TECHNICAL MANUAL

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

DIGITAL MULTIMETER AN/USM-486A

(NSN 6625-01-368-3429) (EIC: N/A)

HEADQUARTERS, DEPARTMENT OF THE ARMY

30 DECEMBER 1994

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

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

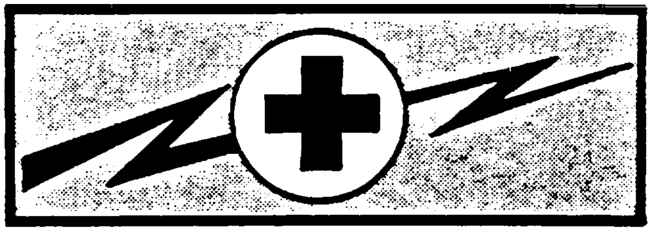
2 **IF POSSIBLE, TURN OFF THE ELECTRICAL POWER**

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 the technicians are aided by operators, they must be warned about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact high-voltage connections or 115 Vac input connections 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 the body.

Warning:
Do not be misled by the term " low voltage." Potentials as low as 50 V may cause death under adverse conditions.

For Artificial Respiration, refer to FM 4-25.11.

CAUTION

THIS EQUIPMENT CONTAINS PARTS AND ASSEMBLIES SENSITIVE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD). USE ESD PRECAUTIONARY PROCEDURES WHEN TOUCHING, REMOVING OR INSERTING PRINTED CIRCUIT BOARDS.

E S D
CLASS 1

GENERAL HANDLING PROCEDURES FOR ESDS ITEMS

- USE WRIST GROUND STRAPS OR MANUAL GROUNDING PROCEDURES
- KEEP ESDS ITEMS IN PROTECTIVE COVERING WHEN NOT IN USE
- GROUND ALL ELECTRICAL TOOLS AND TEST EQUIPMENT
- PERIODICALLY CHECK CONTINUITY AND RESISTANCE OF GROUNDING SYSTEM
- USE ONLY METALIZED SOLDER SUCKERS
- HANDLE ESDS ITEMS ONLY IN PROTECTED AREAS

MANUAL GROUNDING PROCEDURES

- MAKE CERTAIN EQUIPMENT IS POWERED DOWN
- TOUCH GROUND PRIOR TO REMOVING ESDS ITEMS
- TOUCH PACKAGE OF REPLACEMENT ESDS ITEM TO GROUND BEFORE OPENING
- TOUCH GROUND PRIOR TO INSERTING REPLACEMENT ESDS ITEMS

ESDS PROTECTIVE PACKAGING AND LABELING

- INTIMATE COVERING OF ANTISTATIC MATERIAL WITH AN OUTER WRAP OF EITHER TYPE 1 ALUMINIZED MATERIAL OR CONDUCTIVE PLASTIC FILM - OR HYBRID LAMINATED BAGS HAVING AN INTERIOR OF ANTISTATIC MATERIAL WITH AN OUTER METALIZED LAYER
- LABEL WITH SENSITIVE ELECTRONIC SYMBOL AND CAUTION NOTE

CAUTION

Devices such as CMOS, NMOS, MNOS, VMOS, HMOS, thin-film resistors, PMOS, and MOSFET used in many equipments can be damaged by static-voltages present in most repair facilities. Most of the components contain internal gate protection circuits that are partially effective, but sound maintenance practice and the cost of equipment failure in time and money dictate careful handling of all electrostatic sensitive components.

The following precautions should be observed when handling all electrostatic sensitive components and units containing such components.

CAUTION

Failure to observe all of these precautions can cause permanent damage to the electrostatic sensitive device. This damage can cause the device to fail immediately or at a later date when exposed to an adverse environment.

STEP 1 Turn off and/or disconnect all power and signal sources and loads used with the unit.

STEP 2 Place the unit on grounded conductive work surfaces.

STEP 3 Ground the repair operator using a conductive wrist strap or other device using a 1-M series resistor to protect the operator.

STEP 4 Ground any tools (including soldering equipment) that will contact the unit. Contact with the operator's hand provides a sufficient ground for tools that are otherwise electrically isolated.

STEP 5 All electrostatic sensitive replacement components are shipped in conductive foam or tubes and must be stored in the original shipping container until installed.

STEP 6 When these devices and assemblies are removed from the unit, they should be placed on the conductive work surface or in conductive containers.

STEP 7 When not being worked on, wrap disconnected circuit boards in aluminum foil or in plastic bags that have been coated or impregnated with a conductive material.

STEP 8 Do not handle these devices unnecessarily or remove from their packages until actually used or tested.

CHANGE)
)
No. 2)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 30 May 2006

OPERATOR'S, UNIT DIRECT SUPPORT GENERAL SUPPORT MAINTENANCE MANUAL FOR DIGITAL MULTIMETER AN/USM-486A (NSN 6625-01-368-3429)(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 1, dated 10 May 1995, 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 AMCOM G-4 (Logistics) Environmental Division. As of the base document through change 1, dated 10 May 1995, 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.

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Change No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *10 May 1995*

Operator's, Unit, Direct Support and General Support Maintenance Manual
FOR
DIGITAL MULTIMETER
AN/USM-486A
(NSN 6625-01-368-3429) (EIC: N/A)

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Dates of issue for original and changed pages are:

Original	0	30 DEC 1994
Change	1	10 MAY 1995
Change	2	30 MAY 2006

Total number of pages in this publication is 133 consisting of the following:

Page No.	*Change No.
Cover	2
a thru d	2
A/(B blank)	2
i and ii	2
iii	0
1-0	0
1-1 and 1-2	2
1-3 through 1-8	0
1-9/(1-10 blank)	0
2-1 through 2-28	0
3-1 through 3-6	0
4-1/(4-2 blank)	0
5-1 through 5-40	0
5-41/(5-42 blank)	0
A-1/(A-2 blank)	2
B-1 through B-4	0
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Technical Manual)
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No. 11-6625-3277-14)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 30 December 1994

OPERATOR'S, UNIT, DIRECT SUPPORT GENERAL SUPPORT MAINTENANCE MANUAL FOR DIGITAL MULTIMETER AN/USM-486A (NSN 6625-01-368-3429)(EIC: N/A)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can 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. Instruction 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

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HOW TO USE THIS MANUAL

This manual tells about the Digital Multimeter AN/USM-486A and contains instructions about how to use and maintain it during maintenance on other electronic equipment.

The technical manual for the electronic equipment being maintained will tell where to make certain connections and when to use various accessories which are part of the AN/USM-486A.

When first receiving the AN/USM-486A, start at the front of the manual and go all the way through to the back. Become familiar with the manual and the AN/USM-486A.

This manual has an edge index which will help find specific information in a hurry. Simply spread the pages on the right edge of the manual until the printed blocks can be seen. Open the manual where the block on the edge of the page lines up with the selected topic printed on the front cover block.

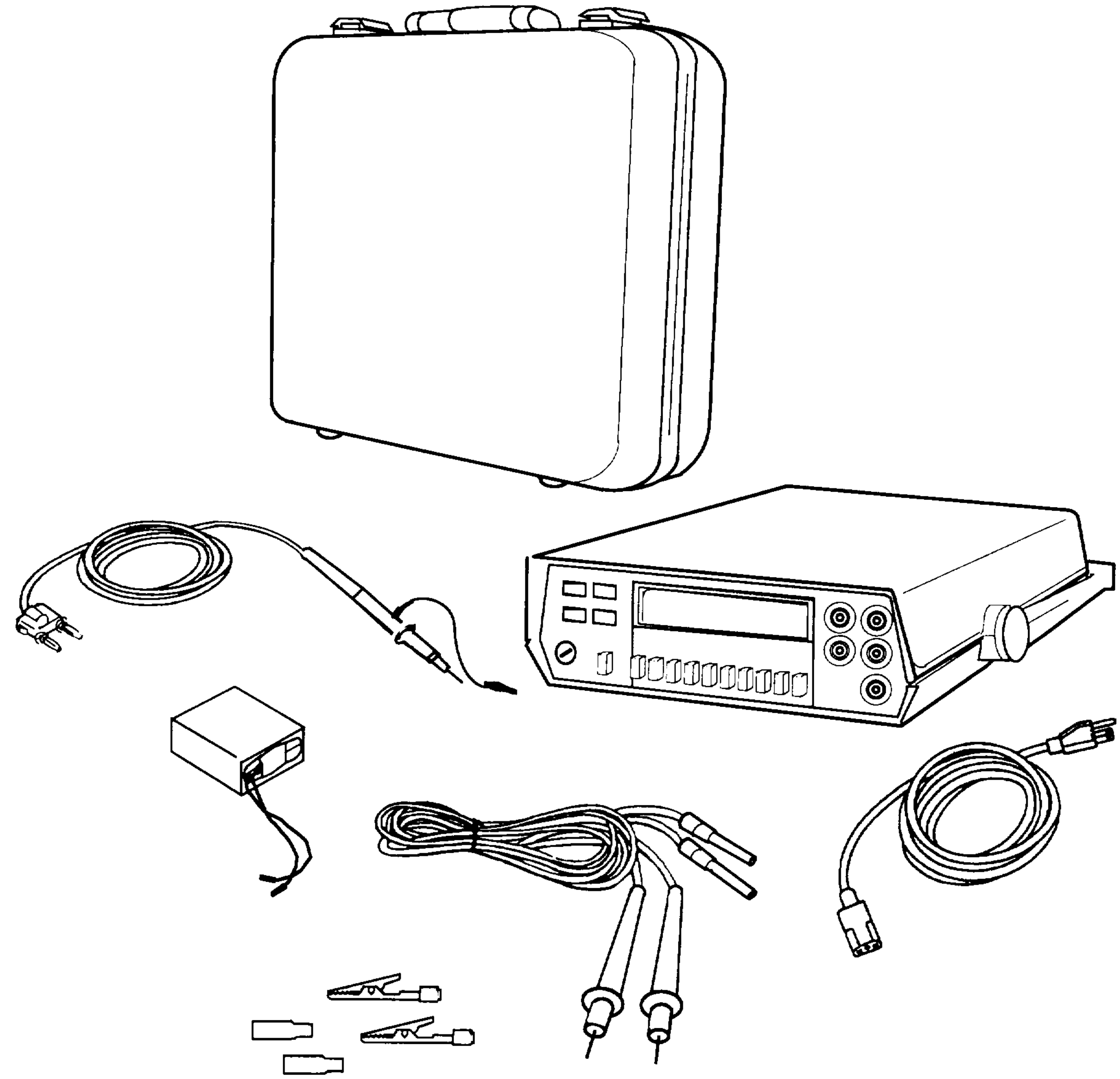

Figure 1-1. Digital Multimeter AN/USM-486A

CHAPTER 1
INTRODUCTION

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Section I. GENERAL INFORMATION

1-1. SCOPE.

a. *Type of Manual:* Operator’s, Unit, Direct Support, and General Support Maintenance Manual.

b. *Equipment Name and Model Number:* Digital Multimeter AN/USM-486A.

c. *Purpose of Equipment:* The digital multimeter measures and indicates various electrical characteristics needed to test and troubleshoot electrical equipment.

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 Maintenance Management Update.

b. *Reporting of Item and Packaging Discrepancies.* Fill out and forward SF 364, Report of Discrepancy (ROD) as prescribed in AR 735-11-2/DLAR 4140.55/SECNAVINST 4355.18/AFR 400-54/MCO 4430.3J.

c. *Transportation Discrepancy Report (TDR) (SF361).* Fill out and forward SF361, Transportation Discrepancy Report (TDR) (SF 361) as prescribed in DA Pam 25-30/NAVSUPINST 4610.33C/AFR75-18/MCO P4610.19D/DLAR 4500.15.

1-4. ADMINISTRATIVE STORAGE.

Administrative storage of equipment issued to and used by Army activities will have Preventive Maintenance Checks and Services (PMCS) performed before storing. When removing the equipment from administrative storage, the PMCS checks should be performed to assure operational readiness.

1-5. DESTRUCTION OF ARMY ELECTRONICS MATERIEL.

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

1-6. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRs).

If your AN/USM-486A 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 your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to: U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NM, Redstone Arsenal, AL 35898-5000. We'll send you a reply.

1-7. WARRANTY.

The Digital Multimeter AN/USM-486A is warranted by Keithley Instruments, Inc. for a period of one year with the exception of the following items that are warranted for a period of 90 days: probes, cables, rechargeable batteries, diskettes, and documentation. The warranty starts on the date of shipment to the original buyer. Report all defects to your supervisor, who will take appropriate action.

1-8. SAFETY, CARE, AND HANDLING.

Warnings, safety precautions, and safety procedures are provided at the front of this manual. Operators should become familiar with all warnings, safety precautions, and safety procedures before handling or operating the equipment. For ESDS (electrostatic discharge sensitive) items, be sure to follow the protective and control measures provided on page C at the front of this manual.

1-9. NOMENCLATURE CROSS REFERENCE LIST.

Common names will be used when major components of the Digital Multimeter AN/USM-486A are mentioned in this manual.

NOTE

Official nomenclature must be used when filling out report forms or looking up technical manuals.

Common Name	Official Name
Multimeter	Digital Multimeter AN/USM-486A

1-10. LIST OF ABBREVIATIONS.

This list identifies abbreviations and acronyms that are used in this manual.

a/d	analog-to-digital
EMI	electromagnetic interference
LCD	liquid crystal display
ms	millisecond
NVRAM	nonvolatile random access memory
RAM	random access memory
RF	radio frequency
RMS	root-mean-square
TRMS	true root-mean-square

Section II. EQUIPMENT DESCRIPTION

1-11. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

a. Characteristics.

- Measures dc and low and high frequency true root mean square (TRMS) ac voltage,
- makes two-wire and four-wire resistance measurements,
- measures dc and TRMS ac current,
- measures decibels,
- tests diodes.

b. Capabilities and Features.

- 5-1/2 digit liquid crystal display (LCD),
- data logger records up to 92 readings,
- autoranging for easier measurements,
- selectable dB reference impedances of 50 Ω , 75Ω, 93Ω, 135Ω, 300Ω, and 600Ω,
- pushbutton power, function, and range switches simplify operation.

1-12. EQUIPMENT DATA.

WEIGHTS AND DIMENSIONS

Digital Multimeter AN/USM-486A

Weight..8 lbs 10.5 oz (4.0 kg)
Length..13 in. (331 mm)
Width..14 in. (356 mm)
Height..4-1/2 in. (115 mm)

Multimeter

Weight..4 lbs 12 oz (2.2 kg)
Length..10-3/4 in. (274 mm)
Width..9-1/4 in. (235 mm)
Height..3-1/2 in. (89 mm)

REQUIREMENTS

Voltage ....105 to 125 Vac or 210 to 250 Vac
Frequency..50-60 Hz, 400 Hz
Current Fuse (O to 2 A range)..2 A, 250 V, 3 AG, fast blow
Current Fuse (10 A range) ....16 A, 250 V, 5 x 20 mm, fast blow
Line Fuse..1/8 A, 250 V, 3 AG, slow blow

1-12. EQUIPMENT DATA - Continued.

ENVIRONMENTAL

Operating Temperature Range .... 32° to 122°F (0°to 50°C)
Storage Temperature Range .... -40° to +158°F (-40° to +70°C)
Relative Humidity .... less than 80% RH up to 95°F (35°C)
(linearly derate 3% RH/°C between 35° and 50°C)
Temperature Coefficient (0°-18°C and 28°-50°C) .... ±(0.1 x applicable one year accuracy specification)/°C
Maximum Altitude .... <10, 000 ft.

GENERAL

LCD Display .... ±220, 000-count (±10, 000-count for 1000 V, 750 Vac, 10 A range), 0.45 in. height
Resistance (Ω) Vdc and Vac, (ranging) .... Auto or Manual
Autoranging Time (average) .... 300 ms per range
Ac and dc Ampere (ranging) .... Manual
Overrange Indication .... "OL" displayed
Conversion Rate .... 3 readings per second
Maximum Common Mode Voltage .... 500 V peak
Warm-up .... 5 minutes

DC VOLTS

Accuracy 1 year, 64° to 82°F (18° to 28°C) (when properly zeroed)

RANGE	RESOLUTION NO.	±(% OF READING+ OF COUNTS)
200 mV	10µV	0.05 + 10
2 V	10µV	0.05 + 30
20 V	1 mV	0.05 + 30
200 V	10 mV	0.05 + 30
1000 V	100 mV	0.05 + 30

Input Resistance .... >9.5 Mn
Shunt Capacitance .... <100 pF
Normal Mode Rejection Ratio .... >60 dB at 50 Hz, 60 Hz
Common Mode Rejection Ratio (1 kΩ unbalance) .... >90 dB at dc,
>60 dB at 50 Hz, 60 Hz
Response Time (to rated accuracy of final reading on range) .... 1 second
Overload Protection .... 1000 Vdc or peak ac (<10 seconds per minute on 200 mV and 2 V ranges), 300 VRMS continuous.

TRMS AC VOLTS

Accuracy 1 year, 64° to 82°F (18° to 28°C)

		±(% OF READING + NO. OF COUNTS)				
RANGE	RESOLUTION	20 Hz to 50 Hz*	50 Hz to 10 kHz*	10 kHz to 20 kHz*	20 kHz to 50 kHz**	50 kHz to 100 kHz**
200 mV	10µV	1.5 + 100	0.5 + 100	1.0 + 100	2.0 + 500	29.2 + 0
2 V	100µV	1.5 + 100	0.5 + 100	1.0 + 100	2.0 + 500	29.2 + 0
20 V	1 mV	1.5 + 100	0.5 + 100	1.0 + 100	2.0 + 500	29.2 + 0
200 V	10 mV	1.5 + 100	0.5 + 100	1.0 + 100	2.0 + 500	29.2 + 0
750 V	100 mV	1.5 + 100	0.5 + 100	1.0 + 100	2.0 + 500	29.2 + 0

* Above 1800 counts.
** Above 18000 counts.

Input Resistance .... >950 kΩ
Shunt Capacitance .... <100 pF
Common Mode Rejection Ratio (1 kΩ unbalance) .... >90 dB at dc,
>60 dB at 50 Hz, 60 Hz
Response Time (to within rated accuracy of final reading on range)
< 50 Hz 2.5 seconds
> 50 Hz 1 second
Overload Protection ....750 VRMS, 1000 V peak (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous; 10^7 V•Hz maximum
3 dB Bandwidth ....100 kHz minimum
Detection ....3:1 crest factor maximum

DC AMPS

Accuracy 1 year, 64° to 82°F (18° to 28°C)

RANGE	RESOLUTION	±(% OF READING + NO. OF COUNTS)
200 µA	0.01 µA	0.2 + 10*
2mA	0.1 µA	0.2+ 10
20 mA	1 µA	0.2 + 10
200 mA	10 µA	0.2 + 10
2000 mA	100 µA	0.5 + 20
10 A	1 mA	0.5 + 20**

*When properly zeroed.
** Above 5 A derate 0.15% of reading per amp above 5 A for self-heating.

1-12. EQUIPMENT DATA - Continued.

DC AMPS - Continued.

Maximum Voltage Burden .... 1.0 V
Overload Protection
mA Input .... 2 A fuse (250 V), externally accessible
10 A Input .... 16 A fuse (250 V), internally accessible, 20 A input for 15 seconds maximum.
Response Time (to within rated accuracy of final reading on range).. 1 second

TRMS AC AMPS

Accuracy 1 year, 64° to 82°F (18° to 28°C)

RANGE	RESOLUTION	±(% OF READING + NO. OF COUNTS) 20 Hz to 50 Hz*	50 Hz to 20 kHz*
200 µ A	0.01 µ A	2.0 + 250	2.0 + 500
2 mA	0.1 µA	2.0 + 250	2.0 + 500
20 mA	1 µA	2.0 + 250	2.0 + 500
200 mA	10 µA	2.0 + 250	2.0 + 500
2000 mA	100 µA	2.0 + 250	2.0 + 500
10 A	1 mA	2.0 + 250	2.0 + 250**

* Above 1800 counts.
** 10 kHz maximum.

Maximum Voltage Burden .... 1.0 VRMS
Overload Protection
mA Input .... 2 A fuse (250 V), externally accessible
10 A Input .... 16 A fuse (250 V), internally accessible, 20 A input for 15 seconds maximum.
Response Time (to within rated accuracy of final reading on range).. 1 second
Detection .... 3:1 crest factor maximum

OHMS

Accuracy 1 year, 64° to 82°F (18° to 28°C)

RANGE	RESOLUTION	NOMINAL 1-SHORT OUTPUT	± (% OF READING + NO. OF COUNTS)
200Ω	10 mΩ	2 mA	0.1 + 10*
2kΩ	100mΩ	2mA	0.1 +10
20 kΩ	1Ω	400 µA	0.05 + 10
200 kΩ	10Ω	40 µA	0.05 + 10
2 MΩ**	100Ω	4 µA	0.2 + 20
20 MΩ**	1 kΩ	400 µA	0.2 + 20

* When properly zeroed.
** Appropriate range selected automatically in MO.

