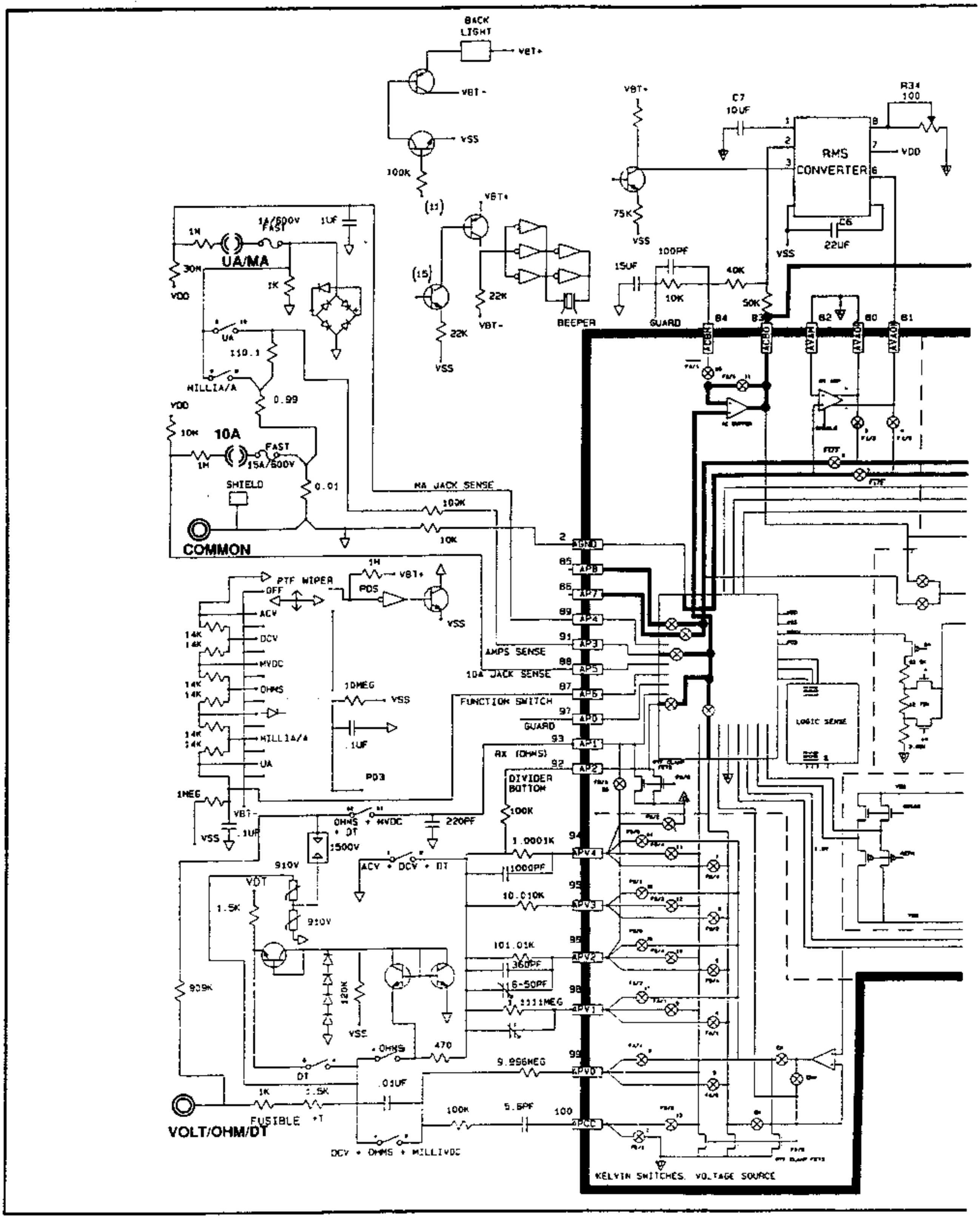
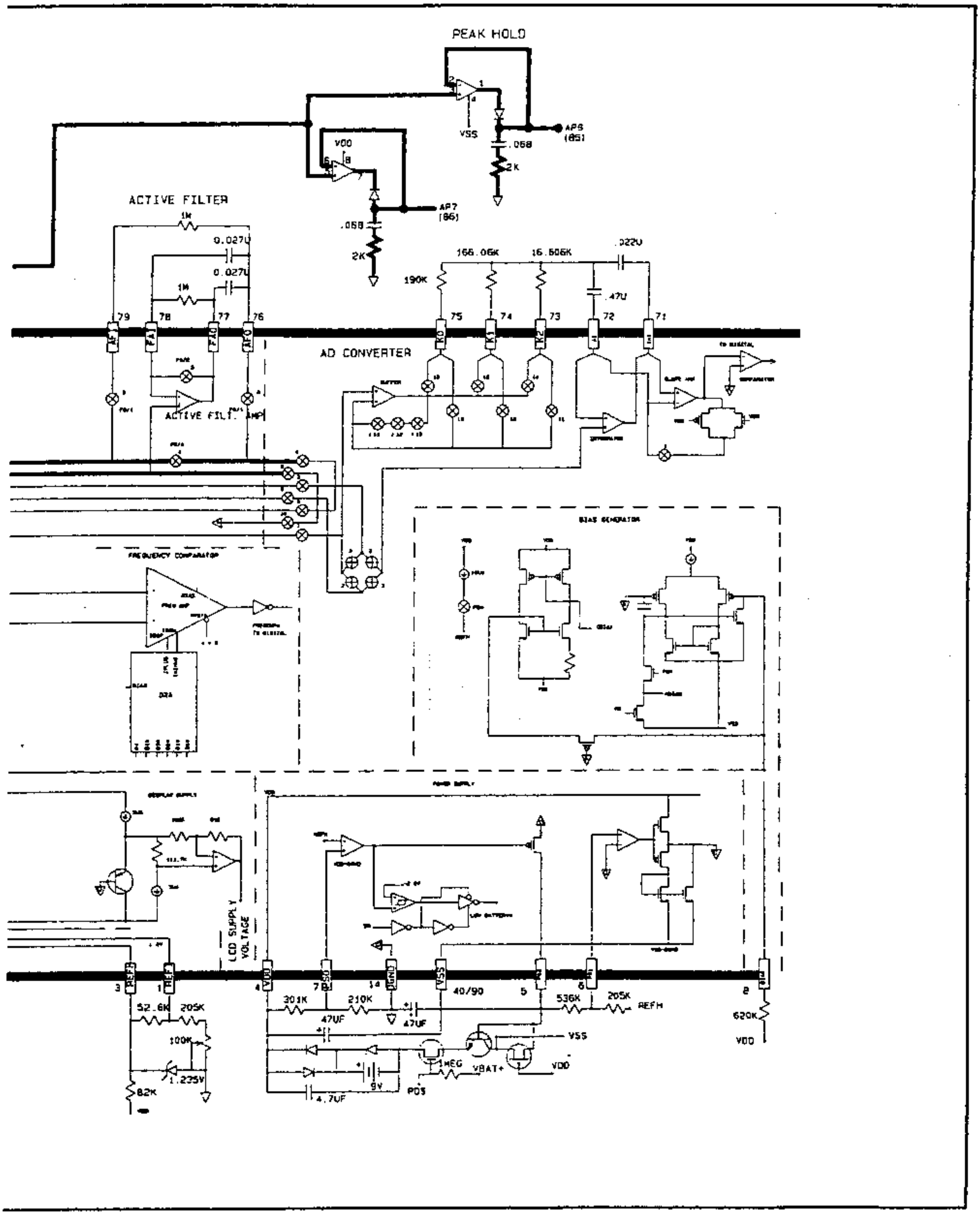


