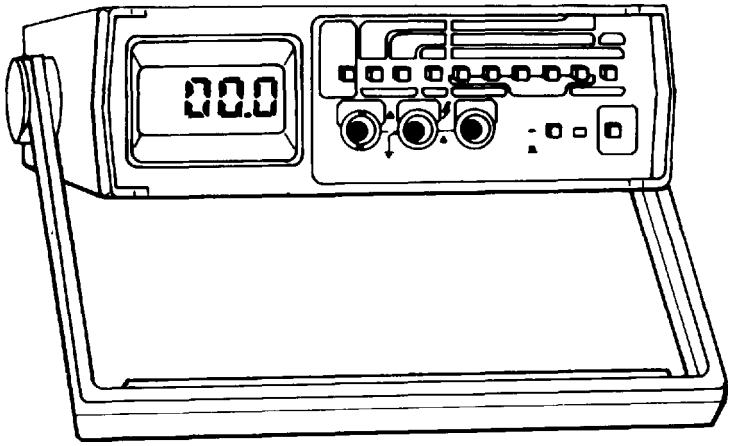
TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL



DIGITAL MULTIMETER AN/USM-486/U (NSN 6625-01-145-2430) (EIC: N/A)

HEADQUARTERS, DEPARTMENT OF THE ARMY
30 JULY 1984

5 **SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK:**

1 **DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL.**

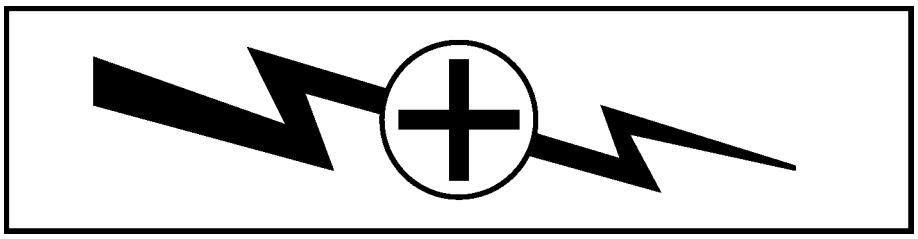
2 **IF POSSIBLE, TURN OFF THE ELECTRICAL POWER.**

3 **IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A DRY WOODEN POLE OR A DRY ROPE OR SOME OTHER INSULATING MATERIAL.**

4 **SEND FOR HELP AS SOON AS POSSIBLE.**

5 **AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION.**

WARNING



HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When technicians are aided by operators, they must warn them about dangerous areas.

A periodic review of safety precautions in TB 385-4, Safety Requirements for Maintenance of Electrical and Electronic Equipment, is recommended. When the equipment is operated with covers removed, DO NOT TOUCH exposed connections or components. MAKE CERTAIN you are not grounded when making connections or adjusting components inside the test instrument.

Be careful not to contact high-voltage connections of 115-volt ac input when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

WARNING

Do not be misled by the terms "LOW VOLTAGE." Potentials as low as 50 volts can cause death under certain conditions.

For First Aid, refer to FM 4-25.11.

CHANGE
No. 3

Headquarters
Department of the Army
Washington, D.C., 05 December 2006

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL
FOR
DIGITAL MULTIMETER
AN/USM-486/U
(NSN 6625-01-145-2430) (EIC: N/A)

HAZARDOUS MATERIAL INFORMATION – This document has been reviewed for the presence of solvents containing hazardous materials as defined by the EPCRA 302 and 313 lists by the AMCOM G-4 (Logistics) Environmental Division. As of the base document through Change 2, dated 15 August 1990, all references to solvents containing hazardous materials have been removed from this document by substitution with non-hazardous or less-hazardous materials where possible.

OZONE DEPLETING CHEMICAL INFORMATION – This document has been reviewed for the presence of Class I ozone depleting chemicals by the AMCOM G-4 (Logistics) Environmental Division. As of the base document through Change 2, dated 15 August 1990, all references to Class I ozone depleting chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

WARNING – This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U. S. C., Sec 2751 et seq) or the Export Administration Act 1979, as amended, Title 50, U.S.C., App. 2401 et seq.. Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with provisions of DOD Directive 5230.25.

DISTRIBUTION STATEMENT D – Distribution authorized to Department of Defense and DoD contractors only to protect critical technical data on systems or hardware. This determination was made Oct 1986. Other requests shall be referred to: Program Manager, TMDE, ATTN: SFAE-CS-FT-T-TEMOD, Redstone Arsenal, AL 35898-5000.

DESTRUCTION NOTICE – Destroy by any method that will prevent disclosure of contents or reconstruction of the document.

TM 11-6625-3055-14 dated 30 July 1984, is changed as follows:

1. Remove old pages and insert new pages as indicated below.
2. New or changed text is indicated by a vertical bar in the outer margin of the page.
3. Added illustrations are indicated by a vertical bar adjacent to the illustration identification number. Changed illustrations are indicated by a miniature pointing hand adjacent to the updated area and a vertical bar adjacent to the illustration identification number.

Remove Pages	Insert Pages
A and B	a and b
None	A/(B blank)

Remove Pages	**Insert Pages**
i through 1-0	i through iii/(iv blank)
None	v and 1-0
1-1 and 1-2	1-1 and 1-2
3-1 through 3-4	3-1 through 3-4
A-1/(A-2 blank)	A-1/(A-2 blank)
D-1/(D-2 blank)	D-1/(D-2 blank)
DA Forms 2028-2	DA Forms 2028
Cover	Cover

2. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

JOYCE E. MORROW
Administrative Assistant to the
Secretary of the Army
0622806

DISTRIBUTION:

To be distributed in accordance with the Initial Distribution Number (IDN) 511710, requirements for TM 11-6625-3055-14.

TM 11-6625-3055-14
C2

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 15 August 1990

Operator's, Organizational, Direct Support,

And General Support Maintenance Manual

DIGITAL MULTIMETER AN/USM-486/U

(NSN 6625-01-145-2430)

TM 11-6625-3055-14, 30 July 1984, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page. Added or revised illustrations are indicated by a vertical bar adjacent to the identification number or by a miniature pointing hand on the illustration page.

Remove pages	Insert pages
1-9 and 1-10	1-9 and 1-10
2-5 and 2-6	2-5 and 2-6

2. File this change in the front of the publication for reference purposes.

TM 11-6625-3055-14
C2

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-51 requirements for TM 11-6625-3055-14.

TM 11-6625-3055-14
C1

CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 1 January 1989

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT,

AND GENERAL SUPPORT MAINTENANCE MANUAL

DIGITAL MULTIMETER AN/USM-486/U

(NSN 6625-01-145-2430)

TM 11-6625-3055-14, 30 July 1984, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page. Added or revised illustrations are indicated by a vertical bar adjacent to the identification number.

Remove pages	Insert pages
5-29 and 5-30	5-29 and 5-30
B-3 through B-6	B-3 through B-6
C-1 and C-2	C-1 and C-2

2. File this change in the front of the publication for reference purposes.

TM 11-6625-3055-14
C1

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN II
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-51 Operator, Unit, and DS/GS requirements for AN/USM-486.

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

LIST OF EFFECTIVE PAGES

NOTE

ON CHANGED PAGES, THE PORTION OF THE TEXT AFFECTED BY THE LATEST CHANGE IS INDICATED BY A VERTICAL LINE OR OTHER CHANGE SYMBOL IN THE OUTER MARGIN OF THE PAGE.

Date of issue for original and changed pages are:

Original	0	30 July 1984
Change	1	1 January 1989
Change	2	15 August 1990
Change	3	05 December 2006

Total number of pages in this publication is 150 consisting of the following:

Page No.	* Change No.	Page No.	*Change No.
Cover	3	4-1	0
a and b	3	4-2 blank	0
A	3	5-1 through 5-29	0
B blank	3	5-30	1
i and ii	3	5-31 through 5-53	0
iii	3	5-54 blank	0
iv blank	3	A-1	0
v	3	A-2 blank	0
1-0	0	B-1 through B-3	0
1-1 and 1-2	3	B-4 through B-6	1
1-3 through 1-8	0	C-1	0
1-9	2	C-2	1
1-10 through 1-13	0	D-1	3
1-14 blank	0	D-2 blank	3
2-1 through 2-4	0	Index-1 through Index-5	0
2-5	2	Index-6 blank	0
2-6 through 2-16	0	FO 1 (Sheet 1 of 3)	0
3-1 through 3-3	3	FO 1 (Sheet 2 of 3)	0
3-4 through 3-13	0	FO 1 (Sheet 3 of 3)	0
3-14 blank	0		

* Zero in this column indicates an original page.

TECHNICAL MANUAL
NO. 11-6625-3055-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 30 July 1984

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL FOR DIGITAL MULTIMETER, AN/USM-486/U (NSN 6625-01-145-2430) (EIC: N/A)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: Commander, U. S. Army Aviation and Missile Command, AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also provide DA Form 2028 information to AMCOM via email, fax or the World Wide Web. Our fax number is: DSN 788-6546 or Commercial 256-842-6546. Our email address is: 2028@redstone.army.mil. Instructions for sending an electronic 2028 may be found at the back of this manual immediately preceding the hardcopy 2028. For the World Wide Web use: https://amcom2028.redstone.army.mil.

HAZARDOUS MATERIAL INFORMATION

This document has been reviewed for the presence of solvents containing hazardous materials as defined by the EPCRA 302 and 313 lists by the AMCOM G-4 (Logistics) Environmental Division. As of the base document through Change 2, dated 15 August 1990, all references to solvents containing hazardous materials have been removed from this document by substitution with non-hazardous or less hazardous materials where possible.

OZONE DEPLETING CHEMICAL INFORMATION

This document has been reviewed for the presence of Class I ozone depleting chemicals by the AMCOM G-4 (Logistics) Environmental Division. As of the base document through Change 2, dated 15 August 1990, all references to Class I ozone depleting chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

WARNING – This document contains technical data whose export is restricted by the Arms Export Control Act (Title 22, U. S. C., Sec 2751 et seq) or the Export Administration Act 1979, as amended, Title 50, U.S.C., App. 2401 et seq.. Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with provisions of DOD Directive 5230.25.

DISTRIBUTION STATEMENT D – Distribution authorized to Department of Defense and DoD contractors only to protect critical technical data on systems or hardware. This determination was made Oct 1986. Other requests shall be referred to: Program Manager, TMDE, ATTN: SFAE-CS-FT-T-TEMOD, Redstone Arsenal, AL 35898-5000.

DESTRUCTION NOTICE – Destroy by any method that will prevent disclosure of contents or reconstruction of the document.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

HOW TO USE THIS MANUAL

This manual tells you about your Digital Multimeter, AN/USM-486/U, and contains instructions about how to use it while testing and maintaining other equipment.

The technical manual for the equipment you are maintaining will give you some guidance in the correct method to make certain connections when testing and troubleshooting with the multimeter.

When you first receive your multimeter, start at the front of the manual and go all the way through to the back, and become familiar with every part of the manual and the multimeter.

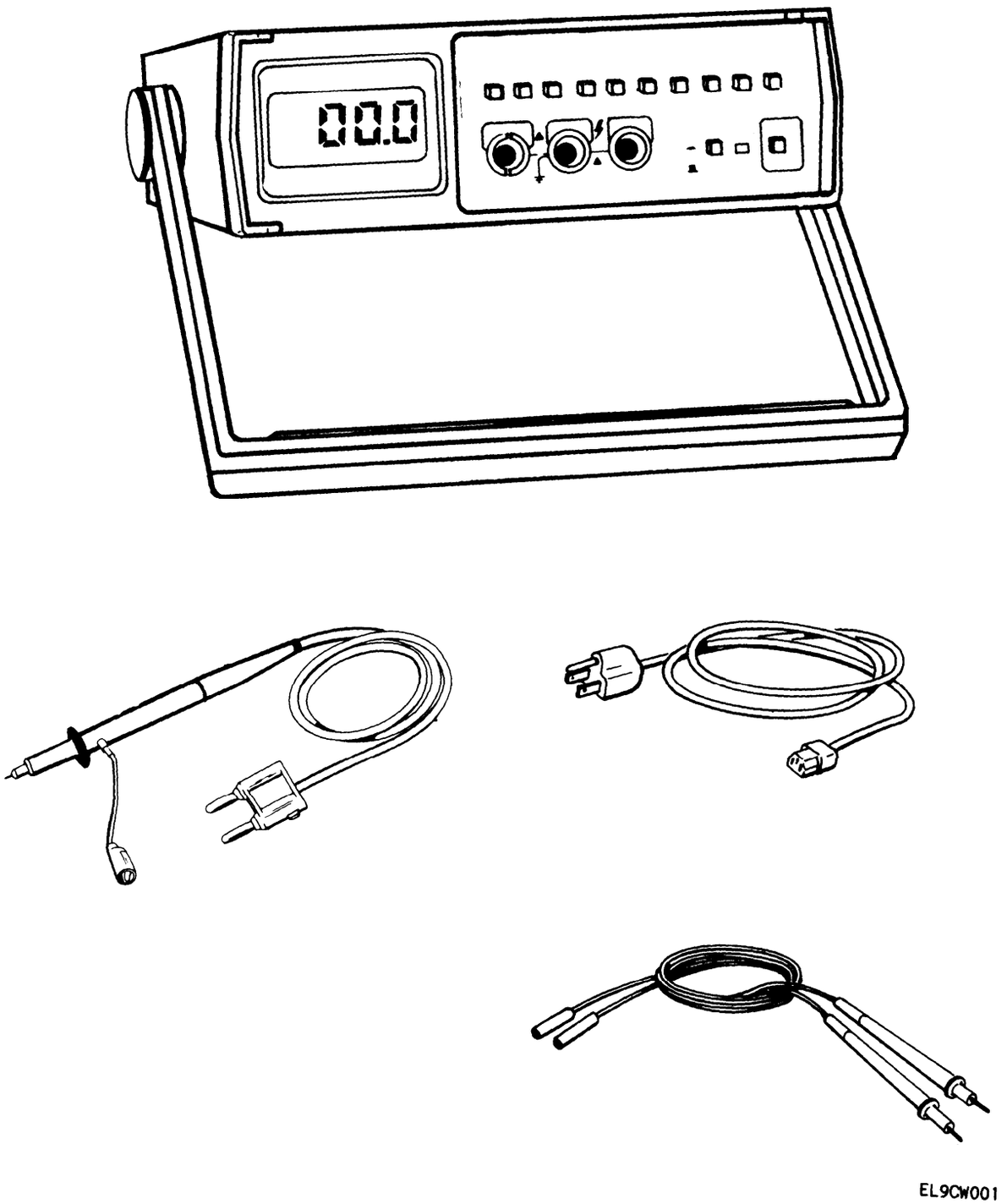


Figure 1-1. Digital Multimeter AN/USM-486/U

CHAPTER 1
INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

This manual describes the Digital Multimeter AN/USM-486/U (multimeter) and provides instructions for operation and maintenance. It gives directions on how to clean and inspect the multimeter. Testing, troubleshooting, and repair procedures are given for organizational and general support maintenance personnel. The multimeter (figure 1-1) is a portable, bench-type multimeter used to measure ac/dc volts, ac and dc current, resistance, and conductance.

1-2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS

Refer to the latest issue of DA Pam 25-30 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

1-3. MAINTENANCE FORMS, RECORDS, AND REPORTS

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 750-8 as contained in The Army Maintenance Management System (TAMMS) Users Manual.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 [Report of Discrepancy (ROD)] as prescribed in AR 735-11-2/DLAI 4140.55/SECNAVINST 4355.18A/AFJMAN 23-215.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in DA Pam 25-30.

1-4. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE

Demolition and destruction of electronic equipment will be under the direction of the Commander and in accordance with TM 750-244-2.

1-5. PREPARATION FOR STORAGE OR SHIPMENT

Storage and shipment procedures for the multimeter are in chapters 3 and 5.

1-6. SAFETY, CARE, AND HANDLING

Observe all WARNINGS, CAUTIONS, AND NOTES in this manual. This equipment can be extremely dangerous if these instructions are not followed.

1-7. NOMENCLATURE CROSS-REFERENCE LIST

This listing identifies approved nomenclature usage that is different from the official nomenclature:

Common Name	Official Nomenclature
Multimeter 8050A-0l	Digital Multimeter AN/USM-486/U

1-8. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your multimeter needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about the multimeter. Let us know why you don't like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Aviation and Missile Command, AMSAM-MMC-MA-NM, Redstone Arsenal, AL. 35898-5000. We'll send you a reply.

1-9. WARRANTY INFORMATION

The Digital Multimeter AN/USM-486/U is warranted by John Fluke Mfg. Co., Inc. for 1 year. The warranty starts on the date of purchase by the original buyer. Report all defects in material or workmanship to your supervisor who will take appropriate action through your organizational maintenance shop.

1-10. LIST OF ABBREVIATIONS

This list identifies special or unique abbreviations, acronyms, or descriptors that are not in The American Society of Mechanical Engineering (AMSE), Abbreviations and Acronyms, ASME Y14.38:

Abbreviation	Term
AC x 1	AC buffer gain of 1 command
AC x 100	AC buffer gain of 100 command
AN/USM	Army-Navy/General utility-special-maintenance
AR	Army Regulation
AZ	auto zero
BII	basic issue item
BP	back plane drive signal, 50 Hz square wave
BT	low battery charge
C	operator/ crew
cm	centimeter
CMOS	complementary metal-oxide-semiconductor
DA	Department of the Army
dam	decibel referred to 1 milliwatt
dBV	decibel referred to 1 volt
dBW	decibel referred to 1 watt
DOD	Department of Defense
DE(+R)	de-integrate + reference used with a - input
DE(-R)	de-integrate - reference used with a + input
DISREP	discrepancy in shipment report
DMM	digital multimeter
DMWR	Depot maintenance work requirement
EIR	equipment improvement recommendation
F	direct support maintenance
Fa, Fb, Fc, Fd	function inputs to microprocessor
H	general support maintenance
HI	defines front panel high connection

Abbreviation	Term
Hz	hertz (formerly cps)
INT	integrate command
kg	kilogram
kHz	kilohertz
LO	defines front panel common connection
MAC	maintenance allocation chart
mA	milliampere
MHz	megahertz
mS	millisiemen
MOE	modified table of organization and equipment
mV	millivolt
mW	milliwatt
nA	nanoampere
NATO	North Atlantic Treaty Organization
nH	nanohenry
no	nanosiemen
NON	National/NATO stock number
o	organizational maintenance
pF	picofarad
Pk-Pk	peak-to-peak
PMCS	preventive maintenance checks and services
rqr	required
S	siemen
SMR	source, maintainability, and recoverability
S.S.	static sensitive
ST	sequential strobe pulses
TAMES	The Army Maintenance Management System
TIDE	test, measurement, and diagnostic equipment
U/M	unit of measure
µA	microampere
µV	microvolt

Section II. EQUIPMENT DESCRIPTION

1-11. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

The multimeter is a rugged, lightweight instrument used to measure the electrical properties of circuits during testing and troubleshooting.

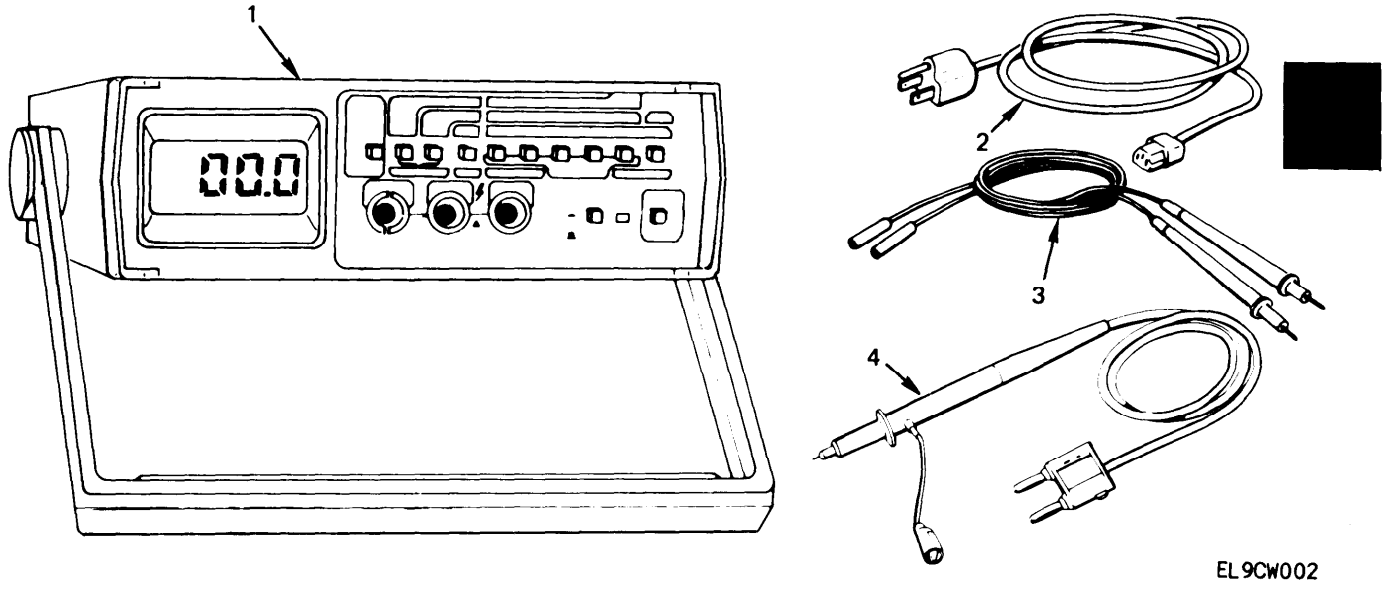
a. **Characteristics.**

- Measures ac voltage and dc voltage
- Measures ac current and dc current
- Measures db voltage
- Measures resistance
- Measures conductance

b. **Capabilities and Features.**

- Stores any input signal as an offset or relative reference value
- Turns on PN junctions, allowing testing of diodes and transistors
- 4-1/2-digit LCD (liquid crystal display) for easy reading
- Pushbutton power, function, and range switches simplify operation

1-12. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS



MULTIMETER (1) — The multimeter is a self-contained, multirange measuring instrument. It measures and indicates various electrical characteristics needed to test and troubleshoot electrical equipment. It has a carrying handle that can be adjusted as an eight-position stand for convenient viewing.

AC POWER CORD (2) — Provides for operation from the ac power line.

STANDARD TEST LEADS (3) — Red and black leads to connect the multimeter to circuit under test in normal use.

RF PROBE (4) — Replaces standard test leads (3) for high frequency measurements above 100 kHz.

1-13. EQUIPMENT DATA

DC VOLTAGE:	
Ranges	200 mV, 2 V, 20 V, 200 V, 1000 V
Max. Input Signal Limits	1000 v
Accuracy	±(0.03% + 2 digits) on all ranges
Response Time	1 sec max to rated accuracy in range
AC VOLTAGE:	
Ranges	200 mV, 2 V, 20 V, 200 V, 750 V
Conversion Type	True rms, ac coupled
Extended Freq. Response	-3 dB at 200 kHz typical
Max. Input Signal Limits	1000 V peak ac, 750 V rms or 10^7 V÷HZ
Accuracy:(5% to l00% of range)	±(1% + 10 digits) at 20 Hz to 45 Hz
	±(0.5% + 10 digits) at 45 Hz to 10 kHz
	±(1% + 10 digits) at 10 kHz to 20 kHz
	±(2% + 10 digits) at 20 kHz to 50 kHz
Response Time	2 sec max to rated accuracy in range
DC CURRENT:	
Ranges	200 µA, 2 mA, 20 mA, 200 mA, 2000 mA
Max. Input Signal Limits	2 A, 250 V fuse protected
Accuracy:	
200 µA to 200 mA Range	±(0.2% + 1 digit)
2000 mA Range	±(0.3% + 2 digits)
Response Time	1 sec max to rated accuracy in range
AC CURRENT:	
Ranges	200 µA, 2 mA, 20 mA, 200 mA, 2000 mA
Conversion Type	True rms, ac coupled
Max. Input Signal Limits	2 A, 250 V fuse protected
Accuracy: (5% to 100% of range)	
200 µA to 200 mA Range	±(1% + 25 digits) at 20 Hz to 45 Hz
	±(1% + 10 digits) at 45 Hz to 10 kHz
	±(2% + 10 digits) at 10 kHz to 20 kHz
2000 mA Range	±(2% + 10 digits) at 20 Hz to 20 kHz
Response Time	2 sec max to rated accuracy in range
RESISTANCE:	
Ranges	200 ohm; 2, 20, 200, and 2,000 kohm, 20 Megohm
Max. Input Signal Limits	500 V dc or ac rms
Accuracy:	
200 ohm to 2000 kohm Ranges	±(0.1% + 1 digit)
20 Megohm Range	±(0.2% + 2 digits)
AC VOLTAGE, dB MODE:	
(AC Voltage Specs above apply except Accuracy):	
0.77 mV to 2 mV Range	±0.5 dBm from 20 Hz to 20 kHz
2 mV to 750 V Range	±0.25 dBm at 20 Hz to 45 Hz
	±0.15 dBm at 45 Hz to 10 kHz
	±0.25 dBm at 10 kHz to 20 kHz
	±0.75 dBm at 20 kHz to 50 kHz

CONDUCTANCE:

Ranges	2 mS, 200 nS
Equivalent Resistance	500 ohm to 1 0 Megohm (2 mS); 5 megohm to 100,000 Megohm (200 nS)
Accuracy:	
2 mS Range	±(0.1% + 5 digits)
200 nS Range	±(0.5% + 20 digits)

GENERAL:

Input Impedance (Volts)	10 Megohm, < 100 pF, all ranges
Operating Temperature	32° F(0°C)to 122°F(50°C)
Storage Temperature	-67°F(-55°C) to 149°F(65°C)
Battery Operating Time	10 hours, typical (rechargeable Ni-Cads)
Battery Recharge Time	14 hours, full charge (power switch off)
Size	Height =2.52 in. (6.40 cm) Width =8.55 in. (21.72 cm) Depth = 10.65 in. (27.05 cm) with handle
Weight	4 lb, 12 oz (2.15kg) complete end item
Power Consumption	4 watts max
Power Requirements	47 to 440 Hz at 90 to 110V, 105 to 132 V, or 200 to 264 V (field changeable)

HIGH FREQUENCY PROBE:

Ac to dc ratio	1:1
Voltage Range	0.25 to 30 V rms
Max. Input Voltage	30 V rms, 200 V dc
Input Capacitance	Approximately 3 pF
Connector	Fits std 0.75-in. (1.9 cm) dual banana connectors
Rated Accuracy	±5% at l MHz and 10 megohm load

Section III. TECHNICAL PRINCIPLES OF OPERATION

1-14. GENERAL DESCRIPTION

Figure 1-2 shows the major operating sections of the multimeter. Internal meter circuitry is protected from damage by input signal voltage and current protection circuits. The function and range pushbuttons select and route the input signal through the signal conditioners. The signal conditioners develop a de-voltage level at the input to the analog-to-digital (a/d) converter. Thea/d converter, working with the microcomputer, changes the analog value of the input signal into a digital value. The microcomputer processes this digital value to a format useable by the display drivers which produce voltages that create the LCD readout.

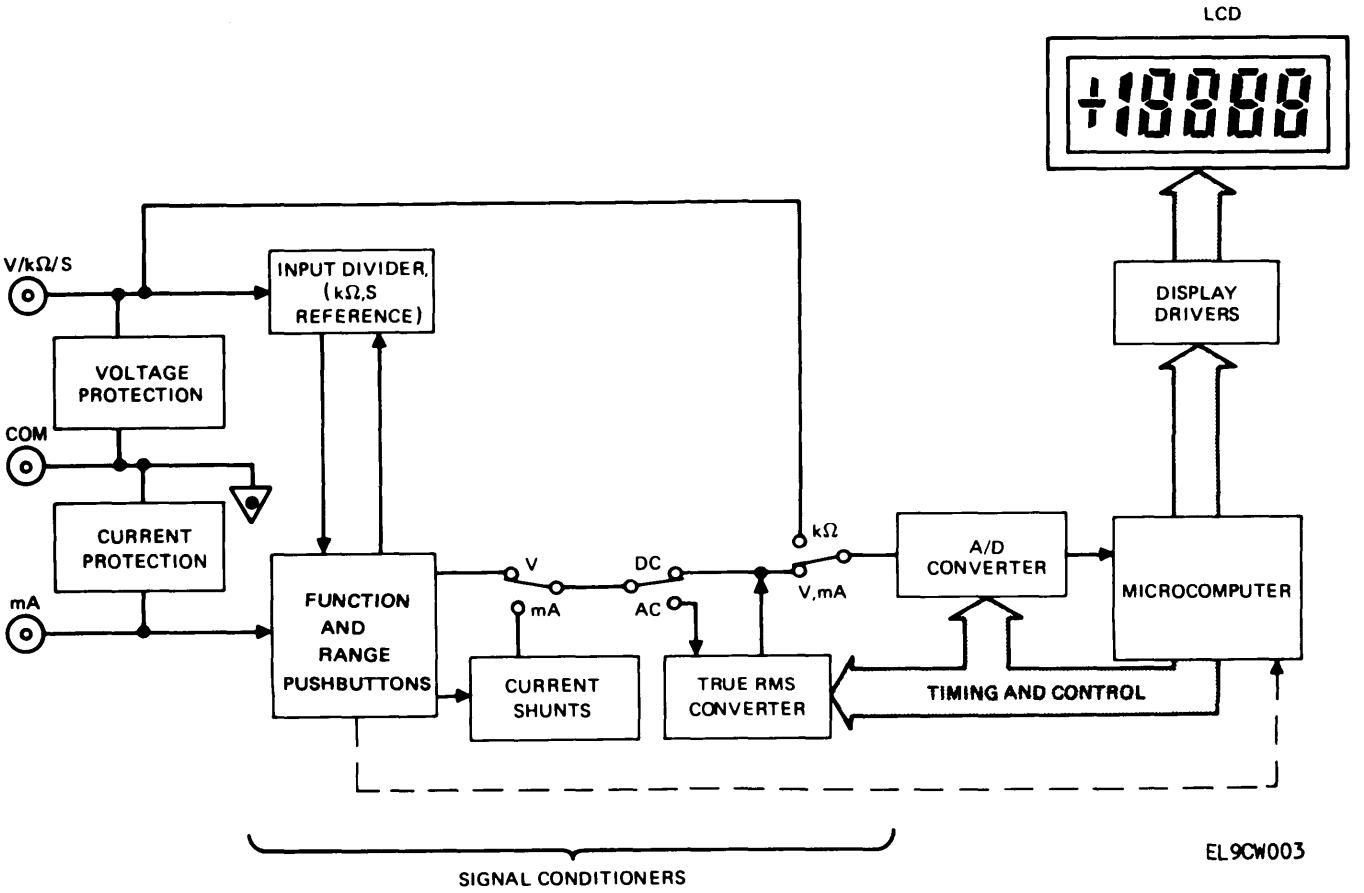


Figure 1-2. Multimeter Functional Block Diagram

1-15. OPERATIONAL DESCRIPTION

a. **Liquid Crystal Display.** The LCD can easily be read from several feet away. With its 4-1/2 digits it can register from 0000 to 19999. For ease of discussion, the 19999 will be rounded off to 20000 in this manual. That is, we will refer to the 2 V range, not the 1.9999 V range. Figure 1-3 shows the LCD with all possible elements in the display illustrated. This cannot happen in real life and is only shown here to make it easier to describe the elements.