Maximum Open-Circuit Voltage .... 6.0 V
Overload Protection .... 450 Vdc or peak ac (<10 seconds per minute), 300 VRMS continuous.
Response Time .... 10 seconds maximum on 20 MΩ range; 2 seconds to within rated accuracy on all other ranges.
Diode Test Display reads junction voltage up to 2.2 V.
Diode Test Current .... 1.6 mA nominal

DECIBEL (dB)

Accuracy (referenced to 6002)

RANGE	RESOLUTION	INPUT	±dBm 20 Hz - 20 kHz
20 V to 200 V	0.01 dBm	2.5 to 25 V (10 to 30 dBm)	0.25
2 V to 20 V	0.01 dBm	250 mV to 2.5 V (-10 to 10 dBm)	0.5
2 V	0.1 dBm	20 mV to 250 mV (-32 to -10 dBm)	0.5
200 mV	0.1 dBm	3 mV to 20 mV (-48 to -32 dBm)	1.0
	1.0 dBm	1 mV to 3 mV (-58 to -48 dBm)	2.0

Input Impedance .... >950 kΩ
Shunt Capacitance .... <100 pF
Overload Protection .... 450 Vdc or peak ac
Reference Impedance .... 50, 75, 93, 135, 300, or 600Ω (default); front panel selectable.

1-12. EQUIPMENT DATA- Continued.

RF PROBE

Range 0.25 V to 25 VRMS
Accuracy (used with equipment) .... <10% constant voltage over frequency;
.... 5% constant frequency over voltage.
Frequency Range .... 100 kHz to 500 MHz
Input Impedance .... 1.8 MΩ minimum shunted by 10 pF maximum

Section III. TECHNICAL PRINCIPLES OF OPERATION

1-13. GENERAL FUNCTIONAL DESCRIPTION.

Digital Multimeter AN/USM-486A (fig. 1-2) measures ac and dc voltage, performs two- and four-wire resistance measurements, ac and/or dc current, decibels (dB), and tests diodes. Measurement and test results appear on front panel digital display.

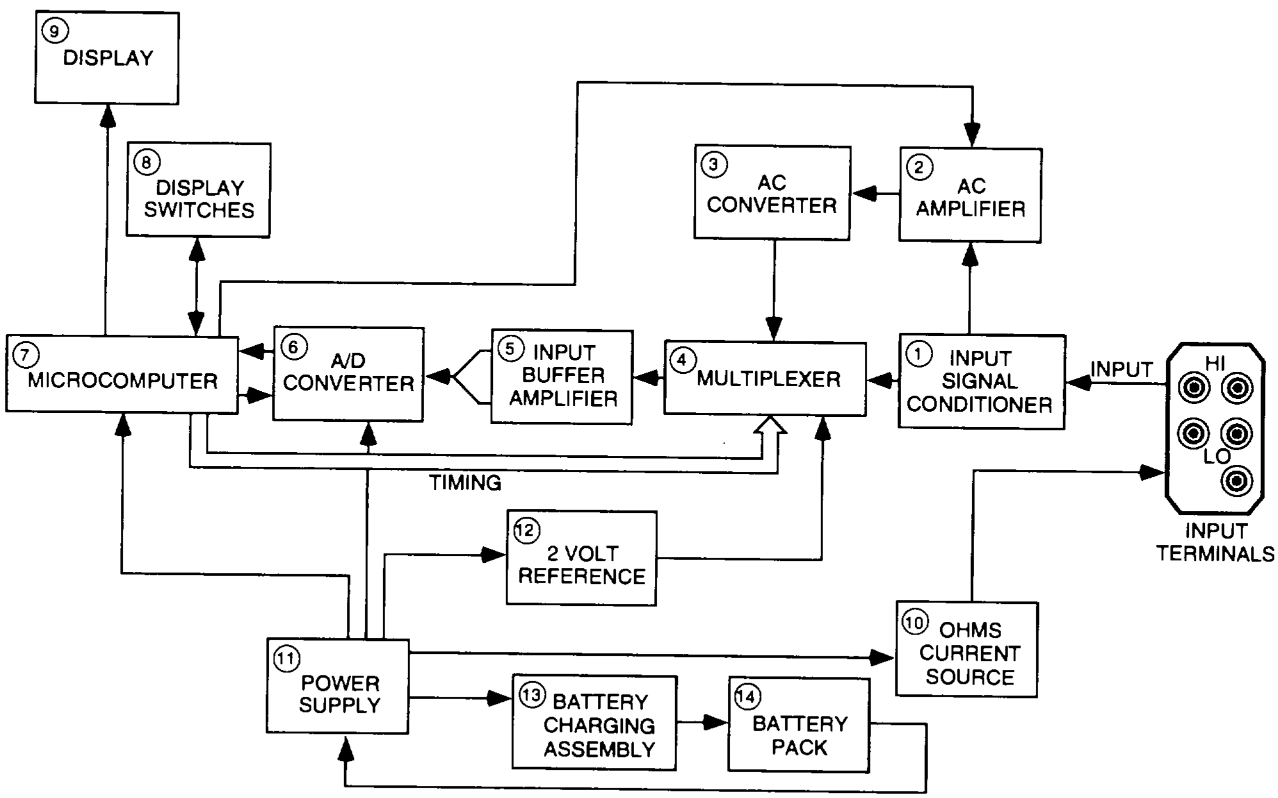

Figure 1-2. Digital Multimeter AN/USM-486A Functional Block Diagram

(1) The input signal conditioner is a circuit that scales the incoming signal to a form that can be used by the multiplexer (4).

(2) The ac amplifier increases the ac signal by x1 or x5, so the ac converter (3) can convert the ac signal to a dc signal.

(3) The ac converter scales the ac voltage or ac current inputs and converts them to an equivalent dc voltage.

(4) The multiplexer is controlled by the microcomputer (7) through timing circuitry that connects different signals to the input buffer amplifier (5). These signals are: signal being measured, zero, reference, and ohms reference.

(5) The input buffer amplifier provides isolation between input signal and analog to digital (a/d) converter (6). Amplifier gain (x1 or x10) is controlled by the microcomputer (7) and is range and function dependent.

(6) The a/d converter generates a digitally controlled pulse train that allows the microcomputer (7) to process readings from the conditioned analog input signal.

(7) The microcomputer controls virtually every part of the multimeter by controlling information that is sent to it. The controller reads the display switches (8), configures the instrument for the appropriate function and range, triggers the a/d converter (6), calculates the result of each a/d conversion cycle, and controls the display (9).

(8) The display switches allow for manual control of all multimeter ranges and functions. The response of the multimeter to the position of the display switches is governed by the microcomputer (7).

(9) The display is a LCD driven by a flat pack LCD controller chip. It communicates to the microcomputer (7) through four control lines.

(10) The ohms current source supplies a known current to the unknown resistance. The resulting voltage drop across the resistor is converted to the resistance reading.

(11) The power supply provides all of the operating voltages for the circuitry in the multimeter.

(12) The 2 volt reference supplies a reference voltage to the multiplexer (4), which enables the multimeter to compute unknown voltages by comparison to a zero and 2 volt source.

(13) The battery charging assembly provides power to the battery for recharging while the multimeter is connected to a line voltage source. Fastest rate of charge is when the multimeter is plugged in to line voltage but turned off.

(14) The battery pack provides power when suitable line power is not available.

CHAPTER 2
OPERATING INSTRUCTIONS

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

2-1. OPERATOR CONTROLS, INDICATORS, AND CONNECTORS.

This section describes operator controls, indicators, and connectors for Digital Multimeter AN/USM-486A.

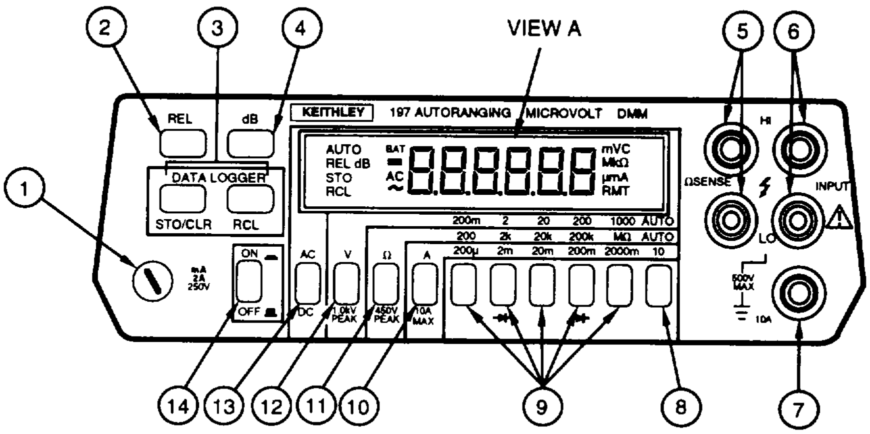
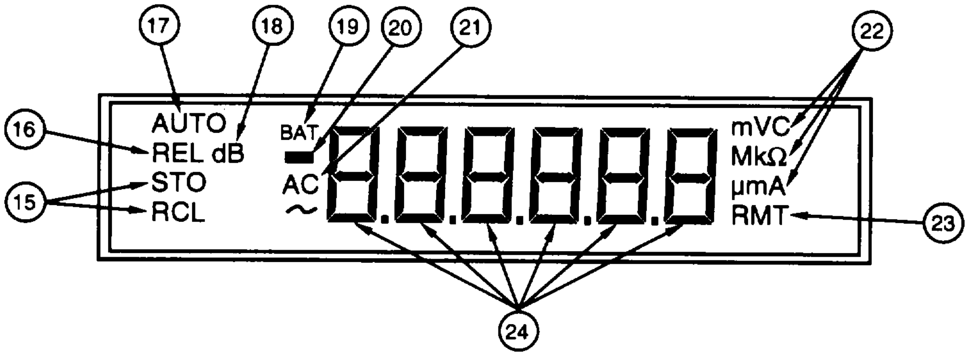


Figure 2-1. Operator's Controls, Indicators, and Connectors, Front View

Key	Control/Indicator	Function
1	Current Fuse	Contains a 2 A, 250 V fuse. Protects the 200 HA through 2000 mA range of -multimeter's current function.
2	REL key	Resets initial value of display to zero for selected function (l, A, V). REL can also be used to make dB measurements independent from impedance.
3	DATA LOGGER	STO/CLR key, when pressed and held, scrolls through seven selectable data reading rates. The rates can be set for automatic operation from three readings per second to one reading per hour or can be manually triggered by the STO/CLR key. RCL key recalls up to 92 stored readings while in the DATA LOGGER mode, including minimum and maximum readings.
4	dB key	Enables digital multimeter to display readings in decibels (dB) rather than voltage.
5	Ω SENSE connectors	Two banana plug connectors used in four-wire resistance measurements.

Key	Control/Indicator	Function
6	HI/LO INPUT connectors	A pair of banana plug connectors used to make connections to the digital multimeter during dc voltage, ac voltage, resistance, and current (less than 2 A) measurements and also for diode tests.
7	10 A Input connector	A banana plug type connector used with the LO INPUT connector to make dc and ac current measurements.
8	AUTO/10 key	Selects autoranging mode when multimeter is in voltage (V) or ohms (Ω) function, and 10 A range when in current (A) function.
9	Manual Range keys	These keys are used to manually set multimeter range for expected value of measurement being taken. Also, while in the ohms function, pressing the 2 kΩ and 200 kΩ keys (➔ symbols) at the same time will test diodes.
10	A (ampere) key	Selects the current measurement function. Either the 2 A input jacks (red and black) or the 10 A input jacks (white and black) can be used when this function is accessed.
11	Ω (ohm) key	Selects two-wire and four-wire Ω measurement function. To activate this function, set AC/DC key to DC position (out).
12	V (voltage) key	Selects voltage measurements function.
13	AC/DC key	Pressing this key in selects AC, releasing this key (out) selects DC.
14	ON/OFF key	Press to turn multimeter on. Releasing (out) this key turns multimeter off.

2-1. OPERATOR CONTROLS, INDICATORS, AND CONNECTORS - Continued.



VIEW A

Key	Control/Indicator	Function
15	STO/RCL indicators	Indicates functions of data logger. STO indicates data is being stored. RCL indicates data is being recalled. RCL flashes when buffer is full during data logging cycle.
16	REL indicator	Indicates the multimeter is operating in REL mode.
17	AUTO indicator	Indicates the multimeter is operating in the autoranging mode.
18	dB indicator	Indicates the multimeter is operating in the decibel (dB) measurements mode.
19	BAT indicator	Indicates a low battery; specifications not guaranteed when lit.
20	Minus (-) indicator	Indicates the digital multimeter is measuring a negative polarity. Positive polarity is implied by absence of Minus indicator.
21	AC indicator	Indicates the digital multimeter is configured for ac mode of measurement. The dc mode of measurement is indicated by the absence of the ac indicator.
22	Units indicator	Indicates voltage, ohms, current units, and calibration mode on display. Voltage measurements are displayed in mV or V. Ohms measurements are displayed in Ω , kΩ, or MΩ. Current measurements are displayed in µA, mA, or A. Calibration mode is indicated by a "C."
23	RMT indicator	Indicates multimeter is in remote control mode.
24	5-1/2 digit display	Indicates measurement information, entry information, and error codes on an alphanumeric liquid crystal display.

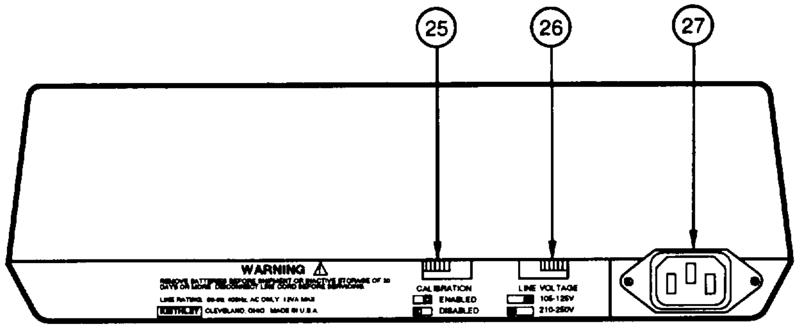


Figure 2-2. Operator's Controls, Indicators, and Connectors, Rear View

Key	Control/Indicator	Function
25	CALIBRATION switch	Enables or disables calibration of the digital multimeter.
26	LINE VOLTAGE switch	Configures instrument voltage either 105 to 125 V or 210 to 250 V to match available line power voltage.
27	Power Line Connector	Used to connect the ac power cord to multimeter.

Section II. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-2. GENERAL.

To be sure your equipment is always ready for your mission, you must do scheduled preventive maintenance checks and services (PMCS). When doing any PMCS checks, keep in mind the warnings and cautions about electrical shock and bodily harm.

2-3. PMCS PROCEDURES.

a. Tools, Materials, and Equipment Required for Preventive Maintenance. No tools or equipment are required for operator preventive maintenance. Cleaning materials required are listed in Appendix D, items I through 3.

b. PMCS for multimeter kit is limited to routine checks such as shown below.

- cleaning,
- dusting,
- wiping,
- checking for frayed cables,
- storing items not in use,
- covering unused receptacles,
- checking for loose fasteners, nuts, and screws.

c. Perform these routine checks anytime you see they must be done.

Section III. OPERATION UNDER USUAL CONDITIONS

2-4. INTRODUCTION.

This section provides the information required to operate the multimeter in each mode: dc voltage, low and high frequency TRMS ac voltage, two-wire and four-wire resistance, dc and/or TRMS ac current, decibel mode measurements, and a diode test. This section also describes data logger operation and provides procedures for relative mode (zeroing) and decibel (dB) offset calculation.

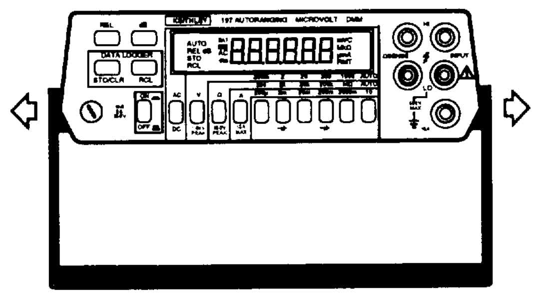
2-5. INITIAL ADJUSTMENTS.

a. Remove any test leads connected to front panel connectors.

b. Adjust handle to the desired operating position as follows:

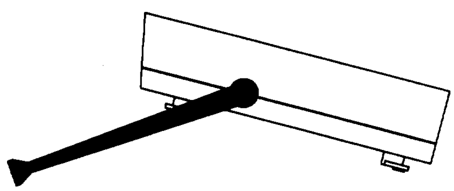
- Pull out the ends of the handle until a hard stop is felt (approximately 1/4 inch).

PULL ENDS OUTWARD TO ROTATE

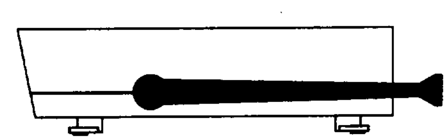


- Rotate handle until it is in desired viewing position as shown below, and allow the ends to return towards unit.

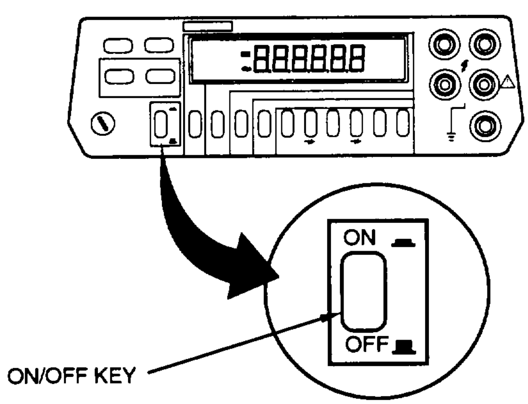
1. VIEWING POSITION

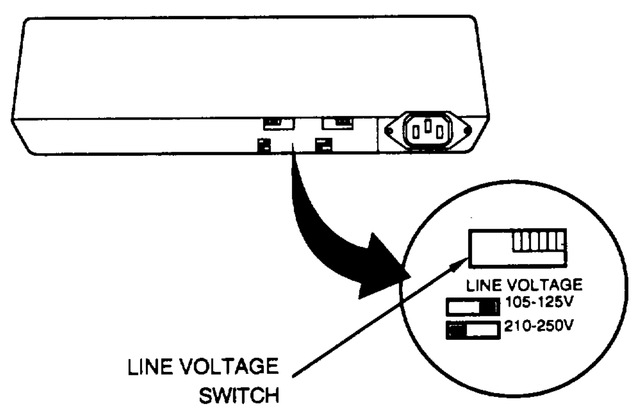


2. ALTERNATIVE VIEWING POSITION



c. Verify ON/OFF key is off (out) and line power is disconnected.





d. Set LINE VOLTAGE switch to correspond to line voltage available.

2-6. POWER-UP SELF TEST

a. Perform the initial adjustments (para 2-5).

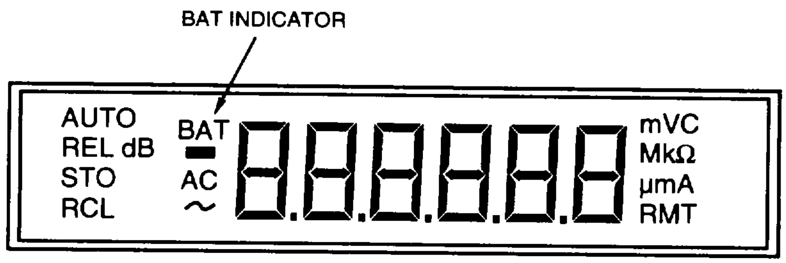
CAUTION

Verify LINE VOLTAGE switch setting matches available power source.

b. Plug power cord into power line connector and grounded supply source.

c. Press in ON/OFF key.

- If BAT indicator lights up, charge the battery (para 2-7).



- If an error code is displayed, determine corrective action using error messages table (Table 2-1).

Table 2-1. Error Messages.

DISPLAY	MESSAGE	CORRECTIVE ACTION
0000	RAM Error	Notify next higher level of maintenance.
cErr	Calibration Error (NVRAM Failure)	Notify next higher level of maintenance.
OL	Overrange	Select a higher range.
AC Err Ω	Invalid Ω Function	Release AC/DC key (select DC).

If multimeter has an open input in ohms, the display will read "OL". This is not an error condition.

2-7. BATTERY CHARGING.