Figure 5-12. Peak/Hold Signal Flow (Model 87)


PEAK HOLD
VDD
VSS
AP6 (85)
AP7 (86)
.068
2K
ACTIVE FILTER
1M
0.027U
79
78
77
76
AF1
FA1
FA0
AF0
AD CONVERTER
166.06K
16.606K
.022U
190K
.47U
75
74
73
72
71
K0
K1
K2
ACTIVE FILT. AMP
LCD SUPPLY VOLTAGE
REFL
REFH
VDD
VSS
3
1
4
7
14
40/90
5
6
8
52.6K
205K
100K
1.225V
82K
301K
210K
47UF
536K
REFH
620K
VSS
VDD
1MEG
VBAT+
9V
4.7UF
PD3

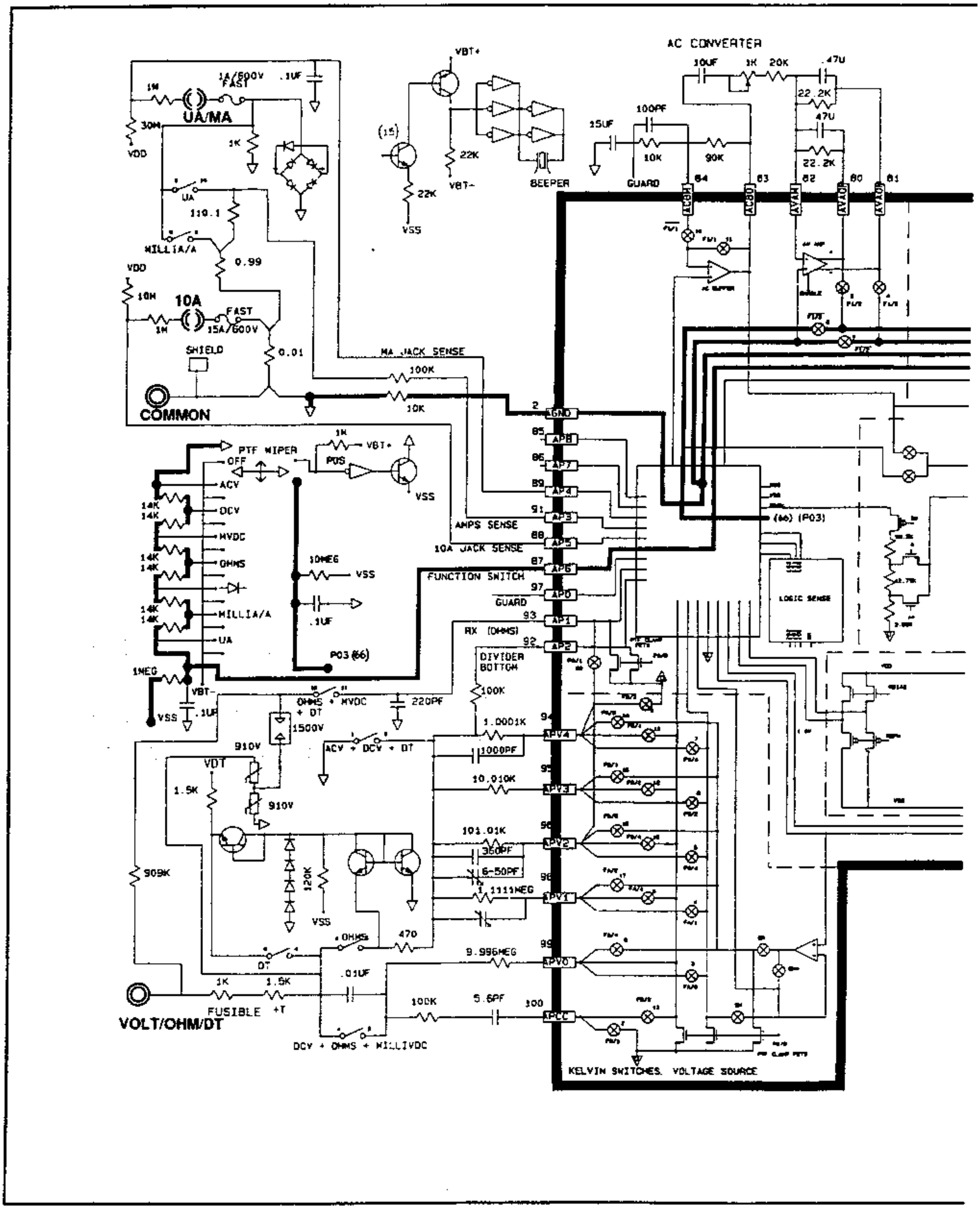
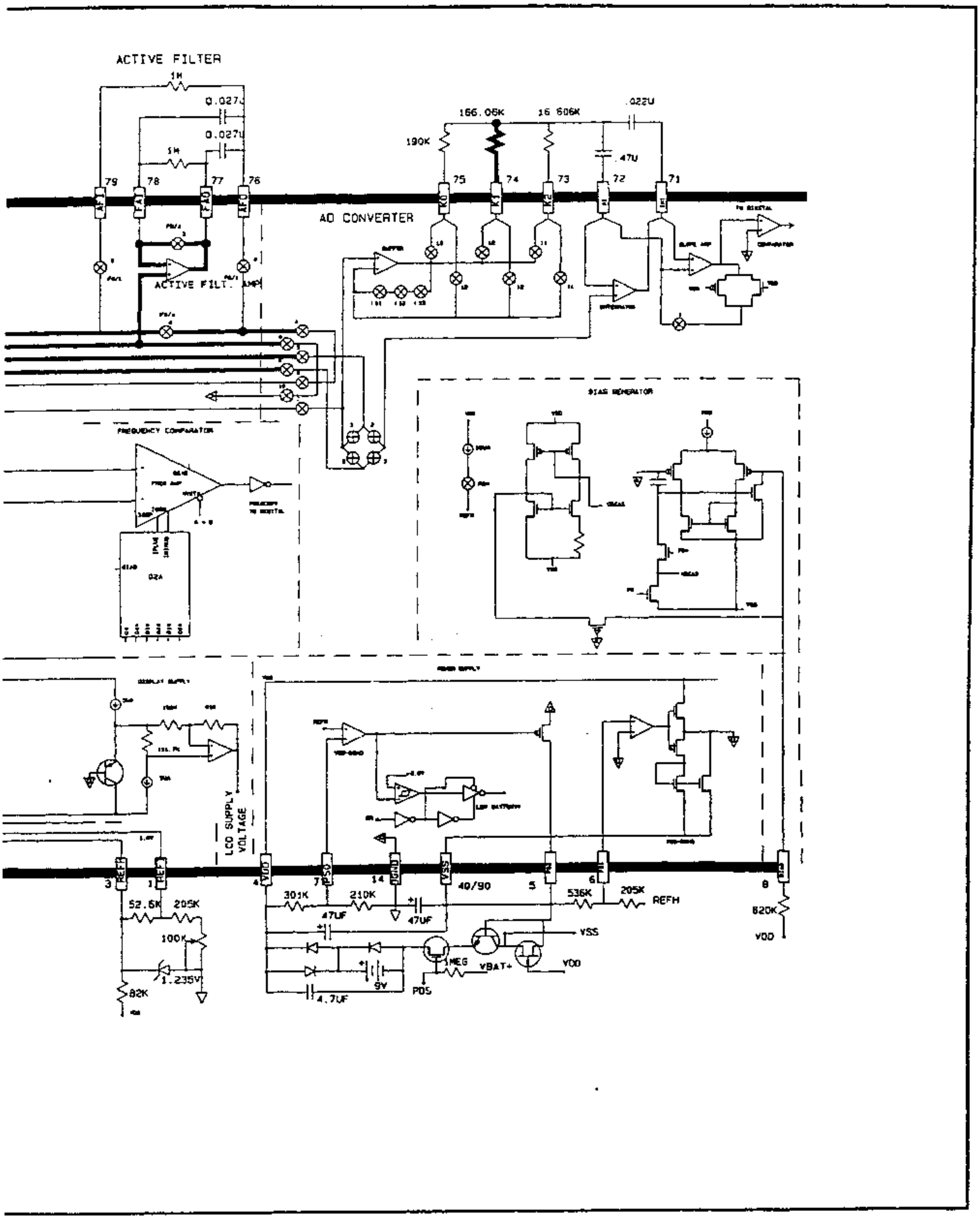