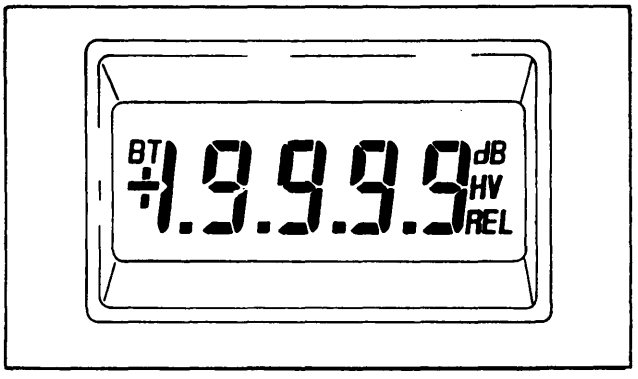


Figure 1-3. Liquid Crystal Display

b. **POWER ON/OFF Pushbutton.** The green POWER ON/OFF pushbutton (figure 1-4) is a push-push switch In is (ON) and out is (OFF). With no ac power connected to the multimeter, the pushbutton energizes the multimeter with battery power. The batteries will charge in the out (OFF) position if a power cord is plugged into the rear of the multimeter and connected to an ac line source. The mltimeter will also operate on ac line power in the in (ON) position, provided the batteries are not discharged.

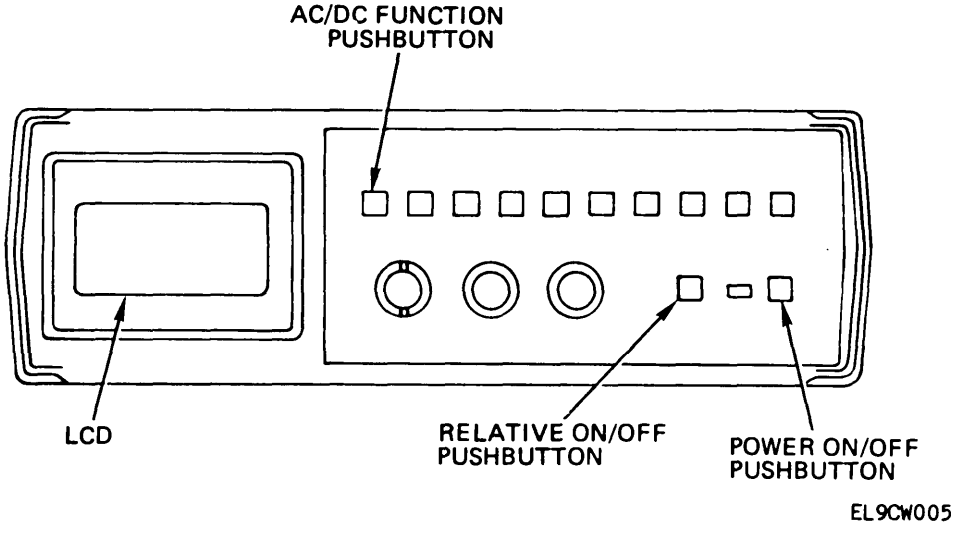


Figure 1-4. POWER, RELATIVE, and AC/DC Pushbuttons

c. **RELATIVE ON/OFF Pushbutton.** The white RELATIVE ON/OFF pushbutton, just to the left of the POWER ON/ OFF pushbutton (figure 1-4), allows direct measurements to be made in relation to a reference level. When the RELATIVE ON/ OFF pushbutton is in (ON), the LCD displayed value is the input signal measurement with a stored reference level algebraically subtracted.

d. **AC/DC Function Pushbutton.** This pushbutton (figure 1-4) is used to select either ac or dc measurements. It works for both voltage and current measurements. Push in once for (AC) and in again for (DC).

e. **Measurement Control Groups.** The following paragraphs describe the grouping of controls and indicators to make measurements with the multimeter. Also pointed out are any special features or techniques used.

(1) Linear Voltage Measurements. This multimeter will make either linear or dB voltage measurements. The controls and terminals for making linear and dB voltage measurements are shown in figure 1-5. The AC/ DC function pushbutton is used first to select whether ac or dc voltage is to be measured. Next the V function pushbutton is depressed to set up the meter input circuitry to measure voltage. The light green area above the V pushbutton extends up and to the right to enclose the five range values of the voltage function. Depress the desired voltage range pushbutton for the expected voltage being measured.

(2) RF Probe Measurements. The RF probe converts the dc voltmeter function of the multimeter into a high frequency ac voltmeter. Ac voltages of 100 kHz to 500 MHz at 0.25 to 30 V rms may be measured. The probe's dc output is calibrated to be equivalent to the rms value of a sine wave input.

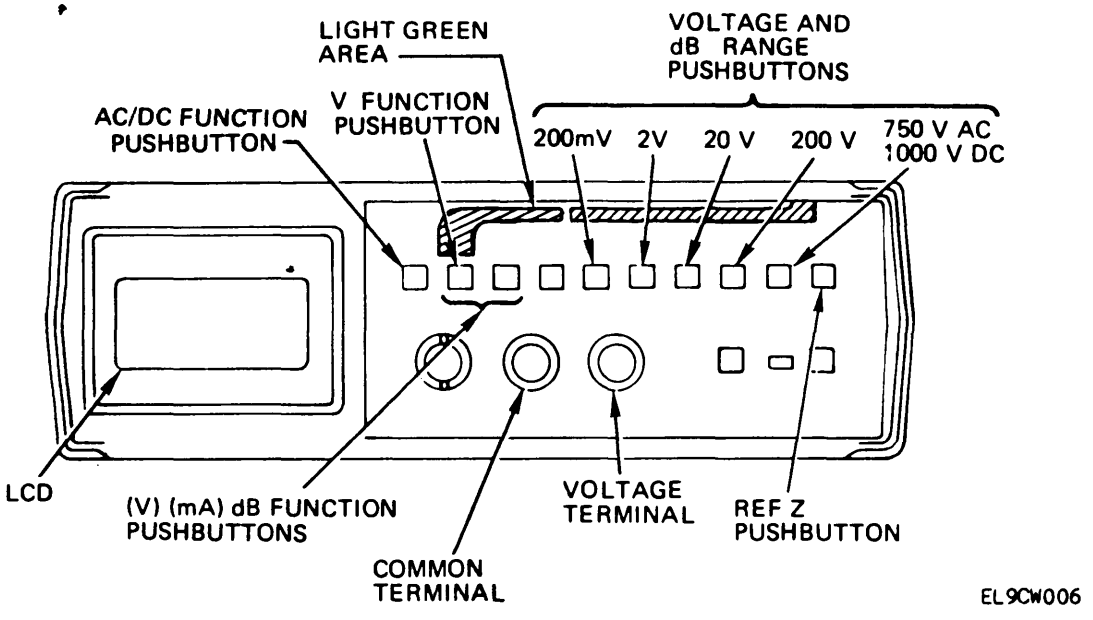


Figure 1-5. Voltage Measurement Controls

(3) dB Voltage Measurements. The controls and terminals for making dB voltage measurements are almost the same as those for linear voltage measurements (figure 1-5). One major difference is that both the V and mA function pushbuttons must be depressed at the same time to select the dB function. The five range pushbuttons are enclosed by a dark blue area and are the same as the linear voltage ones.

(4) Stored Reference Impedances. The standard dB voltage measurements are referenced to 600 ohms for 0 dBm. This standard reference impedance comes up automatically when the multimeter is turned on and dB voltages selected. The multimeter also has 15 other reference impedances (table l-l) stored for use if needed. To select one of the 15, select dB and depress the REF Z pushbutton. For the first 3 seconds, the LCD will display the standard reference impedance of 600 ohms. Then the other 15 stored reference impedances will appear sequentially on the display at the rate of about one per second. When the reference impedance you want to use appears, select any one of the dB ranges. The sequence will stop and the microcomputer will store the displayed impedance as the reference. Normal dB measurements can now be resumed. The multimeter will continue to use the selected reference impedance until you select another or the multimeter is turned off.

Table 1-1. Display Sequence of Reference Impedances

Sequence Number	Reference Impedance 1 mW = 0 dB	Display	Remarks
0	600	600	
1	800	800	
2	900	900	
3	1000	1000	dBV
4	1200	1200	
5	8000	8	dBW into 8 ohms
6	50	50	
7	75	75	
8	93	93	
9	110	110	
10	125	125	
11	135	135	
12	150	150	
13	250	250	
14	300	300	
15	500	500	
REPEATS	REPEATS	REPEATS	REPEATS

(5) Current Measurements. The controls and terminals for current measurements are shown in figure 1-6. The AC/DC and mA function pushbuttons select the correct input circuitry. The pink colored area above the mA pushbutton extends up and to the right to enclose the five range value pushbuttons for measuring current.

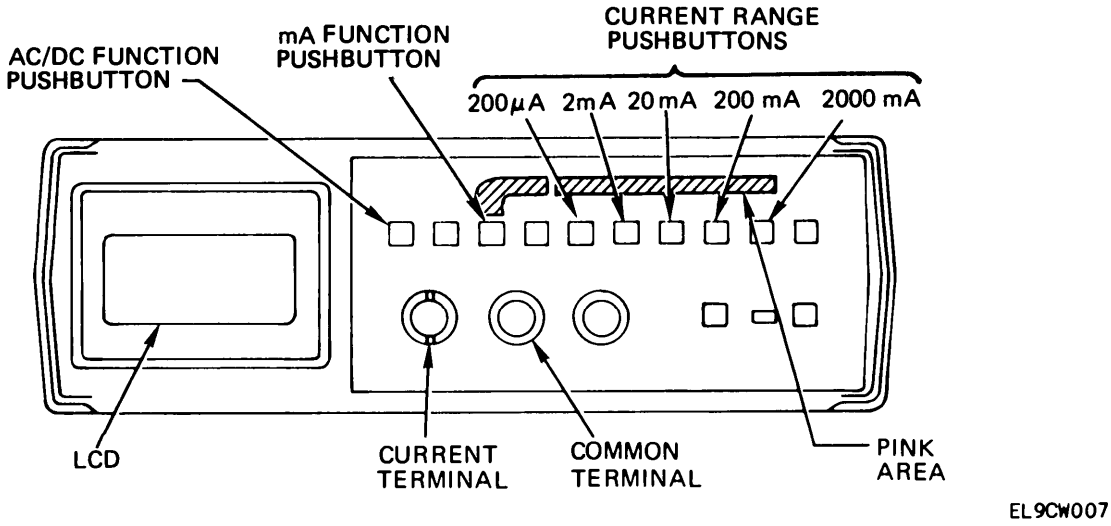


Figure 1-6. Current Measurement Controls

(6) Resistance Measurements. The controls and terminals for resistance measurements are shown in figure 1-7. The k Ω function pushbutton sets up the multimeter input circuitry for resistance measurements. The gold colored area above the k Ω function pushbutton extends up and to the right to enclose the six range value pushbuttons for measuring resistance.

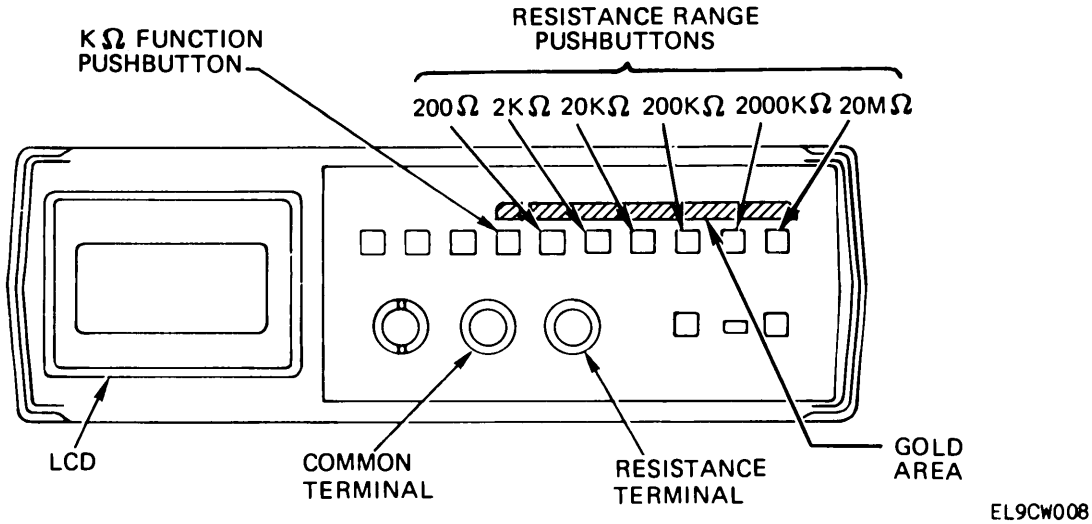


Figure 1-7. Resistance Measurement Controls

(7) Conductance Measurements. The controls and terminals for conductance measurements are shown in figure 1-8. Except for range selection, they are exactly the same as for resistance measurements. There are two conductance measurement ranges: 2 mS and 200 nS. Each range is selected by depressing the two indicated range pushbuttons at the same time.

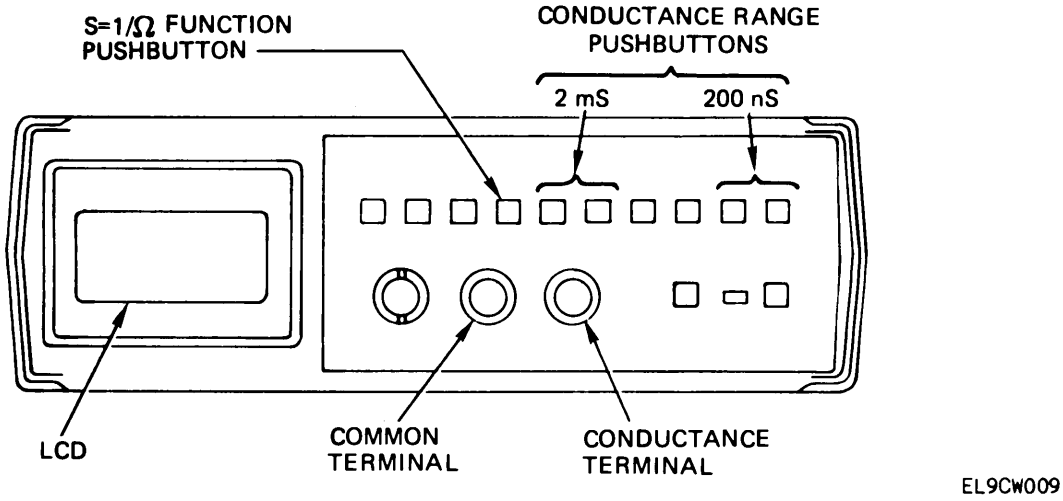
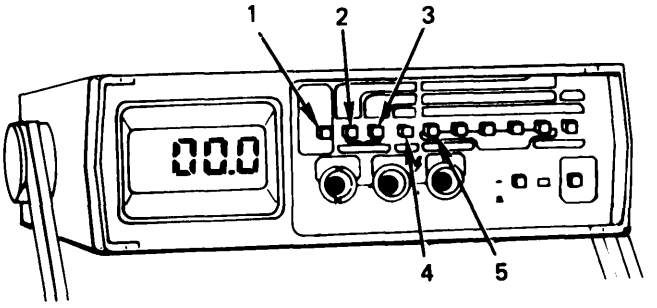


Figure 1-8. Conductance Measurement Controls

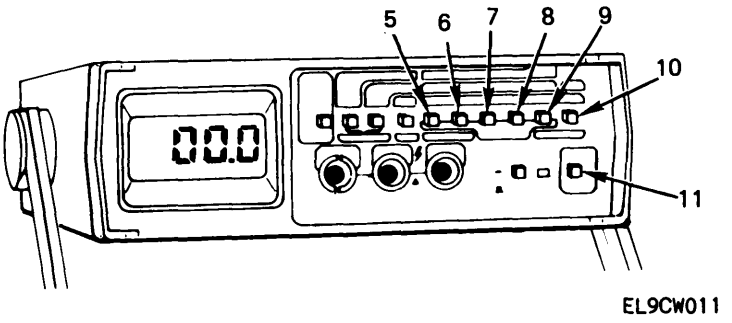
CHAPTER 2
OPERATING INSTRUCTIONS

Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS

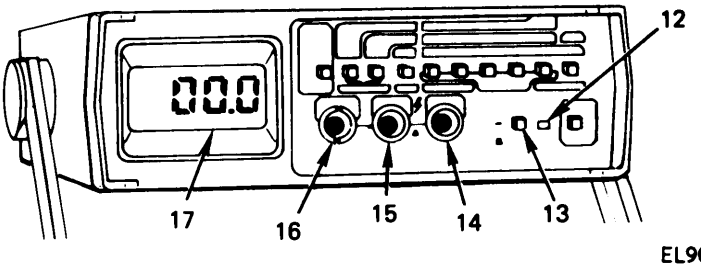


EL9CW010

Key	Control Or Indicator	Function
1	AC/ DC Function Pushbutton	In: selects AC use for volts or milliamps. Out: selects DC use for volts or milliamps.
2	V Function Pushbutton	In: selects voltage measurement function. Out: voltage function inoperative.
2-3	dB Function Pushbuttons	In: (Both pushbuttons), selects power display in decibels for voltage measurements.
3	mA Function Pushbutton	In: selects current measurement function. Out: current function inoperative.
4	k Ω /S= 1 / Ω Function Pushbutton	In: selects resistance or conductance measurement function. Out: resistance and conductance functions inoperative.
5	200 mV/200 µA/200 Ω Range Pushbutton	In: selects first range; 200 millivolts, 200 microamps, or 200 ohms.



Key	Control Or Indicator	Function
5-6	2 mS Range Pushbutton	In: (both pushbuttons), selects 2 mS conductance range.
6	2 Range Pushbutton	In: selects second range; 2 volts, 2 milliamps, or 2 kilohms.
7	20 Range Pushbutton	In: selects third range; 20 volts, 20 milliamps, or 20 kilohms.
8	200 Range Pushbutton	In: selects fourth range; 200 volts, 200 milliamps, or 200 kilohms.
9	750V AC/ 1000V DC/2000 Range Pushbutton	In: selects fifth range; 750 volts ac, 1000 volts dc, 2000 milliamps, or 2000 kilohms.
9-10	200 nS Range Pushbutton	In: (both pushbuttons), selects 200 nS conductance range.
10	REF Z/20M W Range Pushbutton	In: selects 20 megohm resistance range or offers list of reference impedances to choose for dB.
11	POWER ON/OFF Pushbutton	In (ON): energizes multimeter using internal batteries or ac line power if power is connected. Out (OFF): Multimeter is shut off. Batteries will charge if power is connected.



Key	Control Or Indicator	Function
12	BAT CHG Indicator	Lights when battery pack is charging.
13	RELATIVE ON/ OFF Pushbutton	In (ON): stores value displayed when pressed to ON and subtracts the value from later measurements in the same function.
14	V/ K Ω/ S Terminal	Receptacle for red test lead when measuring voltage, resistance, or conductance. Also used as input from accessories.
15	COMMON Terminal	Receptacle for black test lead for all measurements.
16	mA Terminal	Receptacle for red test lead when measuring current.
17	Liquid Crystal Display (LCD) Indicator	High-contrast, 4-1/2-digit display that indicates measurements from 0000 to 19999. Decimal placement is determined by range selected.

Section II. OPERATION UNDER USUAL CONDITIONS

2-1. ASSEMBLY AND PREPARATION FOR USE

Procedures for unpacking, checking, and assembling the multimeter are given in Chapter 3, Section 11 (notify organizational maintenance personnel).

2-2. INITIAL ADJUSTMENTS, CHECKS, AND TESTS

a. **Adjustments.** There are no operator adjustments for the multimeter.

b. **Checks.** Upon receipt, perform the complete Preventive Maintenance Checks and Services (PMCS) as detailed in Chapter 3, Section 111.

c. **Operational Test.**

(1) Depress POWER ON/OFF pushbutton (1) to in (ON). If BT annunciator is displayed, batteries need recharging.

- Depress POWER ON/OFF pushbutton (1) to out (OFF).
- Plug ac power cord into multimeter rear ac power receptacle.
- Plug ac power cord into ac line.
- In this condition, batteries will fully charge in about 14 hours.

NOTE

If batteries were fully discharged, wait 5 minutes before continuing with the test.

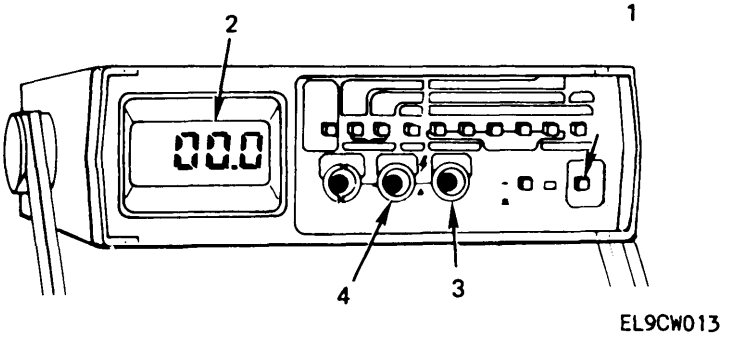
(2) Depress POWER ON/OFF pushbutton (1) to in (ON). As an option, the multimeter will operate on ac power with charged batteries.

NOTE

- If batteries did not accept a charge, the multimeter will not operate on ac power.
- When batteries are fully charged, disconnect the ac power cord and operate the multimeter on battery power.

(3) Note that readout occurs on LCD display (2).

(4) Plugred test lead into V/k, Ω /S terminal (3) and black test lead into COMMON terminal (4). Multimeter is ready for normal operation.



2-3. OPERATING PROCEDURES

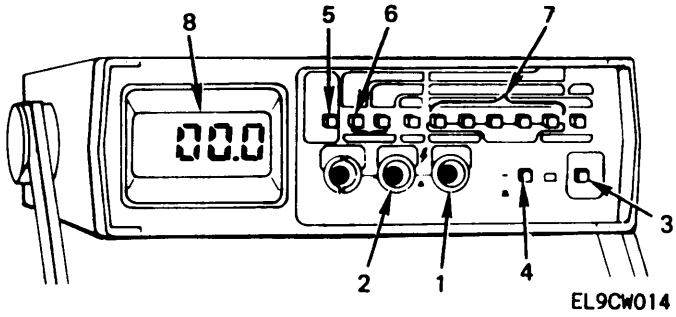
a. **Dc Voltage Measurement.**

(1) Plug red standard test lead into V/ k Ω / S terminal (l).

(2) Plug black standard test lead into COMMON terminal (2).

(3) Set multimeter pushbuttons as follows:

- POWER ON/OFF (3) to in (ON)
- RELATIVE ON/OFF (4) to out (OFF)
- AC/DC (5) to out (DC)
- V function (6) to in (V)



WARNING

Do not attempt to measure voltages on the 1000V DC range which might be greater than 1000 volts.

(4) Depress appropriate (7) voltage range pushbutton (if voltage being measured is unknown, use 1000V DC pushbutton first and work down).

(5) Connect test leads to circuit being measured.

(6) Observe LCD display,(8). Display will show correct polarity, - for negative and no sign for positive. The value of the voltage being measured will be appear as a decimal readout.

(7) Disconnect test leads from circuit being measured after measurement is complete.

(8) Depress POWER ON/OFF pushbutton (3) to out (OFF) position.

☆U.S. GOVERNMENT PRINTING OFFICE: 1991 - 512-085/40142

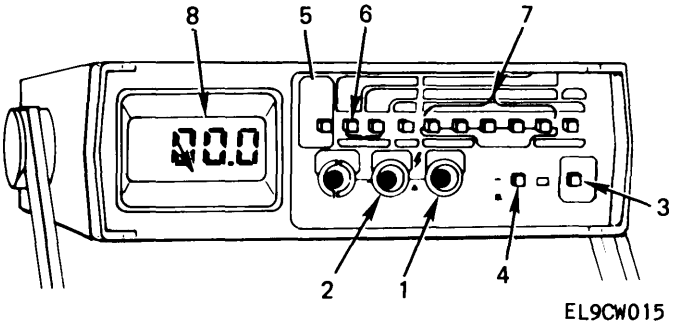
b. **Ac Voltage Measurement.**

(1) Plug red standard test lead into V/ k Ω / S terminal (1).

(2) Plug black standard test lead into COMMON terminal (2).

(3) Set multimeter pushbuttons as follows:

- POWER ON/OFF (3) to in (ON)
- RELATIVE ON/ OFF (4) to out (OFF)
- AC/DC (5) to in (AC)
- V function (6) to in (V)



WARNING

Do not attempt to measure voltages on the 750V AC range which might be greater than 750 V ac rms or 1000 V peak.

(4) Depress appropriate (7) voltage range pushbutton (if voltage being measured is unknown, use 750V AC pushbutton first and work down).

(5) Connect test leads to circuit being measured.

(6) Observe LCD display (8). Display will show the value of the voltage being measured as a decimal readout.

(7) Disconnect test leads from circuit.

(8) Depress POWER ON/ OFF pushbutton (3) to out (OFF) position.

c. **High Frequency Ac Voltage Measurement.** The RF probe allows measurement of ac voltages from 100 kHz to 500 MHz at 0.25 to 30 V rms. Even though the measurements are ac, they use the dc voltmeter functions. The dB mode (para 2-3d) can be used on DC to display probe measurements in dBm.

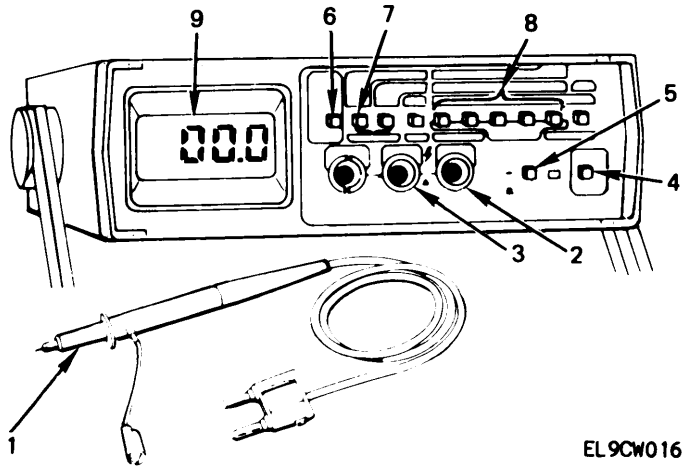
CAUTION

To avoid probe damage, the dc component of the input signal must not exceed 200 volts including transients. The maximum probe inputs are 30 V ac rms and 200 V dc. The chance of damage may be reduced by discharging the probe's input capacitor at the end of each measurement by momentarily touching the probe tip to the ground clip.

(1) Plug dual-prong end of RF probe (1) into V/ k Ω / S (2) and COMMON (3) terminals ensuring that side of plug with tab marked GND goes into COMMON (3) terminal.

(2) Set multimeter pushbuttons as follows:

- POWER ON/OFF (4) to in (ON)
- RELATIVE ON/ OFF (5) to out (OFF)
- AC/ DC (6) to out (DC)
- V function (7) to in (V)



(3) Depress appropriate (8) voltage range pushbutton for range to be measured (display reading is same as voltage measured).

NOTE

- For measurement below 100 MHz, ground clip lead near point of measurement and touch probe tip to circuit under test.
- For measurement between 100 MHz and 300 MHz, use minimum cable lengths to terminated 50-ohm system.
- For measurement above 300 MHz, both probe tip and ground shield must touch circuit under test for rated accuracy.

(4) Connect probe to circuit being measured.

(5) Observe LCD display (9). Display will show the value of the voltage being measured as a decimal readout.

(6) Disconnect probe from circuit being measured after measurement is complete.

(7) Depress POWER ON/OFF pushbutton (4) to out (OFF) position.

(8) Unplug RF probe (1) from input terminals.

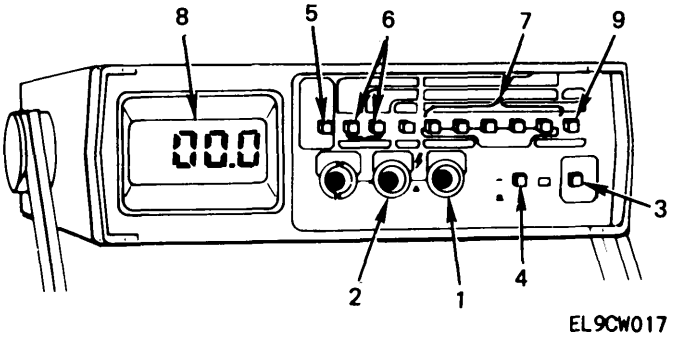
d. **dB Voltage Measurement.** The multimeter can be used to determine the bandwidth of an amplifier or filter as a typical dB voltage measurement.

(1) Plug red standard test lead into V/ k Ω / S terminal (1).

(2) Plug black standard test lead into COMMON terminal (2).

(3) Set multimeter pushbuttons as follows:

- POWER ON/OFF (3) to in (ON)
- RELATIVE ON/OFF (4) to out (OFF)
- AC/ DC (5) to in (AC)
- Depress at same time:
  - V function (6) to in (dB)
  - mA function (6) to in (dB)



WARNING

- Do not attempt to measure voltages on the 750V AC range which might be greater than 750 V ac rms or 1000 V peak.
- Do not connect the COMMON terminal to more than 500 V dc or peak ac above earth ground. Electrical shock and/ or multimeter damage may result.

(4) Depress desired dB range pushbutton (7).

(5) Place test leads across voltage to be measured.

(6) Observe that display (8) reads dB. The reading is equivalent to dBm referenced to 600 ohm impedance.

- The reference impedance can be chosen from a list of 16 impedances using the REF Z pushbutton as described in paragraph 1-15e, steps (4) and (5).

OR

- A reference impedance not listed can be established. Apply and adjust an ac signal in the voltage mode to read the zero dB voltage for the desired reference impedance.

$$\text{zero dB voltage} = \sqrt{0.001\ Z_{ref}}$$

- Depress pushbuttons for dB and then for RELATIVE.

OR

- When using the wrong reference impedance, correction can be made to the reading by adding the correction factor below.

$$\text{dB correction factor} = 10 \log (\text{REF Z/CKT Z})$$

- Relative dB measurements allow gain or loss measurements displayed in dB. In this case REF Z is ignored but not changed during readings. The reference level is set to zero dB by depressing the RELATIVE ON/ OFF pushbutton while measuring your reference signal, displayed in dB. Further dB measurements will then be referenced to your reference signal level until you release the RELATIVE ON/OFF pushbutton or turn the unit off.

(7) Disconnect test leads from circuit.

(8) Depress POWER ON/ OFF pushbutton (3) to out (OFF) position.

e. **Dc Current Measurement.**

(1) Plug red standard test lead into mA terminal (1).