CAUTION

Do not charge battery until battery pack is completely discharged (BAT indicator displayed). Charging battery that is not completely discharged will reduce battery life.

1. Perform initial adjustments (para 2-5).
2. Plug power cord into power line connector and grounded supply source.
3. Allow battery pack to charge for ten hours (minimum).

NOTE

If battery does not retain charge for five hours after a full (ten hour) charge cycle, perform steps 4 through 7.

4. Disconnect multimeter from line power.
5. Press ON/OFF key to on (in position) and completely discharge battery pack.
6. Charge battery.
7. Repeat steps 4 through 6 three more times.

2-8. OPERATING PROCEDURES.

Operation of the digital multimeter is described in paragraphs 2-9 through 2-22, including procedures for decibel offset calculation, data logger operation, and zeroing (relative mode). Refer to Section I for a further description of controls, indicators, and connectors.

2-9. DC VOLTAGE MEASUREMENTS.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 1000 Vdc or peak ac (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

a. Connect test leads to HI/LO INPUT connectors (1).

b. Set the AC/DC key (2) for DC (out).

c. Press V (voltage) key (3).

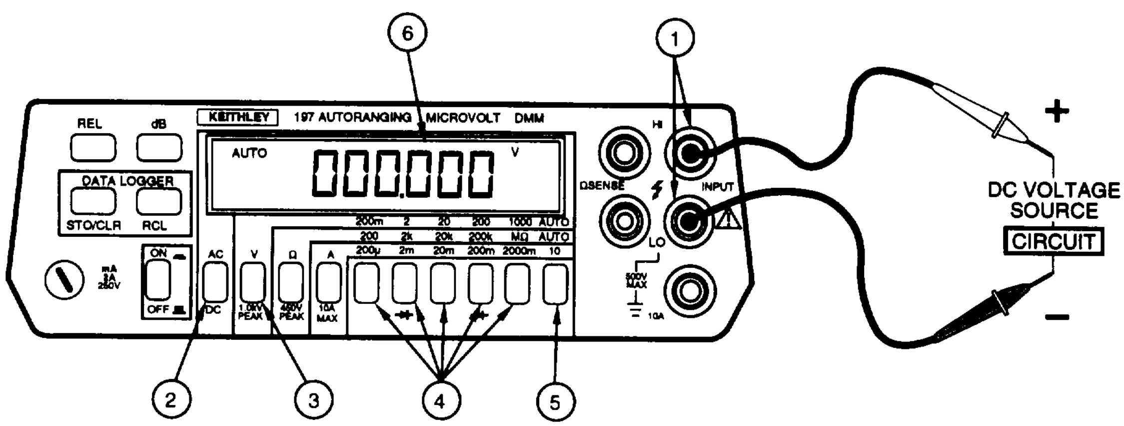
CAUTION

To prolong instrument life, manual ranging is recommended for routine measurements above 200 Vdc.

d. Set Range.

- Select and press a manual range key (4) for manual ranging.
- Press AUTO/10 key (5) for automatic range selection.

e. Connect test leads to voltage source as shown.



NOTE

"OL" displayed indicates an overrange condition. If this happens, select a higher range until a numerical reading is displayed.

f. Read dc voltage value on the display (6).

2-10. DC MICROVOLT MEASUREMENTS.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 1000 Vdc or peak ac (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

a. Twist test leads and connect to HI/LO INPUT connectors (1).

b. If necessary in high EMI environment, shield test leads using conductive material and connect to LO INPUT connection.

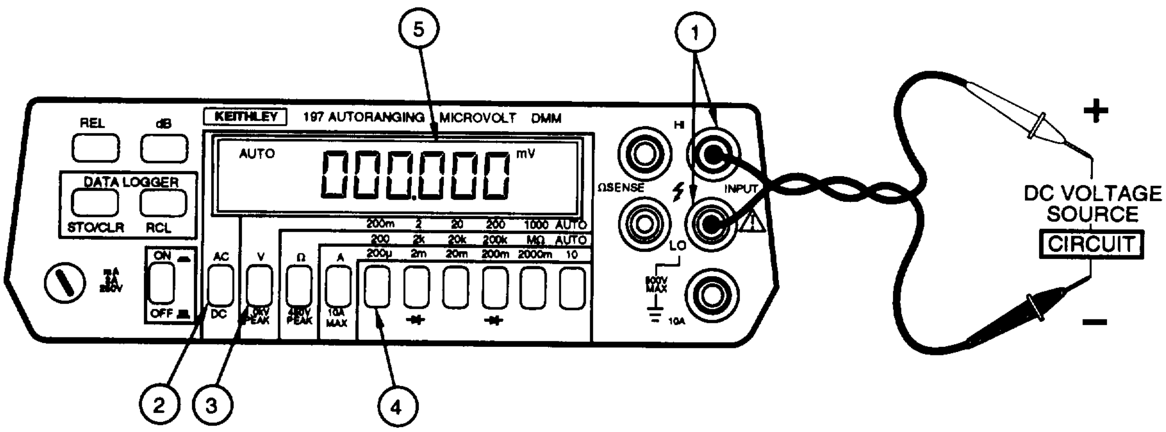
c. Set AC/DC key (2) for DC (out).

d. Press V (voltage) key (3).

e. Press 200 mV manual range key (4).

f. Zero multimeter [enable REL mode (para 2-22)].

g. Connect test leads to voltage source as shown.



NOTE

"OL" displayed indicates an overrange condition. If this happens, select a higher range until a numerical reading is displayed.

h. Read dc microvolt value on the display (5).

2-11. HIGH FREQUENCY (>100 kHz) TRMS AC VOLTAGE MEASUREMENTS.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 30 VRMS, 200 Vdc. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

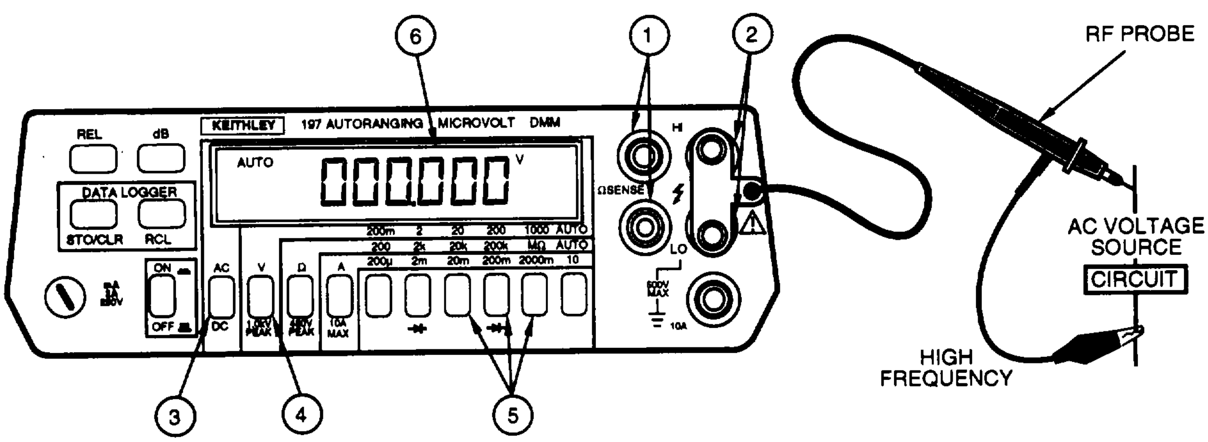
NOTE

- **To avoid false or inaccurate readings, disconnect any test leads to the ΩSENSE - four- wire connectors (1) before making TRMS ac voltage measurements.**
- **This procedure uses the dc measurement function of the multimeter to measure the output generated by the RF probe. The RF probe generates a dc voltage of the same magnitude as the peak ac voltage being measured. The RF probe is calibrated to read the RMS value of a sine wave.**

a. Connect RF probe to the HI/LO INPUT connectors (2).

NOTE

The low side of the RF probe output is marked GND.



b. Set the AC/DC key (3) for DC (out).

c. Press the V (voltage) key (4).

d. Press 20, 200, or 1000 V manual range key (5).

e. Zero multimeter [enable REL mode (para 2-22)].

f. Connect RF probe to high frequency voltage source as shown.

NOTE

"OL" displayed indicates an overrange condition. If this happens, select a higher range until a numerical reading is displayed.

g. Read display (6) as a TRMS ac voltage value.

2-12. LOW FREQUENCY (<100 kHz) TRMS AC VOLTAGE MEASUREMENTS.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

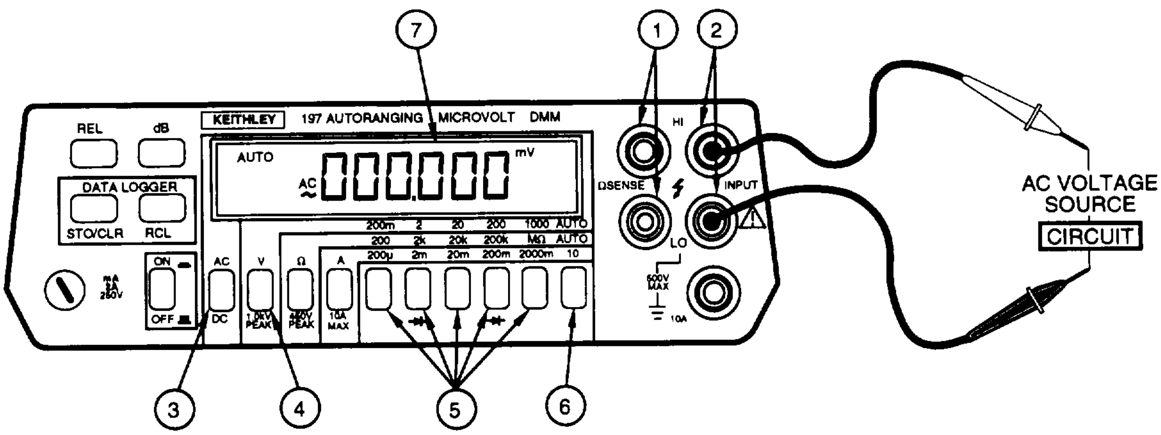
The maximum allowable inputs are 750 VRMS, 1000 V peak (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous; 107 V•Hz. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

NOTE

To avoid false or inaccurate readings, disconnect any test leads to the ΩSENSE - four-wire connectors (1) before making TRMS ac voltage measurements.

a. Connect test leads to HILO INPUT connectors (2).

b. Set AC/DC key (3) for AC (in).



c. Press V (voltage) key (4).

CAUTION

To prolong instrument life, manual ranging is recommended for routine measurements above 200 VRMS.

d. Set Range.

- **Select and press a manual range key (5) for manual ranging.**
- **Press AUTO/10 key (6) for automatic range selection.**

e. Connect test leads to voltage source as shown.

NOTE

"OL" displayed indicates an overrange condition. If this happens, select a higher range until a numerical reading is displayed.

f. Read TRMS ac voltage value on the display (7)

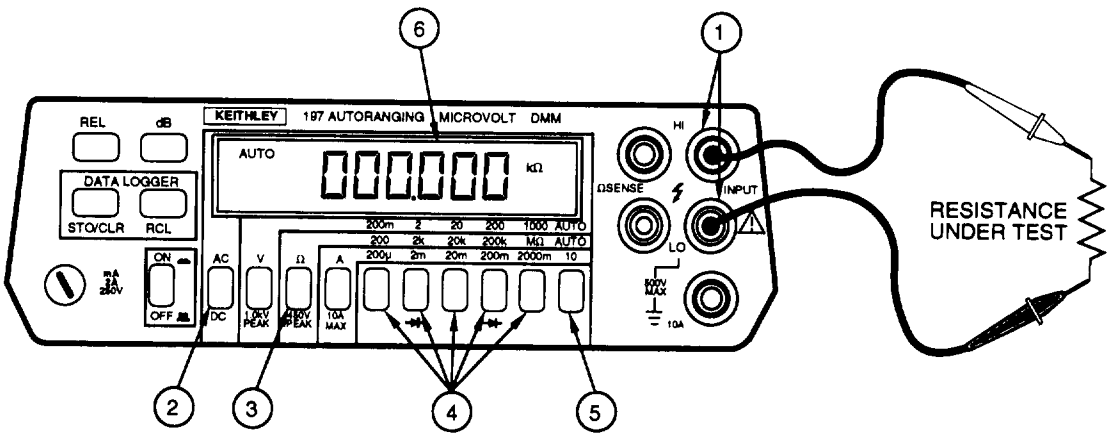
2-13. TWO-WIRE RESISTANCE MEASUREMENTS.

WARNING

- **Operator injury or multimeter damage may result if resistance measurement is made while circuit is live.**

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

a. Connect leads to HI/LO INPUT connectors (1).



b. Set AC/DC key (2) for DC (out).

c. Press C (ohms) key (3).

d. Set Range.

- **Select and press a manual range key (4) for manual ranging.**

- **Press AUTO/10 key (5) for automatic range selection.**

e. Zero multimeter [enable REL mode (para 2-22)].

f. Connect test leads to resistance as shown.

NOTE

"OL" displayed indicates an overrange condition. If this happens, select a higher range until a numerical reading is displayed.

g. Read resistance value on the display (6).

2-14. CURRENT MEASUREMENTS (DC OR TRMS AC).

WARNING

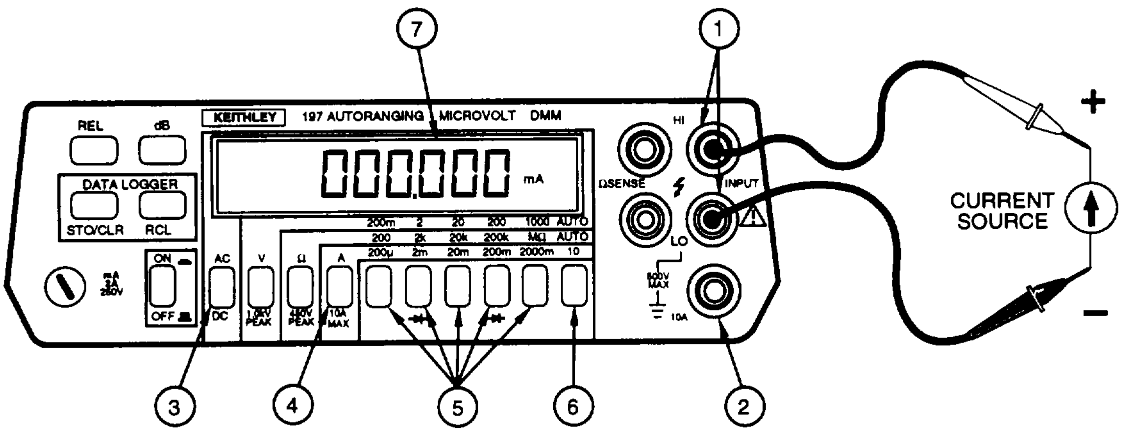
The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 2 A continuous on the mA input (1), 16 A continuous on the 10 A input (2), and 20 A for 15 seconds maximum on the 10 A input (2). The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

2.14.1 Measurements Between 200 μA and 2000 mA.

a. Connect test leads to HI/LO INPUT connectors (1).



b. Set AC/DC key (3) for AC (in) or DC (out).

c. Press A (ampere) key (4).

NOTE

The current function of the digital multimeter does not autorange. Select appropriate range for the expected current using manual range keys (5). If the AUTO/10 key (6) is pressed while in the current function, 10 A range will be selected.

d. Select appropriate range for expected current using manual range keys (5).

e. Connect the test leads to the current source as shown.

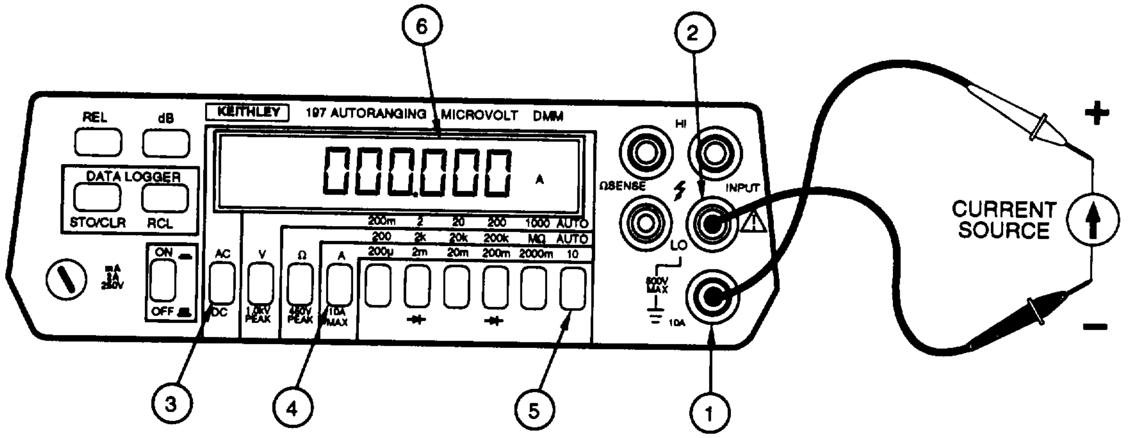
NOTE

"OL" displayed indicates an overrange condition. If this happens, select a higher range until a numerical reading is displayed.

f. Read current value on the display (7).

2.14.2 Measurements Between 2000 mA and 10 A.

a. Connect test leads to 10 A input connector (1) and LO INPUT (2) of HILO INPUT connectors.



b. Set AC/DC key (3) for AC (in) or DC (out).

c. Press A (ampere) key (4).

NOTE

The current function of the digital multimeter does not autorange.

d. Select 10 A current range by pressing AUTO/10 key (5).

NOTE

Current up to 5 A may be measured continuously with the digital multimeter. Current exceeding 5 A will have a self heating effect. For continuous measurements of currents above 5 A, derate 0.15% of the reading per amp above 5 A.

e. Connect test leads to current source as shown.

f. Read current value on the display (6)

2-15. CURRENT MEASUREMENTS (TRMS AC PLUS DC).

a. Set AC/DC key for AC (in) and measure TRMS ac current (para 2-14). Record as I_{ac}.

b. Set AC/DC key for DC (out) and measure dc current (para 2-14). Record as I_{dc}.

c. Using a calculator with a square root key (4x) and a square function key (x2), compute the rms (root mean square) value by solving the equation:

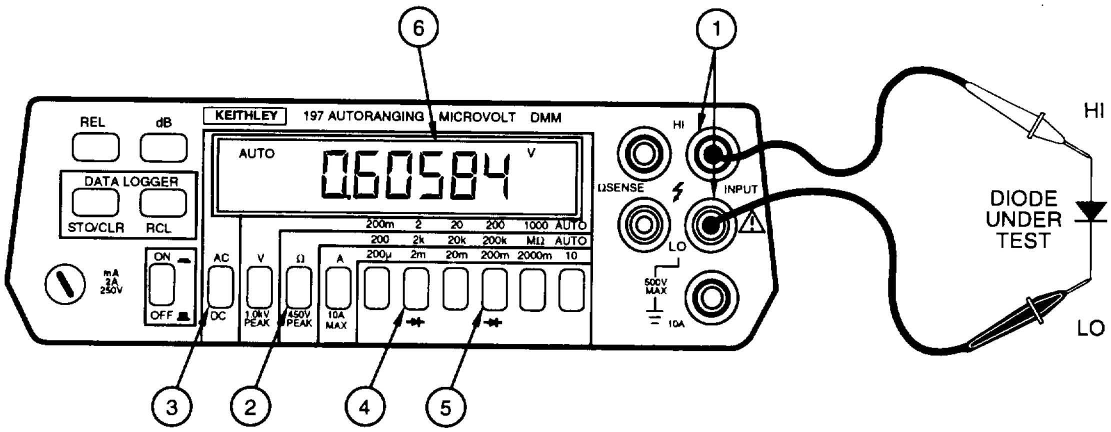
$$I_{rms} = \sqrt{(I_{ac})^2 + (I_{dc})^2}$$

- Clear calculator.
- Enter value recorded as I_{ac}.
- Press the square key (x^2) key. Record value on calculator as $(I_{ac})^2$.
- Clear calculator.
- Enter the value recorded as I_{dc}.
- Press the square key (x^2) key.
- Press addition key (+).
- Enter value recorded as $(I_{ac})^2$.
- Press square root key ($\sqrt{x}$).
- Result is the I_{rms} signal that contains both ac and dc components.

2-16. DIODE TEST.

a. Connect test leads to HI/LO INPUT connectors (1).

b. Press Ω key (2).



c. Set AC/DC key (3) for DC (out).

d. Press 2k (4) and 200k (5) buttons (➔I symbols) of the manual range keys simultaneously.

e. Connect test leads to diode as shown.