Figure 5-13. Function Switch Range Signal Flow


ACTIVE FILTER
1M
0.027U
0.027U
1M
79
78
77
76
AF1
FA1
FA0
AF0
ACTIVE FILT. AMP
AD CONVERTER
166.05K
16.606K
.022U
190K
.47U
75
74
73
72
71
LCD SUPPLY VOLTAGE
REFH
REFL
VDD
VSS
3
1
4
7
14
40/90
5
6
8
52.6K
205K
100K
1.235V
82K
301K
210K
47UF
47UF
4.7UF
9V
1MEG
VBAT+
POS
VSS
VDD
536K
205K
REFH
620K
VDD

LIMITED WARRANTY & LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is three years and begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Fluke's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest Fluke authorized service center. Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

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Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

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MULTIMETER SAFETY

The Fluke 83, 85, 87 Multimeters have been designed and tested according to IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus. This manual contains information and warnings which must be followed to ensure safe operation and retain the meter in safe condition. Use of this equipment in a manner not specified herein may impair the protection provided by the equipment.

These multimeters comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these multimeters may not cause harmful interference, and (2) these multimeters must accept any interference received, including interference that may cause undesired operation.

Some common international electrical symbols used in this manual are shown below.

~	AC – ALTERNATING CURRENT	ϟ	DANGEROUS VOTLAGE
⎓	DC – DIRECT CURRENT	⏚	EARTH GROUND
≂	EITHER AC OR DC CURRENT	⚠	SEE EXPLANATION IN MANUAL
–▭–	FUSE	⧈	DOUBLE INSULATION FOR PROTECTION AGAINST ELECTRIC SHOCK

Before using the meter, read the following safety information carefully. In this manual, "WARNING," is reserved for conditions and actions that pose hazard(s) to the user; "CAUTION," is reserved for conditions and actions that may damage your meter.

- Avoid working alone.
- Follow all safety procedures for equipment being tested.
- Inspect the test leads for damaged insulation or exposed metal. Check test lead continuity. Damaged leads should be replaced.
- Be sure the meter is in good operating condition.
- Select the proper function for your measurement.
- To avoid electrical shock, use caution when working above 60V dc or 30V ac RMS.
- Disconnect the live test lead before disconnecting the common test lead.
- Disconnect the power and discharge high-voltage capacitors before testing in Ω and →|– ·))).
- When making a current measurement, turn the circuit power off before connecting the meter in the circuit.
- Check meter fuses before measuring transformer secondary or motor winding current. An open fuse may allow high voltage build-up, which is potentially hazardous.
- Use clamp-on probes when measuring circuits exceeding 10 amps.
- When servicing the meter, use only the replacement parts specified.
- Do not allow meter to be used if it is damaged or if its safety is impaired.