(2) Plug black standard test lead into COMMON terminal (2),

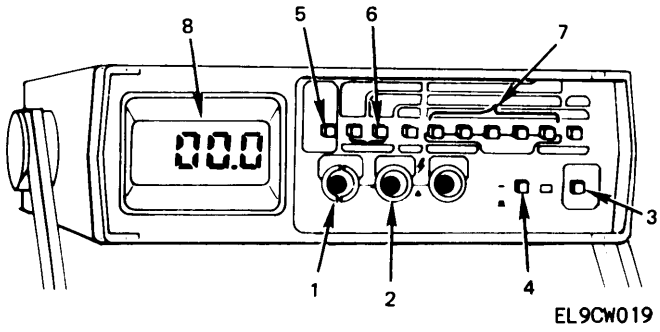
(3) Set multimeter pushbuttons as follows:

. POWER ON/OFF (3) to in (ON)

l RELATIVE ON/OFF (4), to out (OFF)

l AC/DC (5) to out (DC)

. mA (6) to in (mA)



WARNING

Operator injury and/ or multimeter damage may result if the protective fuse blows while current is being measured in a circuit with an open circuit voltage more than 600 V. Do not attempt to measure current greater than 2000 mA.

(4) Depress appropriate (7) current range pushbutton (if current being measured is unknown, use 2000 mA pushbutton first and work down).

WARNING

Remove all power from circuit being measured and discharge all capacitors before connecting test leads.

(5) Connect test leads in series in circuit being measured.

(6) Apply power to circuit being measured.

(7) Observe LCD display (8). Display will show the value of the current being measured as a decimal readout.

WARNING

Remove all power from circuit being measured after the measurement is complete.

(8) Disconnect test leads from circuit being measured after measurement is complete.

(9) Depress POWER ON/OFF pushbutton (3) to out (OFF) position

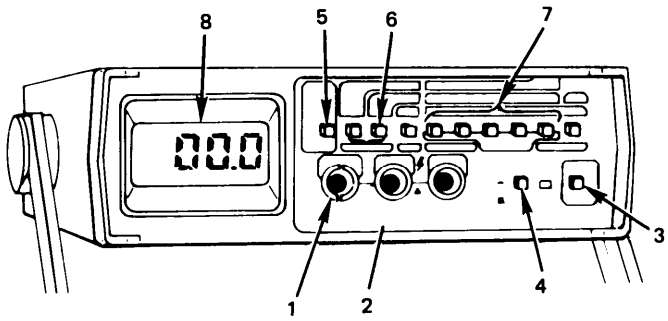
f. **Ac Current Measurement.**

(1) Plug red standard test lead into mA terminal (1).

(2) Plug black standard test lead into COMMON terminal (2).

(3) Set multimeter pushbuttons as follows:

- POWER ON/OFF (3) to in (ON)
- RELATIVE ON/OFF (4) to out (OFF)
- AC/DC (5) to in (AC)
- mA (6) to in (mA)



EL9CW020

WARNING

Operator injury and/ or multimeter damage may result if the protective fuse blows while current is being measured in a circuit with an open circuit voltage more than 600 V. Do not attempt to measure current greater than 2000 mA.

(4) Depress appropriate (7) current range pushbutton (if current being measured is unknown, use *2000* mA pushbutton first and work down).

WARNING

Remove all power from circuit being measured and discharge all capacitors before connecting test leads.

(5) Connect test leads in series in circuit being measured.

(6) Apply power to circuit being measured.

(7) Observe LCD display (8). Display will show the value of the current being measured as a decimal readout.

WARNING

Remove all power from circuit being measured after the measurement is complete.

(8) Disconnect test leads from circuit being measured after measurement is complete.

(9) Depress POWER ON/OFF pushbutton (3) to out (OFF) position.

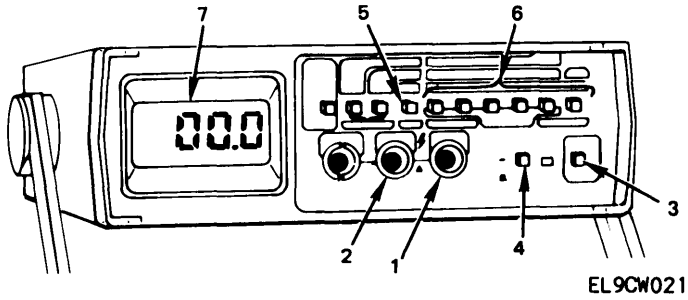
g. **Resistance Measurement.**

(1) Plug red standard test lead into V/ k Ω / S terminal (1).

(2) Plug black standard test lead into COMMON terminal (2).

(3) Set multimeter pushbuttons as follows:

- POWER ON/OFF (3) to in (ON)
- RELATIVE ON/ OFF (4) to out (OFF)
- k Ω /S=l / Ω (5) to in (k Ω)



CAUTION

Accidental input of voltage greater than 500 V dc or ac rms when the multimeter is in the resistance mode may damage the multimeter.

NOTE

When measuring low resistances, test lead resistance may cause wrong readings. Test lead resistance should be subtracted from the display reading for correct readings.

(4) Short test lead tips together and press RELATIVE ON/ OFF (4) pushbutton to in (ON). Test lead resistance will be automatically subtracted from following readings.

(5) Depress appropriate (6) resistance range pushbutton (if test resistance is unknown, use 20M Ω pushbutton first and work down).

CAUTION

Remove all power from circuit being measured and discharge all capacitors before connecting test leads.

(6) Connect test leads across resistance to be measured.

(7) Display (7) will indicate value of unknown resistance.

(8) Disconnect test leads from circuit.

(9) Depress POWER ON/ OFF pushbutton (3) to out (OFF) position.

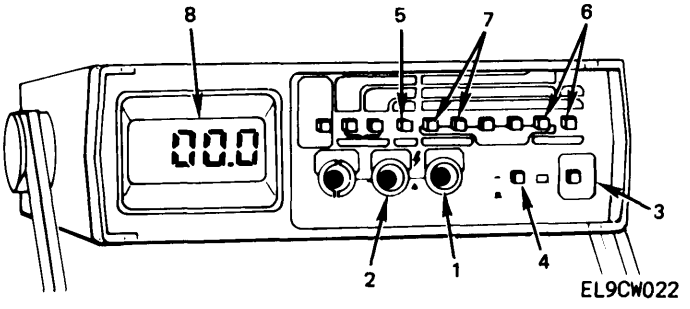
h. **Conductance Measurement.**

(1) Plug red standard test lead into V/k Ω /S terminal(l).

(2) Plug black standard test lead into COMMON terminal (2).

(3) Set multimeter pushbuttons as follows:

- POWER ON/OFF (3) to in (ON)
- RELATIVE ON/OFF (4) to out (OFF)
- Depress both 200 nS pushbuttons (6) at same time (ON)
- k Ω /S= 1 / Ω pushbutton (5) to in (ON)



WARNING

Remove all power from circuit being measured and discharge all capacitors before connecting test leads.

CAUTION

Do not input voltage greater than 500 V dc or ac rms when in the conductance mode or it may damage the multimeter.

NOTE

The low conductance range (200 nS) can be used for making resistance measurements from 5 megohms to 100,000 megohms. Except for high-voltage stress testing, this range can be used instead of a megger.

(4) Hold sampling ends of test leads apart. After settling, display should read 00.01 to 00.20.

(5) Connect test leads across conductance to be measured.

(6) Display (8) will indicate value of unknown conductance.

(7) Disconnect test leads from circuit being measured.

(8) Depress POWER ON/ OFF pushbutton (3) to out (OFF) position.

i. **Diode Test.** The three resistance ranges with a diode symbol beside the range value have a high enough measurement voltage to turn on a silicon junction. These ranges can be used to check silicon diodes and transistors. The 2 kohm range is marked with the largest symbol and is the preferred range. The measurement voltage is too low on unmarked ranges to turn on a silicon junction and they may be used to make in-circuit resistance measurements.

Section III. OPERATION UNDER UNUSUAL Conditions

2-4. OPERATION IN UNUSUAL WEATHER

The multimeter was designed as a bench-type meter to be used in a controlled environment. It does not have a weatherproof or waterproof case. It may be used outdoors as long as it is protected from extreme heat, excessive cold, water, sand, mud, or similar conditions. Refer to chapter 1, paragraph 1-13 for multimeter specifications that should not be exceeded.

2-5. EMERGENCY PROCEDURES

The multimeter contains internal battery assemblies for up to 10 hours operation in the absence of ac line power. Battery operation is selected automatically when the POWER ON/ OFF pushbutton is depressed if no ac line power is available. Refer to chapter 3, table 3-1 for battery checks and recharge procedures.

CHAPTER 3
OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

3-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) at your unit.

3-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

There are no special tools required for operator and organizational maintenance of the Digital Multimeter AN/USM-486/U.

3-3. REPAIR PARTS

Repair parts are listed and illustrated in the Repair Parts and Special Tools List (TM 11-6625-3055-24P) covering organizational and general support maintenance for Digital Multimeter AN/USM-486/U.

Section II. SERVICE UPON RECEIPT

3-4. UNPACKING

The multimeter is shipped assembled in its original packing container. Unpack carefully and do not damage the container while unpacking. Save the container for use in reshipment.

3-5. CHECKING UNPACKED EQUIPMENT

a. Inspect the equipment for damage incurred during shipment. Report any damage on SF 364, Report of Discrepancy.

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 750-8.

c. Check to see whether the equipment has been modified.

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

3-6. GENERAL

Operator and organizational level PMCS of the multimeter consist of a general inspection, an operational check, and recharging the batteries when required.

a. Before You Operate. Always keep in mind the CAUTIONS and WARNINGS. Perform your before - PMCS.

b. While You Operate. Always keep in mind the CAUTIONS and WARNINGS. Perform your during - PMCS.

c. After You Operate. Be sure to perform your after - PMCS.

d. If Your Equipment Fails to Operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA Pam 750-8.

3-7. PMCS TABLE

The PMCS are done as shown in table 3-1.

a. Item Number Column. The numbers appearing in this column are in the order the work should be done. The numbers are keyed to figure 3-1 to identify work locations. This column shall also be used as a source of item numbers for the TM Number Column on DA Form 2404 (Equipment Inspection and Maintenance Worksheet) in recording results of PMCS.

b. Interval Column. This column indicates whether PMCS are done before operation (B), during operation (D), after operation (A), or weekly (W).

c. Item to be inspected Column. This column identifies the item to be inspected.

d. Procedures Column. This column contains a brief description of the check or service to be performed and step-by-step procedures.

e. Equipment is Not Ready if Column. This column identifies the condition that prevents the equipment from being ready for operation.

Table 3-1. Operator and Organizational Level PMCS

WARNING

High voltage is used in the operation of this equipment. Death on contact may result if you fail to observe safety precautions. Learn the areas where there may be dangerous voltages present in the multimeter.

Refer to figure 5-6 for static awareness techniques to protect critical multimeter components from damage.

B = Before D = During A = After W = Weekly

Item No.	Interval B	D	A	W	Item to be Inspected	Procedure	Equipment is Not Ready If:
1	•			•	Multimeter	Inspect case and front panel for corrosion, dents, cracks, or other physical damage, loose or missing hardware.	Case or front panel is badly damaged.
2	•	•	•	•	LCD Indicator/ Battery Assembly	Inspect for status with POWER ON/OFF pushbutton ON. If BT annunciator is visible or display is blank, recharge batteries as follows: a. Plug power cord into ac outlet. b. Set POWER ON/OFF pushbutton to OFF. c. Verify BAT CHG indicator lights and leave in this setup for 14 hours.	BT annunciator is visible.
3	•			•	AC power cord	Inspect for frayed, broken, or abraded insulation, broken wires or damaged connectors. Replace if damaged.	Cord shows any signs of damage.
4	•			•	Standard Test Leads	Inspect for frayed, broken, kinked, or abraded insulation, broken wires or damaged connectors. Replace if damaged.	Leads show any signs of damage.
5	•	•		•	RF Probe	Inspect for frayed, broken, or abraded insulation, broken wires, damaged connectors or failure to respond to input signals. Replace if damaged.	Probe shows any signs of damage or fails to respond to input signals.
6				•	Fuse F1	Inspect fuse and fuseholder for damage or corrosion. Clean if corroded or replace fuse if damaged or blown.	Blown or damaged fuse or too much corrosion.

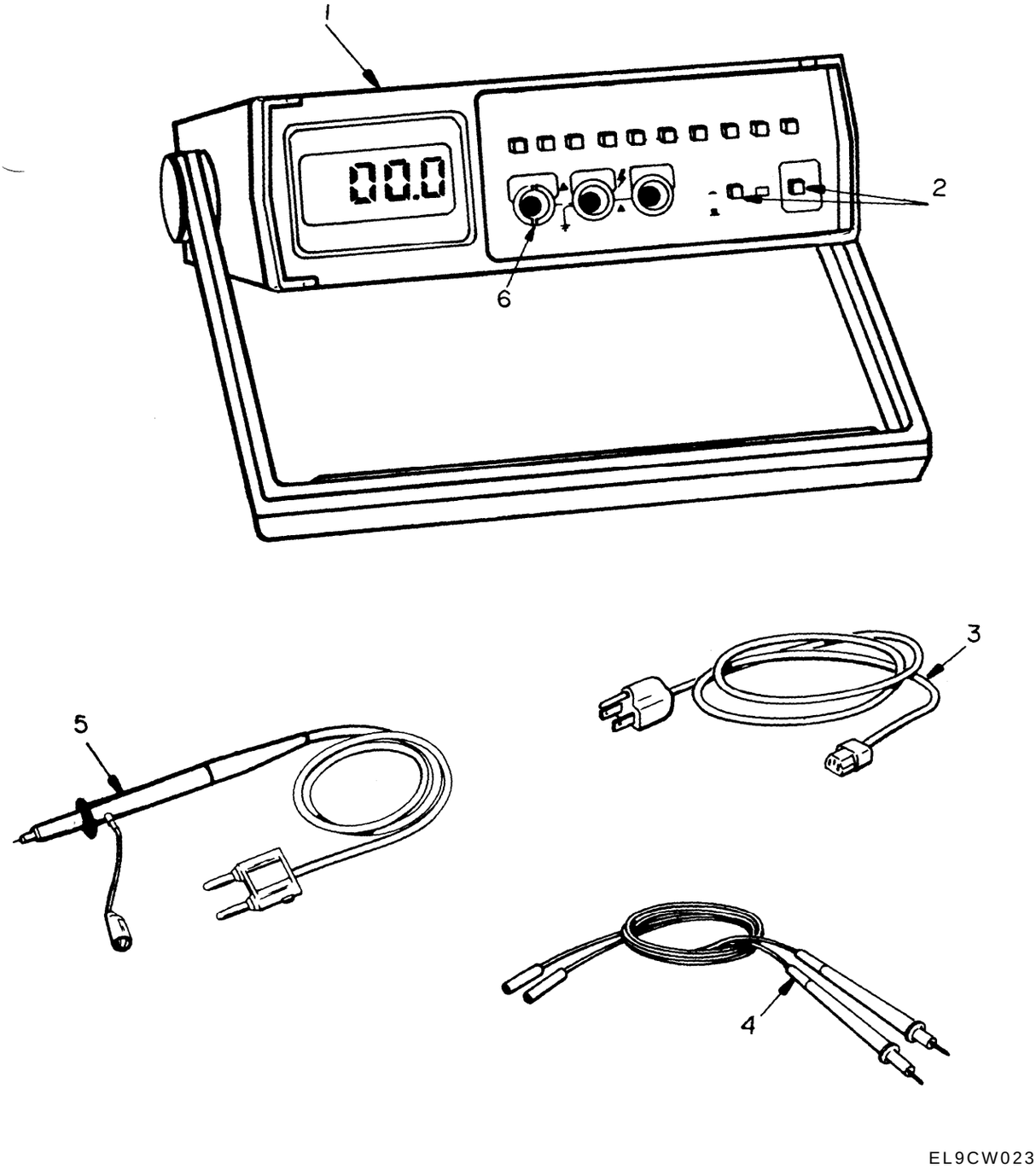


Figure 3-1. Multimeter PMCSLocation Diagram

Section IV. TROUBLESHOOTING

3-8. SAFETY PRECAUTIONS

WARNING

High voltage is used in the operation of this equipment. Death on contact may result if you fail to observe safety precautions. Learn the areas where there may be dangerous voltages present in the multimeter. Do not work inside the multimeter unless you are qualified to do so. If you do work inside the multimeter, always turn the power off and ground points of high potential before touching them.

3-9. TROUBLESHOOTING PROCEDURES

The troubleshooting procedures listed in table 3-2 are those that may be done by operators and organizational maintenance level personnel. Problems that may arise during operation are listed under malfunction. Tests or inspections to conduct and corrective actions to take to repair the malfunction are listed in the two columns to the right of the malfunction column. Refer to figure FO-1, the multimeter schematic diagram, at the back of this manual as required.

Table 3-2. Operator and Organizational Level Troubleshooting

Malfunction Test or Inspection Corrective Action

1. LCD DISPLAY STAYS BLANK WHEN POWER lS TURNED ON DURING BATTERY Operation.

   Step 1. Check that POWER ON/OFF pushbutton is in (ON).

   - If not, set to in (ON).

   Step 2. Check for very low batteries by recharging. See table 3-1.

   - If BAT CHG indicator does not glow, go to Malfunction 2.
   - If batteries do not charge, replace batteries. See paragraph 3-12.
   - If malfunction still remains, contact next higher level of maintenance.

2. BAT CHG INDICATOR FAILS TO GLOW WHEN CHARGING,

   Check ac power cord and connections.

   - Replace ac power cord, if faulty.
   - If malfunction still remains, contact next higher level of maintenance.

3. MULTIMETER DOES NOT RESPOND CORRECTLY TO ANY INPUT SIGNALS.

   Check standard test leads and RF probe.

   - Replace faulty test leads or RF probe.
   - If malfunction remains, contact next higher level of maintenance.

4. MULTIMETER CURRENT FUNCTIONS INOPERATIVE (OTHER FUNCTIONS OKAY).

   Check condition of fuse F1.

   - Replace open fuse F1. See paragraph 3-13.
   - If malfunction remains, contact next higher level of maintenance.

5. ANY MALFUNCTION NOT COVERED IN (1) THROUGH (4).

   Contact next higher level of maintenance.

Section V. MAINTENANCE PROCEDURES

3-10. OPERATIONAL TEST

DESCRIPTION

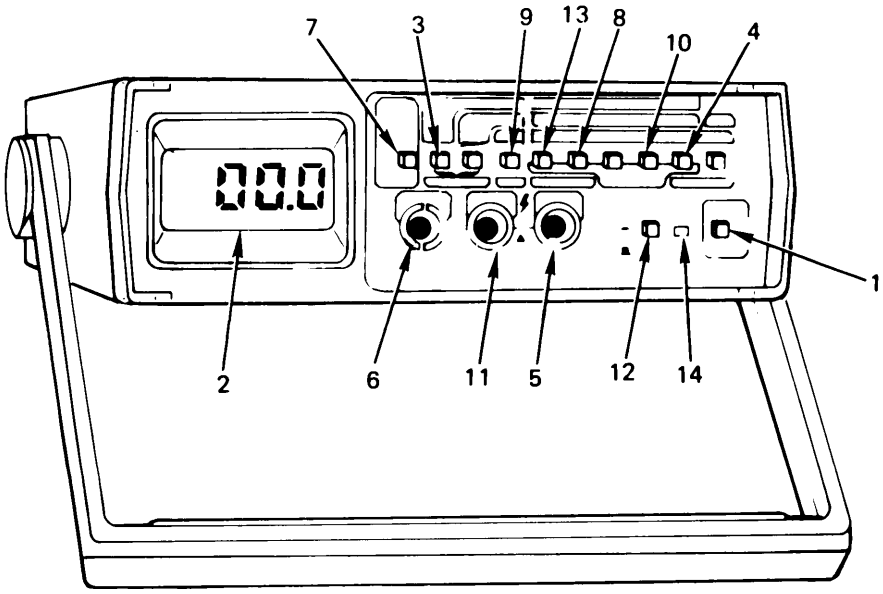
This procedure covers: operational readiness check of multimeter.

WARNING

Do not attempt to measure input signals that exceed the maximum input signals listed in paragraph 1-13.

a. With ac power cord disconnected (battery operation), depress POWER ON/OFF pushbutton (1) to ON,

- Verify that BT annunciator does not appear in LCD display (2) throughout this operational check.
- If BT annunciator appears, recharge batteries. See table 3-1.



EL9CW024

b. Depress AC/DC (7) pushbutton to out (DC).

c. Depress V function (3) and 1000V DC pushbuttons (4) with no inputs.

- Display (2) should settle to read 000.0 (plus or minus 2 digits).

d. Plug red test lead into V/ k Ω / S terminal (5) and touch probe end to mA terminal (6).

- Display (2) should read between -001.0 and -002.0.
- Unplug red test lead.

e. Depress AC/ DC pushbutton (7) to in (AC), and 2 V pushbutton (8) with no connection to input terminals.

- A low reading may appear in the display (2) and should increase slightly when a standard test lead inserted in the V/ k Ω /S terminal (5) is held in the fingers.

f. Depress k Ω pushbutton (9) and 200 kohm range pushbutton (10).

g. Touch probe to COMMON terminal (11).

- Display should read 00.00 (plus or minus 1 digit).

h. Remove probe tip from COMMON terminal.

- Display should upscale to 1 .

i. Touch red test lead to mA terminal (6).

- Display should read between -30.00 and -40.00.

j. Depress RELATIVE pushbutton (12) to (ON).

- Display should read 00.00 REL.

k. Depress RELATIVE ON/ OFF pushbutton (12) to release.

l. Depress 200 W range pushbutton (13).

- Observe no display change.

m. Remove red test lead probe tip from mA terminal (6).

- Observe that display (2) goes to 1 .

n. Depress POWER ON/ OFF pushbutton (1) to OFF.

o. Plug multimeter into ac line with ac power cord.

- Observe that BAT CHG indicator (14) glows.

END OF TASK

3-11. CASE REMOVAL/INSTALLATION

DESCRIPTION

This procedure covers: Remove and Install.

REMOVE

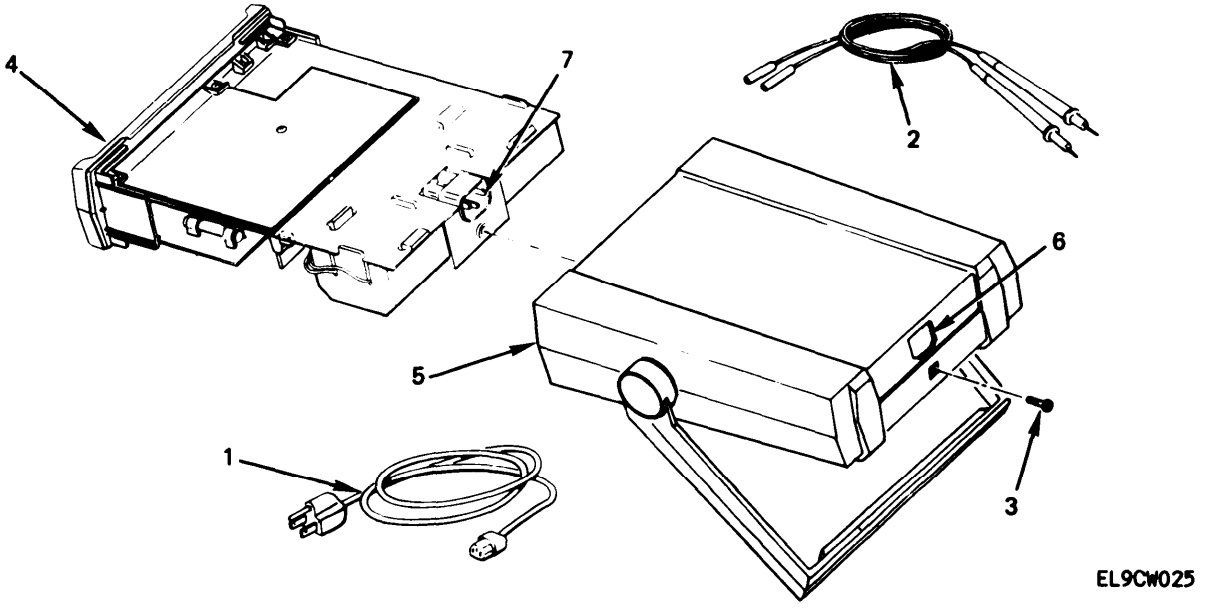
a. Depress POWER ON/ OFF pushbutton to OFF.

b. Unplug power cord (1) from ac power source and remove from multimeter.

c. Unplug standard test leads (2) if installed.

d. Remove case-attaching screw (3) from rear of multimeter.

e. Grasp front panel (4) and slide unit out of molded case (5).



INSTALL

a. Hold front panel (4) firmly and slide multimeter into case (5).

b. Aline ac line receptacle hole (6) with ac line receptacle (7).

c. Install case-attaching screw (3).

END OF TASK

3-12. BATTERY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

NOTE

Replace both battery packs at the same time. This procedure is typical of either pack.

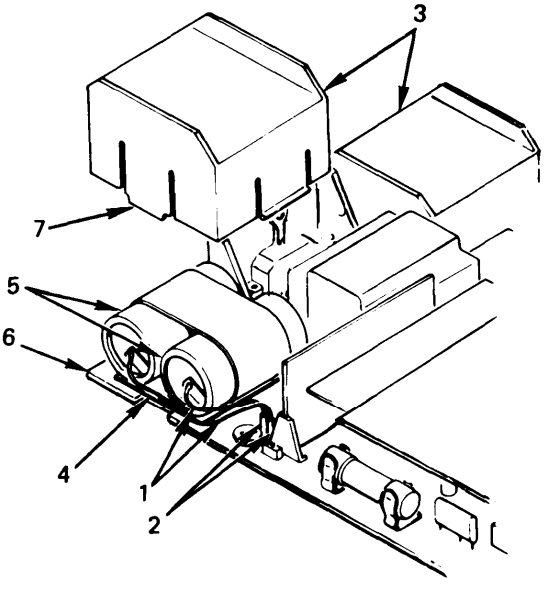
REMOVE

a. Remove case. See paragraph 3-11.

b. Turn multimeter upside down and unplug red and black battery wires (1) from pcb pins (2).

c. Squeeze front and rear sides of battery retainer (3) and remove.

d. Remove batteries (5) and absorbent pad (4)



EL9CW026

INSTALL

a. Install new batteries (5) and absorbent pad (4).

b. Insert battery retainer tabs (7) into pcb (6) slots and snap in place.

c. Connect battery wires (1) to pcb pins (2). Red to “+” and black to “-”.

d. Install case. See paragraph 3-11.

e. Depress POWER ON/ OFF pushbutton to in (ON) and leave multimeter ON until batteries discharge and display goes blank.

f. Charge batteries to ensure charging occurs. See table 3-1.

END OF TASK

3-13. FUSE F1 REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

REMOVE

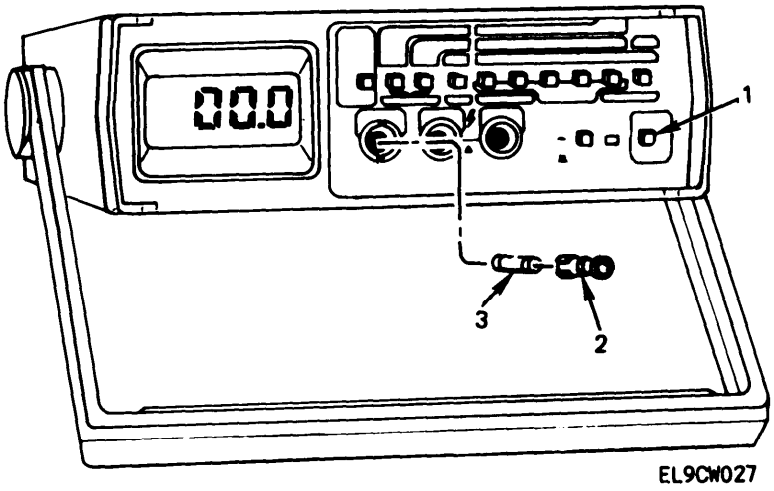
a. Depress POWER ON/ OFF pushbutton (1) to OFF.

b. Unplug ac power cord.

c. Push in mA terminal (2) and rotate counterclockwise.

d. Terminal (2) and fuse F1 (3) will pop out after about 1/4 turn.

e. Remove fuse F1 (3) from mA terminal (2).



INSTALL

a. Install new fuse F1 (3) into mA terminal (2).

b. Insert mA terminal (2) with attached fuse (3) into hole.

c. Push in mA terminal (2) and rotate about 1/4 turn clockwise.

END OF TASK

3-14. CLEANING

The only cleaning required is wiping dirt off the outer surfaces. Clean by wiping with a soft cloth dampened with a mild solution of detergent and water.

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

3-15. PREPARATION FOR STORAGE OR SHIPMENT

If original packing material was saved, pack the multimeter in the same manner as it was received. When using packing materials other than the original, use the following guidelines:

a. Insert multimeter in its case.

b. Insert multimeter and case into a waterproof bag.

c. Use plenty of shock-absorbing material all around multimeter to protect against damage and insert into a suitable size container.

d. Wrap container in heavy paper and seal with filament tape.

e. Mark container “FRAGILE-DELICATE INSTRUMENT” to insure proper handling.

3-16. TYPES OF STORAGE

a. Short-term (administrative) = 1 to 45 days. All equipment in this type must be made ready within 24 hours for use on a mission. Make sure the next scheduled PMCS is done and all deficiencies corrected before placing in storage. The storage site should provide protection from extreme weather conditions and allow you to reach it for inspections or exercises if needed.

b. Intermediate = 46 to 180 days.

c. Long term = over 180 days.

CHAPTER 4
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

There is no direct support maintenance for Digital Multimeter AN/USM-486/ U.

CHAPTER 5
GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section 1. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

5-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) at your unit.

5-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

There are no special tools required for general support maintenance of Digital multimeter AN/USM-486/U.

5-3. REPAIR PARTS

Repair parts are listed and illustrated in the repair parts and special tools list (TM 11-6625-3055-24P) covering organizational and general support maintenance for Digital Multimeter AN/USM-486/U.

Section II. SERVICE UPON RECEIPT

Refer to chapter 3 for service upon receipt instructions.

Section III. THEORY OF OPERATION

5-4. GENERAL

This section provides additional theory of operation needed by general support maintenance personnel to repair the multimeter. It is in addition to the information provided in Chapter 1, Section III.