NOTE

- **Display reads forward voltage drop of a silicon diode at 1.6 mA (1.1 mA for an LED) up to 2.2 V.**

- **"OL" will be displayed if red terminal [HI INPUT connector (1)] is connected to diodes low input. Make sure multimeter's leads are connected to diode's inputs correctly.**

f. Read forward voltage drop of diode on the display (6)

2-17. DECIBEL (dBm) MEASUREMENTS.

NOTE

dBm is defined as decibels relative to 1 mW. The multimeter reads 0 dBm when the voltage needed to dissipate 1 mW through the selected reference impedance is applied. For a 600Ω reference impedance, 0.7746 V must be applied to read 0 dBm.

$$E = \sqrt{P \bullet R} = \sqrt{10^{-3}\,W} = 0.7746\ V$$

2-17.1 Measuring Decibels (dBm) with a Selectable Impedance (600Ω (Default), 300Ω, 135Ω, 93Ω, 75Ω, 50Ω).

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 1000 Vdc or peak ac, 750 VRMS (<10 seconds per minute on 200 mV and 2 V range); 300 VRMS continuous; 10^7 V•Hz. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

a. Connect test leads to HI/LO INPUT connectors (1).

b. Set AC/DC key (2) for AC (in) or DC (out).

c. Press V (voltage) key (3).

NOTE

To briefly display present value of selectable dB impedance, press and release dB key. On power-up, default setting for dB impedance is 600f.

d. Scroll through selectable reference impedances by holding in dB key (4). Release dB key when desired reference impedance is displayed.

e. Connect test leads to voltage source as shown.

f. Read voltage (in dBm) from display (5).

2.17.2 Measuring Decibels (dBm) with Non-selectable Impedances.

a. Determine decibel (dB) offset for desired reference impedance (para 2-20).

b. Select 600w as reference impedance and measure decibels (dBm) (para 2-17.1).

c. Algebraically add decibel offset determined in paragraph 2-20 from dBm reading. The result is value of voltage measured in dBm at desired reference impedance.

2-18. MEASURING BANDWIDTH (dB).

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

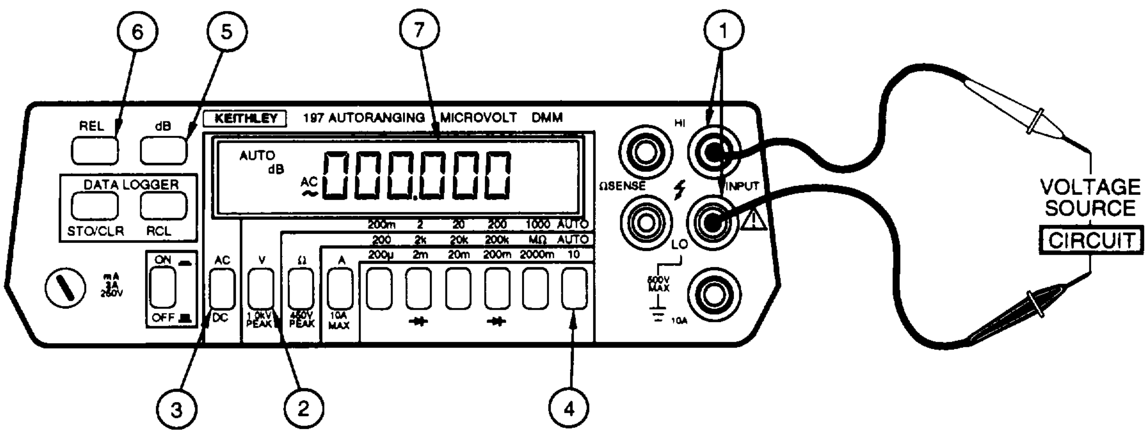
CAUTION

The maximum allowable inputs are 1000 Vdc or peak ac, 750 VRMS (<10 seconds per minute on 200 mV and 2 V range); 300 VRMS continuous; 107 V•Hz. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

2-18.1 Measuring Bandwidth.

a. Connect test leads to HI/LO INPUT connectors (1).

b. Press V (voltage) key (2).



c. Set AC/DC key (3) for AC (in).

d. Press AUTO/10 key (4).

e. Connect test leads to the circuit to be measured as shown.

f. Apply a signal to the circuit, and adjust frequency until a peak ac voltage is displayed on the multimeter.

g. Press dB key (5).

h. Press REL key (6).

i. Increase frequency until multimeter reads -3.00 dB on display (7).

j. Record frequency as high end limit of bandwidth.

k. Decrease frequency until multimeter again falls through 0 dB to -3.00 dB.

l. Record frequency as low end limit of bandwidth.

2.18.2 Determining Circuit Quality Factor (0).

NOTE

Center frequency is equal to the frequency when the peak ac voltage is registered on the multimeter.

a. Determine center frequency and bandwidth of circuit (para 2-18.1).

b. Divide center frequency by the bandwidth using the following formula:

$$Q = \frac{\text{Center Frequency}}{\text{Bandwidth}}$$

c. Result (Q) is equal to the quality factor.

2-19. MEASURING CIRCUIT GAIN OR LOSS (dB).

WARNING

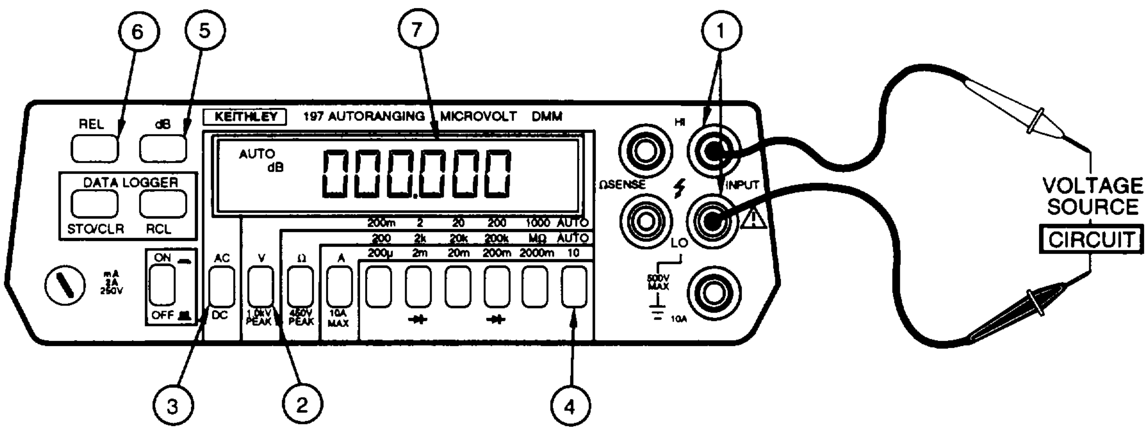
The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 1000 Vdc or peak ac, 750 VRMS (<10 seconds per minute on 200 mV and 2 V range); 300 VRMS continuous; 107 V•Hz. The maximum voltage between LO INPUT and chassis ground is 500V peak. Exceeding these values may damage the instrument.

a. Connect test leads to HI/LO INPUT connectors (1).

b. Press V (voltage) key (2).



c. Set AC/DC key (3) for AC (in) or DC (out).

d. Press AUTO/IO key (4).

e. Press dB key (5).

f. Connect test leads to a reference point in the circuit to be measured as shown.

g. Press REL key (6) to set 0 dB point.

h. With reference to the 0 dB point, gain or loss of other points in the circuit can now be read on the display (7).

2-20. DECIBEL (dB) OFFSET.

a. Look up reference impedance in the table below. Decibel (dB) offset is given in right hand column.

DESIRED REFERENCE IMPEDANCE Ω	DECIBEL OFFSET TO ADD TO READING TO CREATE 0 dBm (MULTIMETER SET TO 600Ω REFERENCE)
8	+18.75
50	+10.79
75	+9.03
93	+8.10
135	+6.49
150	+6.03
300	+3.01
600	-0.00
1000	-2.22

b. If reference impedance is not listed, calculate offset as follows:

$$\text{offset} = 10 \log \frac{R_{\text{DESIRED REFERENCE}}}{600\Omega}$$

offset = 10 log

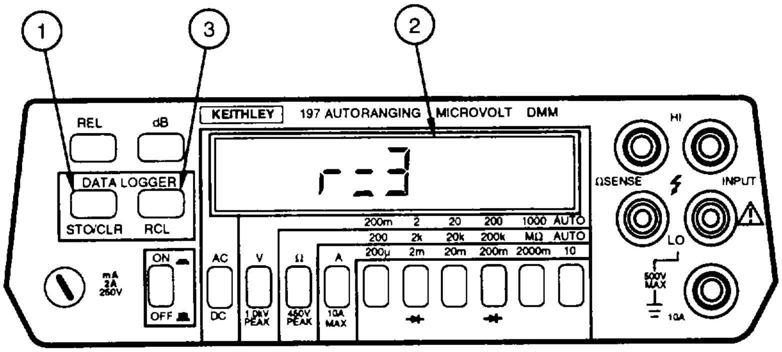
- Use a calculator with logarithmic functions (LOG key) and the following procedure to make calculations.
- Clear calculator.
- Enter desired reference impedance.
- Press divide (+) key.
- Enter a 600.
- Press LOG key.
- Press multiplication key (x).
- Enter a 10.
- Press equals (=) key. Resulting value is decibel offset.
- Add the selected reference impedance and decibel offset to the table for future reference.

2-21. DATA LOGGER OPERATION.

a. Set up multimeter for desired measurement (para 2-9 through 2-19).

NOTE

It is unnecessary to select a reading rate if minimum and maximum readings are the only readings desired.



b. Press and hold in STO/CLR key (1) to scroll through the following reading rate codes on the display (2).

RATE (DISPLAYED)	MEANING
r=0	Every reading is logged
r=1	1 reading/second
r=2	1 reading/l0 seconds
r=3	1 reading/minute
r=4	1 reading/10 minutes
r=5	1 reading/hour
r=6	1 reading when STO/CLR key is pressed

c. Release STO/CLR key (1) when desired reading rate is displayed.

NOTE

- **If r=6 is selected, the buffer location of the data is briefly displayed after STO/RCL key is depressed.**
- **The RCL indicator will flash when data logger has stored the maximum number of readings (92). Minimum and maximum values will still be updated as long as data logger is in operation.**

d. Press STO/CLR (1) to stop logging cycle. If in manual trigger mode (r=6), first press RCL key (3), then press STO/CLR key to stop logging cycle.

RETRIEVING DATA.

a. Press and hold in RCL key (3) to scroll through the data points, minimum points, and maximum points.

NOTE

- **Pressing and releasing the RCL key will advance to the next data point.**
- **The first data point displayed will be the last reading stored. The next two points displayed are the high and then the low readings taken during that logging cycle.**
- **The longer RCL key is held in, the faster the data points scroll.**

b. Release the RCL key (3) at desired data point and note data displayed.

2-22. RELATIVE MODE.

Perform the following steps to set a baseline for a selected function. When a REL level is set for a function, it is same for each range of that function. When setting a new REL level, previous REL level will be canceled.

NOTE

Once the REL level is set, that level is algebraically subtracted from the input signal. For example, -1.0 V REL level is set and +1.5 V is applied. The instrument displays +2.5 V. If the input is +2.2 V the instrument overranges.

a. Set digital multimeter for desired measurement (para 2-9 through 2-19).

b. Short test leads as shown and wait until display (1) reading stabilizes.

NOTE

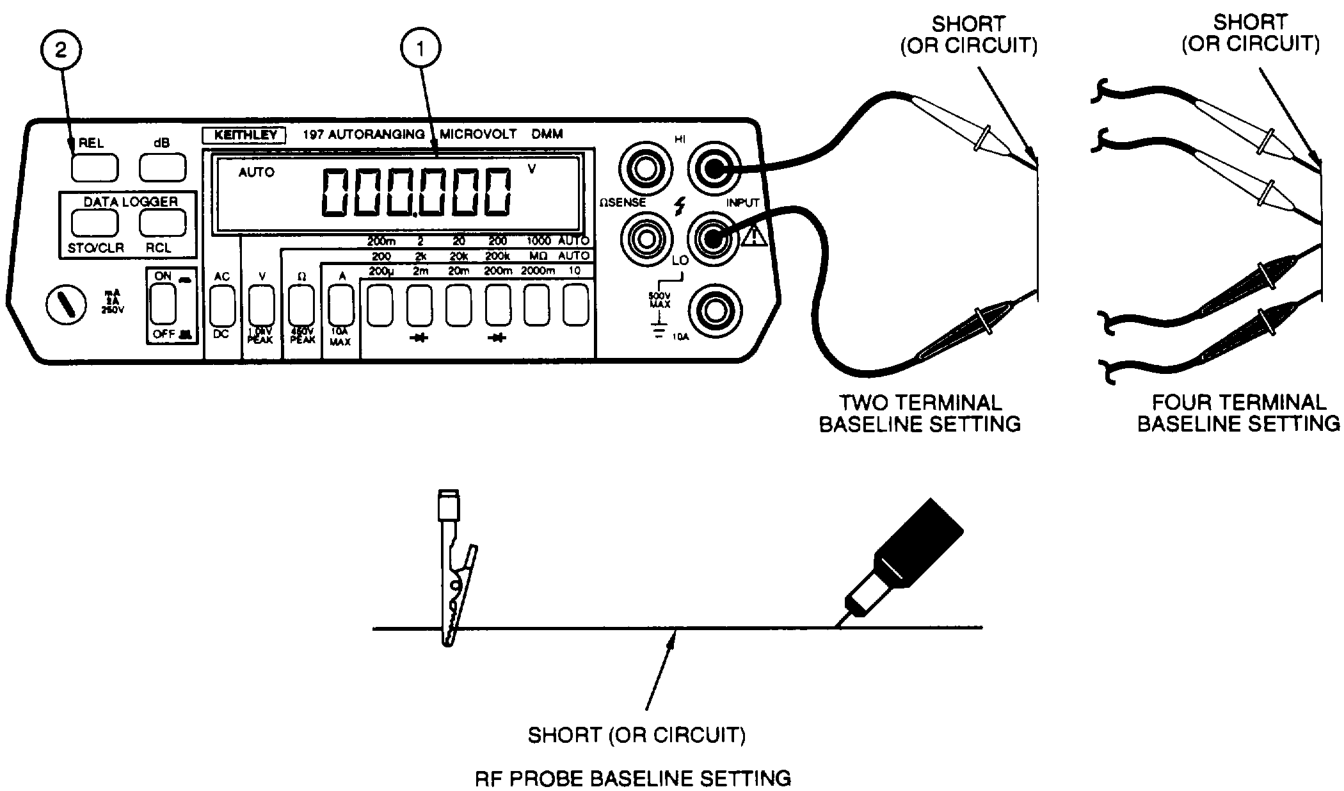
The display may require a few seconds to stabilize because of electrical noise and thermal EMFs.

- **Use TWO TERMINAL BASELINE SETTING if using two leads to make measurements.**

* **Use FOUR TERMINAL BASELINE SETTING if using four leads to make measurements.**

* **Use RF PROBE BASELINE SETTING if using RF probe to make measurements.**

c. Press REL key (2).



CHAPTER 3
UNIT MAINTENANCE

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Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

3-1. COMMON TOOLS AND EQUIPMENT.

Common tools and equipment required for unit maintenance of Digital Multimeter AN/USM-486A are listed in the Maintenance Allocation Chart (MAC) (Appendix B).

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

No special tools, TMDE, or support equipment are required.

3-3. REPAIR PARTS.

Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 11-6625-3277-24P.

Section II. SERVICE UPON RECEIPT

3-4. SERVICE UPON RECEIPT OF MATERIAL.

a. Unpacking. Special material in this shipping carton provides maximum protection for the multimeter. Avoid damaging carton and packing material during equipment unpacking. Use the following steps for unpacking the multimeter.

- Cut and remove paper sealing tape on carton top and open carton.
- Grasp multimeter test case firmly while restraining shipping carton and lift equipment vertically.
- Open test case and place multimeter on a suitable, flat, clean, and dry surface.

b. Checking Unpacked Equipment.

- Inspect equipment for damage incurred during shipment. If the equipment was damaged, report the damage on SF 364, Report of Discrepancy (ROD).

- Check the equipment against the packing slip to see if shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Send equipment to General Support for GS preliminary servicing (para 5-5).

3-5. PRELIMINARY SERVICING AND ADJUSTMENT OF EQUIPMENT.

a. Charge battery (para 2-7).

b. Perform PMCS (para 2-3).

c. Perform the power-up self test (para 2-6).

Section III. TROUBLESHOOTING

SYMPTOM INDEX

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2. Multimeter Display Operating but Erratic Measurements.......... 3-3
3. No Current Measurement - Other Functions Operate Normally.......... 3-3
4. Multimeter Fails Self Diagnostic Program.......... 3-3
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3-6. TROUBLESHOOTING TABLE.

Table 3-1 lists common malfunctions found during operation or maintenance of the multimeter. Perform the tests/inspections and corrective actions for a particular malfunction in the order given.

NOTE

Table 3-1 does not list all malfunctions that may occur or all tests/inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify next higher level of maintenance.

Table 3-1. Troubleshooting.

Malfunction
Test or Inspection
Corrective Action

1. MULTIMETER NOT OPERATING - DISPLAY BLANK.

Check power cord to the multimeter.

- Replace the power cord.
- If multimeter fails to operate, notify the next higher level of maintenance.

2 MULTIMETER DISPLAY OPERATING BUT ERRATIC MEASUREMENTS.

Check to see if one or both test leads are defective.

- Replace test leads if defective.
- If test leads are not defective, notify next higher level of maintenance.

3. NO CURRENT MEASUREMENT - OTHER FUNCTIONS OPERATE NORMALLY.

Check to see if the AIFI current fuse is blown or broken.

- Replace A1F1 current fuse (para 3-7).
- If the multimeter fails to measure current, notify next higher level of maintenance.

4. MULTIMETER FAILS SELF DIAGNOSTIC PROGRAM (para 3-8).

Check error code displayed.

- If one or more segments or indicators fails to light, notify next higher level of maintenance.
- If display locks up with zeroes, notify next higher level of maintenance.
- If "cErr" is displayed, notify next higher level of maintenance.

5. A1A1BA1 BATTERY PACK DOES NOT MAINTAIN CHARGE FOR FIVE HOURS.

Charge A1A1BA1 battery pack for 10 hours (para 2-7).

- If A1A1BA1 battery pack does not maintain charge, notify next higher level of maintenance.

Section IV. MAINTENANCE PROCEDURES

3-7. A1F1 CURRENT FUSE REPLACEMENT.

DESCRIPTION

This procedure covers: Removal. Installation.

REMOVE

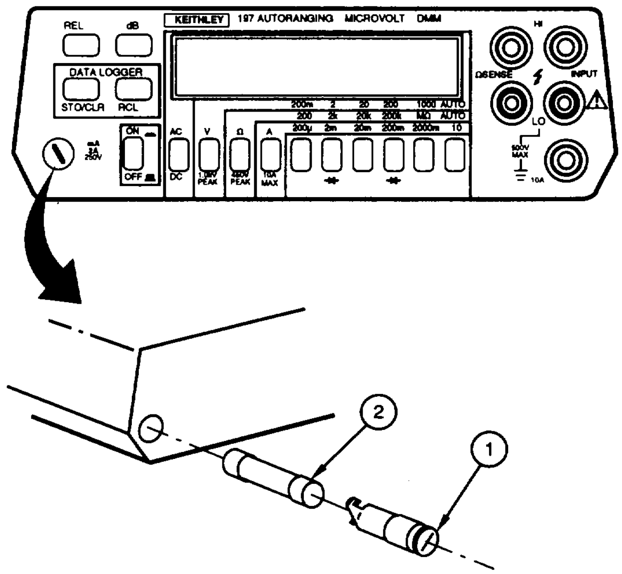
1. Press ON/OFF key to off (out position) and disconnect power cord and test leads to multimeter.
2. Using a flat blade screwdriver, press in on fuse holder (1) slot and turn 1/4 turn counterclockwise.
3. Remove A1F1 current fuse (2) and fuse holder (1) from multimeter.

INSTALL

I. Insert new A1F1 current fuse (2) in fuse holder (1).

2. Insert A1F1 current fuse (2) and fuse holder (1) in multimeter and turn 1/4 turn clockwise.

3. Check multimeter for up to 2A current operation.



END OF TASK

3-8. SELF DIAGNOSTIC PROGRAM.

DESCRIPTION

This procedure activates the multimeter's self diagnostic program.

1. Perform initial adjustments (para 2-5).

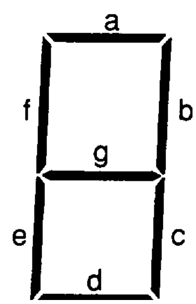
2. Plug multimeter power cord into AC power source.

3. Press and hold in the dB key.

4. Continuing to hold in the dB key, press the ON/OFF key in (ON) (do not release the dB key).

5. When the display test runs, determine if any segments or indicators failed to light. After all segments and annunciators light and the firmware revision is shown, the display test will sequentially display all components in the following order:

   - The "a" segments of the digits, the dB and the V indicators,
   - The "b" segments of the digits,
   - The "c" segments of the digits,
   - The "d" segments of the digits, the m (mA) and RCL,
   - The "e" segments of the digits, the minus sign (-), REL, M, and Ω ,
   - The "f' segments of the digits, the AUTO, BAT, m (mV) and c indicators are displayed,
   - The "g" segments of the digits, the AC and k indicators are displayed,
   - The decimal points, most significant digit, STO, µ , and A indicators are displayed.



6. If one or more segments or indicators fails to light, refer to Multimeter Fails Self Diagnostic Program, troubleshooting table (table 3- 1).

7. The RAM (random access memory) and NVRAM (nonvolatile random access memory) will then automatically be tested.

   - If an error code is displayed, determine corrective action using table below.

DISPLAY	MESSAGE	CORRECTIVE ACTION
0000	RAM Error	Refer to Multimeter Fails Self Diagnostic Program, troubleshooting table (table 3-1).
cErr	Calibration Error (NVRAM Failure)	Refer to Multimeter Fails Self Diagnostic Program, troubleshooting table (table 3-1).
OL	Overrange	Verify test leads are not connected.
Ãc Err Ω	Invalid Ω Function	Release AC/DC key (select DC).

   - If an error code is not displayed, multimeter passes self diagnostic program.

8. Release the dB key when the display starts cycling through 0-1-2-3.

END OF TASK

Section V. PREPARATION FOR STORAGE OR SHIPMENT

3-9. PACKAGING.

Package the multimeter in the original shipping container. When using packing materials other than the original, use the following guidelines:

a. Wrap the multimeter in plastic material.

b. Use a double-wall cardboard shipping container.

c. Protect all sides with shock-absorbing material to prevent the multimeter from movement within the container.

d. Seal the shipping container with approved sealing tape.

e. Mark "FRAGILE" on all sides, top, and bottom of the shipping container.

3-10. TYPES OF STORAGE.

- Short Term Storage (administrative) = 1 to 45 days.
- Intermediate = 46 to 180 days.
- Long Term = over 180 days. After long term storage, perform power-up self test (para 2-6) and charge battery (para 2-7). If either procedure fails, perform troubleshooting procedures (table 3-1).

3-11. ENVIRONMENT.

The multimeter should be stored in a clean, dry environment. In high humidity environments, protect the multimeter from temperature variations that could cause internal condensation. The following environmental conditions apply for both shipping and storage:

Temperature..-40° to 158°F (-40° to +70°C)
Relative Humidity (noncondensing)..............................less than 80% RH up to 95°F (35%)
(linearly derate 3% RH/°C between 35° and 50°C)
Altitude..<10,000 ft.

CHAPTER 4
DIRECT SUPPORT MAINTENANCE

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

CHAPTER 5
GENERAL SUPPORT MAINTENANCE

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Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

5-1. COMMON TOOLS AND EQUIPMENT.

Common tools and equipment required for general support maintenance of Digital Multimeter AN/USM-486A are listed in the Maintenance Allocation Chart (MAC) (Appendix B).

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

No special tools, TMDE, or support equipment are required.

5-3. REPAIR PARTS.

Repair parts are listed and illustrated in the Repair Parts and Special Tools List TM 1 1-6625-3277-24P.

Section II. SERVICE UPON RECEIPT

5-4. SERVICE UPON RECEIPT OF MATERIAL.

For service upon receipt information, refer to Chapter 3, Section II.

5-5. PRELIMINARY SERVICING AND ADJUSTMENT OF EQUIPMENT.

a. Install battery (para 5-17).

b. Complete performance tests (para 5-21).

Section III. THEORY OF OPERATION

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

5-6. DETAILED FUNCTIONAL DESCRIPTION.

A functional block diagram of the multimeter is shown in fig. FO-1.

(1) *Input Terminals*. Connections between the test circuit and multimeter are made at the input terminals. Voltage measurements, 2-wire resistance measurements, and current measurements up to 2 A are made with the INPUT HI and LO terminals. Four-wire resistance measurements also use the n SENSE HI and LO terminals. Current measurements up to 10 A are made with the 10 A and INPUT LO terminals.

(2) *Input Signal Conditioner*. The input signal conditioner is a circuit that scales the incoming signal to a form that can be used by the multiplexer (5).

(3) *AC Amplifier*. The ac amplifier increases the ac signal by x1 or x5, so the ac converter (4) can convert the ac signal to a dc signal.

(4) *AC Converter*. The ac converter scales the ac voltage or ac current inputs and converts them to an equivalent dc voltage.

(5) *Multiplexer.* The multiplexer is controlled by the microcomputer (8) through timing circuitry that connects different signals to the input buffer amplifier (6). These signals are: signal being measured, zero, 2 V reference, and ohms reference.

(6) *Input Buffer Amplifier*. The input buffer amplifier provides isolation between the input signal and the analog to digital converter (7). Amplifier gain (x1 or x10) is controlled by the microcomputer (8) and is range and function dependent.

(7) *Analog to Digital (a/d) Converter*. The a/d converter generates a digitally controlled pulse train that allows the microcomputer (8) to process readings from the conditioned analog input signal.

(8) *Microcomputer*. The microcomputer controls virtually every part of the multimeter by controlling information that is sent to it. The microcomputer reads the function and range switches (12), configures the instrument for the appropriate function and range, reads the REL, dB, STO/CLR, and RCL switches (11), triggers the a/d converter (7), calculates the result of each a/d conversion cycle, and controls the display driver (9).

(9) *Display Driver*. The display driver is a flat pack LCD controller chip that communicates to the microcomputer (8) through five control lines. During power-up, the microcomputer configures this controller chip to drive the triplexed display. To drive the display, voltages are obtained from the motherboard assembly.

(10) *Display and Indicators*. The liquid crystal display shows measurement values and functions, messages, and indicators.

(11) *REL, dB, STO/CLR and RCL*. The display panel assembly also houses the special function keys: REL, dB, STO/CLR and RCL. A press of one of these keys is detected by the microcomputer (8).

(12) *Function and Range*. The measurement function and range select switches are on the motherboard assembly. Key presses are detected by the microcomputer (8).

(13) *Power Connector*. The AC power cord connects to the multimeter through the power connector A1A3.

(14) *Power Supply*. The power supply contains line fuse A1A1F2, a power ON/OFF switch, the line voltage configuration switch, and a power transformer. The secondary voltage of the transformer is rectified, regulated, and divided down for the voltages needed by the multimeter.

(15) *Ohms Current Source*. The ohms current source with the input signal conditioner (2) supplies a known current to the unknown resistance at the input terminals (1). The resulting voltage drop across the resistor is converted to the resistance reading.

(16) *Battery Pack*. The batteries contained in the battery pack are of the quick recharge type and will charge in ten hours. With the instrument turned on, the batteries will trickle charge at approximately 40 mA. With the battery pack installed, the negative supply is generated using a CMOS voltage inverter. Low battery detection is accomplished by the comparator (18) and microcomputer (8).

(17) *Charging Circuit*. The battery charging circuit is driven by the power supply (14). Maximum rate is achieved when the instrument is connected to line power and ON/OFF key is out (OFF). Full wave rectified voltage is applied to charge the batteries. A current sink protects the batteries if the charging current rises above 150 mA. With the multimeter unplugged and turned on, the battery pack (16) sources +12 Vdc to the charging circuit, which sources the +V and -V supply voltages to the motherboard assembly.

(18) *Comparator Circuit*. The comparator circuit checks the battery pack voltage. When the battery voltage drops below 10.8 Vdc, a signal is sent to the microcomputer (8) for the BATT indicator.

A functional block diagram of the motherboard is shown in fig. FO-2.

(1) *Input Signal Conditioner*. The input signal conditioner provides the multiplexer (4) with a usable signal by conditioning the input signal. For voltage signals (ac and dc), the conditioning is performed by resistor dividers and associated shunt capacitors. The following attenuation is provided:

- Divide by one on the 200 mV and 2 V ranges.
- Divide by ten on the 20 V range.
- Divide by 100 on the 200 V range.
- Divide by 1000 on the 1000 Vdc and 750 Vac ranges.

Current signals are conditioned by a series of shunt resistors. For dc current measurements, the shunt voltage drop is applied directly to the multiplexer. For ac current, the shunt voltage drop is treated as an ac voltage and is first switched to the ac amplifier (2) and ac converter (3).

Resistance measurements are created in the input signal conditioner using the ratiometric technique. When the resistance function is selected, a series circuit is formed among the ohms current source (8), a reference resistor, and the unknown resistance. A current flows through the reference resistor and the unknown resistance. Since this current is common to both resistances, the value of the unknown resistance can be calculated by measuring the voltage across the reference resistor and the voltage across the unknown resistance.

(2) *AC Amplifier*. The ac amplifier increases an ac signal by x5 when on the 20 mV range, and by x1 when on all other ac ranges. This provides an accurate voltage for lower frequencies and lower input levels.

(3) *AC Converter*. The ac converter changes ac voltage to a corresponding dc voltage. This converted voltage is then applied to the signal being measured FET (field effect transistor) in the multiplexer (4).

(4) *Multiplexer.* The multiplexer connects one of four signals to the input buffer amplifier (5). It uses four FETs, which are controlled by the microcomputer (7) through FET drivers to connect the signals. The FETs are: signal being measured, ohms reference, 2 V reference, and zero. The drivers convert digital signals of the microcomputer to signals usable by the FETs. Transients that are created due to FET switching are minimized by software generated delays. The only FET used in the multiplexer that is range dependent is the zero FET while in the dc volts function. The output of the multiplexer is directed toward the input buffer amplifier.

(5) *Input Buffer Amplifier*. The input buffer amplifier provides the necessary isolation between the input signal and the a/d converter (6). The amplifier is a non-inverting, low noise, high impedance circuit with x1 or x10 gain. The gain is controlled by the microcomputer (7) and is range and function dependent.

(6) *Analog to Digital (a/d) Converter.* The multimeter uses a combination a/d converter, which is controlled by the microcomputer (7). This converter is a combination constant frequency variable pulse width converter with charge balance and single slope phases. The a/d converter translates the conditioned analog input signal into a form usable by the microcomputer.

The charge balance phase begins at the end of a software generated delay. The delay allows the signal to stabilize after the appropriate multiplexer FET (function dependent) is activated. This delay sets the input enable/disable line to high.

At this point, an offset is added to the signal, which converts it to a negative, unipolar signal. This signal has a range that is function dependent. The voltage range is -2.2 to +2.2 Vdc while the multimeter is in the volt or ampere function.
In the ohms function, the range is 0 to +4 Vdc. The charge balance phase continues for 100 ms.

The integrator ramps up to just past the charge balance signal's threshold voltage. At this point the integrator ramps down below the charge balance threshold voltage. The integrator's output continues to ramp up and down around the charge balance threshold for 100 ms. The output of the charge balance comparator is gated with the microcomputer's internal clock and the pulses are counted.

The single slope phase begins at the completion of the charge balance phase. The integrator's output is directed to the input of the non-inverting single slope comparator. The single slope comparator's output will stay high until the integrator ramps to zero volts.

At the point when the integrator ramps negative, the single slope comparator is gated with the microcomputer's internal clock and counted. When the single slope comparator output goes low, the microcomputer ends the counting, which completes the reading and directs the output signal of the a/d converter to the microcomputer.

(7) *Microcomputer*. The microcomputer centers around a complementary metal oxide semiconductor (CMOS) microprocessor. It is an eight-bit microprocessor with direct addressing of up to 8 K bytes on a shared address and data bus.

Timing of the microprocessor is accomplished by the use of a 2.62144 MHz crystal. Internally, this frequency is divided down by four to obtain a bus operating frequency of 655.36 kHz. This frequency supplies all parts of the instrument requiring timing through the binary divider.

The software for the microprocessor unit is stored in programmable read-only memory (PROM). Temporary storage is provided in NVRAM. The NVRAM is a 16 x 16-bit serial RAM used to store the calibration constants. This storage is used to share the calibration constants on power-up and as RAM for the microprocessor's in-house functions. It also stores readings for the data logger. NVRAM is internal to the microprocessor.

(8) *Ohms Current Source.* An ohms current source through the input signal conditioner (1) is applied across unknown resistances to determine their resistance. This source is driven by a +5 Vdc source that is reduced to +4.3 Vdc by a protection diode.

(9) *Function and Range*. The four function switches and six range switches are read back over eight lines to the microcomputer (7).

(10) *Fuse 1/8A*. The ac line fuse A1A1F2 is rated at 1/8 A, 250 V.

(11) *Line Voltage Switch*. The line voltage configuration switch selects 115 Vac or 230 Vac operation by placing the power transformer (12) primary windings in parallel or series.

(12) *Power Transformer*. The power transformer has two secondary windings: one for the supply voltages and one for an IEEE-488 interface.

(13) *Power Switch*. The power switch is on a secondary winding of the power transformer (12).
(14) *Full Wave Bridge Rectifier*. The bridge rectifier functions as a full wave rectifier for both the +V and -V supply voltages.

(15) *Voltage Regulator*. The -V supply voltage is regulated to -9 Vdc and -6.4 Vdc for the analog circuitry.

(16) *+10 Vdc Voltage Regulator*. The +V supply voltage is regulated to +10 Vdc for the analog circuitry.

(17) *+2 Vdc Voltage Reference*. The +10 Vdc is regulated and divided down to a +2 Vdc reference for the multiplexer (4).

(18) *+5 Vdc Voltage Regulator*. The +V and -V supply voltages, along with the +10 Vdc, are further regulated and filtered to +5 Vdc Analog for the analog circuitry and +5 Vdc Digital for the digital circuitry.

(19) *Voltage Divider*. The +5 Vdc Digital is further divided to +3.3 Vdc and +1.67 Vdc for the display driver.

5-7. RF PROBE OPERATION.

The RF probe transfers radio frequency ac voltage into a corresponding dc voltage. The multimeter measures the output of the RF probe (in dc voltage), which corresponds to the ac voltage that is connected to the RF probe tip. The multimeter displays a dc voltage value, which is equivalent to the radio frequency ac voltage value measured.

The RF probe responds to a peak value at its input and is calibrated to read the RMS value of a sine wave.

Section IV. TROUBLESHOOTING

SYMPTOM INDEX

Multimeter Symptom Page

1. Multimeter Not Operating - Display Blank 5-8
2. Multimeter Display Operating But Erratic Measurements 5-8
3. No Current Measurement - Other Functions Operate Normally 5-9
4. Multimeter Fails Self Diagnostic Program....................5-9
5. A1A1BA1 Battery Pack Does Not Maintain Charge For Five Hours....................5-9

NOTE

- **Before using this troubleshooting section, check the equipment work order and, if possible, talk to unit maintenance personnel for a description of the symptoms and steps taken to correct them.**

- **Check all forms of tags attached to and accompanying the multimeter to determine the reason for removal from service.**

5-8. TROUBLESHOOTING GUIDELINES.

The following is a list of aids that can be used when troubleshooting the multimeter.

a. Refer to the Theory of Operation (Chapter 5, Section III) as required. The theory of operation provides the circuit theory of each section of the multimeter.

b. Problems with the instruments that have been in service for a long period of time or in a harsh environment may be caused by corrosion. Sometimes removing and reseating the affected assembly connectors will correct a malfunction.

5-9. EQUIPMENT INSPECTION.

The following inspection procedure is used to locate obvious malfunctions with the multimeter.

a. Inspect all external surfaces of the multimeter for physical damage or breakage.

WARNING

When cover of multimeter is removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

CAUTION

Do not disconnect or remove any connectors, components, or printed circuit boards from the multimeter unless ON/OFF switch is in the OFF (out) position and multimeter is isolated from all external power. The multimeter has several components that can be damaged by electrostatic discharge. Use conductive foam and grounding straps when servicing in area of static-sensitive devices. Use care when removing and inserting modules that contain integrated circuits.

b. Remove multimeter upper cover (para 5-14) to access the internal components.

c. Inspect printed circuit board surfaces for discoloration, cracks, breaks, and warping.

d. Inspect printed circuit conductors for breaks, cracks, cuts, erosion, or looseness.

e. Inspect all assemblies for burnt or loose components.

5-10. TROUBLESHOOTING TABLE.

Troubleshooting table (table 5-1) lists common malfunctions that may be found during operation or maintenance of the multimeter. Perform the tests, inspections, and corrective actions for a particular malfunction in the order given.

Table 5-1. Troubleshooting.

Malfunction
Test or Inspection
Corrective Action

1. MULTIMETER NOT OPERATING - DISPLAY BLANK.

Step 1. Perform initial adjustments (para 2-5).

- Set LINE VOLTAGE switch to correspond to line voltage supplied to multimeter.

Step 2. Check to see if A1A1F2 line fuse is blown or broken.

- Replace A1A1F2 line fuse (para 5-15).

Step 3. Remove battery board ribbon cable from A1A1 motherboard (para 5-19).

- If display operates, perform A1A1A1 battery pack charging assembly fault isolation test (para 5-13).

Step 4. Perform A1A1 motherboard assembly fault isolation test (para 5-12).

- Replace A1A1 motherboard (para 5-20).

Step 5. Perform A1A2 display panel fault isolation test (para 5-11).

- Replace A1A2 display panel assembly (para 5-18).

2. MULTIMETER DISPLAY OPERATING BUT ERRATIC MEASUREMENTS.

Step 1. Perform A1A1 motherboard assembly fault isolation test (para 5-12).

- Replace A1A1 motherboard assembly (para 5-20).

Step 2. Perform A1A2 display panel fault isolation test (para 5-11).

- Replace A1A2 display panel assembly (para 5-18).

Table 5-1. Troubleshooting - Continued.

Malfunction
Test or Inspection
Corrective Action

3. NO CURRENT MEASUREMENT - OTHER FUNCTIONS OPERATE NORMALLY.

Step 1. Check to see if A1A1F3 current fuse is blown or broken (para 5-16).

- Replace A1A1F3 current fuse (para 5-16).

Step 2. Check for connection between white and black wires of A1A1 motherboard to A1A2 display panel (para 5-18).

- Connect white and/or black wires from A1A1 motherboard to A1A2 display.

Step 3. Perform A1A1 motherboard assembly fault isolation test (para 5-12).

- Replace A1A1 motherboard assembly (para 5-20).

4. MULTIMETER FAILS SELF DIAGNOSTIC PROGRAM (para 3-8).

Check value displayed.

- If one or more segments or indicators fails to light, replace A1A2 display panel assembly (para 5-18).
- If display locks up with zeroes replace A1A1 motherboard (para 5-20).
- If "cErr" is displayed, the multimeter is not adjusted properly.
  - Press REL key. The "C" indicator should flash.
  - Simultaneously press REL and dB until "CAL" message is displayed. Release REL and dB keys.
  - Simultaneously press REL and dB again until "Stor" message is displayed.
- If "C" indicator goes out, adjust multimeter (para 5-22).
- If "C" indicator keeps flashing, replace motherboard assembly (para 5-20).

5. A1A1BA1 BATTERY PACK DOES NOT MAINTAIN CHARGE FOR FIVE HOURS.

Perform A1A1A1 battery pack charging assembly fault isolation test (para 5-13).

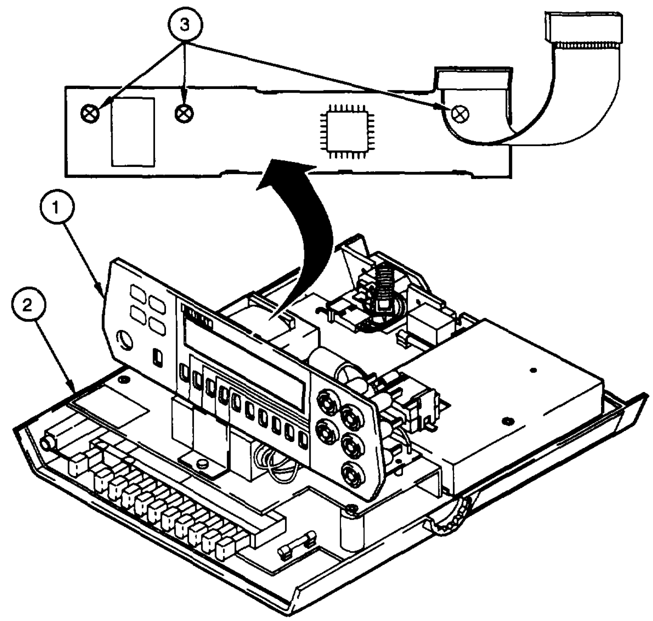
- Replace defective assembly: A1A1BA1 battery pack (para 5-17), A1A1A1 battery pack charging assembly (para 5-19), or A1A1 motherboard assembly (para 5-20).