5-5. CIRCUIT DESCRIPTIONS

The following paragraphs provide descriptions of major multimeter functional circuits. Simplified block diagrams or schematics are provided to help illustrate a description when required for clarity.

a. **A/D Converter.** The analog-to-digital (a/d) converter uses the dual slope method of conversion. In this method, the input signal voltage analog charges a capacitor for an exact length of time. The capacitor is then discharged by a reference voltage. The length of time it takes the capacitor to discharge to its initial level is proportional to the unknown input signal. The microcomputer measures the discharge time and displays the result.

b. The microcomputer controls the a/ d converter via complementary metal-oxide-semiconductor (CMOS) switches. Simplified circuits formed during the major periods of a/ d conversion cycles are shown in figure 5-1. Timing diagram (figure 5-2) shows the a/d converter cycle resulting from three different input signals. Assume in the following paragraph that the DC V function and the 2 V range are selected and the multimeter is nearing the end of the autozero (AZ) period in its conversion cycle.

c. As part A in figure 5-1 shows, the CMOS switches U18B and U19A are closed providing voltage levels that allow C8 and C33 to store the offset voltages of the buffer, integrator, and comparator. The switches connect the flying capacitor C7 to a reference voltage. Since the V function is selected, C7 is charged by the a/d converter reference voltage source. At the end of AZ, C7 is fully charged, C8 and C33 are charged up to the offset voltages, and the comparator output (CM) is near a threshold level.

d. Assume that an input of -1.0000 V dc is present at the multimeter input (first set of waveforms in figure 5-2). The microcomputer starts the integrate (INT) command at the same time that it ends the AZ command. Thea/d converter circuit switches to the configuration shown in figure 5-1, part B. The CMOS switch U 18A connects the output of the signal conditioners to the input terminal of the buffer. For a 2 V range, the microcomputer will select the X 1 gain in the buffer and the input from the signal conditioner is applied to the buffer and integrator in series. The integrator begins to charge C9. The instant that the charge on C9 shifts from its initial level, the comparator will toggle. That is, its CM output goes to a steady level. Since the unknown input to the multimeter is negative, the buffer goes negative, the integrator goes positive, and CM will go negative. Capacitor C9 continues to charge to the end of the 100 millisecond integrate period. The microcomputer controlled integrate period is exactly the same length for every measurement cycle regardless of selected range and function of the input signal.

e. After the microcomputer ends the integrate period, it prevents C9 from charging or discharging during a brief hold period. During hold, the microcomputer examines the polarity of CM to determine the polarity of the unknown input to the multimeter. Since CM is negative, the microcomputer initiates the read period with the reintegrate plus reference DE (+ R) command (figure 5-1, part C). Also, the CMOS switch U18B connects the buffer input to common, and CMOS switches U20A and U20B connect C7 in the buffer feedback loop so that the integrator input is a known level (1 V) of the opposite polarity from the input signal. The integrate capacitor C9 begins to discharge and the microcomputer starts to count from 00000. The count adds up until C9 discharges to its initial level. The instant C9 reaches its initial level, the comparator will toggle CM positive, stopping the count in the microcomputer. The count in this case will be 10,000. This count, with the appropriate decimal point, is the same numerically as the -1.0000 V dc input to the multimeter.

f. The third set of waveforms show the timing that would result from a positive full-scale input (in this example, +1.9999 V dc). Note that for positive inputs, CM is positive so the microcomputer uses the DE (–R) command during the read period. This connects C7 so that its polarity is reversed as it must be to discharge C9.

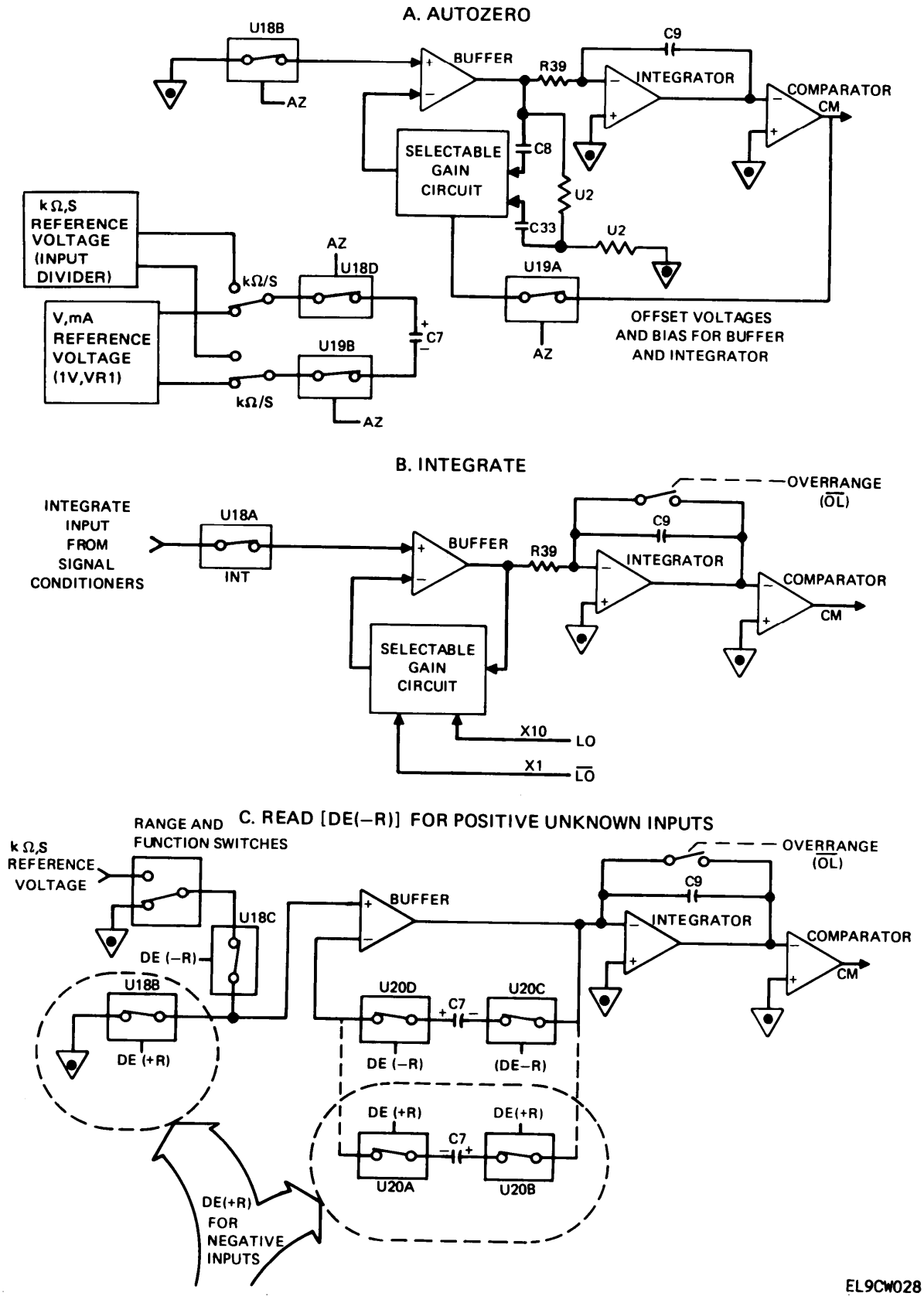


Figure 5-1. A/D Converter Simplified Circuitry

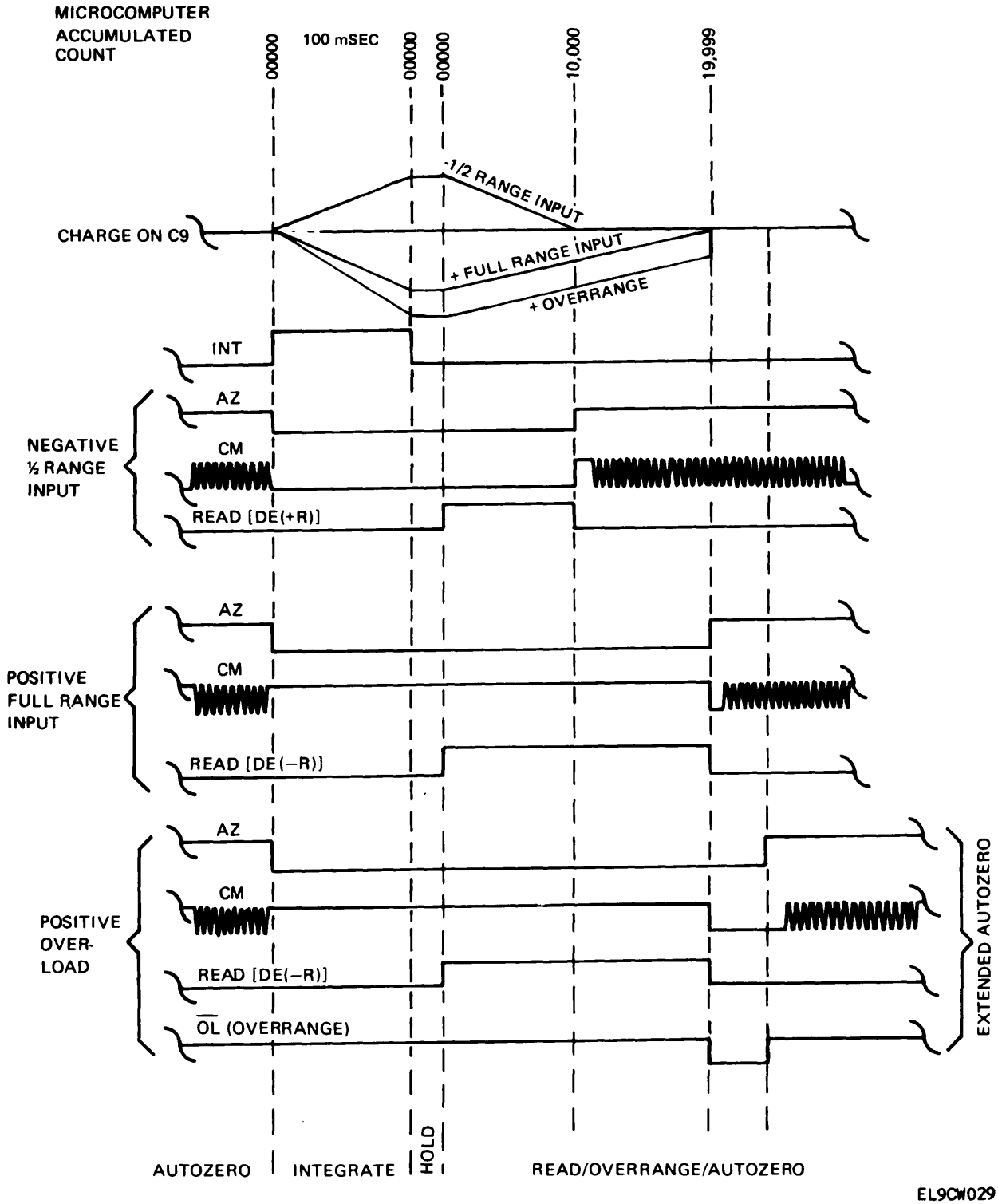


Figure 5-2. A/D Converter Waveforms

g. The bottom set of waveforms in figure 5-2 show the timing that results from a positive overrange input to the multimeter. If the microcomputer count reaches 20,000 before CM toggles, the microcomputer will detect this as an overrange condition and issue a NOT OL command for 5 milliseconds. NOT OL will short C9, dumping the remaining charge. The following AZ period will be doubled to 200 milliseconds. Overrange input signal polarity is retained and displayed. Between 20,000 and 20,055 counts the display indicates overload, but the a/d will continue to integrate normally and NOT OL will not occur.

h. The a/d reference scheme is different if either the k Ω or S functions are selected. When the 2 mS, 200 Ω, or 2 kohm range is selected, flying capacitor C7 is charged during AZ by the voltage drop across the reference resistor instead of the a/d converter reference voltage source. In kohm during INT, the voltage drop across the unknown resistance is integrated. During read, the buffer input is connected to common and C7 is connected in the feedback loop of the buffer. Therefore, the count accumulated in the microcomputer during read is proportional to the ratio: ^{V}RX divided by ^{V}OHMERF to the unknown V divided by the reference V. Or, the ratio of voltage drops across the unknown and reference resistors. If any of the other ranges are selected, C7 is charged from the high side (VH) of the reference resistor. During INT, the voltage drop across the unknown resistance is integrated. During read, the low end of the reference resistor (VL) is connected to the buffer input and C7 is connected in the buffer feedback loop. The count is again proportional to the same ratio mentioned above. For conductance measurements, the microcomputer will send the DE(-R) command after AZ, then the INT command. This inverts the measurement (S + 1/ Ω).

i. **Microcomputer.** The microcomputer (figure 5-3) performs four functions: control, measurement, calculation, and display drive. The positions of the front panel pushbuttons determine how the microcomputer performs each of these functions. The microcomputer controls the gain and timing of the a/d converter and the gain of the ac buffers in accordance with the measurement function and range selected.

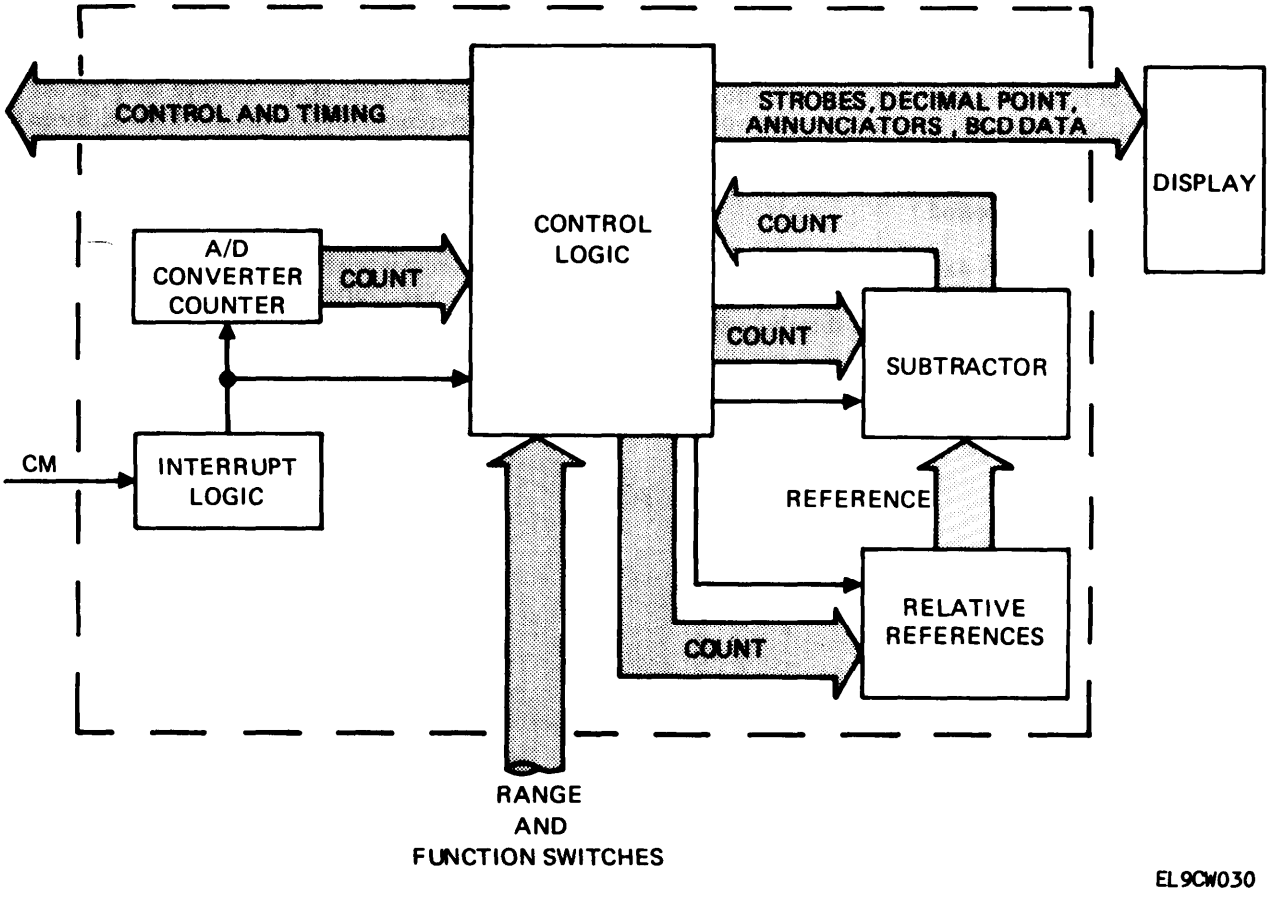


Figure 5-3. Microcomputer Simplified Block Diagram

j. The microcomputer measure the output of the a/d converter by accumulating counts. In any measurement function, the count accumulate linearly (count pulses evenly spaced). The total count is numerically the same as the unknown input to the multimeter. A 1.5001 V input results in an accumulated count of 1500l. If the dB function is selected, the microcomputer calculates the dB r reading from the linear reading based on the reference impedance (REFZ) seleted. When the RELATIVE ON/OFF pushbutton is set to the ON position, the microcomputer drives, the display so that the REL annunciator appears and the microcomputer stores the first measurement value as the relative reference. This relative reference will be algebraically subtracted from later measurements made in that measurement function until the RELATIVE ON/OFF pushbutton is set to the OFF position.

k. **Signal Conditioning.** Some inputs must be scaled and/or conditioned before being sent to the a/d converter. For example, high voltage levels must be attenuated ac inputs must be attenuated and converted into equivalent dc voltage levels. The a/d converter has two ranges; ±200mV full scale and ±2V full scale.

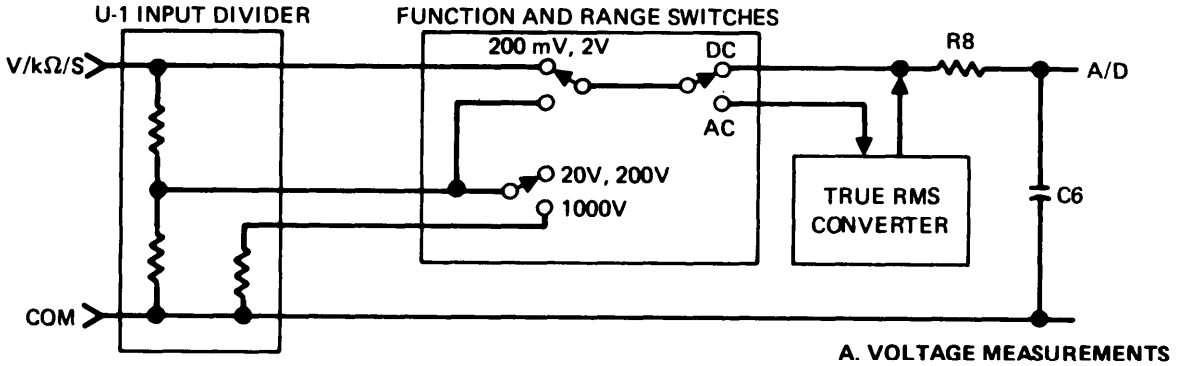
(1) Voltage Signal Conditioning. As put A of figure 5-4 shows. the voltage signal conditioning is done with an input voltage divider network. The division factor of the network is determined by the range selected. That is 1/100 for the 20 V and 200 V ranges, ad 1/1000 for the 1000VDc (750V AC) range. If the AC/DC function pushbutton is in the AC position, the output of the divider network will be routed directly to the a/d converter. In ohms and conductance, de input divider resistors art used as the reference resistors.

(2) Current Signal Conditioning. As part B of figure 5-4 shows, current measurements are made using a selectable value current shunt to perform the current-to-voltage conversion required by the a /d converter. The range pushbuttons determine the value of current shunt, thus determinethe scale of the voltage level developed across the shunt. If the AC/ DC function pushbutton is in the AC position, the voltage level developed across the shunt will be applied to the input of the rms converter. If the AC/ DC function pushbutton is in the DC position, the voltage across the shunt will be applied directly to the input of the a/d convener.

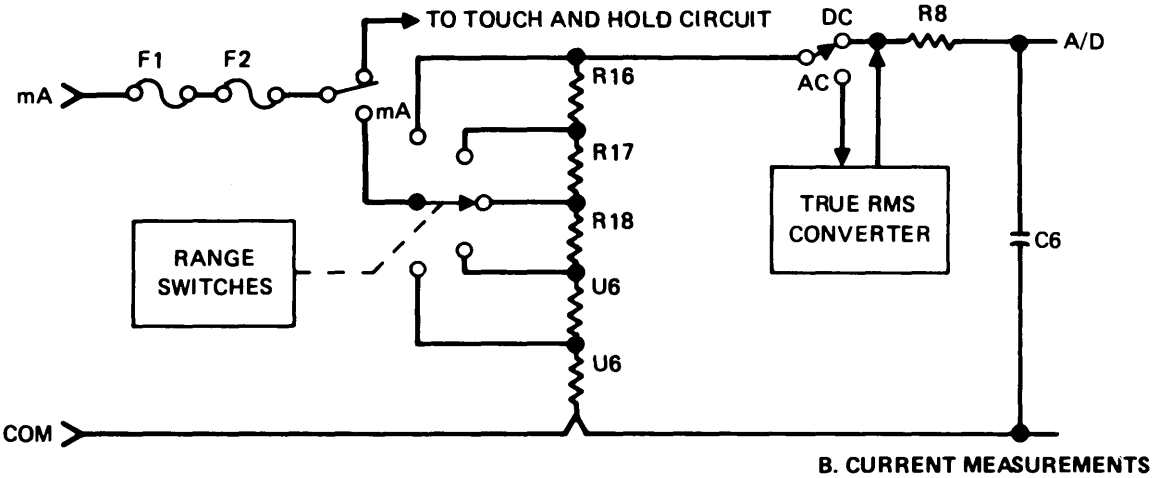
(3) Resistance/Conductance Signal Conditioning. Resistance and conductance measurements made on the 2 mS, 200 Ω, and 2 kohm ranges use a direct ratio method. Other ranges use a subtraction and ratio method to indirectly derive a ratio. As part C of figure 5-4 shows, when the 2 mS, 200 Ω, or 2 kohm range is selected, the voltage drop across the unknown resistance is measured in relation to the voltage drop across the reference resistor which is known. Since the same current is flowing through both resistors, the value of the unknown resistance can be computed by using the formula: ^{V}RX divided by - ^{V}OHMREF equals RX divided by ^{R}REF. (Minus VOHMREF is necessary for de-integration during the read period.)

(4) As part C of figure 5-4 shows, when ray range but 2 mS, 200 Ω, or 2 kohm is selected, the voltage drop across the unknown resistance is measured and C7 charges up to the ohms voltage source, VH-During read, the a/d buffer subtracts the voltage on C7 from the low side. VL, thereby getting-VOHMREF.

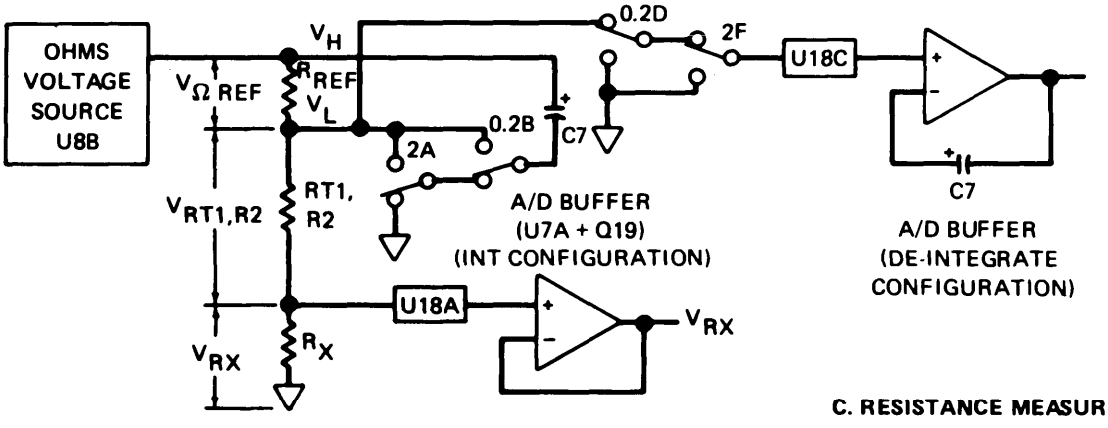
(5) For conducrance measurements, the microcomputer inverts the κΩ measurements (S+1/ohm) by reversing the order of the integrate and read periods of the a/d converter.



A. VOLTAGE MEASUREMENTS



B. CURRENT MEASUREMENTS



C. RESISTANCE MEASUREMENTS

	BUFFER OUTPUT		READING
	INT	DE-INT	
200Ω, 2 kΩ	V_{RX}	$-V_{\Omega REF}$	$\frac{V_{RX}}{-V_{\Omega REF}} = \frac{R_X}{R_{REF}}$
ALL OTHER RANGES	V_{RX}	$V_{RX} + V_{RT1, R2} - V_{C7}$ $= V_{RX} + V_{RT1, R2} - (V_{RX} + V_{RT1, R2} + V_{R REF})$ $= -V_{\Omega REF}$	$\frac{V_{RX}}{-V_{\Omega REF}} = \frac{R_X}{R_{REF}}$

EL9CW031

Figure 5-4. Signal Conditioning Measurements

1. **True RMS Converter.** The true rms converter is made up of two ac buffers and a hybrid rms converter.

(1) AC Buffers. The ac buffers consist of operational amplifiers U23, U21, and their associated components. Through the buffers, the input signal is scaled to a level within the range of the hybrid rms converter. Each buffer has a gain of 1 or 10 which is controlled by the microcomputer. Refer to table 5-1 for the buffer gains versus the range selected. In the dB function with the 200 mV range selected, the buffers autorange through X1, X10, and X100 gains depending on input signal level. Thus, the multimeter appears to have a single range from -60 dBm to +8 dBm (600 ohm REF Z). Upranging occurs at the linear ac range equivalent of 20,000 counts, downranging at the equivalent of 1,800 counts. The output of the first buffer is divided in half then amplified by a factor of two in the hybrid rms converter. This reduces the required dynamic range of the true rms converter amplifier which allows handling waveforms with crest factors up to 3 at full scale.

Table 5-1. AC Buffer Gains

Range	First Buffer	Second Buffer	Overall Gain
200 mV, dB only	Autorange only	Autorange only	Xl, Xl0, X100
200 mV, linear	Xl	Xl0	Xl0
2V	X1	Xl	Xl
20 V	X1	Xl0	Xl0
200 V	Xl	X1	X1
750 V	Xl	Xl	Xl

(2) Hybrid Rms Converter. An rms amplitude is that value of alternating voltage that results in the same power dissipation-in a given resistance as a dc voltage of the same numerical value. The formula for computing the rms value of an ac voltage is: Vrms equals the square root of the average of Vi^2. The multimeter's rms converter monitors the instantaneous voltage and computes the rms value of the input signal. Figure 5-5 shows the mathematical derivation of the rms conversion circuit in the multimeter and a block diagram of that circuit.

m. **Touch and Hold Circuit.** This circuit operates in conjunction with a touch and hold probe. It works in all measurement functions except mA and dB. If the mA or dB function is not selected and the control switch on the touch and hold probe is pressed, the touch and hold circuit will place a logic zero (-5 V) on the touch and hold input (pin 16) of the microcomputer. At this signal, the microcomputer will freeze the display with the data present when the control switch was pressed. Touch and hold will not operate if fuse F1 and/or F2 is blown.

n. **Voltage Protection.** In the V mode of operation, protection against inputs and transients above the input ratings of the multimeter is provided by metal oxide varistors RV1, RV2, RV3, and R1, R2, and Q1. Varistors RV1, RV2, and RV3 clamp the voltage across the measurement circuitry at about +1200 V while R1 and R2 limit the input current. In the kohm mode of operation, protection is provided by thermistor RT1 and the clamp/zener action of Q2. As RT1 heats up, its resistance increases sharply.

o. **Current Protection.** In the current mode of operation, diode bridge U28 and diode CR1 clamp the voltage across the current shunts until fuses F1 and/or F2 blow. Backup fuse F2 is used to open up at voltages between 250 and 600 V.

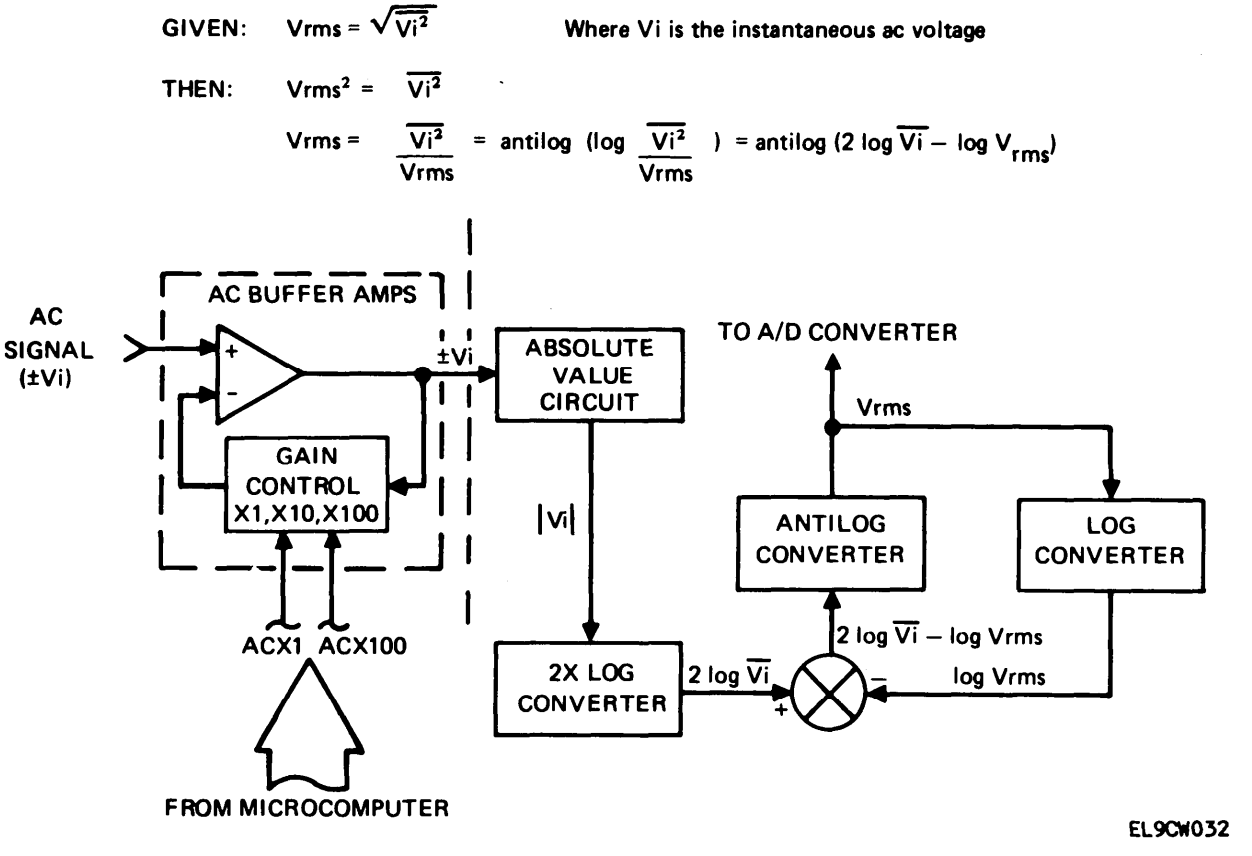


Figure 5-5. Rms Converter Simplified Block Diagram

Section IV. TROUBLESHOOTING

WARNING

High voltage is used in the operation of this equipment. Death on contact may result if you fail to observe safety precautions. Do not work inside the multimeter unless qualified. If you do, always turn the power off and ground points of high potential.