5-11. A1A2 DISPLAY PANEL ASSEMBLY FAULT ISOLATION TEST.

DESCRIPTION

This test determines faults in the A1A2 display panel assembly.

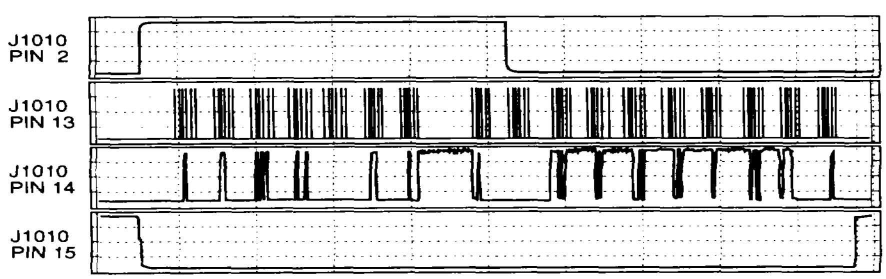
1. Set AC/DC key for DC (out).
2. Press A (amps) key in.
3. Press 2000 mA manual range key.
4. Remove upper cover (para 5-14).
5. Remove A1A2 display panel assembly (1) from multimeter base assembly (2).
6. Remove mounting screws (3) from display panel PCB.
7. Press ON/OFF key to on (in).
8. Check the following points to determine faults in A1A2 display panel assembly.
   - The signals can be acquired at the soldered connection of the display panel ribbon cable to the display panel PCB (fig. FO-6).
   - All signals are referenced to GND test point on motherboard (fig. FO-5).
   - Scope is set to 2 V/div, 2 ms/div, normal trigger at 1.6 V (positive slope on pins 2, 13, 14; negative slope on pin 15).



DISPLAY PANEL RIBBON CABLE CONNECTOR	CONDITION	REMARKS
Pin 2	see waveform below	Data from microcomputer
Pin 3	0 to +5 Vdc $\pm$0.5 V square wave; 82 kHz +1%	Clock
*Pin 4	+5 Vdc $\pm$0.5 V	Reset
*Pin 6	+3.3 Vdc $\pm$0.2 V	Voltage - LCD 1
*Pin 7	+1.67 Vdc $\pm$0.1 V	Voltage - LCD 2
*Pin 8	+5 Vdc $\pm$0.5 V	Power to display
Pin 13	see waveform below	Data from microcomputer
Pin 14	see waveform below	Data from microcomputer
Pin 15	see waveform below	Data from microcomputer

*Measure with dc voltmeter.

- If all test points are good, replace A1A2 display panel assembly (para 5-18).

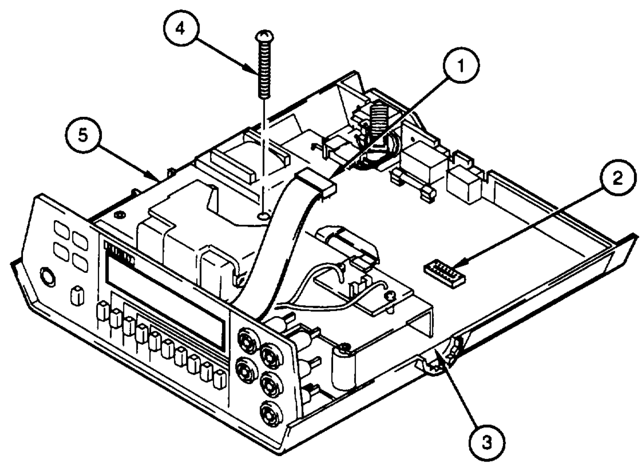


5-12. A1A1 MOTHERBOARD ASSEMBLY FAULT ISOLATION TEST.

DESCRIPTION

This test determines faults in the A1A1 motherboard assembly.

1. Set AC/DC key for DC (out).
2. Press A (amps) key in.
3. Press 2000 mA manual range key.
4. Remove upper cover (para 5-14).
5. Remove A1A2 display panel assembly (para 5-18).
6. Reconnect ribbon cable (1) to display connector (2) iocated on A1A1 motherboard assembly (3).
7. Remove battery pack (para 5-17).
8. Remove battery pack charging assembly (para 5-19).
9. Remove mounting screw (4) from motherboard analog shield (5).
10. Press ON/OFF key to on (in).
11. Check the following points to determine faults in A1A1 motherboard assembly.
    - The signals can be acquired on the motherboard PCB (fig. FO-5).
    - All signals are referenced to GND test point on motherboard (fig. FO-5).



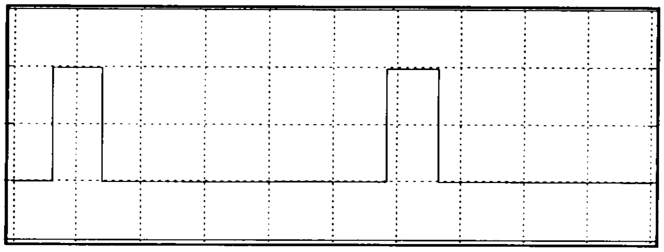
TEST POINT	CONDITION	REMARKS
* RESET	+5 Vdc ± V	System reset
* +5D	+5 Vdc ±0.25 V	Digital power
* -9V	-9 Vdc ± 1 V	Analog negative supply
* +5A	+5 Vdc ±0.5 V	Analog +5 V power
* +10V	+10 Vdc ±1 V	Analog positive supply
* U104 pin 6	0 Vdc ±5 mV	ac amplifier zero
* U101 pin 7	0 Vdc ±5 mV	Guarded volts output
* U103 pin 8	+1.43 Vdc ±0.14 V	Comparator reference
* R111 (towards switch deck)	+2 Vdc ±0.05 V	+2 Vdc reference
U102 pin 6	see waveform below	Multiplexer output
UI01 pin I	see waveform below	Guarded MUX output
Y101 pin EXTAL	2.62 MHz ±1% sine wave	Crystal frequency
YI01 pin XTAL	2.62 MHz ±1% square wave	Crystal frequency
U119 pin 10	655 kHz ±1% square wave	A/D timebase and microcomputer address strobe
U119 pin 9	328 kHz +1% square wave	Gating clock for timer input
U119 pin 7	164 kHz ±1% square wave	Generates set for U117A
U119 pin 6	82 kHz ±1% square wave	Clock
U119 pin 5	41 kHz ±1% square wave	Clock
U119 pin 12	1.28 kHz ±1% square wave	Clock
U118 pin 6	see waveform next page	S1 input of U1 18B
U110 pin 6	see waveforms next page	Integrator waveform
U108 pin 7	see waveform next page	Comparator output (charge balance)
U117 pin 6	see waveform next page	Charge balance current control
U105 pin 15	see waveform next page	U124 timer input
U117 pin 9	see waveform next page	Integrator charge balance control

*Measure with dc voltmeter.

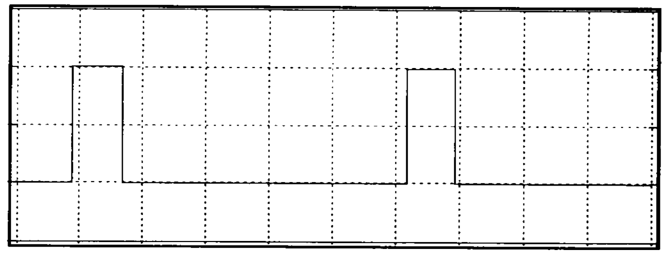
5-12. A1A1 MOTHERBOARD ASSEMBLY FAULT ISOLATION TEST - Continued.

* If any test point is bad, replace A1A1 motherboard assembly (para 5-20).

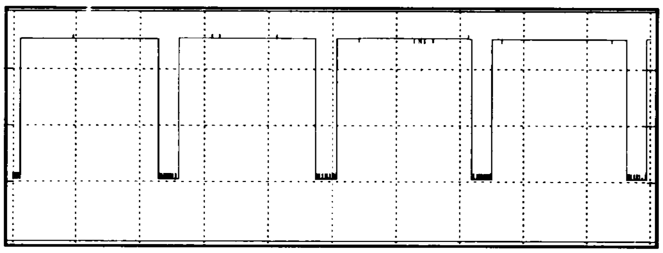
* If any waveform is not present, cycle power to reset multimeter.



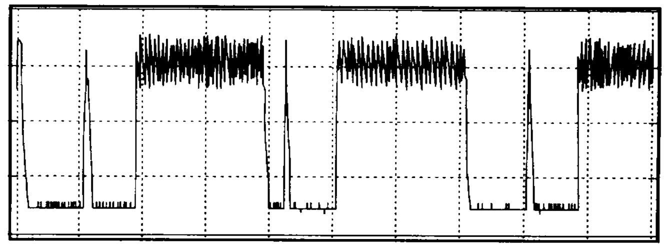
U102 PIN 6
1 V/div
200 ms/div



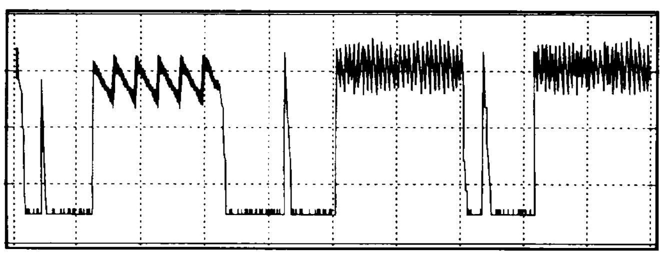
U101 PIN 1
1 V/div
200 ms/div



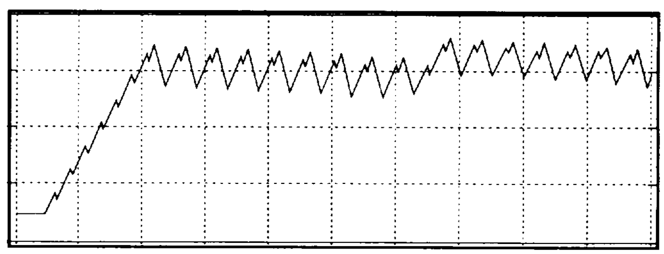
U118 PIN 6
2 V/div
10 µs/div



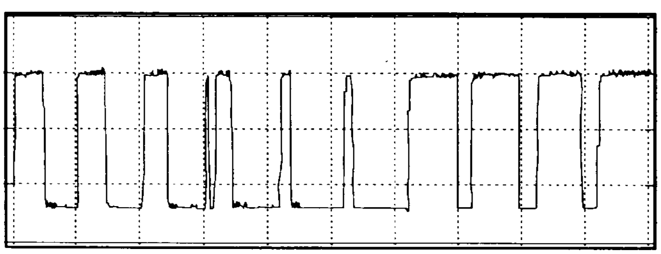
U110 PIN 6
2 V/div
50 ms/div



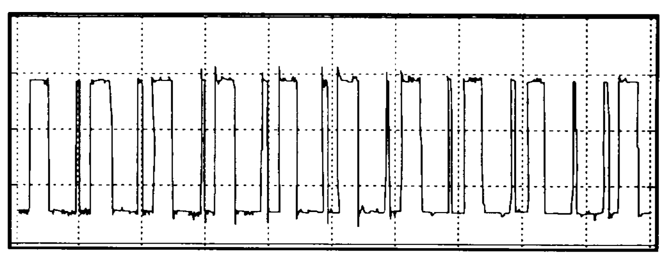
U110 PIN 6
ALTERNATIVE
WAVEFORM
2 V/div
50 ms/div



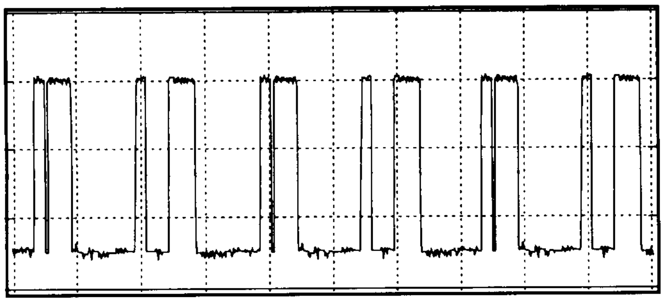
U110 PIN 6
2 V/div
100 µs/div



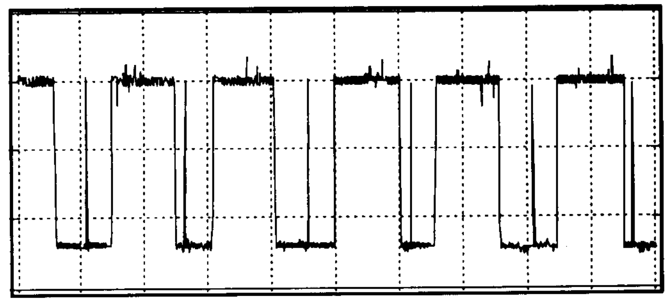
U108 PIN 7
2 V/div
50 µs/div



U117 PIN 6
2 V/div
50 µs/div



U105 PIN 15
2 V/div
50 µs/div



U117 PIN 9
2 V/div
100 ms/div

12. Press ON/OFF key to off (out).

13. Disconnect ribbon cable (1) from display connector (2) located on A1A1 motherboard assembly (3).

14. Press ON/OFF key to on (in).

15. Check the following points to determine faults in the display interface of the A1A1 motherboard assembly.

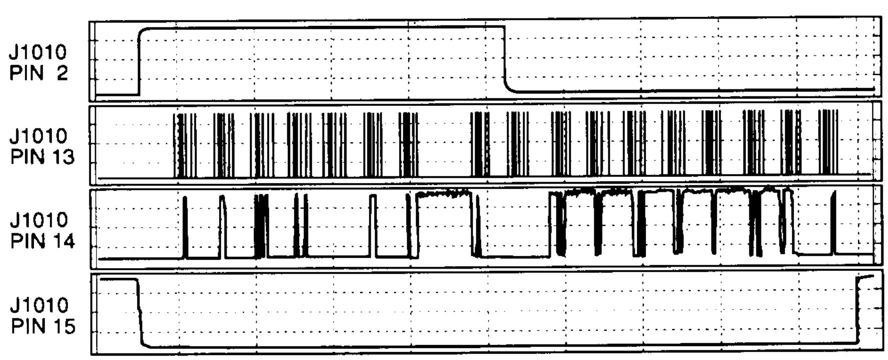
    - The signals can be acquired at the J1010 display connector on the motherboard (fig. FO-5).
    - All signals are referenced to GND test point on motherboard (fig. FO-5).
    - Scope is set to 2 V/div, 2 ms/div, normal trigger at 1.6 V (positive slope on pins 2, 13, 14; negative slope on pin 15).

J1010 Pin	CONDITION	REMARKS
Pin 2	see waveform below	Data from microcomputer
Pin 3	0 to +5 Vdc ±0.5 V square wave; 82 kHz +1%	Clock
* Pin 4	+5 Vdc ±0.5 V	Reset
* Pin 6	+3.3 Vdc ±0.2 V	Voltage - LCD 1
* Pin 7	+1.67 Vdc ±0.1 V	Voltage - LCD 2
* Pin 8	+5 Vdc ±0.5 V	Power to display
Pin 13	see waveform below	Data from microcomputer
Pin 14	see waveform below	Data from microcomputer
Pin 15	see waveform below	Data from microcomputer

*Measure with dc voltmeter.

16. If any test point is bad, replace A1A1 motherboard assembly (para 5-20).

17. If all test points are good, perform steps 4 through 6 of motherboard assembly replacement installation (para 5-20).



5-13. A1A1A1 BATTERY PACK CHARGING ASSEMBLY FAULT ISOLATION TEST.

DESCRIPTION

This test determines faults in the A1A1A1 battery pack charging assembly.

1. Remove upper cover (para 5-14).

2. Connect ac line cord to power line connector.

3. Press the ON/OFF key to on (in).

4. Check the following points to determine faults in the battery charging circuit.

   - The signals can be acquired at the P1009 connector on the battery pack charging assembly ribbon cable (fig. FO-6).
   - All signals are referenced to GND test point on motherboard (fig. FO-5).

P1009 PIN	CONDITION	REMARKS
1	+15 Vdc ±1.5 V	+V supply
3	+5 Vdc ±1 V	BATT indicator
5	+15 Vdc ±1.5 V	Battery voltage
7	+5 Vdc ±0.25 V	+5 digital
9	-15 Vdc ±1.5 V	-V supply

   - If any test point is bad. replace battery pack charging assembly (para 5-19).

5. Press ON/OFF key to off (out).

6. Check the following test points (fig. FO-6).

TEST POINT	CONDITION	REMARKS
P1009 Pin 1	<+400 m Vdc	
P1009 Pin 3	<0.6 Vdc	BATT indicator
P1009 Pin 5	+15 Vdc ±1.5 V	Battery voltage
P1009 Pin 7	<+1.0 Vdc	+5 digital
P1009 Pin 9	<-1.0 Vdc	
R102 (towards mounting screw)	+0.6 Vdc ±0.1 Vdc	While charging

   - If any test point is bad, replace battery pack charging assembly (para 5-19).

7. Disconnect ac line cord from power line connector.

8. Press ON/OFF key to on (in).

9. Check the following test points at the P1009 connector.

P1009 PIN	CONDITION	REMARKS
1	>+10.8 Vdc	Battery voltage under load
3	+5 Vdc ± 1 V	BATT indicator
5	>+10.8 Vdc	Battery voltage under load
7	+5 Vdc ± 0.25 V	+5 digital
9	-12 Vdc	Level depends on battery charge level

- If any test point is bad, replace battery pack charging assembly (para 5-19).

NOTE

If attempting to operate the multimeter while charging a completely discharged battery, the display may not turn on right away. Allow approximately 10-15 minutes of charging with the power off before turning on multimeter.

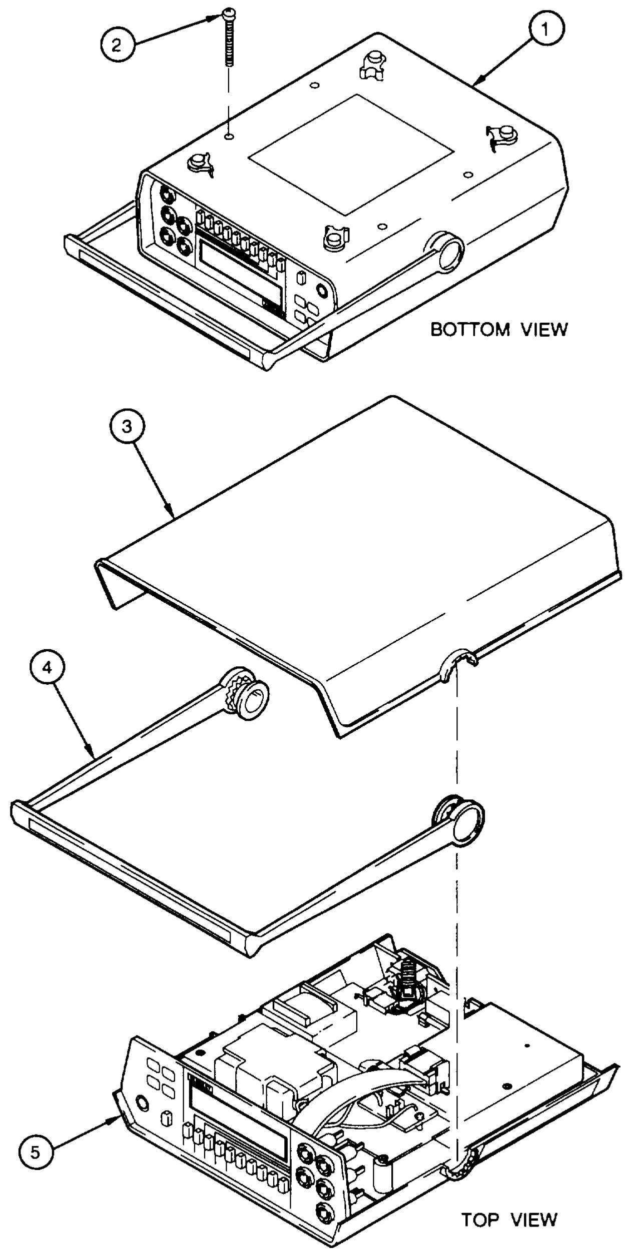
Section V. MAINTENANCE PROCEDURES

5-14. UPPER COVER REPLACEMENT.

DESCRIPTION

This procedure covers: Remove. Install.

REMOVE



WARNING

Disconnect the ac line cord and test leads from the multimeter. With the cover removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

CAUTION

Equipment is electrostatically sensitive. Follow the procedures on pages C and D.

1. Working from the bottom side of the multimeter (1), remove the four retaining screws (2).

2. Turn multimeter (1) over and remove upper cover (3) and handle (4) from multimeter base assembly (5).

INSTALL

1. Working from the upper side, place handle (4) and upper cover (3) onto multimeter base assembly (5).

2. Working from the bottom side, install four retaining screws (2).

END OF TASK

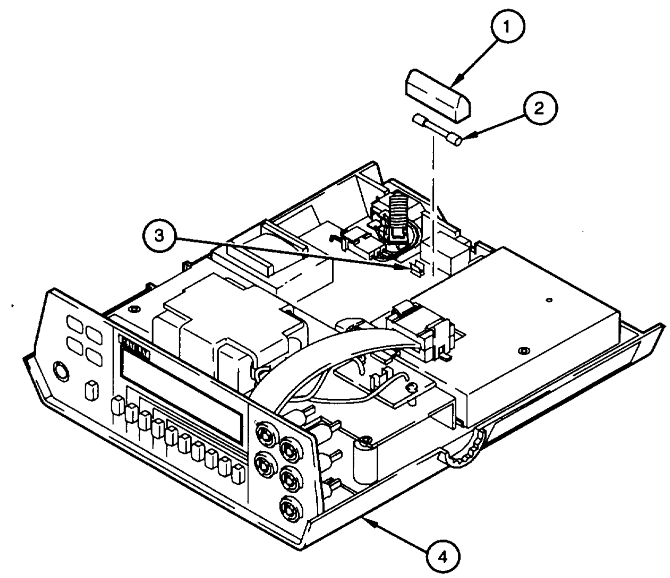
5-15. A1A1F2 LINE FUSE REPLACEMENT.

DESCRIPTION

This procedure covers: Remove. Install.

REMOVE

1. Remove upper cover (para 5-14).
2. Remove fuse cover (1) from A1A1F2 line fuse (2).
3. Remove A1A1F2 line fuse from holder (3) on multimeter base assembly (4).



INSTALL

1. Place new A1A1F2 line fuse (2) into holder (3)
2. Replace fuse cover (1).
3. Install upper cover (para 5-14).
4. Connect multimeter to ac line.
5. Press ON/OFF key to ON (in) and verify multimeter display operates.

END OF TASK

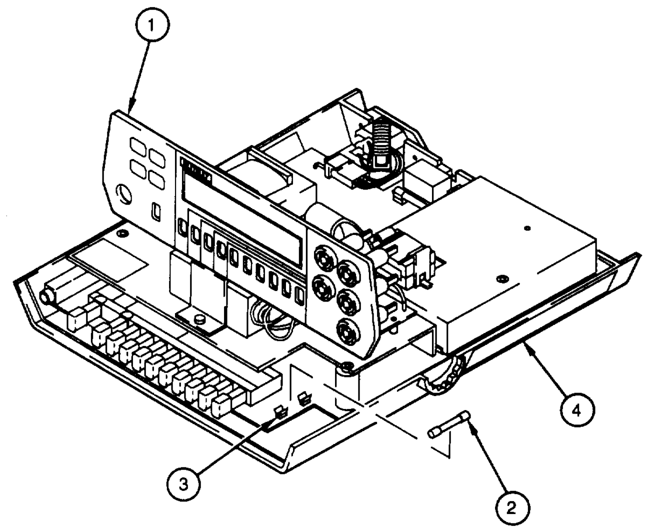
5-16. A1A1F3 CURRENT FUSE REPLACEMENT.

DESCRIPTION

This procedure covers: Remove. Install.

REMOVE

1. Remove upper cover (para 5-14).
2. Move A1A2 display panel assembly (1) to gain access to A1A1F3 current fuse (2).
3. Remove A1A1F3 current fuse from holder (3) on multimeter base assembly (4).



INSTALL

1. Place new A1A1F3 current fuse (2) into holder (3).
2. Place A1A2 display panel assembly (1) onto multimeter base assembly (4).
3. Install upper cover (para 5-14).
4. Connect multimeter to ac line.
5. Press ON/OFF key to ON (in) and verify multimeter operates on 10 A range.

END OF TASK

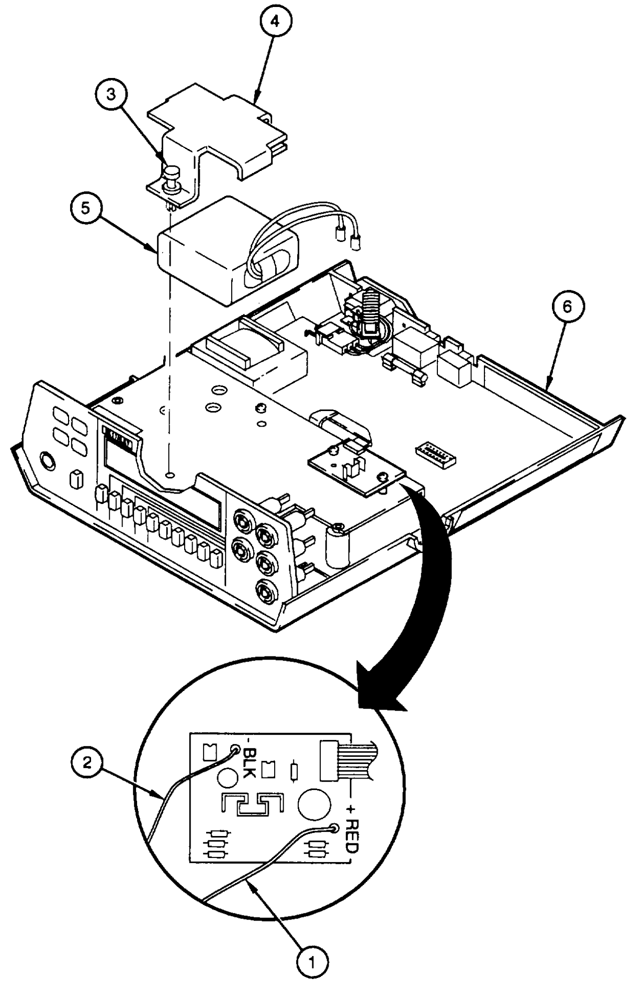
5-17. A1ABA1 BATTERY PACK REPLACEMENT.

DESCRIPTION

This procedure covers: Remove. Install.

REMOVE

1. Remove upper cover (para 5-14).
2. Disconnect the red (1) and black (2) battery pack leads from the A1A1A1 battery pack charging assembly.
3. Loosen retaining clips (3).
4. Remove bracket (4), and A1A1BA1 battery pack (5) from multimeter base assembly (6).



INSTALL

1. Install A1A1BA1 battery pack (5) with leads to the rear of the multimeter. Secure with bracket (4) and clips (3) to multimeter base assembly (6).
2. Connect red (1) and black (2) leads to A1A1A1 battery pack charging assembly.
3. Install upper cover (para 5-14).
4. Connect multimeter to ac line.
5. Charge A1A1BA1 battery pack (para 2-7).

END OF TASK

5-18. A1A2 DISPLAY PANEL ASSEMBLY REPLACEMENT.

DESCRIPTION

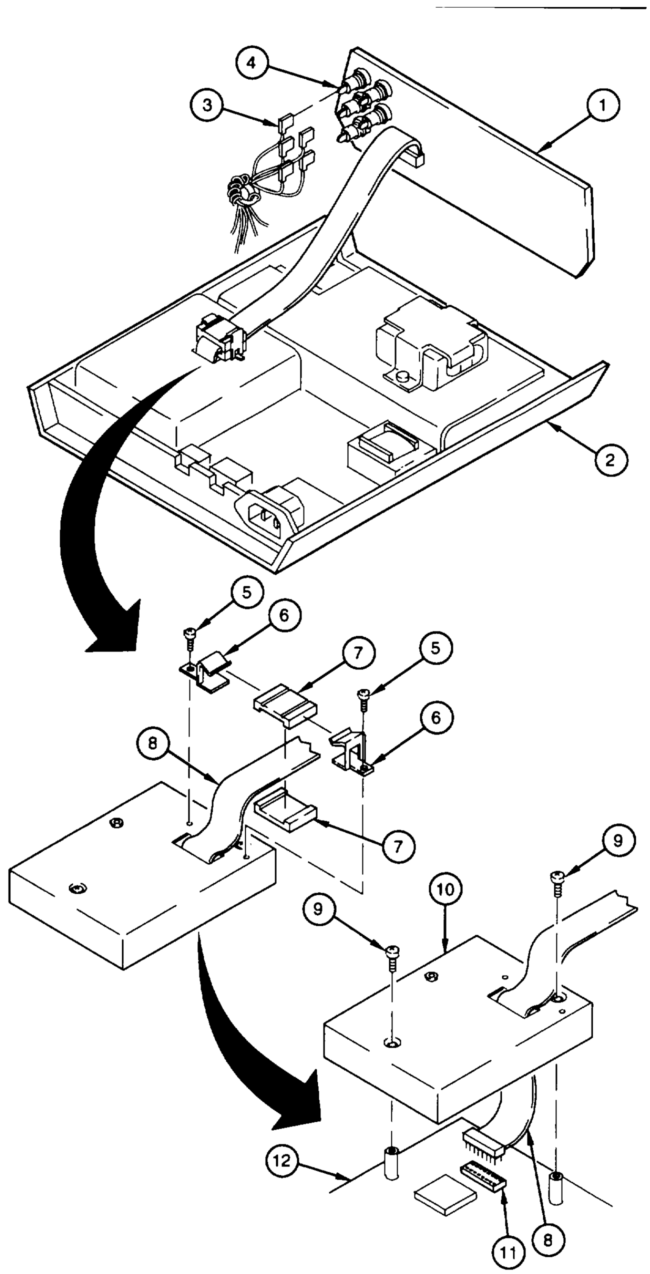
This procedure covers: Remove. Install.

REMOVE

1. Remove upper cover (para 5-14).
2. Remove A1A2 display panel assembly (1) from multimeter base assembly (2).
3. Disconnect input leads (3) from connectors (4).
4. Remove retaining screws (5) from choke clips (6).
5. Remove choke clip (6) and choke (7) from ribbon cable (8).
6. Remove retaining screws (9) from digital shield (10).
7. Lifting up edge of digital shield (10) that is away from A1A2 display panel assembly (1), disconnect the ribbon cable (8) from display connector (11) located on A1A1 motherboard assembly (12).
8. Remove ribbon cable (8) from hole in digital shield (10).

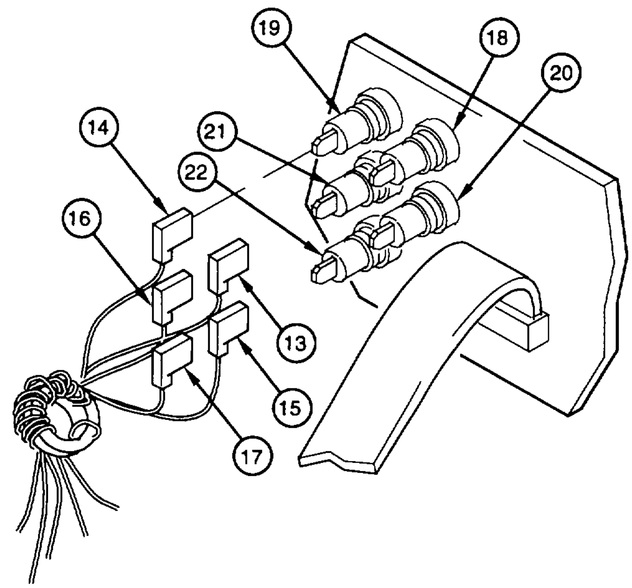
INSTALL

1. Insert ribbon cable (8) through hole in digital shield (10).
2. Connect ribbon cable (8) to display connector (11) located on A1A1 motherboard assembly (12).
3. Secure digital shield (10) with retaining screws (9).
4. Install choke (7) and choke clips (6) onto ribbon cable (8).
5. Install choke assembly on digital shield (10) and secure with retaining screws (5).



6. Connect input leads (13 through 17) to connectors (18 through 22). Use chart to determine color coding.

Insulator Color	Input Terminal
Red (13)	Input HI (18)
Black (14)	Input LO (19)
Orange (15)	Ω Sense HI (20)
Grey (16)	Ω Sense LO (21)
White (17)	Ω A Input (22)



7. Install A1A2 display panel assembly (1) on multimeter base assembly (2).

8. Install upper cover (para 5-14).

9. Connect multimeter to ac line.

10. Press ON/OFF key to ON (in) and make sure multimeter display operates.

NOTE

If attempting to operate the multimeter while charging a completely discharged battery, the display may not turn on right away. Allow approximately 10-15 minutes of charging with the power off before turning multimeter on.

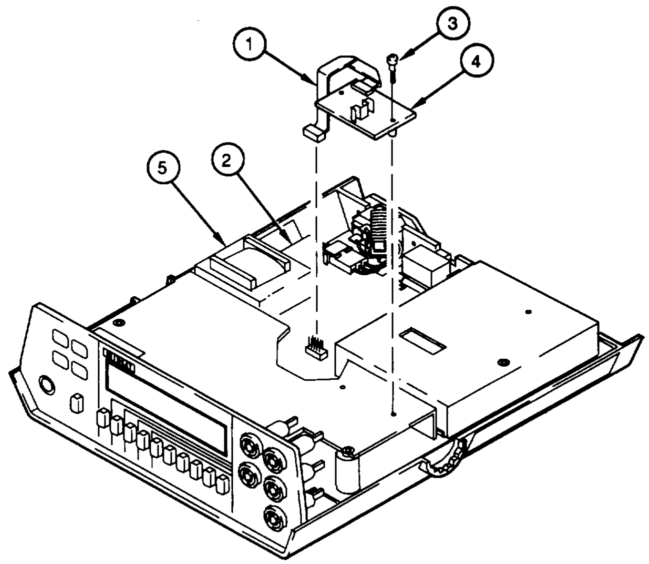
END OF TASK

5-19. A1A1A1 BATTERY PACK CHARGING ASSEMBLY REPLACEMENT.

DESCRIPTION

This procedure covers: Remove. Install.

REMOVE



1. Remove upper cover (para 5-14).
2. Remove A1A1BA1 battery pack (para 5-17).
3. Disconnect battery pack charging assembly ribbon cable (1) from A1A1 motherboard (2).
4. Remove screws (3) and A1A1A1 battery pack charging assembly (4) from A1A1 motherboard (2).

INSTALL

1. Install A1A1A1 battery pack charging assembly (4) securing with screws (3) to A1A1 motherboard (2).
2. Connect battery pack charging assembly ribbon cable (1) to A1A1 motherboard (2) with red wire towards transformer (5).
3. Install A1A1BA1 battery pack (para 5-17).
4. Install upper cover (para 5-14).
5. Charge A1A1BA1 battery pack (para 2-7).

END OF TASK

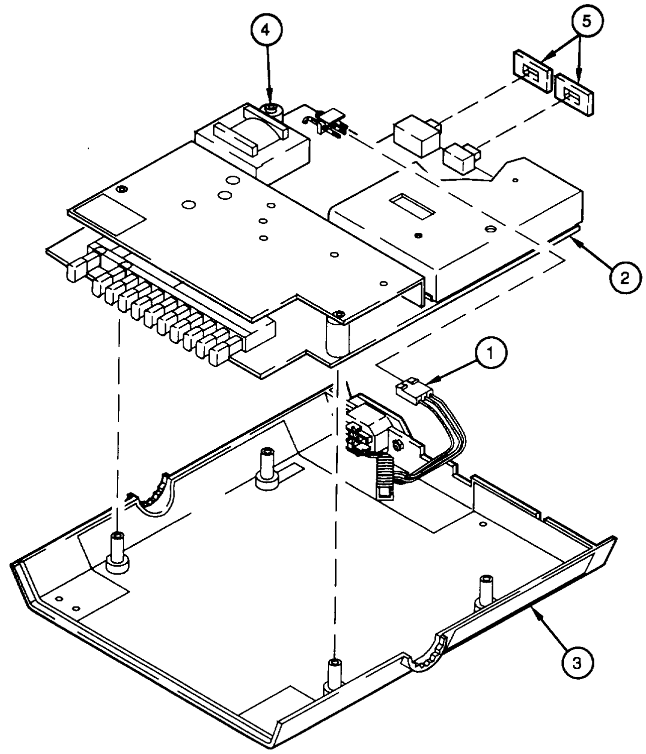
5-20. A11 MOTHERBOARD ASSEMBLY REPLACEMENT.

DESCRIPTION

This procedure covers: Remove. Install.

REMOVE

1. Remove upper cover (para 5-14).
2. Remove A1A1BA1 battery pack (para 5-17).
3. Remove A1A2 display panel assembly (para 5-18).
4. Remove A1A1A1 battery pack charging assembly (para 5-19).
5. Disconnect A1A3 power line connector assembly (1) from A1A1 motherboard assembly (2).
6. Remove spacer (4) and switch guards (5) from A1A1 motherboard assembly (2).
7. Remove A1A1 motherboard assembly (2) from lower cover (3).



INSTALL

1. Place A1A1 motherboard assembly (2) on lower cover (3).
2. Install spacer (4) and switch guards (5).
3. Attach A1A3 power line connector assembly (1) to A1A1 motherboard assembly (2).
4. Install A1A1A1 battery pack charging assembly (para 5-19).
5. Install A1A2 display panel assembly (para 5-18).
6. Install upper cover (para 5-14).
7. Complete performance tests (para 5-21).

END OF TASK

5-21. PERFORMANCE TESTS.

DESCRIPTION

This procedure covers:

- dc voltage test,
- ac voltage test,
- resistance test,
- dc current test,
- ac current test,
- frequency compensation test,
- RF probe test

INITIALIZED SET-UP.

1. Verify that the LINE VOLTAGE switch position matches the local line voltage used (para 2-5).

2. Plug multimeter ac power cord into ac power source.

3. Press the ON/OFF key to the ON position and allow the multimeter to warm up for one hour.

4. Activate self diagnostic program (para 3-8).

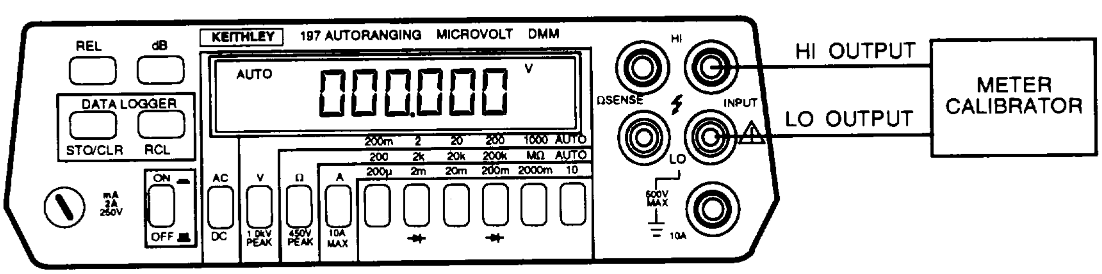
5. Turn multimeter off, and then turn it back on using ON/OFF key.

DC VOLTAGE TEST.

1. Set up multimeter as follows:

   - ON/OFF key to ON (in).
   - AC/DC key to DC (out).
   - V (voltage) key to voltage (in).
   - AUTO/10 key to AUTO (in).

2. Connect the equipment as shown.



WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 1000 V dc peak ac (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous. The maximum voltages between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

3. Set calibrator to 0 Vdc and zero multimeter [enable REL mode (para 2-22)].

4. Set meter calibrator to each applied dc voltage (190 mV through 1000 V) in each multimeter range (200 mV through 1000 V) as shown below. Verify that the display reads within the specified limits for each voltage applied. If the display does not read within all specified limits, perform dc voltage adjustment (para 5-24).