5-6. TEST POINT INFORMATION

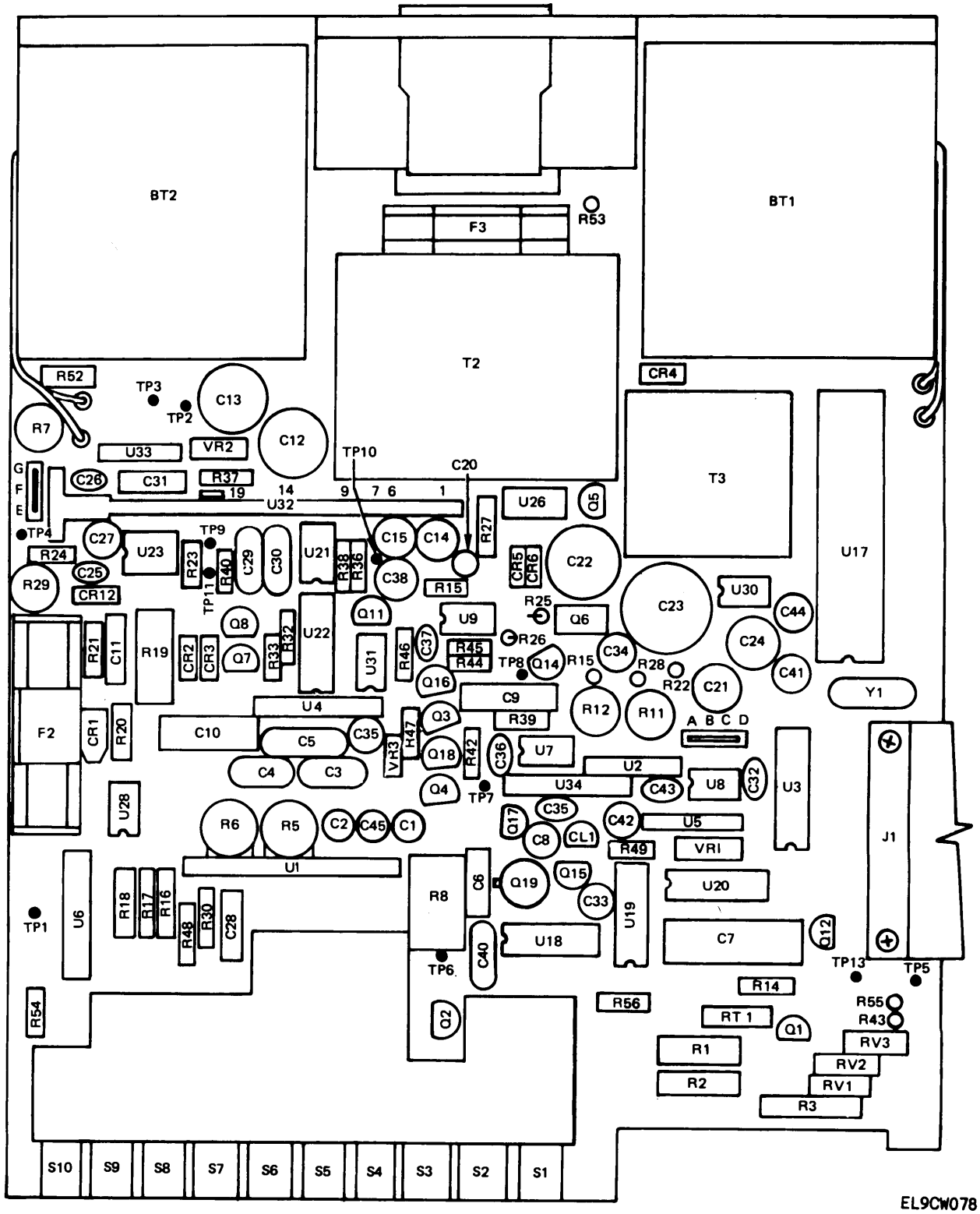
Identification and function of test points used in the following procedures for the multimeter is listed in table 5-2. All test point numbers and locations are shown on the facing page and on figure FO-1, the multimeter schematic diagram.

Table 5-2. Test Point Identification

Test Point	Function
1	COMMON
4	-5 V dc (Batt. +)
14	Battery (-). On Display Pcb.

5-7. TROUBLESHOOTING PROCEDURES

The troubleshooting procedures in table 5-3 may be done by general support maintenance personnel. Problems that arise are listed under malfunction. Tests or inspections to conduct and corrective actions to take to repair the malfunction are in the two columns to the right. Refer to figure FO-1, the multimeter schematic diagram, at the back of this manual as required.


BT2
BT1
F3
R53
T2
T3
CR4
U17
R52
TP3
TP2
C13
C12
R7
U33
VR2
TP10
C20
G
F
E
C26
C31
R37
19
14
9
7 6
1
U32
U26
Q5
TP4
C27
U23
TP9
C15
C14
R27
R24
C25
R29
CR12
R23
R40
C29
C30
U21
R38
R36
C38
R15
CR5
CR6
C22
C23
U30
C44
C24
C41
TP11
Q8
Q11
U9
R25
Q6
R26
R21
C11
R19
CR2
CR3
Q7
R33
R32
U22
U31
R46
C37
R45
R44
TP8
Q14
R15
C34
R28
R22
C21
Y1
Q16
C9
U4
R39
R12
R11
A B C D
F2
CR1
R20
C10
C5
C35
VR3
H47
Q3
Q18
R42
C36
U7
U2
C4
C3
U34
C43
U8
C32
U3
Q4
TP7
U28
R6
R5
C2
C45
C1
C17
C35
C42
U5
C8
CL1
R49
VRI
J1
U1
R8
C6
Q19
Q15
C33
U19
U20
TP1
U6
R18
R17
R16
R48
R30
C28
C40
U18
C7
Q12
TP6
TP13
TP5
R14
R54
Q2
R56
R55
R43
RT 1
Q1
RV3
R1
RV2
R2
RV1
R3
S10
S9
S8
S7
S6
S5
S4
S3
S2
S1

EL9CW078

Table 5-3. General Support Level Troubleshooting

Malfunction	Test or Inspection	Corrective Action

1. LCD STAYS BLANK WHEN POWER IS TURNED ON DURING BATTERY OPERATION.

Step 1. Depress POWER ON/ OFF (1) pushbutton to out (OFF).

Remove case. See paragraph 3-11.

Check continuity of fuse F3 (5).

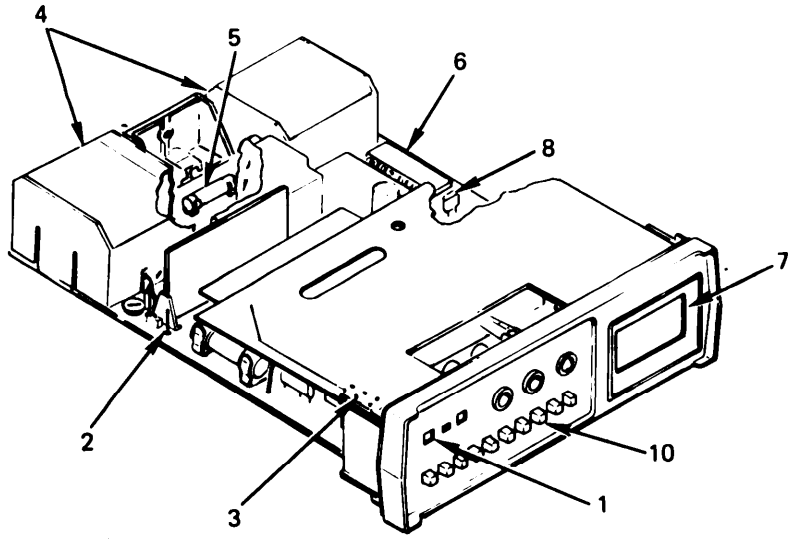
- Replace open fuse F3. See paragraph 5-16.

Step **2.** Measure battery voltage between TP4 (2) and TP14 (3).

Use TP14 as common and record reading.

Plug in ac power cord and watch voltage reading.

- If reading rises by 0.1 V or more, recharge batteries (4). See table 3-1.
- If reading does not rise, replace AN/USM-486/ U.



EL9CW033

Table 5-3. General Support Level Troubleshooting — Continued

Malfunction	Test or Inspection	Corrective Action

Step 3. Check microprocessor U17 (6) by substitution.

- Replace microprocessor U17. See paragraph 5-12.
- If malfunction remains, install original U17.

Step 4. Check operation of LCD (7).

- Remove and install LCD to check alignment. See paragraph 5-11.
- If malfunction remains, replace LCD with new one.
- If malfunction still remains, install original LCD.

Step 5. Check crystal Y1 (8) by substitution.

- Replace crystal Y1. See paragraph 5-13.
- If malfunction remains, replace AN/USM-486/U.

2. MULTIMETER FAILS TO RESPOND TO ANY INPUTS.

Check condition of standard test leads.

- Replace bad test leads with new ones.
- Repeat malfunction 1 steps.

3. MULTIMETER FAILS TO RESPOND WHEN USING RF PROBE.

Check operation of RF probe by substitution.

- Replace RF probe with new one.

4. MULTIMETER FAILS TO RESPOND TO V/k Ω INPUTS OR FAILS VOLTS OR OHMS PERFORMANCE TEST.

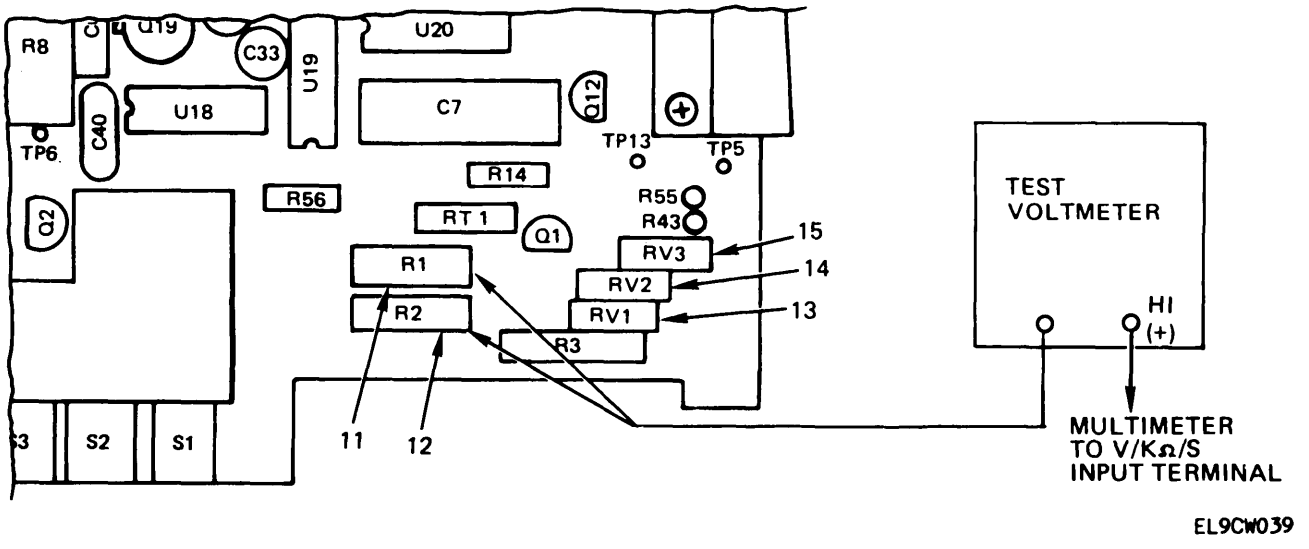
Step 1. Check values of R1 and R2 protection resistors.

- Depress POWER ON/ OFF (1) pushbutton to OFF.
- Disconnect ac power cord.
- Depress mA function (10) pushbutton.
- Connect test voltmeter as shown.

Table 5-3. General Support Level Troubleshooting - Continued

Malfunction	Test or Inspection	Corrective Action

- If R 1 (11) does not read between 90 and 110 kohm, replace. See paragraph 5-15.
- If R2 (12) does not read between 0.9 and 1.1 kohm, replace. See paragraph 5-15.



Step 2. Check varistors RV1 (13), RV2 (14), and RV3 (15) by disconnecting one end of any one of them and check if malfunction has been corrected.

- If malfunction is corrected, replace all three varistors. See paragraph 5-14.
- If malfunction remains, reconnect varistor and replace AN/USM-486/ U.

5. MULTIMETER FAILS TO RESPOND TO mA INPUTS ONLY.

Step 1. Check continuity of fuse F1 (16).

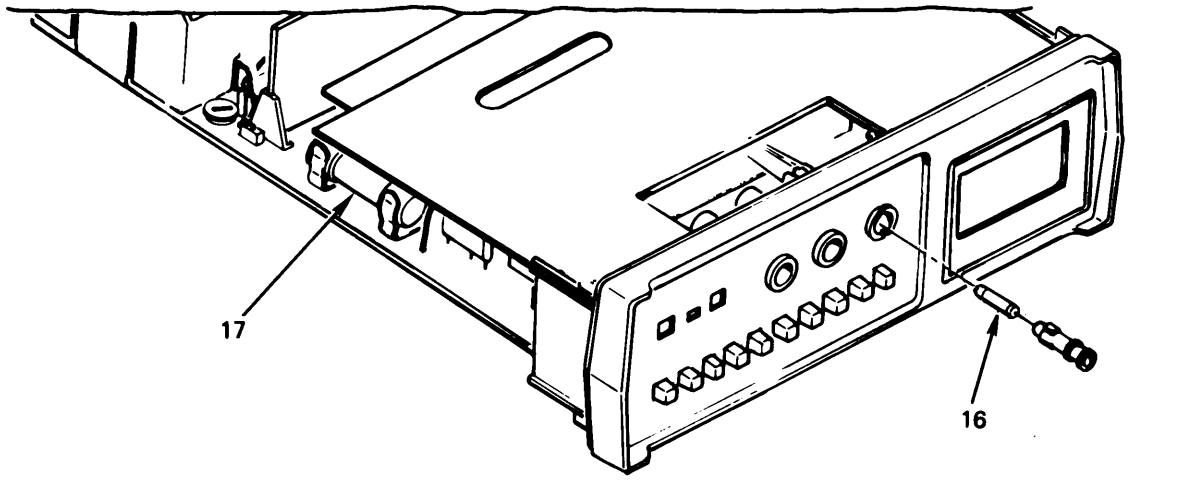
- Replace if open. See paragraph 3-13.

Step 2. Check continuity of fuse F2 (17).

- Replace if open. See paragraph 5-16.
- If malfunction remains, replace AN/USM-486/ U.

Table 5-3. General Support Level Troubleshooting — Continued

Malfunction Test or Inspection Corrective Action



6. MULTIMETER FAILS dB VOLTAGE PERFORMANCE TEST.

Do ac voltage performance test. See paragraph 5-17d.

- If test results are good, replace microprocessor U17. See paragraph 5-12.
- If test fails, repeat malfunction 4.

7. MULTIMETER FAILS LCD DISPLAY TEST.

Step 1. Do malfunction 1, step 4.

Step 2. Do malfunction 1, step 3.

- If malfunction remains, replace AN/USM-486/U.

8. ANY MALFUNCTION NOT COVERED IN (1) THROUGH (7).

Replace AN/USM-486/U.

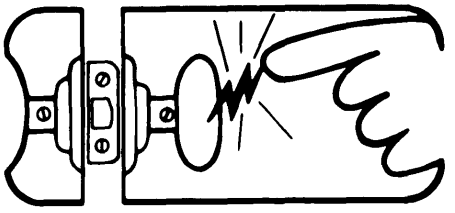
Section V. MAINTENANCE PROCEDURES

5-8. GENERAL

General support maintenance is limited to repairing or replacing components as directed in the following procedures.

5-9. ACCESS INFORMATION

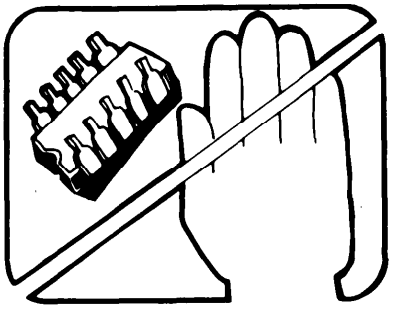
Removal of the molded case exposes the main body and most parts. Unfastening the display pcb and flopping it over is required to change the LCD or gain access to main pcb parts and test points underneath. Try to avoid contaminating the pcb's with oil from the fingers during disassembly. Handle pcb's by their edges or wear gloves while working. Many of the semiconductor and IC devices used in this multimeter are static sensitive. Refer to figure 5-6 for static awareness techniques to protect critical multimeter components from static damage.



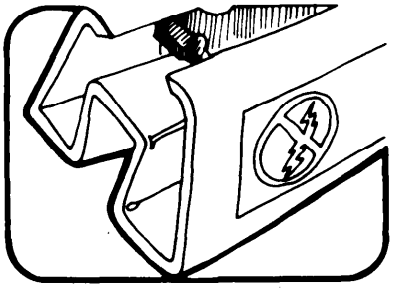
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

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

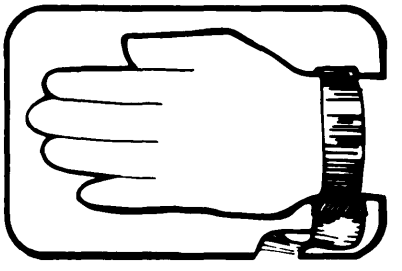
The following practices should be followed to minimize damage to S.S. devices.



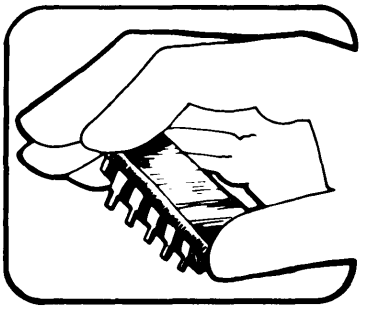
1. MINIMIZE HANDLING



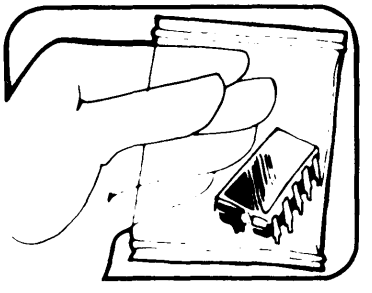
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE



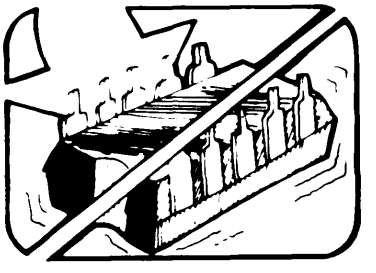
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



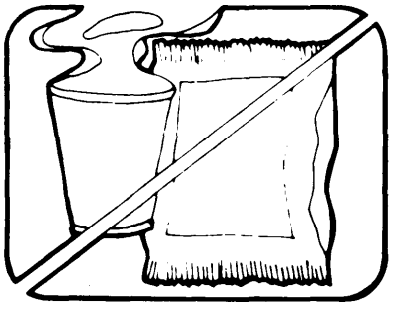
4. HANDLE S.S. DEVICES BY THE BODY



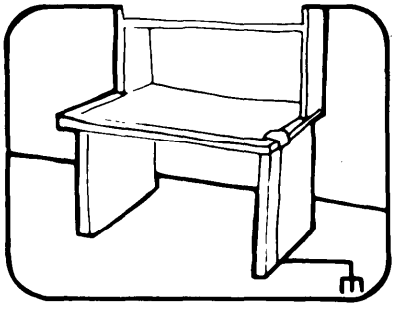
5. USE ANTISTATIC CONTAINERS FOR HANDLING AND TRANSPORT



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



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



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
9. ONLY ANTISTATIC TYPE SOLDER-SUCKERS SHOULD BE USED
10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED

EL9CW041

Figure 5-6. Awareness of Static Sensitive (S.S.) Devices

5-10. DISPLAY PCB REMOVAL/INSTALLATION

DESCRIPTION

This procedure covers: Remove and Install.

REMOVE

WARNING

To prevent possible injury or death, unplug the ac power cord before going any farther.

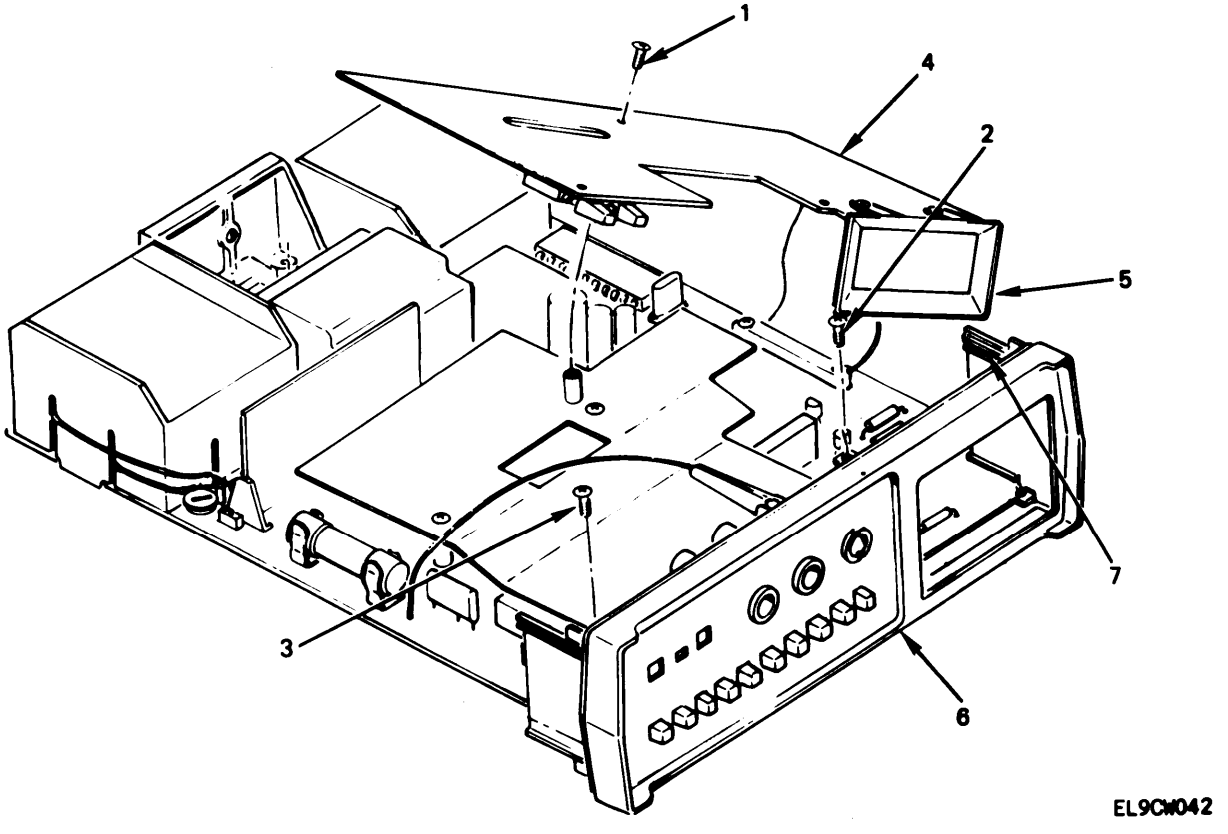
a. Remove case. See paragraph 3-11.

CAUTION

Disconnect one of the right rear battery wires from its pcb pin to prevent multimeter damage due to accidental shorting between the two pcb's.

b. Remove display pcb back screw (l).

c . Remove display pcb center (2) and left (3) screws.



d. Slide display pcb (4) toward rear and upwards until free. Push inward against plastic display frame (5) to help free pcb from front panel (6).

e. Carefully flop display pcb (4) aside.

f. Unit is still operational and all test points can now be reached.

g. Reconnect battery wire that was removed in CAUTION.

INSTALL

CAUTION

Do not force-fit the display pcb into the front panel and main pcb. Special guides and alignment features require that the display pcb be aligned before securing it in position.

a. Lift display pcb (4) and fold it over so that component sides of both pcb's are facing each other.

b. Position display side of display pcb (4) in guide (7) located on same side of front panel (6).

c. Position front part of display pcb (4) under two plastic tabs with holes in them on back of front panel.

d. Slide display pcb (4) forward while guiding LCD into front panel opening until it fits snugly in place and all three screw holes line up.

e. Secure with three screws: two (2 and 3) in front panel tabs and (1) at rear center of display pcb.

f. Install case. See paragraph 3-11.

END OF TASK

5-11. LCD REPLACEMENT

DESCRIPTION

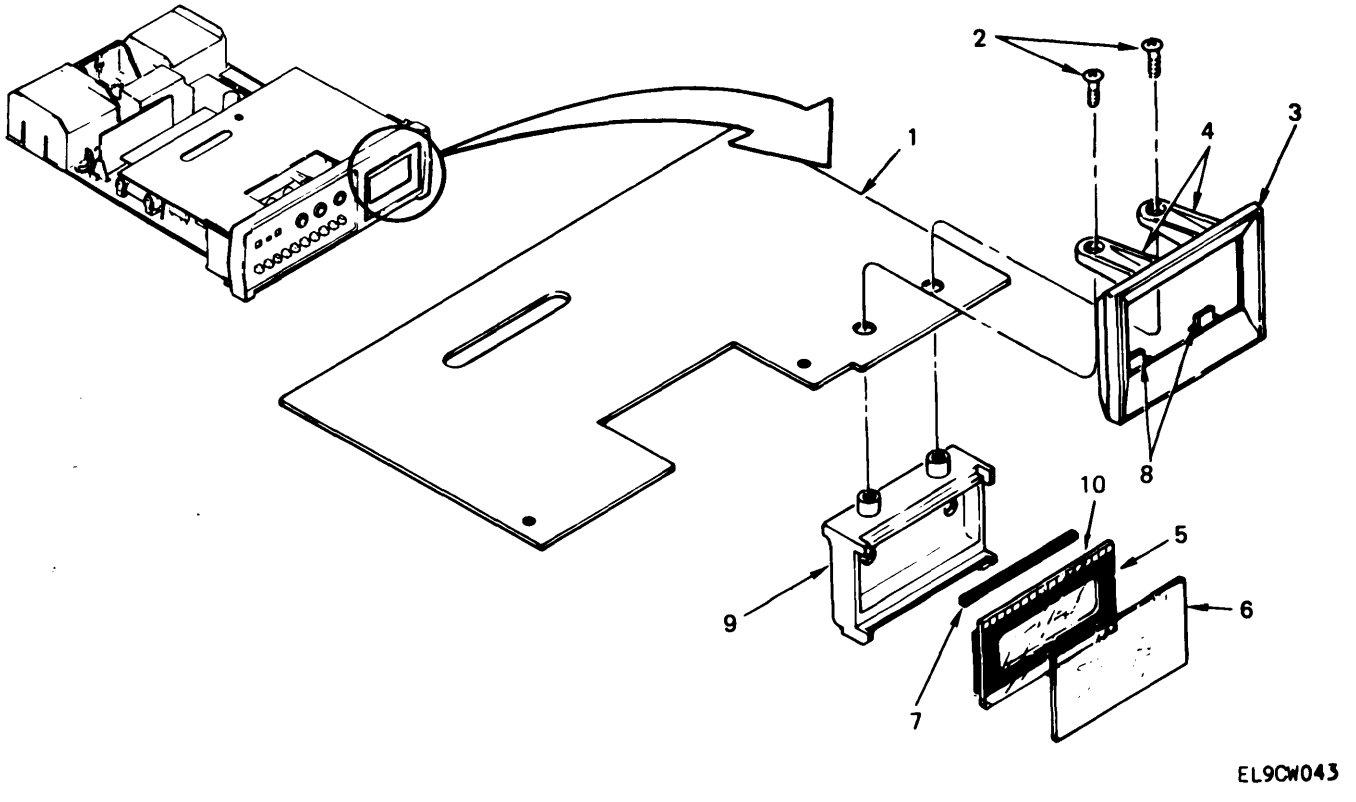
This procedure covers: Remove and Install.

REMOVE

a. Remove case. See paragraph 3-11.

b. Remove display pcb. See paragraph 5-10.

c. Tilt display pcb (1) towards main pcb and remove two LCD screws (2) attaching plastic frame assembly (3) to display pcb.



d. Place screwdriver blade under gray tabs (4) of plastic frame assembly (3) on bare side of display pcb and lift free of screw posts.

e. Taking care LCD (5) and lens (6) do not fall out, rotate plastic frame assembly (3) until two hooks (8) opposite gray tabs (4) release from LCD mounting bracket (9).

f. Handling LCD (5) by side edges, lift free from mounting bracket. When LCD lifts free, the 2-inch, flexible elastomeric strip (7) may fall out of its channel. This strip makes electrical contact between pads on the LCD and the land pattern on-the pcb.

NOTE

Lens (6) may stay in the plastic frame assembly **(3)** during removal and not require handling.

INSTALL

a. Place elastomeric strip (7) in channel on LCD mounting bracket if necessary.

b. Replace LCD (5) with conductor edge (10) down against elastomeric strip.

c. Attach two hooks (8) to mounting bracket and rotate frame around until gray tabs (4) lineup with screw posts. Press onto posts.

d. Install two LCD screws (3) and tighten.

e. Install display pcb (l). See paragraph 5-10.

f. Install case. See paragraph 3-11.

END OF TASK

5-12. MICROPROCESSOR U17 REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

REMOVE

CAUTION

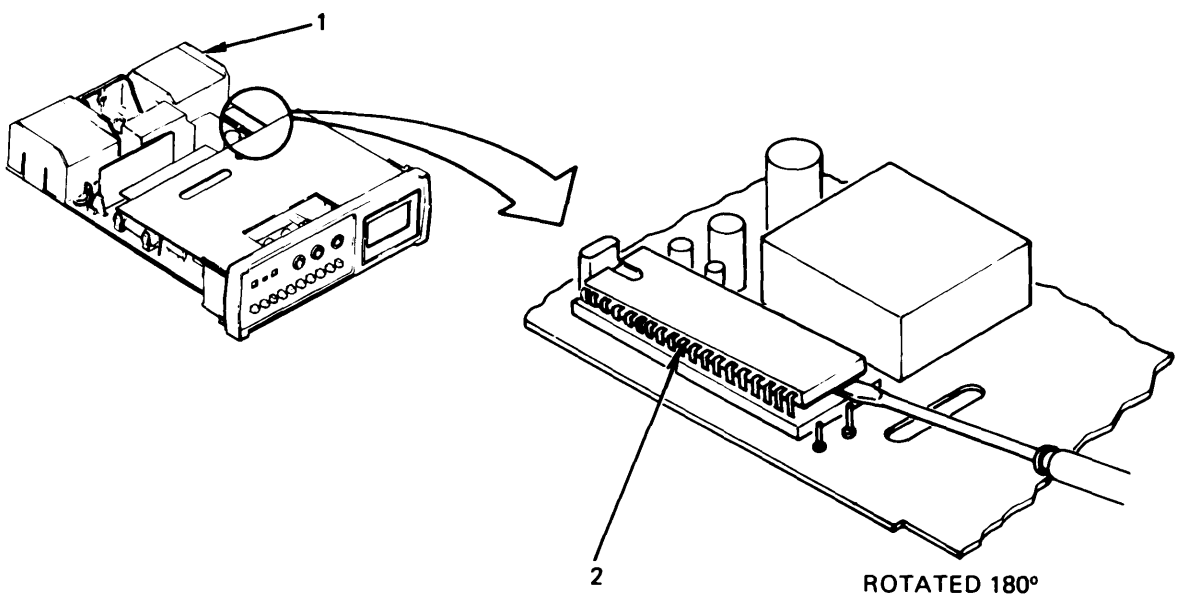
Refer to figure 5-6 for static awareness techniques to protect critical multimeter components from damage.

a. Remove case. See paragraph 3-11.

b. Remove battery assembly (1). See paragraph 3-12.

c. Insert screwdriver between bottom of U 17 (2) and its socket.

d. Work tool in rocking motion to free U 17 from its socket and remove.



EL9CW044

INSTALL

a. Install new U 17 in socket with notch toward front panel.

b. Reinstall battery assembly (l). See paragraph 3-12.

c. Install case. See paragraph 3-11.

END OF TASK

5-13. CRYSTAL Y1 REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

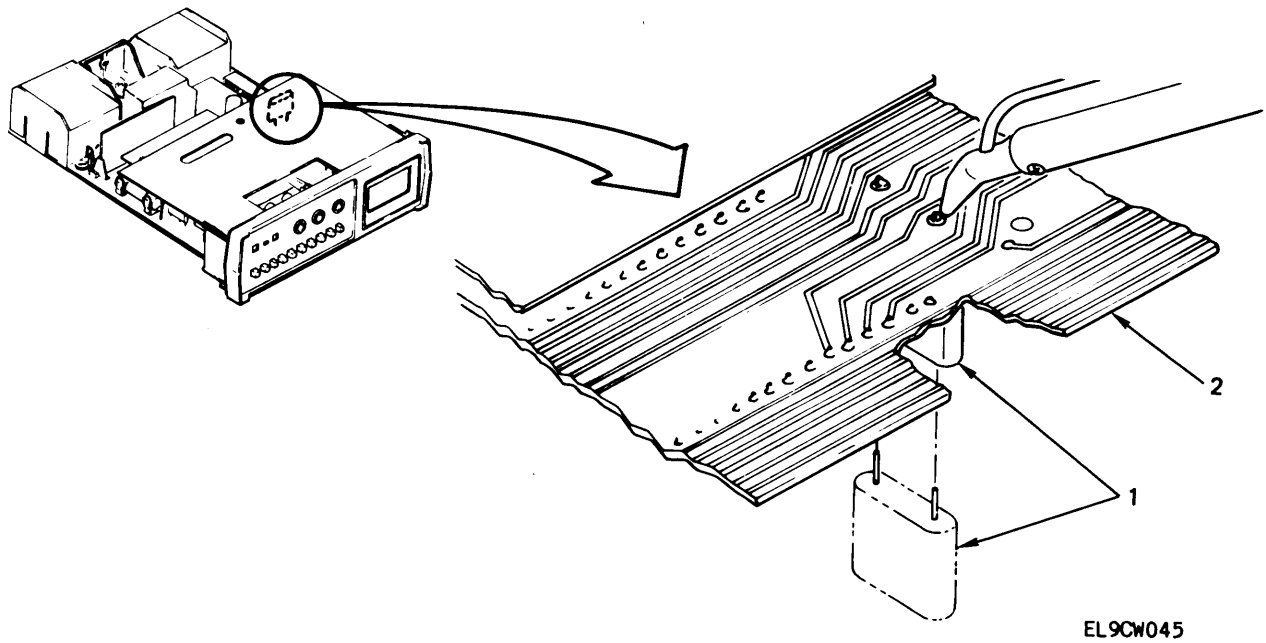
REMOVE

CAUTION

Limit soldering iron wattage to 25 watts maximum to reduce any damage to electronic components. A vacuum-operated resoldering tool shall be used when resoldering.

a. Remove case. See paragraph 3-11.

b. Desolder and remove crystal Y1 (1).



INSTALL

a. Insert new crystal (1) in main pcb (2) and solder in place.

b. Install case. See paragraph 3-11.

END OF TASK

5-14. VARISTORS RV1, RV2, RV3 REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

REMOVE

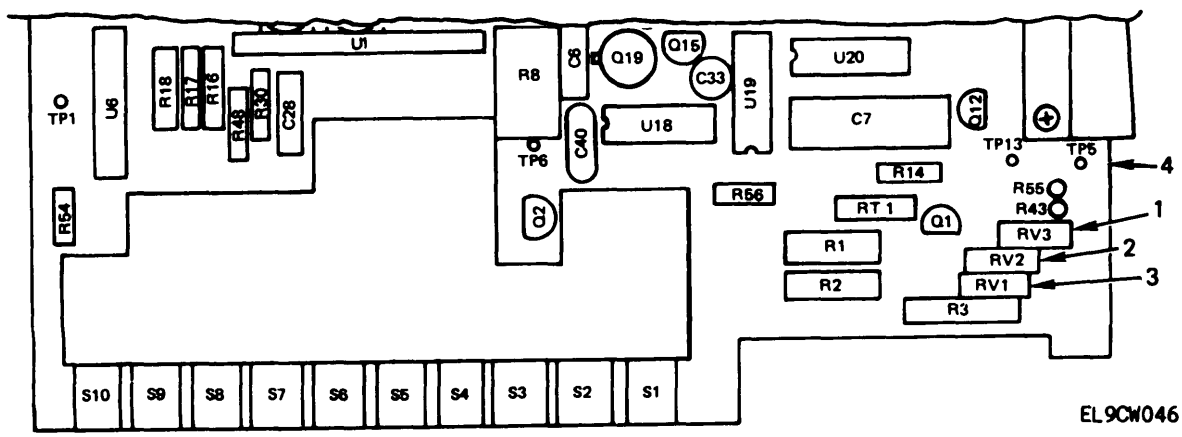
CAUTION

Limit soldering iron wattage to 25 watts maximum to reduce any damage to electronic components. A vacuum-operated resoldering tool shall be used when resoldering.

a. Remove case. See paragraph 3-11.

b. Remove display pcb. See paragraph 5-10.

c. Desolder and remove varistors (1, 2, and 3) from main pcb.



INSTALL

a. Insert new varistors in main pcb (4) and solder in place.

b. Install display pcb. See paragraph 5-10.

c. Install case. See paragraph 3-11.

END OF TASK

5-15. RESISTORS R1 AND R2 REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

REMOVE

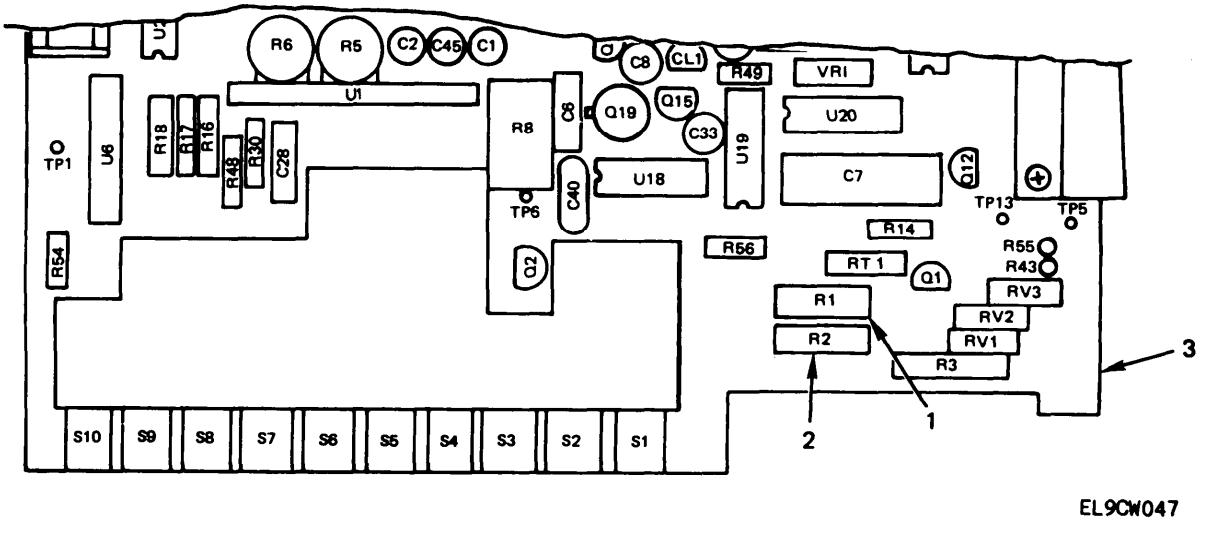
CAUTION

Limit soldering iron wattage to 25 watts maximum to reduce any damage to electronic components. A vacuum-operated resoldering tool shall be used when resoldering.

a. Remove case. See paragraph 3-11.

b. Remove display pcb. See paragraph 5-10.

c. Desolder and remove resistor (1 or 2) from main pcb.



INSTALL

a. Insert replacement resistor in main pcb (3) and solder in place.

b. Install display pcb. See paragraph 5-10.

c. Install case. See paragraph 3-11.

END OF TASK

5-17. PERFORMANCE TESTS AND ADJUSTMENTS

This section consists of doing performance tests on the multimeter after replacement of parts and making the necessary adjustments to ensure the multimeter meets its performance specifications.

NOTE

- If an operational test is required at this time, conduct the test as directed in paragraph 3-10.
- Performance test procedures must be done in the order given.
- A performance test checklist is provided at the end of the performance test procedures. Use the checklist while doing the test procedures.

a. **Initial Setup.**

WARNING

High voltage is used or exposed during the performance of these tests. Death on contact may result if personnel fail to observe safety precautions.

(1) Remove multimeter case. See paragraph 3-11.

(2) Insert red test lead into multimeter V/k Ω/ S terminal.

(3) Insert black test lead into multimeter COMMON terminal.

(4) Plug multimeter ac power cord into 115 V ac source.

(5) Press POWER ON/ OFF pushbutton to ON and allow at least 15 minutes for equipment to warm up and stabilize.

END OF TASK

b. **Display Test.**

TOOLS:

Dc Voltage Standard NSN 6625-00-239-8924

(1) Set multimeter pushbuttons as follows:

- POWER ON/ OFF to in (ON).
- RELATIVE ON/ OFF to out (OFF).
- AC/ DC function to out (DC).
- k Ω function to in (k Ω).
- 200 Ω range to in (200).

(2) With test leads open-circuited, verify that overrange indication 1 . is displayed.

(3) Short test leads, select each range listed below and verify that decimal point is shown as listed:

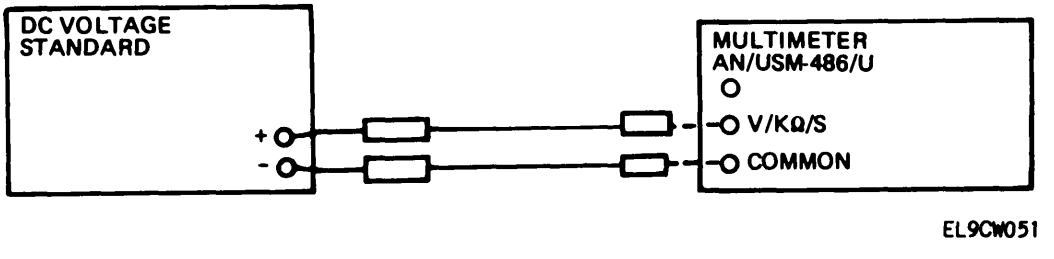
Select Range	Display Reading
200 ohm	00.00*
2 kohm	.0000*
20 kohm	0.000
200 kohm	00.00
2000 kohm	000.0
20M Ω	0.000

***** The least significant digit(s) may change by several digits from zero, depending on test lead resistance.

(4) Depress V function and 20M Ω range pushbuttons.

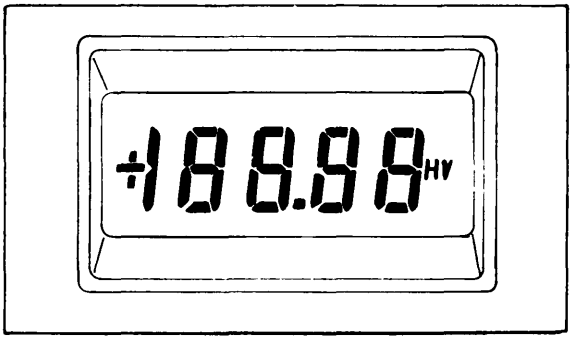
(5) Check that AC/ DC function pushbutton is out (DC) and verify that four decimal points (....) are displayed.

(6) Connect test equipment as shown and select DC V function, and 200 V range on multimeter.



(7) Turn on and adjust dc voltage standard until LCD displays +188.88.

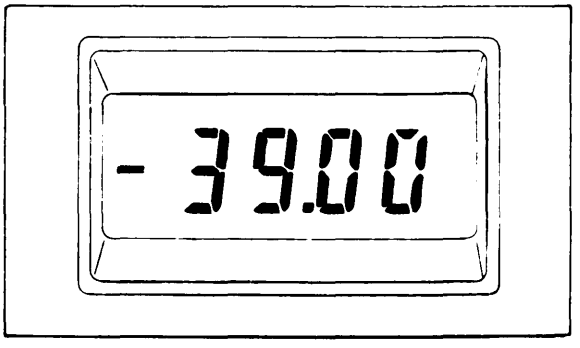
(8) Verify that all segments of each digit show and that HV annunciator has appeared indicating multimeter input is over 40 V.



EL9CW052

(9) Set dc voltage standard for input to multimeter of -39 V dc.

(10) Check that HV annunciator goes away and LCD changes to -39.00.



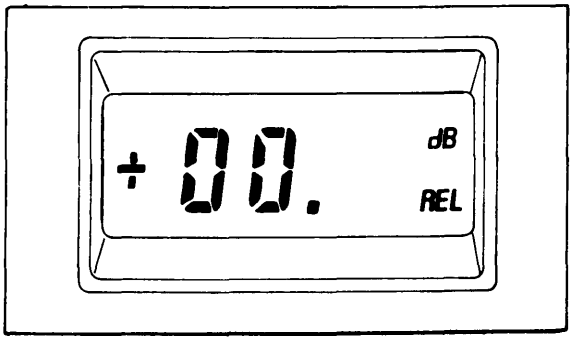
EL9CW05

(11) Disconnect dc voltage standard.

(12) Depress both dB function pushbuttons.

(13) Depress RELATIVE ON/OFF pushbutton to in (ON).

(14) Verify that dB and REL annunciators are displayed.



EL9CW055

(15) Turn off and disconnect equipment,

END OF TASK

C. **Dc Voltage Test and Adjustment.**

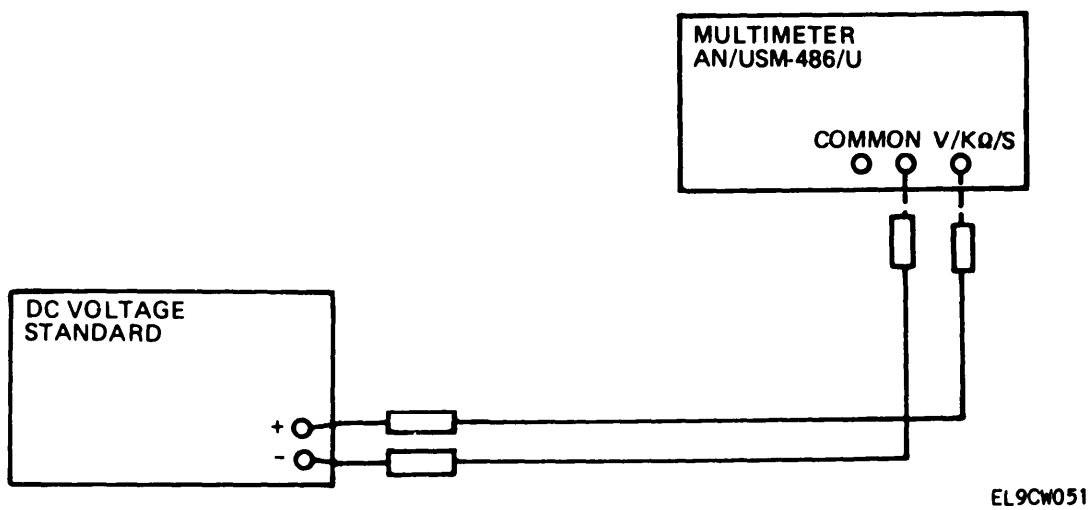
TOOLS:

Dc Voltage Standard	NSN 6625-00-239-8924

(1) Set multimeter pushbuttons as follows:

- POWER ON/OFF to in (ON).
- RELATIVE ON/OFF to out (OFF).
- AC/DC function to out (DC).
- V function to in (V).
- 2-volt range to in **(2** V).

(2) Connect equipment as shown.



(3) Turn on and adjust dc voltage standard output for 1.9000 V.

(4) If multi meter display does not read between 1.8992 and 1.9008 V, adjust R11 (1) to make display read 1.9000 V.

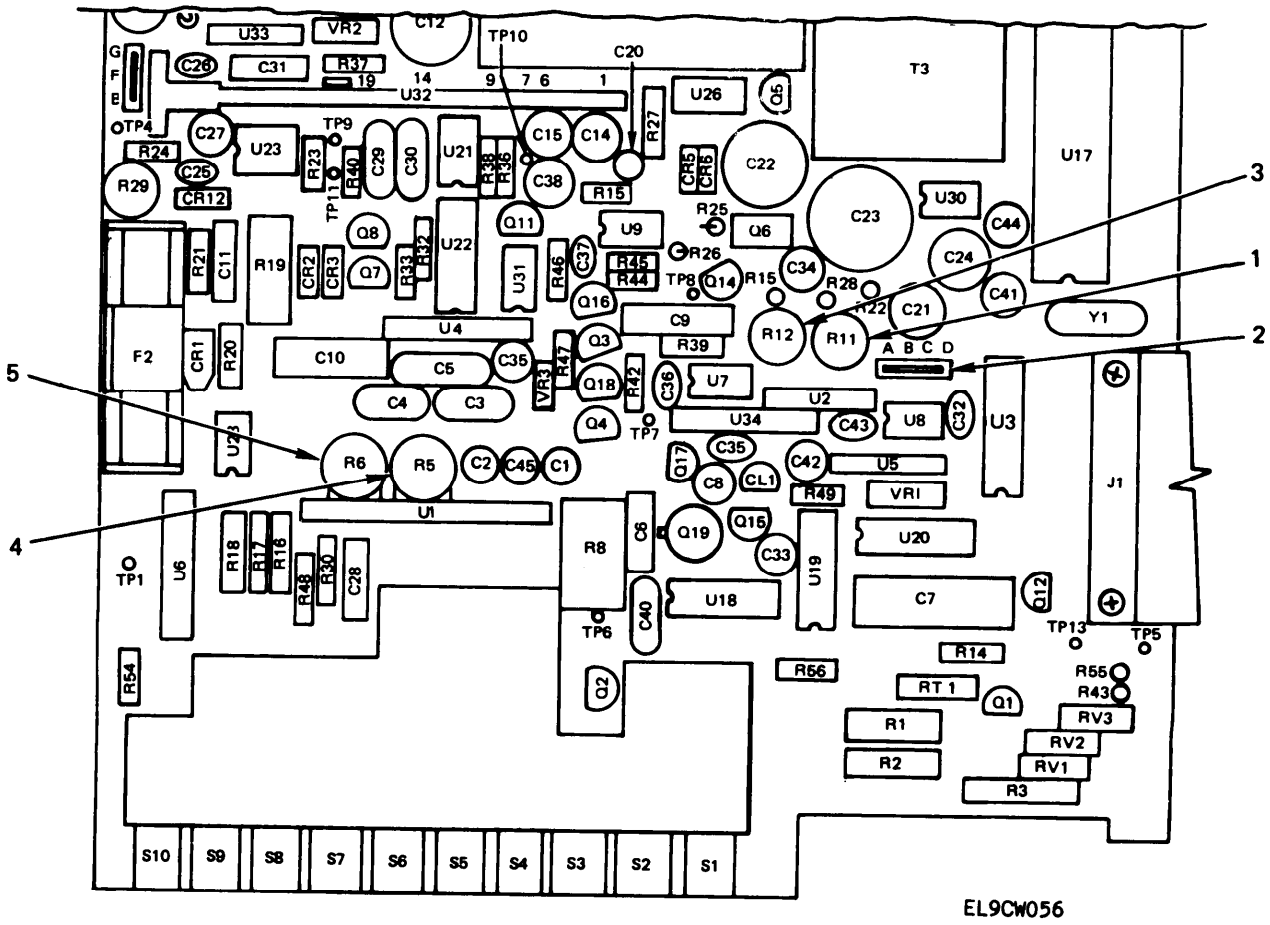
NOTE

Rarely, R11 may not have enough range to bring the reading into allowable limits. This requires replacing U5 (MP 32) jumper (2). See paragraph 5-17i. Then repeat steps (1) through (4).

(5) Set multimeter and dc voltage standard controls as shown in the following table. If multimeter display does not read within listed limits, adjust component listed in Adjustment column.

Dc Voltage Standard	Range Pushbutton	Multimeter Display Indication	Adjustment
+0.19000 V	200 mV	+189.92 to +190.08	R12 (3)
-0.19000 V	200 mV	-189.92 to -190.08	—
+19.000 V	20 V	+18.992 to +19.008	—
+190.00 V	200 V	+189.92 to +190.08	R5 (4)
1000 V	1000 V	+999.5 to +1000.5	R6 (5)

(6) Turn off and disconnect equipment.



END OF TASK

d. **Ac Voltage Test and Adjustment.**

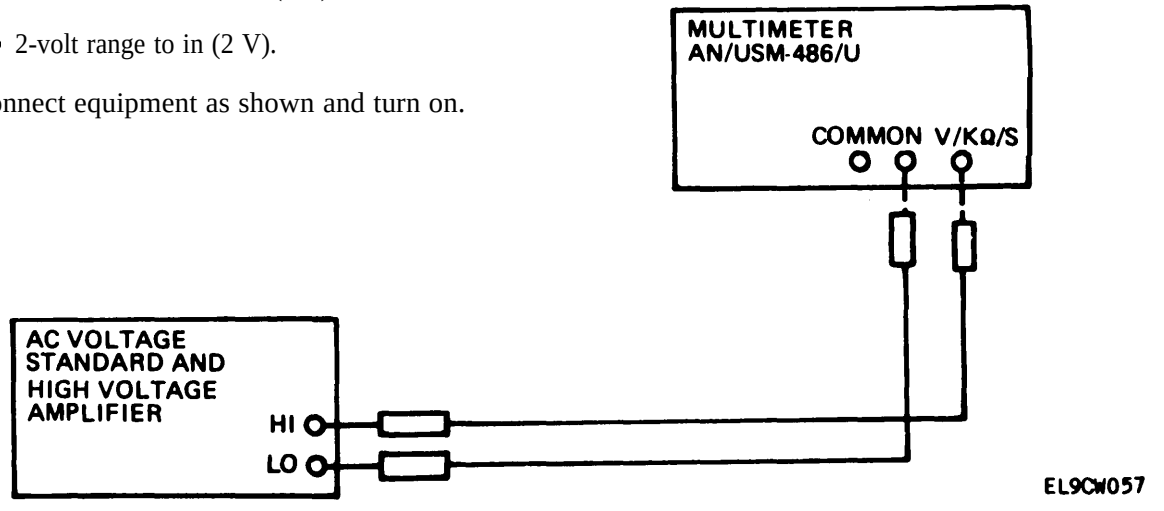
TOOLS:

Ac Voltage Standard	NSN 6625-00-458-4605
High Voltage Amplifier	NSN 6625-00-125-2316

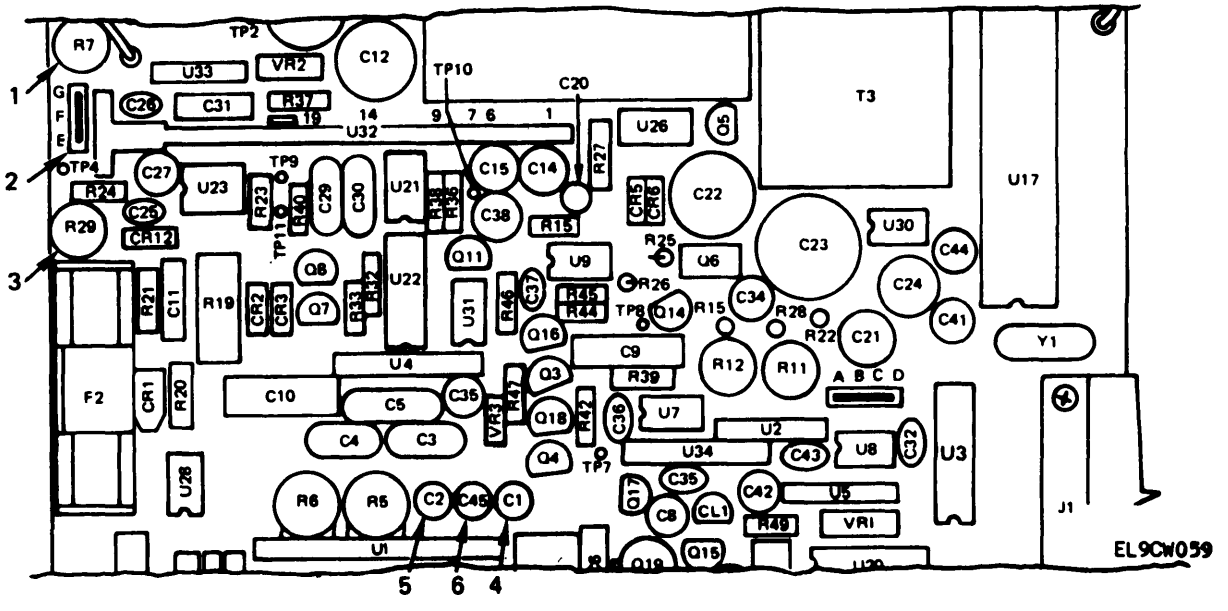
(1) Set multimeter pushbuttons as follows:

- POWER ON/OFF to in (ON).
- RELATIVE ON/ OFF to out (OFF).
- AC/ DC function to in (AC).
- 2-volt range to in (2 V).

(2) Connect equipment as shown and turn on.



(3) Set multimeter and ac voltage standard controls as shown in the following table. If multimeter display does not read within listed limits, adjust component listed in Adjustment column.



Step No.	Ac Voltage Standard		Multimeter		Adjustment
	output Voltage	Frequency	Range Pushbutton	Display Indications	
1	1.9000 V	200 Hz	2V	1.8895 to 1.9105	R7 (l)*
2	0.1000 V	200 Hz	2V	0.0985 to 0.1015	R29(3)**
3	Short	—	2V	<.0040	**
4	19.000 V	10 kHz	20 V	18.895 to 19.105	cl (4)***
5	190.00 V	10 kHz	200 V	188.95 to 191.05	C2 (5)***
6	750.0 V	10 kHz	750 V	745.2 to 754.8	C45(6)***
7	190.00 mV	45 Hz	200 mV	188.95 to 191.05	none
8	190.00 mV	1 kHz	200 mV	188.95 to 191.05	none
9	190.00 mV	20 kHz	200 mV	188.00 to 192.00	none
10	1.9000 V	20 kHz	2V	1.8800 to 1.9200	none
11	1.9000 V	1 kHz	2V	1.8895 to 1.9105	none
12	19.000 V	1 kHz	20 V	18.895 to 19.105	none
13	19.000 V	20 kHz	20 V	18.800 to 19.200	none
14	19.000 V	45 Hz	20 V	18.895 to 19.105	none
15	190.00 V	45 Hz	200 V	188.95 to 191.05	none
16	190.00 V	1 kHz	200 V	188.95 to 191.05	none
17	190.00 V	20 Hz	200 V	188.00 to 192.00	none
18	750.0 V	20 Hz	750 V	741.5 to 758.5	none
19	750.0 V	45 Hz	750 V	745.2 to 754.8	none

*If R7 is outside the adjustment range, do the U33 Jumper (2) Selection procedure. see paragraph 5-17j.

**If R29 is outside the adjustment range, do the Rms Converter Offset Adjustment. See paragraph 5-17k.

***C1, C2, and C45 arc interacting. If any one of them are adjusted, repeat the procedures for all of them until they arc all within limits.

(4) Turn off and disconnect equipment.

END OF TASK

e. **dB Voltage Test.**

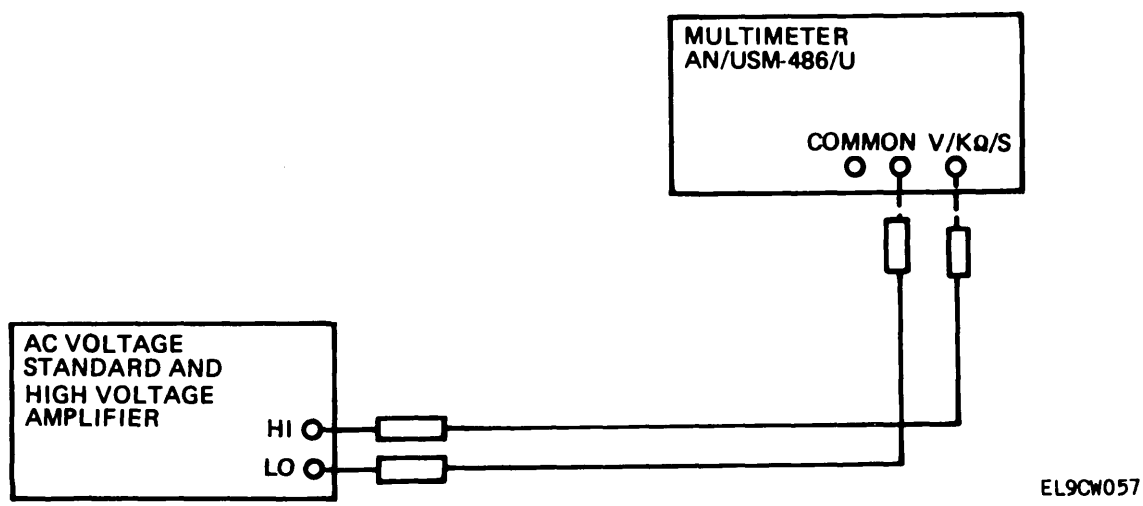
TOOLS:

Ac Voltage Standard	NSN 6625-00-458-4605
High Voltage Amplifier	NSN 6625-00-125-2316

(1) Set multimeter pushbuttons as follows:

- POWER ON/ OFF to in (ON).
- RELATIVE ON/ OFF to out (OFF).
- AC/ DC function to in (AC).
- 200 mV range to in (200 mV).
- V and mA function in together (dB).

(2) Connect equipment as shown and turn on.



(3) Set multimeter and ac voltage standard controls as shown in the following table. Multimeter display will read within limits specified. No adjustments can be made.

Ac Voltage Standard		Multimeter	
Frequency	Voltage	Range Pushbutton	Display Indication
200 Hz	0.001 V	200 mV	-58.3 to -57.3
200 Hz	0.100 V	200 mV	-17.63 to -17.93
200 Hz	1.9000 V	2V	+7.64 to +7.94
200 Hz	19.000 V	20 V	+27.64 to +27.94
200 Hz	190.00 V	200 V	+47.64 to +47.94

(4) Turn off and disconnect equipment.

END OF TASK

f. **Dc Current Test**

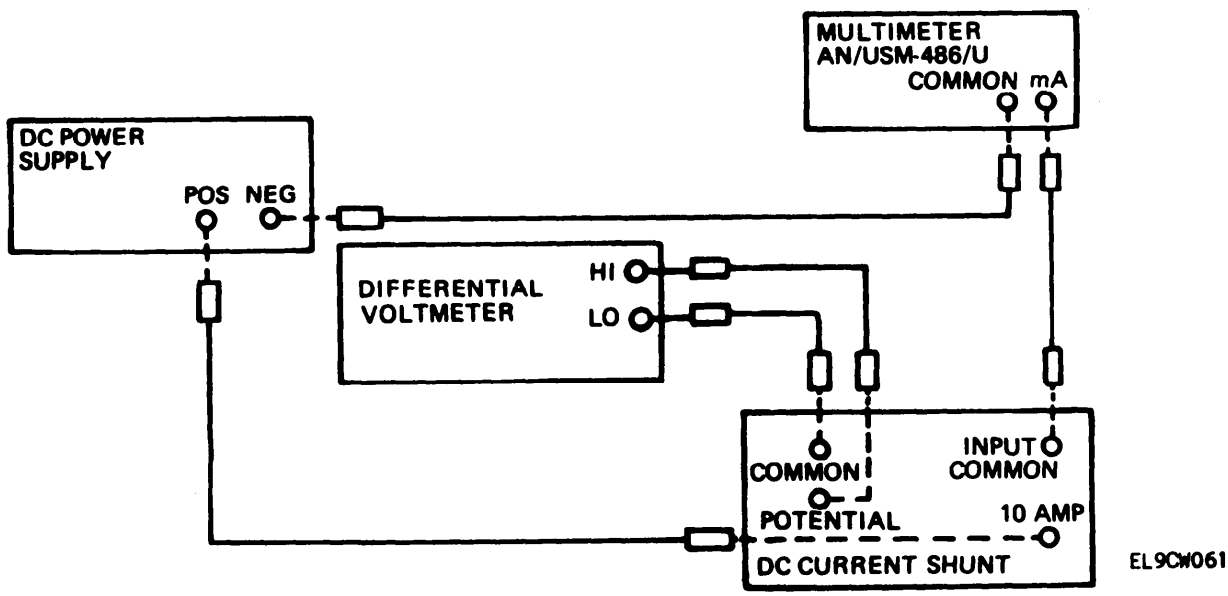
TOOLS:

Dc Power Supply	NSN 4931-00-178-0715
Differential Voltmeter	NSN 4931-00-407-2642
Dc Current Shunt	NSN 6625-00-917-9834

(1) Set multimeter pushbuttons as follows:

- POWER ON/ OFF to in (ON).
- RELATIVE ON/OFF to out (OFF).
- mA function to in (mA).
- AC/ DC function to out (DC).
- 200 µA range to in (200 µA).

(2) Connect equipment as shown.



(3) Set multimeter and other equipment controls as shown in the following table. Multimeter display will read within limits specified. No adjustments can be made.

Standard Current Equipment			Multimeter	
DC Shunt	Differential Voltmeter	current	Range Pushbutton	Display Indication
0.001 A	19.000 mV	0.19 mA	200 µA	189.61 to 190.39
0.01 A	19.000 mV	1.9 mA	2 mA	1.8961 to 1.9039
0.1 A	19.000 mV	19 mA	20 mA	18.961 to 19.039
1A	19.000 mV	190 mA	200 mA	189.61 to 190.39
10A	19.000 mV	1900 mA	2000 mA	1894.1 to 1905.9

(4) Turn off and disconnect equipment.

END OF TASK

g. **Ac Current Test.**

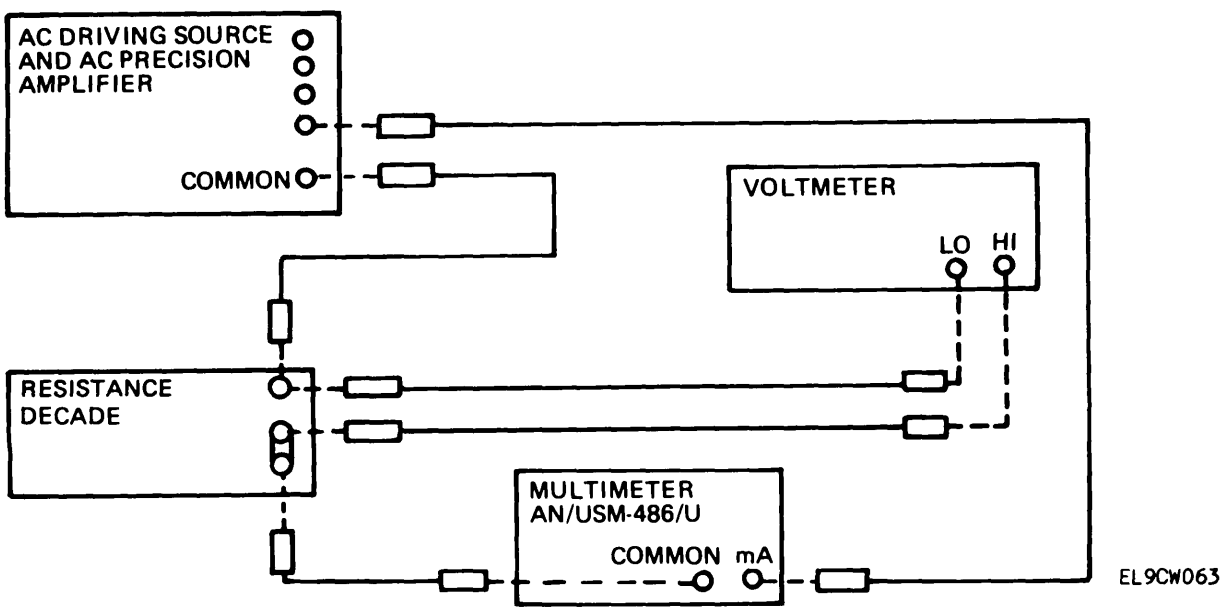
TOOLS:

Ac Driving Source (Oscillator)	NSN 6625-01-020-8109
Ac Precision Amplifier	NSN 6695-01-081-9053
Resistance Decade	NSN 6625-00-071-5343
Voltmeter	NSN 6625-01-010-9255
Ac Ammeter Calibrator	NSN 4931-00-019-4671

(1) Set multimeter pushbuttons as follows:

- POWER ON/OFF to in (ON).
- RELATIVE ON/OFF to out (OFF).
- AC/DC function-to in (AC).
- **mA** function to in (mA).

(2) Connect equipment as shown and turn on.

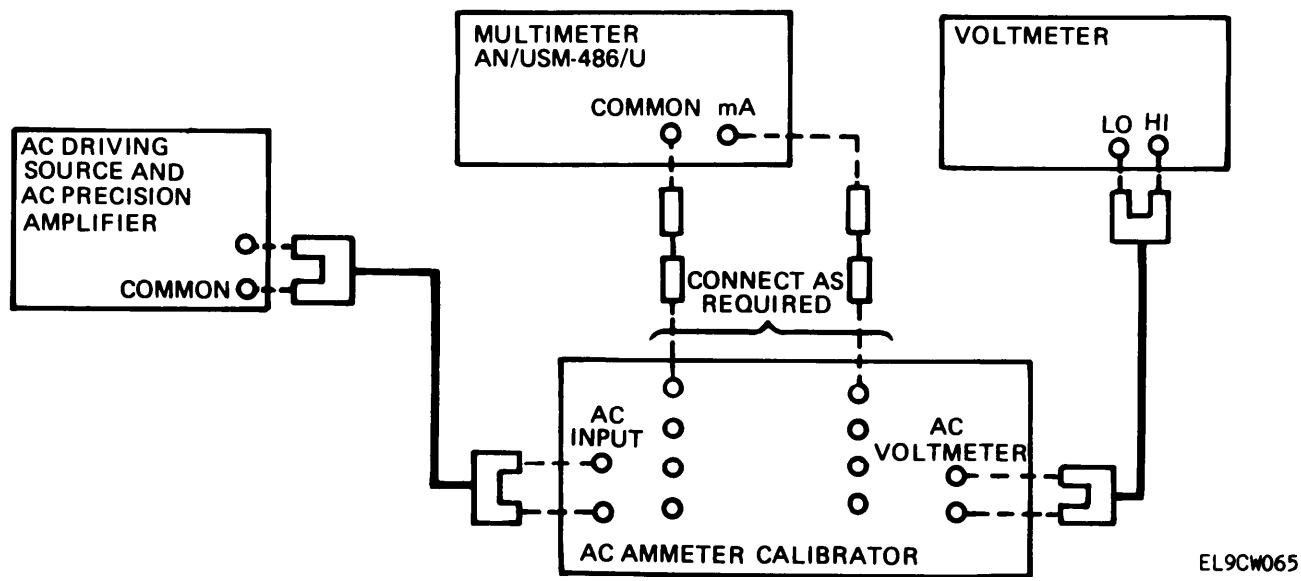


(3) Set multimeter and other equipment controls as shown in the following table. Multimeter display will read within limits specified. No adjustments can be made.

Standard Current Equipment			Multimeter	
AC Driving Source	Differential Voltmeter	Resistance Decade	Range Pushbutton	Display Indication
400 Hz	1.9000V	10,000 ohms	200 µA	188.00 to 192.00 µA
400 Hz	1.9000V	1,000 ohms	2 mA	1.8800 to 1.9200 mA

(4) Turn off and disconnect equipment.

(5) Connect equipment as shown.



(6) Set multimeter and other equipment controls as shown in the following table. Multimeter display will read within limits specified. No adjustments can be made.

Standard Current Equipment			Multimeter	
AC Driving Source	Differential Voltmeter	Ac Ammeter Calibrator	Range Pushbutton	Display Indication
400 Hz	1.0000V	19.00 mA	20 mA	18.800 to 19.200 mA
400 Hz	1.0000 v	190.0 mA	200 mA	188.00 to 192.00 mA
400 Hz	1.0000V	1900 mA	2000 mA	1861.0 to 1939.0 mA

(7) Turn off and disconnect equipment.

END OF TASK

h. **Resistance Test.**

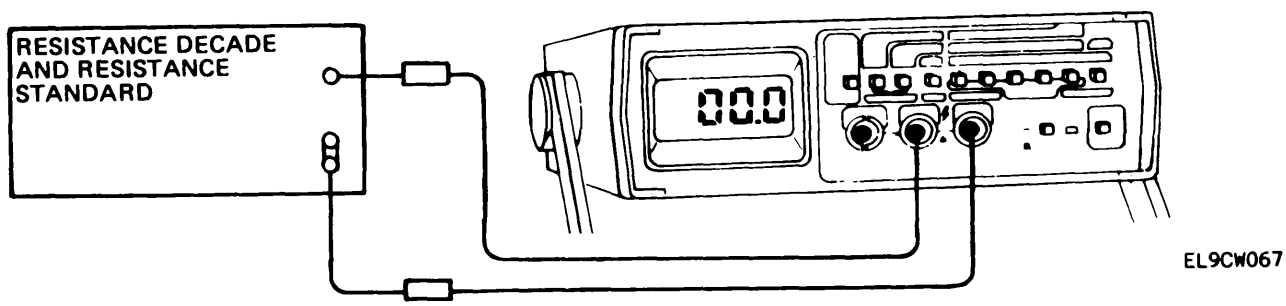
TOOLS:

Resistance Decade	NSN 6625-00-071-5343
Resistance Standard	NSN 6625-00-678-9678

(1) Set multimeter pushbuttons as follows:

- POWER ON/OFF to in (ON).
- RELATIVE ON/ OFF to out (OFF).
- k Ω function to in (ON).

(2) Connect equipment as shown and turn on.



(3) Set multimeter and resistance decade or standard controls as shown in the following table. Multimeter display will read within limits specified. No adjustments can be made.

Resistance Decade	DMM Range Pushbutton	DMM Display Indication
190.00 ohms	200 Ω	189.80 to 190.20
1.9000 kohm	2 k	1.8980 to 1.9020
19.000 kohm	20 k	18.980 to 19.020
190.00 kohm	200 k	189.80 to 190.20
*1900.0 kohm	2000 k	1898.0 to 1902.0
*10.00 megohm	20M Ω	9.978 to 10.022

*Use *2* and 10 Megohm Resistance Standard in place of Resistance Decade

(4) Turn off and disconnect equipment.

END OF TASK

i. **U5 Jumper (MP 32) Selection.** If variable resistor R 11 (1) does not have enough adjustment range, do this procedure. This procedure selects the correct resistance for resistor network US (2).

TOOLS:

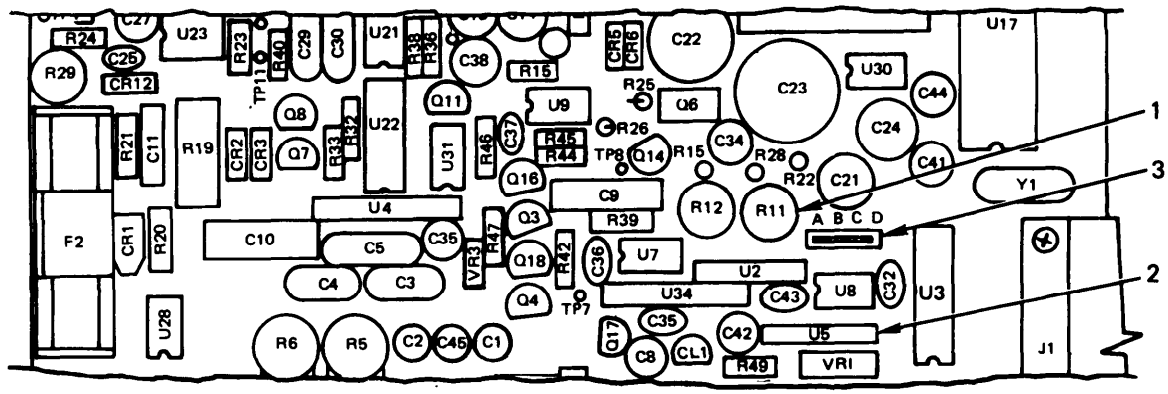
Dc Voltage Standard NSN 6625-00-239-8924

REPLACEMENT PARTS:

US Jumper (5-post), Fluke Part No. 537514

WARNING

High voltage is used or exposed during the performance of these tests. Death on contact may result if personnel fail to observe safety precautions.



EL9CW068

i. **U5 Jumper (MP 32) Selection** (Cont)

(1) Turn power off.

(2) Short all selectable jumper positions A-B-C-D with 5-pin connector (3) provided with Fluke Part No. 537514.

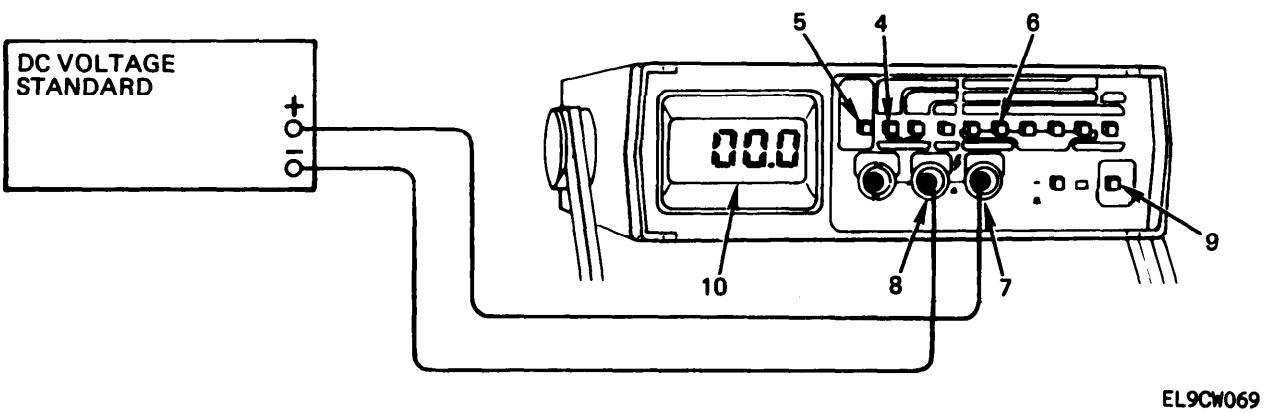
(3) Adjust resistor R11 (1) fully counterclockwise.

(4) Depress V function pushbutton (4).

(5) Depress AC/ DC function pushbutton (5) to out (DC).

(6) Depress 2 V range pushbutton (6).

(7) Connect dc voltage standard as shown and turn on.



(8) Depress multimeter POWER ON/OFF pushbutton (9) to ON.

(9) Set dc voltage standard for multimeter input of +1.8888 V.

(l0) Compare multimeter display (10) reading to figure 5-7 and select display bracket that multimeter reading falls in.

(11) Turn power off and remove U5 jumper (3).

(12) Open jumper positions as indicated in right-hand column. Use diagonal cutters to cut out piece of 5-pin connector as directed.

(13) Install U5 jumper and turn power on.

(14) Redo dc voltage test. See paragraph 5-17c.

(15) Turn off power and disconnect equipment.

DISPLAY (ALL JUMPER PINS INSTALLED)		JUMPER CONFIGURATION AS VIEWED FROM REAR OF MULTIMETER
LOW	HIGH	D C B A
1.8773	1.8879	
1.8667	1.8772	
1.8562	1.8666	
1.8459	1.8561	
1.8356	1.8458	
1.8255	1.8355	
1.8155	1.8254	
1.8056	1.8154	
1.7958	1.8055	
1.7861	1.7957	
1.7765	1.7860	
1.7670	1.7764	
1.7576	1.7669	
1.7483	1.7575	
1.7391	1.7482	
1.7300	1.7390	NO JUMPER INSTALLED

SELECTABLE JUMPER CONFIGURATION FOR DC ADJUSTMENT

EL9CW070

Figure 5-7. US Jumper (MP 32) Selection Criteria

END OF TASK

j. **U33 Jumper (MP 31) Selection.** If variable resistor R7 (1) does not have enough adjustment range, do this procedure. Use the following procedure to select the proper value of resistor network U33 (2).

TOOLS:

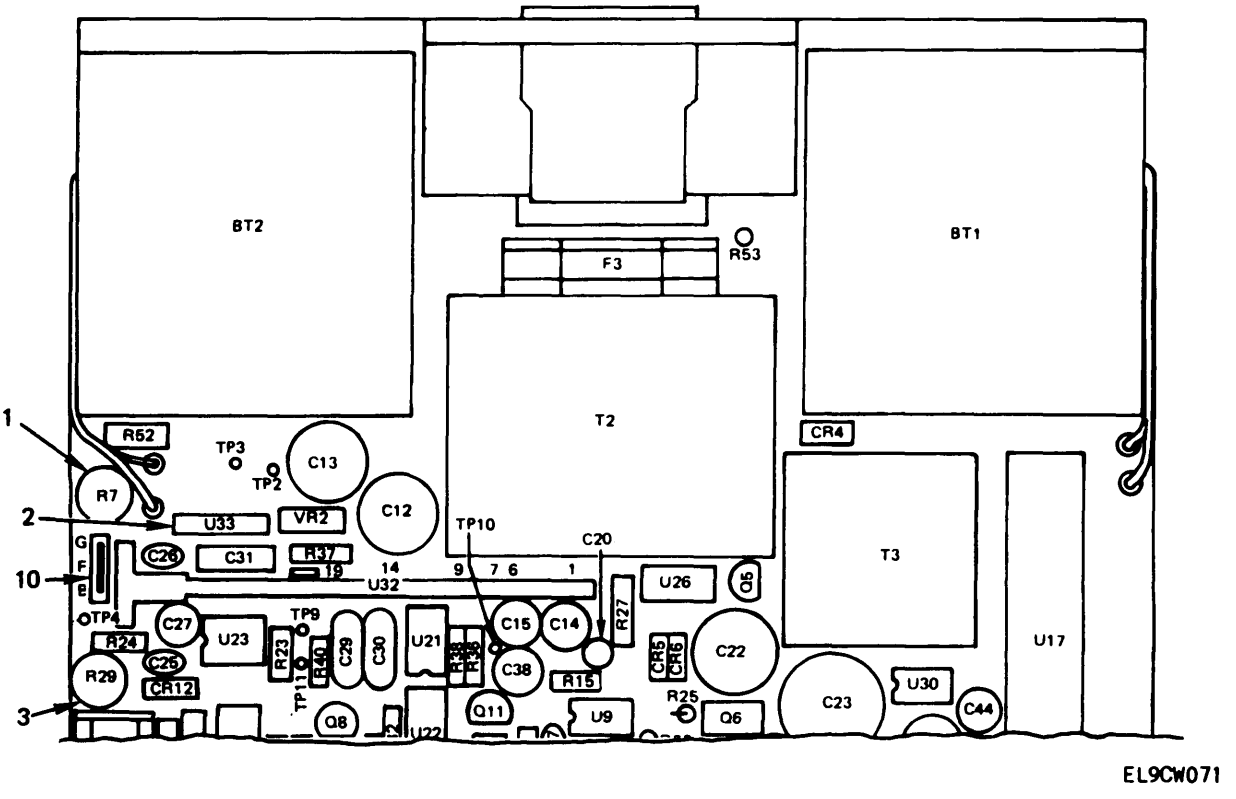
Ac Driving Source (Oscillator)	NSN 6625-01-020-8109
Ac Precision Amplifler	NSN 6695-01-081-9053

REPLACEMENT PARTS:

U33 Jumper (4-post), Fluke Part No. 537522

WARNING

High voltage is used or exposed during the performance of these tests. Death on contact may result if personnel fail to observe safety precautions.



(1) Turn power off.

(2) Short all selectable jumper positions E-F-G with 4-pin connector (10) provided with Fluke Part No. 537522.

(3) Adjust resistor R7 (1) fully clockwise.

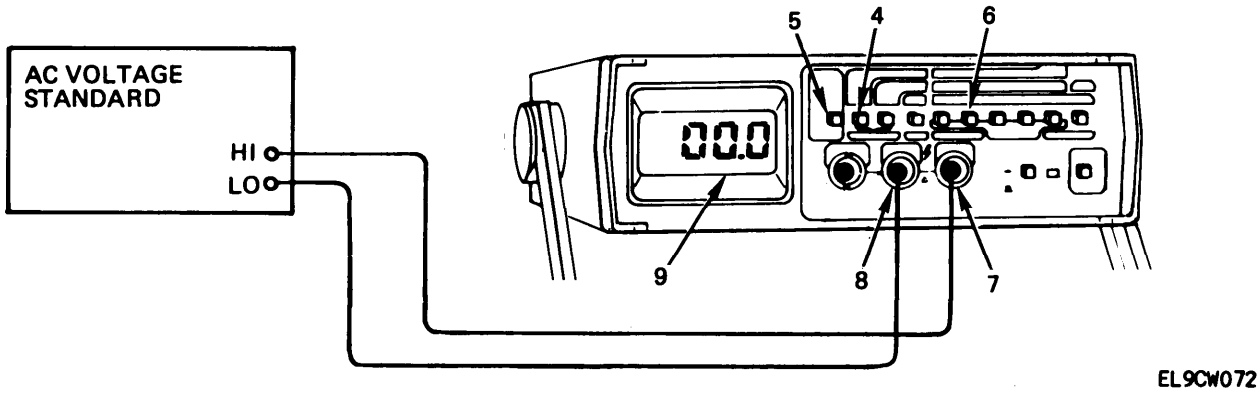
(4) Adjust resistor R29 (3) to about center of its range.

(5) Depress V function pushbutton (4).

(6) Depress AC/ DC function pushbutton (5) in (AC).

(7) Depress 2 V range pushbutton (6).

(8) Connect ac voltage standard as shown and turn on.



(9) Depress multimeter POWER ON/OFF pushbutton to ON.

(l0) Set ac voltage standard for input to multimeter of 1.0000 V ac rms at 200 Hz.

(11) Compare multimeter display (9) reading to figure 5-8 and select display bracket that multimeter reading falls in.

(12) Turn power off and remove U33 jumper (10).

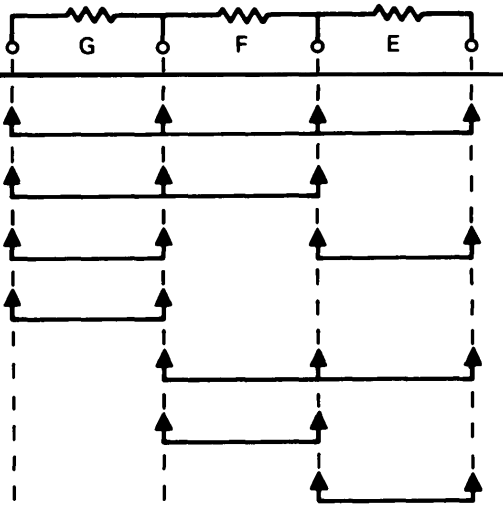
(13) Open jumper positions “as indicated in right-hand column. Use diagonal cutters to cut out piece of 4-pin connector as directed.

(14) Install U33 jumper and turn power on.

(15) Redo ac voltage test. See paragraph 5-17d.

(16) Turn off power and disconnect equipment.

j. U33 Jumper (MP 31) Selection (Cont)

DISPLAY (ALL JUMPER PINS INSTALLED)		JUMPER CONFIGURATION AS VIEWED FROM LEFT SIDE OF MULTIMETER
LOW	HIGH	
1.0100	1.0497	
1.0498	1.0932	
1.0933	1.1366	
1.1367	1.1801	
1.1802	1.2236	
1.2237	1.2671	
1.2672	1.3106	
1.3107	1.3540	NO JUMPERS INSTALLED
SELECTABLE JUMPER CONFIGURATION FOR AC ADJUSTMENT		

EL9CW073

Figure 5-8. U33 Jumper (MP 31) Section Criteria

END OF TASK

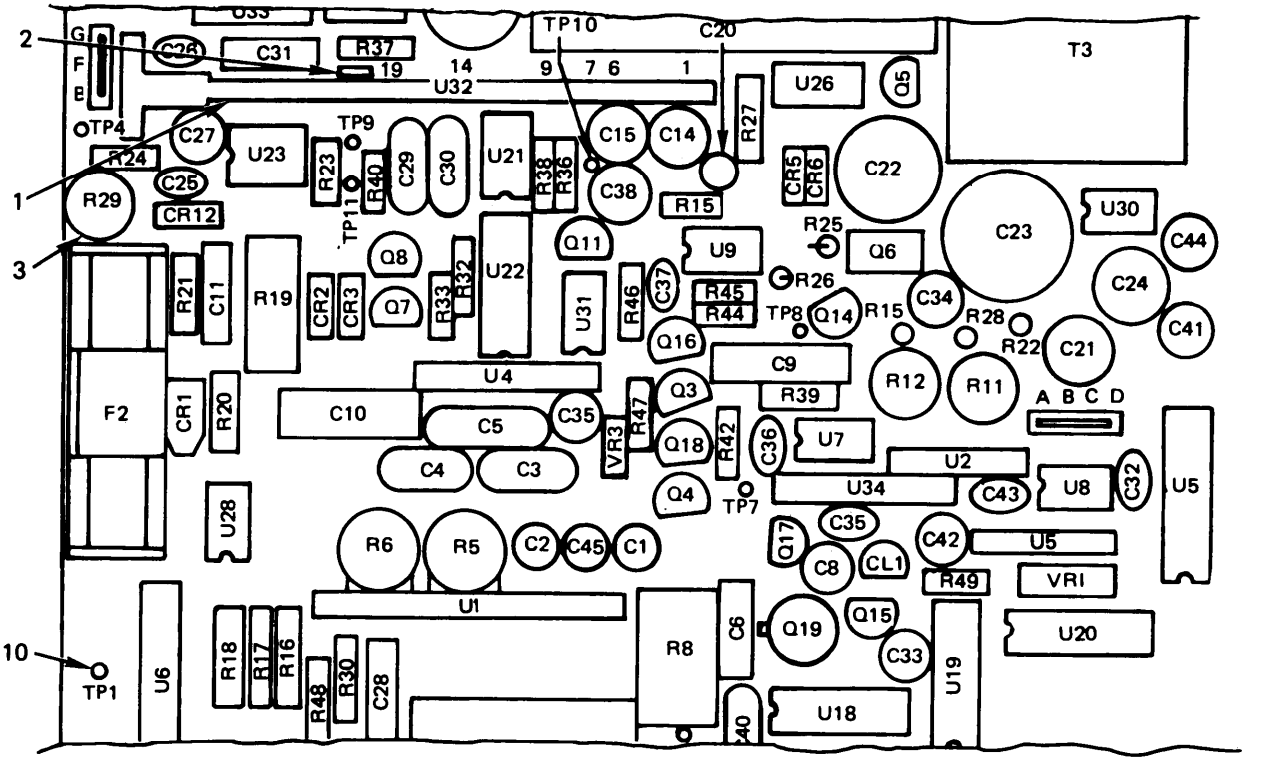
k. **Rms Converter Offset Adjustment.** Therms converter U32 (1) in the multimeter has a factory calibrated adjustment (2) mounted on its ceramic substrate. If R29 (3) is outside of its adjustment range or the ac floor level is greater than 40 digits, do the following procedure.

TOOLS:

Ac Voltage Standard	NSN 6625-00-458-4605
Voltmeter	NSN 6625-01-010-9255

WARNING

High voltage is used or exposed during the performance of these tests. Death on contact may result if personnel fail to observe safety precautions.



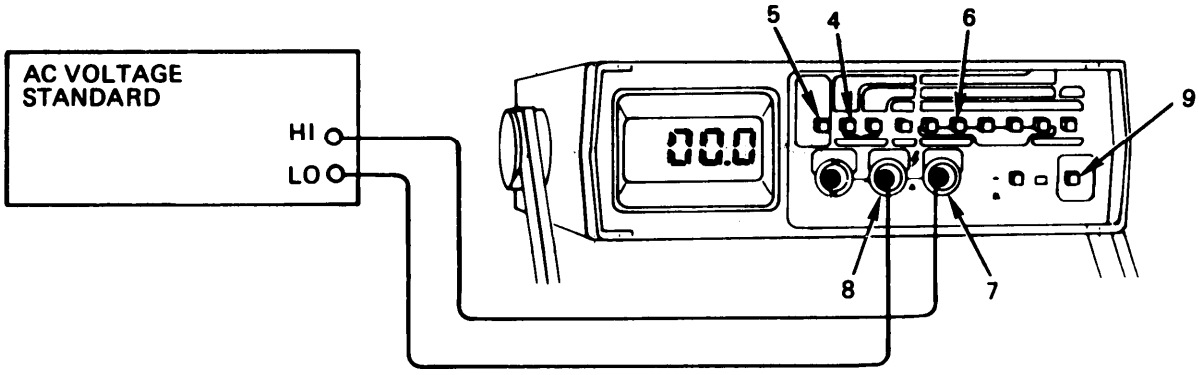
EL9CW074

(1) Set multimeter pushbuttons as follows:

- POWER ON/OFF (9) to out (OFF).
- RELATIVE ON/OFF to out (OFF).
- V function (4) to in (V).
- AC/DC function (5) to in (AC).
- 2 V range (6) to in (2 V).

k. **Rms Converter Offset Adjustment** (Cont)

(2) Connect ac voltage standard as shown and turn on.



EL9CW075

(3) Depress multimcter POWER ON/OFF pushbutton (9) to in (ON).

(4) Set ac voltage standard for input to multimeter of 1.0000 V ac rms at 400 Hz.

(5) Using voltmeter, measure and record dc voltage between U32 (1) pin 7 and TP1 (10) to nearest 0.1 mV. Must be between+ 20 mV dc.

(6) Measure voltage between U32 (1) pin 6 and TP1 (10). If within 0.5 mV of voltage from step 8, rms converter does not need adjustment.

(7) If not within 0.5 mV, adjust potentiometer (2) mounted on U32 (1) so that voltage on pin 6 is within ± 0.2 mV of voltage on pin 7.

(8) Turn off power and disconnect equipment.

END OF TASK

1. Final Instructions.

(1) Turn off and disconnect all equipment.

(2) Install case. See paragraph 3-11.

(3) When multimeter cannot be adjusted wthin tolerance, troubleshoot (see paragraph 5-7) and repair (see paragraphs 5-10 through 5-16).

DISPLAY TEST CHECKLIST

Test and Setup	Display Read	Satisfactory
Setup for ohms, input open-circuited.	1 .	_____
Decimal check, ohms, input shorted.	See page 5-28	_____
Invalid setup, set for V and 20M Ω.	....	_____
Segment and HV check, 200 V range.	+188.88 HV	_____
Segment check.	-39.00	_____
dB and REL check.	dB +00 REL	_____

*The least significant digit(s) may change by several digits from zero, depending on test lead resistance.

DC VOLTAGE TEST CHECKLIST

Dc Voltage Standard	Rang. Pushbutton	Multimeter Display Indication	Adjustment	Satisfactory
+1.90000 V	2V	+1.8992 to +1.9008	Rll (1)	_____
+0.19000 V	200 mV	+189.92 to +190.08	R12 (3)	_____
-0.1’9000 V	200 mV	-189.92 to -190.08	—	_____
+19.000 V	20 V	+18.992 to +19.008	—	_____
+190.00 V	200 V	+189.92 to +190.08	R5 (4)	_____
1000 V	1000 V	+999.5 to +1000.5	R6 (5)	_____

AC VOLTAGE TEST CHECKLIST

Step No.	Ac Voltaga Standard		Multimeter		Adjustment	Check OK
	Output Voltage	Frequency	Range Pushbutton	Display Indications		
1	1.9000V	200 Hz	2V	1.8895 to 1.9105	R7 (l)*	
2	0.1000 V	200 Hz	2V	0.0985 to 0.1015	R29(3)**	
3	Short	—	2V	<.0040	**	
4	19.000 V	10 kHz	20 V	18.895 to 19.105	Cl (4)***	
5	190.00 V	10 kHz	200 V	188.95 to 191.05	C2 (5)***	
6	750.0 V	10 kHz	750 V	745.2 to 754.8	C45(6)***	
7	190.00 mV	45 Hz	200 mV	188.95 to 191.05	none	
8	190.00 mV	1 kHz	200 mV	188.95 to 191.05	none	
9	190.00 mV	20 kHz	200 mV	188.00 to 192.00	none	
10	1.9000 V	20 kHz	2 V	1.8800 to 1.9200	none	
11	1.9000 V	1 kHz	2 V	1.8895 to 1.9105	none	
12	19.000 V	1 kHz	20 V	18.895 to 19.105	none	
13	19.000 V	20 kHz	20 V	18.800 to 19.200	none	
14	19.000 V	45 Hz	20 V	18.895 to 19.105	none	
15	190.00 V	45 Hz	200 V	188.95 to 191.05	none	
16	190.00 V	1 kHz	200 V	188.95 to 191.05	none	
17	190.00 V	20 Hz	200 V	188.00 to 192.00	none	
18	750.0 V	20 Hz	750 V	741.5 to 758.5	none	
19	750.0 V	45 Hz	750 V	745.2 to 754.8	none	

*If R7 is outside the adjustment range, do the U33 Jumper (2) Selection procedure. See paragraph 5-17j.

***If R29 is outside the adjustment range, do the Rms Converter Offset Adjustment. See paragraph 5-17k.

***C1, C2, and C45 are interacting. If any one of them are adjusted, repeat the procedures for all of them until they are all within limits.

dB VOLTAGE TEST CHECKLIST

	Ac Voltage standard		Multimeter		
	Frequency	Voltage	Range Pushbutton	Display Indication	Satisfactory
	200 Hz	0.001 V	200 mV	-58.3 to -57.3	_____
	200 Hz	0.100 V	200 mV	-17.63 to -17.93	_____
	200 Hz	1.9000 V	2 V	+7.64 to +7.94	_____
	200 Hz	19.000 V	20 V	+27.64 to +27.94	_____
	200 Hz	190.00 V	200 V	+47.64 to +47.94	_____

DC CURRENT TEST CHECKLIST

	Standard Current Equipment			Multimeter		
	DC Shunt	Differential Voltmeter	Current	Range Pushbutton	Display indication	Satisfactory
	0.001 A	19.000 mV	0.19 mA	200 µA	189.61 to 190.39	_____
	0.01 A	19.000 mV	1.9 mA	2 mA	1.8961 to 1.9039	_____
	0.1 A	19.000 mV	19 mA	20 mA	18.961 to 19.039	_____
	1 A	19.000 mV	190 mA	200 mA	189.61 to 190.39	_____
	10 A	19.000 mV	1900 mA	2000 mA	1894.1 to 1905.9	_____

AC CURRENT TEST CHECKLIST

Standard Current Equipment			Multimeter		
AC Driving Source	Differential Voltmeter	Resistance Decade	Range Pushbutton	Display Indication	Satisfactory
400 Hz	1.9000 V	10,000 ohms	200 µA	188.00 to 192.00	_____
400 Hz	1.9000 V	1,000 ohms	2 mA	1.8800 to 1.9200	_____
AC Driving Source	**Differential Voltmeter**	**Ac Ammeter Calibrator**	**Range Pushbutton**	**Display indication**	
400 Hz	1.0000 V	19.00 mA	20 mA	18.800 to 19.200	_____
400 Hz	1.0000 V	190.0 mA	200 mA	188.00 to 192.00	_____
400 Hz	1.0000 V	1900 mA	2000 mA	1861.0 to 1939.0	_____

Resistance TEST CHECKLIST

Resistance Decade	DMM Range Pushbutton	DMM Display indication	Satisfactory
190.00 ohms	200 Ω	189.80 to 190.20	_____
1.9000 kohm	2 k	1.8980 to 1.9020	_____
19.000 kohm	20 k	18.980 to 19.020	_____
190.00 kohm	200 k	189.80 to 190.20	_____
*1900.00 kohm	2000 k	1898.0 to 1902.0	_____
*10.00 megohm	20M Ω	9.978 to 10.022	_____

*Use 2 and 10 Megohm Resistance Standard in place of Resistance Decade

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

5-18. PREPARATION FOR STORAGE OR SHIPMENT

If original packing material was saved, pack the multimeter in the same manner as it was received. When using packing materials other than the original, use the following guidelines:

a. Insert multimeter in its case.

b. Insert multimeter and case into a waterproof bag.

c. Use plenty of shock-absorbing material all around multimeter to protect against damage and insert into a suitable size container.

d. Wrap container in heavy paper and seal with filament tape.

e. Mark container “FRAGILE-DELICATE INSTRUMENT” to insure proper handling.

5-19. TYPES OF STORAGE

a. Short-term (administrative) = 1 to 45 days. All equipment in this type must be made ready within 24 hours for use on a mission. Make sure the next scheduled PMCS is done and all deficiencies corrected before placing in storage. The storage site should provide protection from extreme weather conditions and allow you to reach it for inspections or exercises if needed.

b. Intermediate = 46 to 180 days.

c. Long term = over 180 days.

APPENDIX A
REFERENCES

A-1. SCOPE

This appendix lists all forms, field manuals, technical manuals, and miscellaneous publication references in this manual.

A-2. FORMS

Equipment Inspection and Maintenance Worksheet ..... DA Form 2404

Product Quality Deficiency Report ..... SF 368

Recommended Changes to Publications and Blank Forms ..... DA Form 2028

Report of Discrepancy (ROD) ..... SF 364

Transportation Discrepancy Report (TDR) ..... SF 361

A-3. TECHNICAL MANUALS

Organizational, Direct Support, and General Support Maintenance
Repair Parts and Special Tools List, Digital Multimeter AN/USM-486/U
(NSN 6625-01-145-2430) ..... TM 11-6625-3055-24P

Procedures for Destruction of Electronics Materiel
to Prevent Enemy Use (Electronics Command) ..... TM 750-244-2

A-4. MISCELLANEOUS PUBLICATIONS

The American Society of Mechanical
Engineers, Abbreviations and Acronyms ..... ASME Y14.38

Common Table of Allowances, Expendable/Durable Items
(Except Medical, Class V, Repair Parts, and Heraldic Items) ..... CTA 50-970

Consolidated Army Publications and Forms Index ..... DA Pam 25-30

First Aid ..... FM 4-25.11

Reporting of Supply Discrepancies ..... AR 735-11-2

Safety Requirements for Maintenance of Electrical
and Electronic Equipment ..... TB 385-4

The Army Maintenance Management System (TAMMS) Users Manual ..... DA Pam 750-8

APPENDIX B
MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. GENERAL

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

a. **Inspect.** To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. **Test.** To verify serviceability by measuring the mechanical and electrical characteristics of the multimeter and comparing these characteristics with prescribed standards.

c. **Service.** Operations required periodically to keep the multimeter in proper operating condition; i.e., to clean (or decontaminate), to preserve, etc.

d. **Adjust.** To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. **Align.** To adjust specified variable elements of the multimeter to bring about optimum or desired performance.

f. **Calibrate.** To determine and cause corrections to be made or to be adjusted on instruments or TMDE used in precision measurement. This consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. **Remove/install.** To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module in a manner to allow the proper functioning of an equipment or system.

h. **Replace.** To remove an unserviceable item and install a serviceable counterpart in its place. Replace is authorized by the MAC and is shown as the third position code of the SMR code.

i. **Repair.** The application of maintenance services, including fault location/ troubleshooting, removal/ installation, and disassembly/ assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module or end item or system.

j. **Overhaul.** That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/ operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. **Rebuild.** Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II

a. **Column (1) — Group Number.** Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be 00.

b. **Column (2) — Component/Assembly.** Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. **Column (3) — Maintenance Function.** Column 3 lists the functions to be performed on the item listed in Column 2 (see para. B-2).

d. **Column (4) — Maintenance Category.** Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/ assembly time), troubleshooting/ fault location time, and quality assurance/ quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the MAC. The symbol designations for the maintenance categories are as follows:

C . . . . . Operator or crew
O . . . . . Organizational maintenance
F . . . . . Direct support maintenance
H . . . . . General support maintenance
D . . . . . Depot maintenance

e. **Column (5) — Tools and Equipment.** Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. **Column (6) — Remarks.** This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in section IV.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENT, SECTION Ill

a. **Column (1) — Reference Code.** The tool and test equipment reference code correlates with a code used in the MAC, section II, column 5.

b. Column (2) – Maintenance **Category.** The lowest category of maintenance authorized to use the tool or test equipment.

c. **Column (3) — Nomenclature.** Name or identification of the tool or test equipment.

d. **Column (4) - National** Stock Number. The National stock number of the tool or test equipment.

e. **Column (5) — Tool** Number. The manufacturer's part number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV

a. **Column (1) — Reference Code.** The code recorded in column 6, section 11,

b. **Column (2) — Remarks.** This column lists information pertinent to the maintenance function being performed as indicated in the MAC, section II.

Section II. MAINTENANCE ALLOCATION CHART FOR AN/USM-486/U

(1) Group Number	(2) Component Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment	(6) Remarks
00	DIGITAL MULTIMETER AN/USM-486/U	Inspect	0.3						
		Test		0.2					A
		Test				1.0		1 thru 12,16	
		Service	14.0						B
		Adjust				1.5		8,9,10,16	
		Repair		0.5					C
01	DIGITAL MULTIMETER ASSEMBLY	Inspect	0.3						
		Test	0.2						A
		Test				1.0		1 thru 12,16	
		Service	14.0						B
		Adjust				1.5		8,9,10,16	
		Repair	0.3						D,E
		Repair		0.5				15	F
		Repair				0.8		4,13.14,16	G
0101	MAIN PRINTED CIRCUIT BOARD A1	Repair				0.8		4,13,14,16	H

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR AN/USM-486/U

Tool or Test Equipment Ref Code	Maint. category	Nomenclature	National/NATO Stock Number	Tool No.
1	H	AMPLIFIER CALIBRATOR AMMETER HOLT 250	4931-00-019-4671	
2	H	AC DRIVING SOURCE (OSCILLATOR) KROHN-HITE 4100A	6625-01-020-8109	
3	H	AC PRECISION AMPLIFIER KROHN-HITE 7500	6695-01-081-9053	
4	H	VOLTMETER HEWLETT PACKARD 3490A	6625-01-010-9255	
5	H	DC CURRENT SHUNT GUIDELINE 9711	6625-00-917-9834	
6	H	DC POWER SUPPLY RAYTHEON QRE3-300ME	4931-00-178-0715	
7	H	DIFFERENTIAL VOLTMETER FLUKE 887AB	4931-00-407-2642	
8	H	DC VOLTAGE STANDARD FLUKE 332B	6625-00-239-8924	
9	H	AC VOLTAGE STANDARD HEWLETT PACKARD 745A	6625-00-458-4605	
10	H	HIGH VOLTAGE AMPLIFIER HEWLETT PACKARD 746A	6625-00-125-2316	
11	H	RESISTANCE DECADE BIDDLE 6011471	6625-00-071-5343	
12	H	RESISTANCE STANDARD BECKMAN CR10M	6625-00-678-9678	
13	H	OSCILLOSCOPE TEKTRONIX 5440	6625-01-034-3269	
14	H	PLUG-IN, OSCILLOSCOPE TEKTRONIX 5S14N	4931-01-008-1478	
15	O	TOOL KIT, ELECTRONIC EQUIPMENT TK-101/G	5180-00-064-5178	
16	H	TOOL KIT, ELECTRONIC EQUIPMENT JTK-17	4931-01-073-3845	

Section IV. REMARKS

Reference Code	Remarks
A	Operational test.
B	Service is done by periodic recharging of batteries. The multimeter is self-charging if pluged into AC power but not turned on.
C	Repair by replacement of test leads, RF probe and power cord.
D	Repair by replacement of Fuse (F1) at the operator/crew level.
E	Items need no hand tools or equiprnent for removal or replacement.
F	Repair by replacement of battery assembles.
G	Repair is by replacement of piece parts.
H	PC board is repaired in position, non-removable from multimeter assembly and is repaired to piece part level.

APPENDIX C
COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

Section I. INTRODUCTION

C-1. SCOPE

This appendix lists components of end item and basic issue items for the Digital Multimetcr AN/USM-486/U to help you inventory items required for safe and efficient operation.

C-2. GENERAL

This Components of End Item and Basic Issue Items Lists arc divided into the following sections:

a. **Section II. Components of the End Item.** This listing is for informational purposes only, and is not authority to requisition replacements. These items are part of the end item, but arc removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Illustrations are furnished to assist you in identifying the items.

b. **Section III. Basic Issue Items (BII).** These are the minimum essential items required. to place the multimeter in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged, BII must be with the multimeter during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/ requisition replacement BII, based on TOE/ MTOE authorization of the end item.

C-3. EXPLANATION OF COLUMNS

The following provides an explanation of columns found in the tabular listings:

a. **Column (1) - Illustration Number (Illus Number).** This column indicates the number of the illustration in which the item is shown.

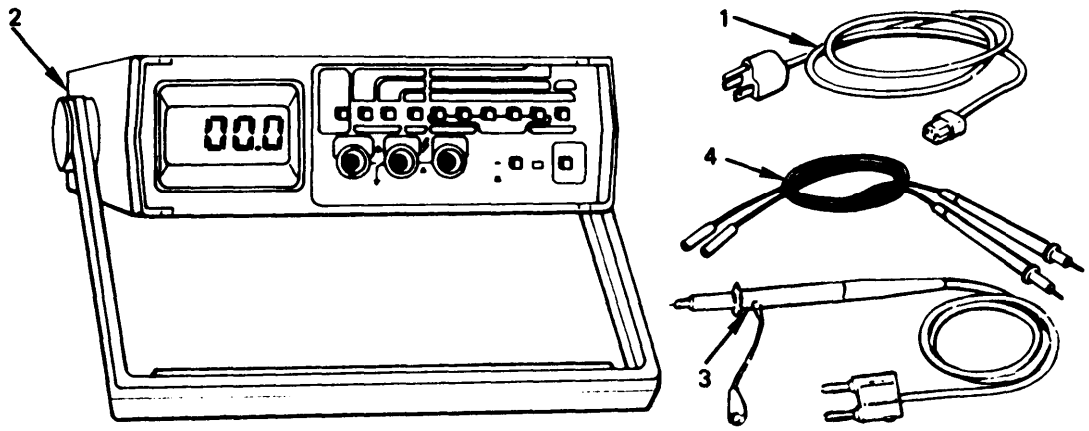
b. **Column (2) - National Stock Number.** Indicates the National stock number assigned to the item and will be used for requisitioning purposes.

c. **Column (3) - Description.** Indicates the Federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the FSCM (in parentheses) followed by the part number. If item needed differs for different models of this equipment, the model is shown under the Usable On heading in this column.

d. **Column (4) – Unit of Measure (U/M).** Indicates the measure used in performing the actual operational/ maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr).

e. **Column (5) - Quantity Required (Qty rqr).** Indicates the quantity of the item authorized to be used with the multimetcr.

Section II. COMPONENTS OF END ITEM



EL9CW076

*Item 5 not illustrated.

(1) Illust. No.	(2) National Stock Number	(3) Description FSCM and Part Number	Usable On Cod.	(4) U/M	(5) Oty Rqr
1	6150-01-069-2263	CABLE ASSEMBLY (AC POWER CORD) (89536) 343723		e a	1
2		MULTIMETER, DIGITAL (89536) 700146		e a	1
3	6625-01-131-3883	PROBE, HIGH FREQUENCY (89536) 85RF		e a	1
4	66254)1-111-7414	TEST LEADS (89536) 516666		s t	1
5 *	6625-01-054-1920	CARRYING CASE (89536) C86		ea	1

APPENDIX D
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

D-1. SCOPE

This appendix lists expendable supplies and materials you will need to operate and maintain the Digital Multimeter AN/USM-486/U. These items are authorized to you by, Common Table of Allowances, CTA 50-970, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

D-2. EXPLANATION OF COLUMNS

a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material.

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed item. Enter as applicable:

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. Column (3) - National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE SUPPLIES AND MATERIALS

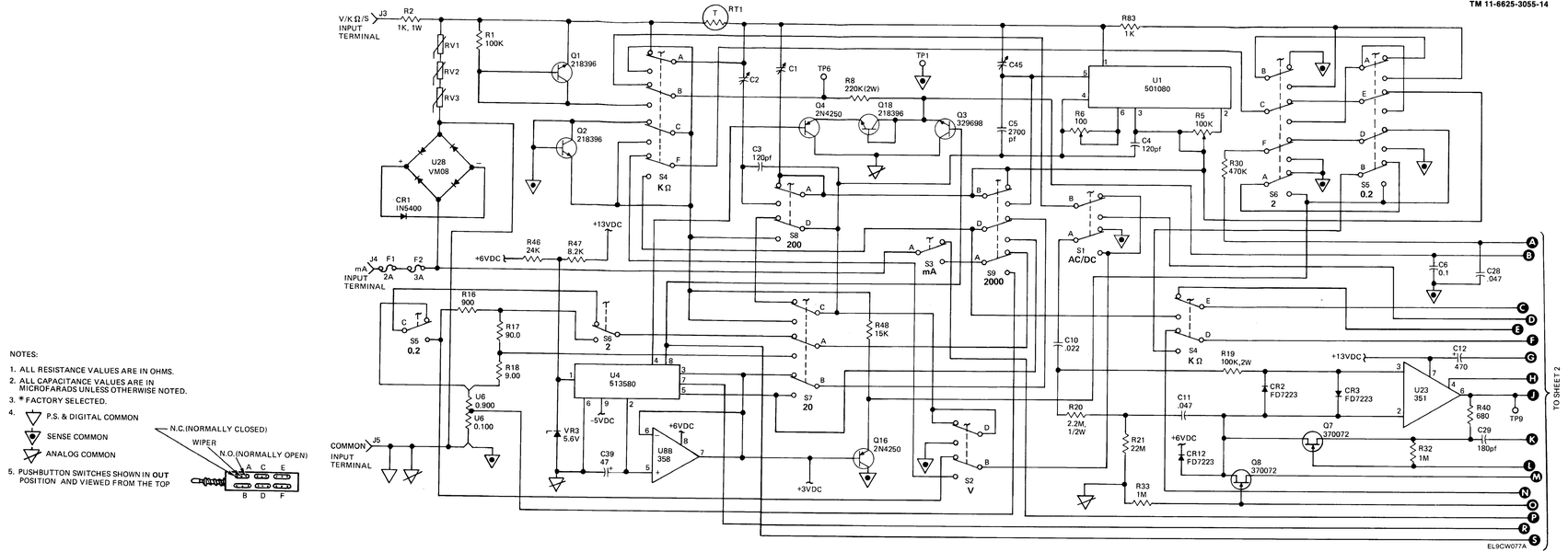
(1) Item No.	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	O	8305-00-267-3015	CLOTH, CHEESECLOTH, COTTON, LINTLESS CCC-C440, TYPE II, CLASS 2 (81348)	YD
2	0		DETERGENT, LIQUID, GENERAL PURPOSE SPECIFICATION NO. P-D-223B	OZ
3	H		SOLDER, ROSIN CORE, TYPE 60-40	RL

INDEX

A

B

C



NOTES:

1. ALL RESISTANCE VALUES ARE IN OHMS.
2. ALL CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. * FACTORY SELECTED.
4. P.S. & DIGITAL COMMON
   SENSE COMMON
   ANALOG COMMON
5. PUSHBUTTON SWITCHES SHOWN IN OUT POSITION AND VIEWED FROM THE TOP

Figure FO-1①. Digital Multimeter Schematic Diagram (Sheet 1 of 3)

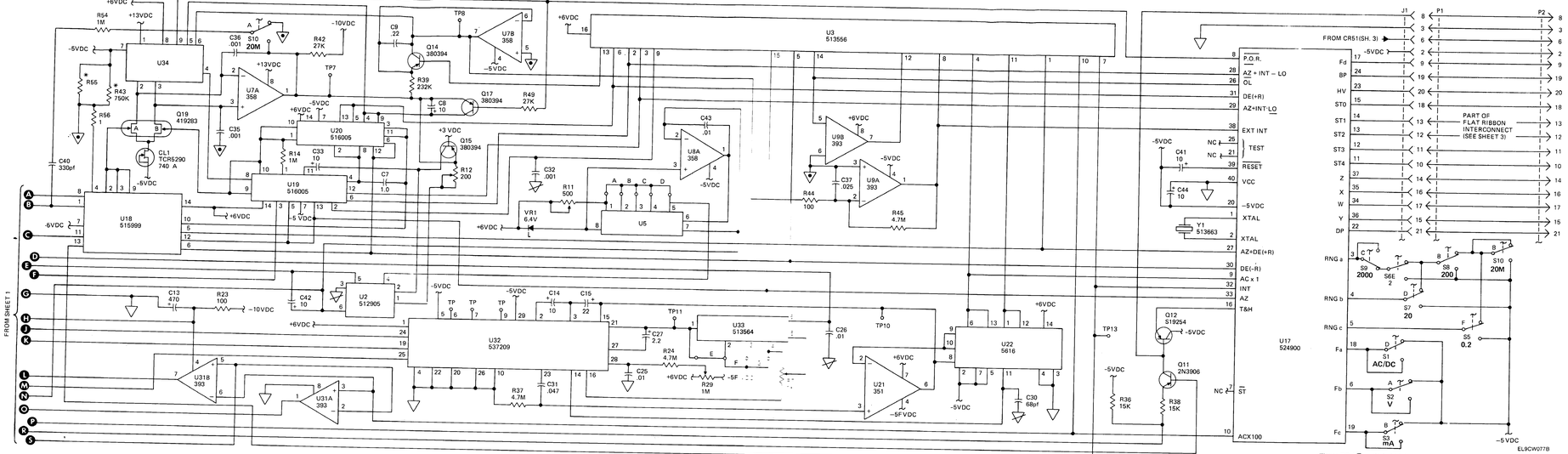


Figure FO-1(2). Digital Multimeter Schematic Diagram (Sheet 2 of 3)

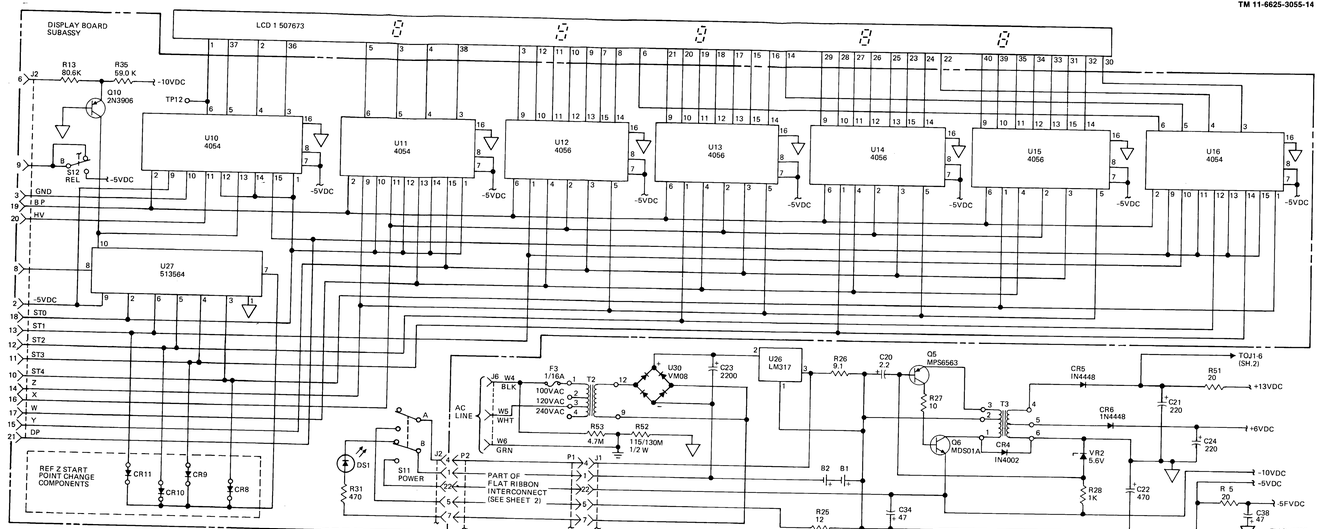


Figure FO-I③. Digital Multimeter Schematic Diagram (Sheet 3 of 3)

By Order of the Secretary of the Army:

JOHN A. WICKHAM JR.
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with special list.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1990 0 - 261-872 (21439)

These are the instructions for sending an electronic 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" <whomever@wherever.army.mil>
To: 2028@redstone.army.mil

Subject: DA Form 2028

1. ***From:*** Joe Smith
2. *Unit:* home
3. ***Address:*** 4300 Park
4. ***City:*** Hometown
5. ***St:*** MO
6. ***Zip:*** 77777
7. ***Date Sent:*** 19−OCT−93
8. ***Pub no:*** 55−2840−229−23
9. ***Pub Title:*** TM
10. ***Publication Date:*** 04−JUL−85
11. *Change Number:* 7
12. *Submitter Rank:* MSG
13. ***Submitter FName:*** Joe
14. *Submitter MName:* T
15. ***Submitter LName:*** Smith
16. ***Submitter Phone:*** 123−123−1234
17. ***Problem:*** **1**
18. *Page:* 2
19. *Paragraph:* 3
20. *Line:* 4
21. *NSN:* 5
22. *Reference:* 6
23. *Figure:* 7
24. *Table:* 8
25. *Item:* 9
26. *Total:* 123
27. ***Text:***

This is the text for the problem below line 27.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25–30; the proponent agency is ODISC4.	Use Part II (*reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/ Supply Manuals (SC/SM)	DATE 8/30/02
TO: (*Forward to proponent of publication or form)(Include ZIP Code)* Commander, U.S. Army Aviation and Missile Command ATTN: AMSAM–MMC–MA–NP Redstone Arsenal, 35898	FROM: (*Activity and location)(Include ZIP Code)* MSG, Jane Q. Doe 1234 Any Street Nowhere Town, AL 34565	

PART 1 – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE
TM 9–1005–433–24	16 Sep 2002	Organizational, Direct Support, And General Support Maintenance Manual for Machine Gun, .50 Caliber M3P and M3P Machine Gun Electrical Test Set Used On Avenger Air Defense Weapon System

ITEM NO.	PAGE NO.	PARA–GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON
1	WP0005 PG 3		2			Test or Corrective Action column should identify a different WP number.

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/ AUTOVON, PLUS EXTENSION	SIGNATURE
MSG, Jane Q. Doe, SFC	788–1234	

TO: (*Forward direct to addressee listed in publication)*	**FROM:** (*Activity and location) (Include ZIP Code)*	**DATE**
Commander, U.S. Army Aviation and Missile Command ATTN: AMSAM–MMC–MA–NP Redstone Arsenal, 35898	MSG, Jane Q. Doe 1234 Any Street Nowhere Town, AL 34565	8/30/02

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III – REMARKS (*Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE
MSG, Jane Q. Doe, SFC	788–1234	

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25–30; the proponent agency is ODISC4.	Use Part II (*reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/ Supply Manuals (SC/SM)	DATE
TO: (*Forward to proponent of publication or form)(Include ZIP Code)*	FROM: (*Activity and location)(Include ZIP Code)*	

PART 1 – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE

ITEM NO.	PAGE NO.	PARA–GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/ AUTOVON, PLUS EXTENSION	SIGNATURE

TO: (*Forward direct to addressee listed in publication)*	**FROM:** (*Activity and location) (Include ZIP Code)*	**DATE**

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III – REMARKS (*Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25–30; the proponent agency is ODISC4.	Use Part II (*reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/ Supply Manuals (SC/SM)	DATE
TO: (*Forward to proponent of publication or form)(Include ZIP Code)*	FROM: (*Activity and location)(Include ZIP Code)*	

PART 1 – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE

ITEM NO.	PAGE NO.	PARA–GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/ AUTOVON, PLUS EXTENSION	SIGNATURE

TO: (*Forward direct to addressee listed in publication)*	**FROM:** (*Activity and location) (Include ZIP Code)*	**DATE**

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III – REMARKS (*Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25–30; the proponent agency is ODISC4.	Use Part II (*reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/ Supply Manuals (SC/SM)	DATE
TO: (*Forward to proponent of publication or form)(Include ZIP Code)*	FROM: (*Activity and location)(Include ZIP Code)*	

PART 1 – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE

ITEM NO.	PAGE NO.	PARA–GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/ AUTOVON, PLUS EXTENSION	SIGNATURE

TO: (*Forward direct to addressee listed in publication)*	**FROM:** (*Activity and location) (Include ZIP Code)*	**DATE**

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III – REMARKS (*Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

PIN: 056102-000