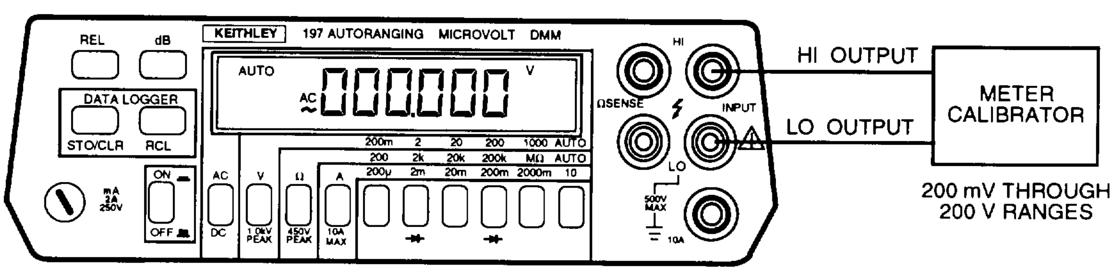
MULTIMETER (Vdc)	APPLIED VOLTAGE (dc)	ALLOWABLE READINGS [64.40 to 84°F (18° to 28°C)]
200 mV	190.000 mV	189.895 mV to 190.105 mV
2 V	1.90000 V	1.89875 V to 1.90125 V
20V	19.0000 V	18.9875 V to 19.0125 V
200 V	190.000 V	189.875 V to 190.125 V
1000 V	1000.00 V	999.2 V to 1000.8 V
200 mV	-190.000 mV	-189.895 mV to -190.105mV
2V	- 1.90000 V	-1.89875 V to -1.90125 V
20V	- 19.0000 V	-18.9875 V to -19.0125 V
200 V	-190.000 V	-189.875 V to -190.125 V
1000 V	-1000.00 V	-999.20 V to -1000.80 V

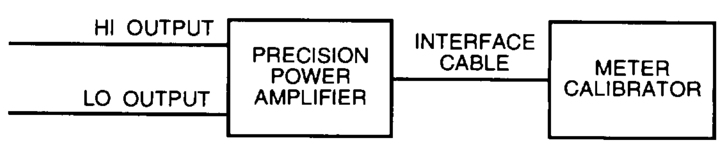
AC VOLTAGE TEST.

1. Set up multimeter as follows:

   - ON/OFF key to ON (in).
   - AC/DC key to AC (in).
   - V (voltage) key to voltage (in).
   - AUTO/10 key to AUTO (in).

2. Connect the equipment as shown.





1000 V RANGE

5-21. PERFORMANCE TESTS - Continued.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 750 VRMS, 1000 V peak (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous; 107 V•Hz. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

3. Set meter calibrator to each applied ac voltage (190 mV through 750 V) and frequencies (20 Hz through 100 kHz) as shown. Verify that the display reads within the specified limits for each voltage applied. If the display does not read within all specified limits, perform ac voltage adjustment (para 5-25).

ALLOWABLE READINGS [64.4° to 82.40F (18° to 280C)]

MULTIMETER RANGE (Vac)	APPLIED VOLTAGE (ac)	20 to 50 Hz	50 Hz to 10 kHz	10 kHz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100kHz
200 mV	190.000 mV	187.050 mV to 192.950 mV	188.950 mV to 191.050mV	188.000 mV to 192.000 mV	185.700 mV to 194.300 mV	134.520 mV to 245.480 mV
2 V	1.90000 V	1.87050 V to 1.92950 V	1.88950 V to 1.91050 V	1.88000 V to 1.92000 V	1.85700 V to 1.94300 V	1.34520 V to 2.45480 V
20 V	19.0000 V	18.7050 V to 19.2950 V	18.8950 V to 19.1050 V	18.8000 V to 19.2000 V	18.5700 V to 19.4300 V	13.4520 V to 24.5480 V
200V	190.000 V	187.050 V to 192.950 V	188.950V to 191.050 V	188.000 V to 192.000 V	185.700V to 194.300 V	*
1000V	750.00 V	737.75 V to 762.25 V	745.25 V to 754.75 V	*	*	*

*Exceeds the V•Hz capability of the multimeter.

4. Disconnect the test equipment.

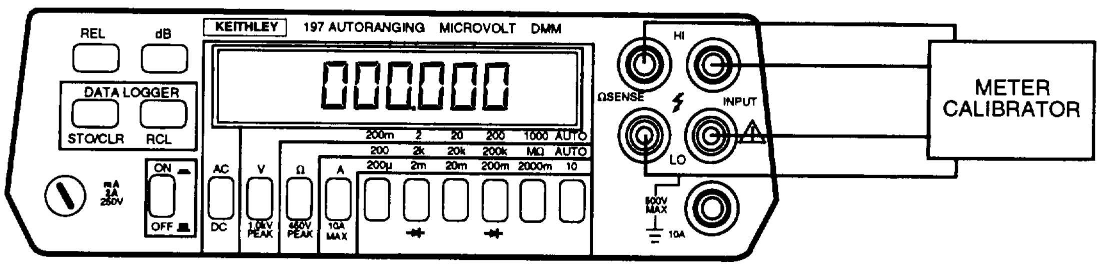
5. Turn off all power.

RESISTANCE TEST.

1. Set up multimeter as follows:

    - ON/OFF key to ON (in).
    - AC/DC key to DC (out).
    - (ohms) key to on (in).
    - 2000 manual range (in).

2. Connect the equipment as shown.



3. Set meter calibrator to 000.000 (short) and zero multimeter [enable REL mode (para 2-22)]. Verify display reads 000.000Ω.

4. Set multimeter for each range and apply each resistance as shown below. Verify that the display reads within the specified limits for each resistance applied. If the display does not read within all specified limits, perform resistance adjustment (para 5-27).

MULTIMETER RANGE	APPLIED RESISTANCE	ALLOWABLE READINGS [64.4° to 82.4°F (18° to 28°C)]
200Ω	190.0004Q	189.800Ω to 190.200Ω
2 kΩ	190.000 Ω	1.89800 Ω to 1.90200Ω
20 kΩ	1.90000 kΩ	18.9895kΩ to 19.0105 kΩ
200 kΩ	190.000 kΩ	189.895kΩ to 190.105Ω
MΩ	1.90000 MΩ	1.89600MΩ to 1.90400 MΩ
	19.0000 MΩ	18.9600 MΩ to 19.0400 MΩ

5. Disconnect the test equipment.

6. Turn off all power.

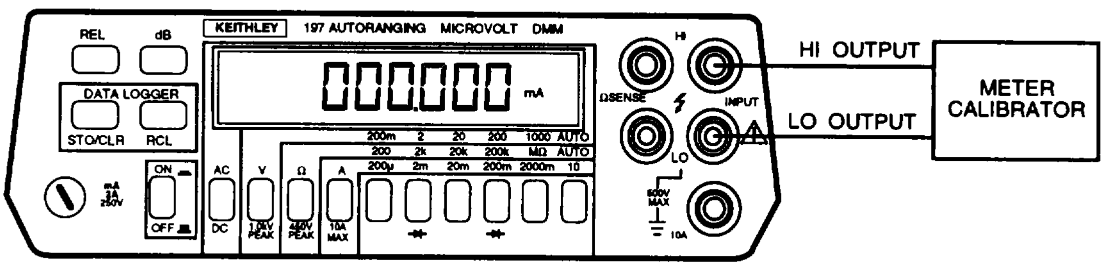
5-21. PERFORMANCE TESTS - Continued.

DC CURRENT TEST.

1. Set up multimeter as follows:

   - ON/OFF key to ON (in).
   - AC/DC key to DC (out).
   - A (ampere) key to ampere function (in).
   - 200 µA manual range key (in).

2. Connect the equipment as shown.

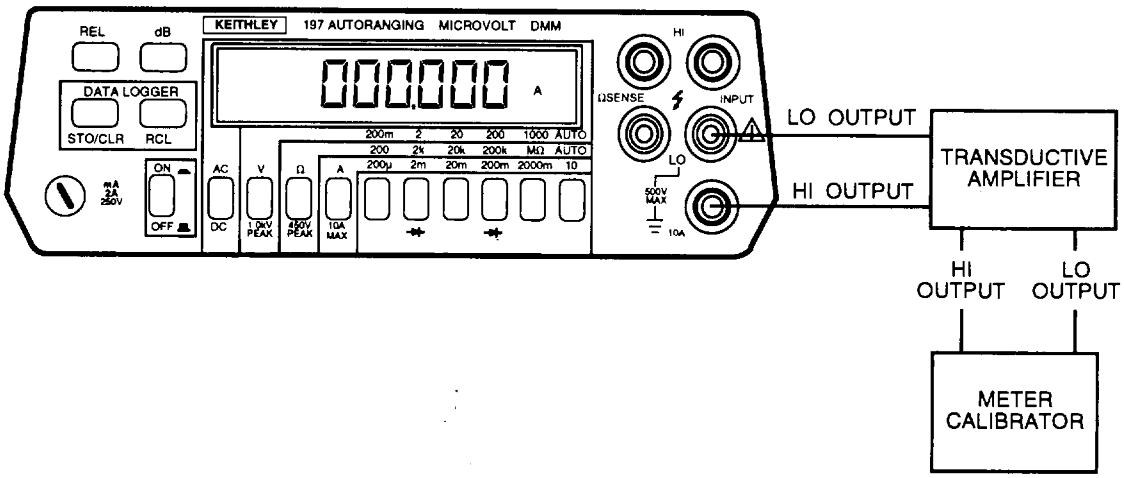


3. Set meter calibrator to 00.000 (short) and zero multimeter [enable REL mode (para 2-22)]. Verify display reads 000.000µ A.

4. Set multimeter for each range and apply each dc current as shown below. Verify that the display reads within the specified limits for each current applied. If the display does not read within all specified limits, perform dc voltage adjustment (para 5-24).

MULTIMETER RANGE (dcA)	APPLIED DC CURRENT	ALLOWABLE READINGS [64.4° to 82.4°F (18° to 28°C)]
200 µA	190.00 pA	189.610 µA to 190.390 µA
2 mA	1.90000 mA	1.89610mA to 1.90390 mA
20 mA	19.0000 mA	18.9610mA to 19.0390 mA
200 mA	190.000 mA	189.610mA to 190.390 mA
2000 mA	1900.00 mA	1890.30 mA to 1909.70 mA
200 µA	-190.00 µA	-189.610 µA to -190.390 µA
2mA	-1.90000 mA	-1.89610mA to -1.90390mA
20 mA	-19.0000 mA	-18.9610mA to -19.0390mA
200 mA	-190.000 mA	-189.610mA to -190.390mA
2000 mA	-1900.00 mA	-1890.30mA to -1909.70mA

5. Connect the equipment as shown.



6. Set multimeter for each range and apply dc current as shown below. Verify that the display reads within the specified limits for each current applied. If the display does not read within all specified limits, refer to Troubleshooting (Chapter 5, Section IV).

MULTIMETER RANGE	APPLIED DC CURRENT	ALLOWABLE READINGS [64.4° to 82.4°F (18° to 28°C)]
10A	+5.000 A	4.9730 to 5.0270A
10A	-5.000A	-4.9730 to -5.0270A

7. Disconnect the test equipment.

8. Turn off all power.

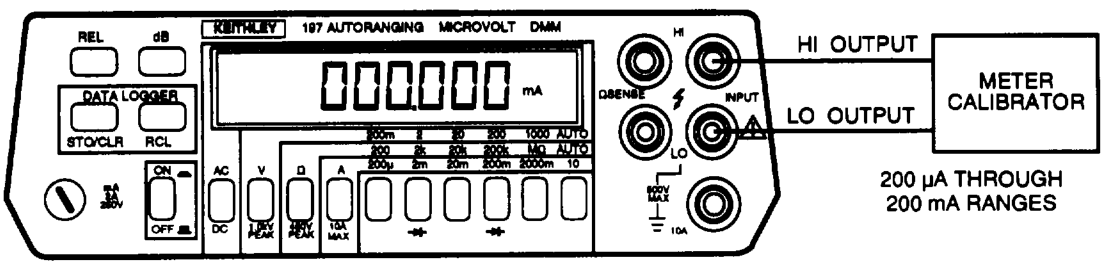
5-21. PERFORMANCE TESTS - Continued.

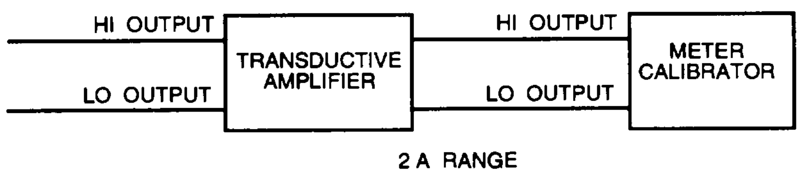
AC CURRENT TEST.

1. Set up multimeter as follows:

   - ON/OFF key to ON (in).
   - AC/DC key to AC (in).
   - A (ampere) key to ampere function (in).
   - 200 HA manual range key (in).

2. Connect the equipment as shown.



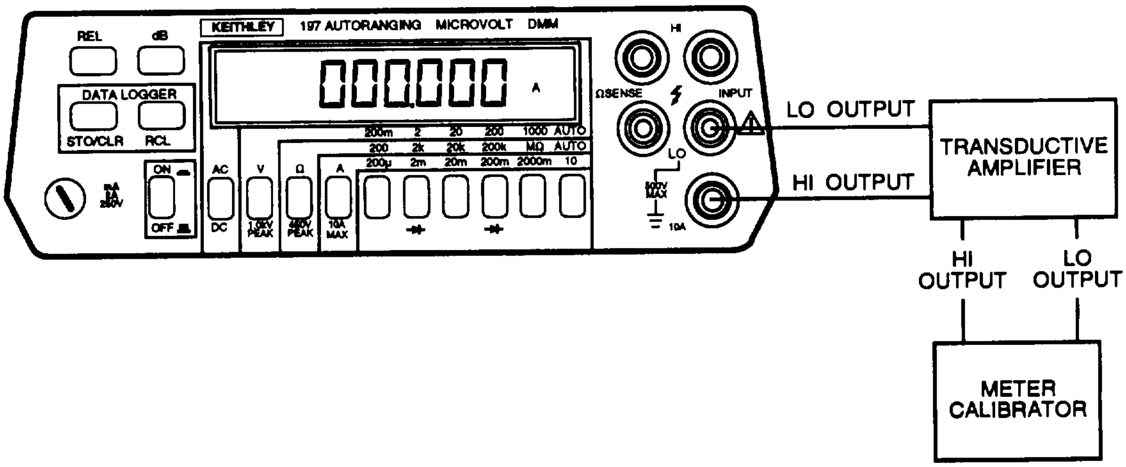


3. Set meter calibrator to each applied ac current (190 µA through 1900 mA) and frequencies (20 Hz through 20 kHz) as shown below. Verify that the display reads within the specified limits for each current applied. If the display does not read within all specified limits, refer to Troubleshooting (Chapter 5, Section IV).

MULTIMETER RANGE (acA)	AC CURRENT	ALLOWABLE READINGS [64.4° to 82.4°F (18° to 28°C)]	
		20 to 50 Hz	**50 Hz to 20 kHz***
200 µA	190.00 µA	185.950 µA to 194.050 µA	185.700 µA to 194.300 µA
2mA	1.90000 mA	1.85950 mA to 1.94050 mA	1.85700 mA to 1.94300 mA
20 mA	19.0000 mA	18.5950 mA to 19.4050 mA	18.5700 mA to 19.4300 mA
200 mA	190.00 mA	185.950 mA to 194.050 mA	185.700 mA to 194.300 mA
2000 mA	1900.00 mA	*	1857.00 mA to 1943.00 mA

* Above 10 kHz on all ranges and below 50 Hz on 2 A range exceeds specified limits of test equipment.

4. Connect the equipment as shown.



5. Set meter calibrator to the applied ac current (10 A) and frequencies (20 Hz through 10 kHz) as shown below. Verify that the display reads within the specified limits for each current applied. If the display does not read within all specified limits, perform ac voltage adjustment (para 5-25).

MULTIMETER RANGE (acA)	AC CURRENT	ALLOWABLE READINGS [64.4° to 82.4°F (18° to 28°C)] 20 Hz to 10 kHz*
10 A	10.0000 A	9.7756 A to 10.2250 A

*Above 5 kHz and below 50 Hz exceeds specified limits of test equipment.

6. Disconnect the test equipment.
7. Turn off all power.

FREQUENCY COMPENSATION TEST.

WARNING

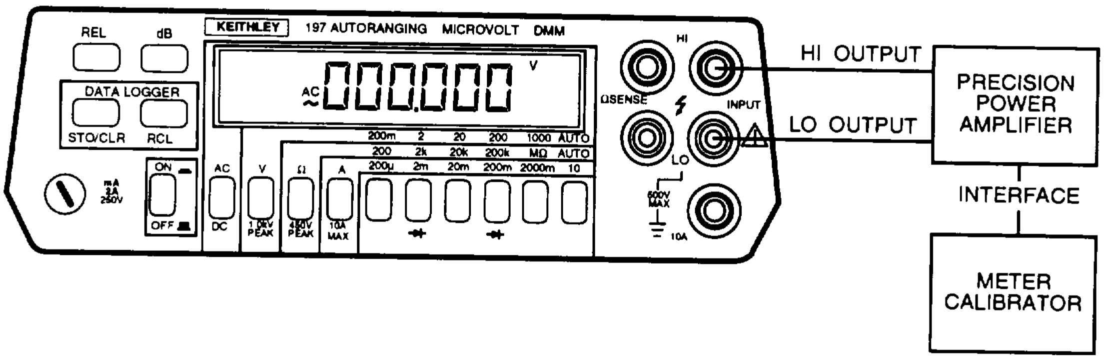
This test requires the use of live circuits and high voltages. To avoid personal injury or death, do not come in contact with circuits or voltages used in this test.

1. Set up multimeter as follows:

- ON/OFF key to ON (in).
- AC/DC key to AC (in).
- V(voltage) key to voltage (in).
- 1000 V manual range key (in).

5-21. PERFORMANCE TESTS - Continued.

2. Connect the equipment as shown.



3. Apply voltage of 500.00 Vac at 500 Hz with meter calibrator. Set this as multimeter's zero [enable REL mode (para 2-22)].
4. Set the meter calibrator output to 500.00 Vac at 20 kHz. Verify the reading on the multimeter is 0000.00 +600 counts.
5. Press REL key.
6. Apply voltage of 100.00 Vac at 500 Hz with the meter calibrator.
7. Press the 200 V manual range key.
8. Set this voltage as the multimeter's new zero [enable REL mode (para 2-22)].
9. Set the meter calibrator output for 100.00 Vac at 20 kHz. Verify the reading on the multimeter is 000.000 +1 100 counts.
10. Press REL key.
11. Apply voltage of 10.00 Vac at 500 Hz with the meter calibrator.
12. Press the 20 V manual range key.
13. Set this voltage as the multimeter's new zero [enable REL mode (para 2-22)].
14. Set the meter calibrator output at 10.00 Vac at 20 kHz. Verify that the reading on the multimeter is 00.0000 +1 100 counts.
15. Press REL key.
16. If the display did not read within all specified limits, perform frequency compensation adjustment (para 5-26).
17. Disconnect the test equipment.
18. Turn off all power.

RF PROBE TEST.

1. Set up multimeter as follows:

    - ON/OFF key to ON (in),
    - AC/DC key to DC (out),
    - V(voltage) key to voltage (in),
    - 20 V manual range key (in).

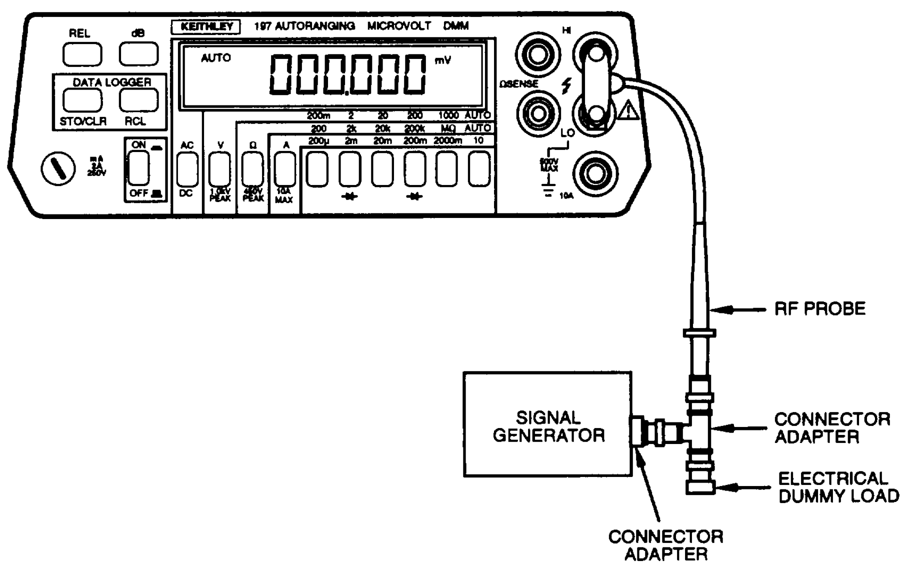
2. Connect the equipment as shown.

3. Apply voltage of 1 Vac at 1 MHz with the signal generator.

4. Read value displayed. Replace RF probe if probe output does not equal 1 Vdc +50 mV.

5. Disconnect the test equipment.

6. Turn off all power.



5-22. ADJUSTMENTS.

The Digital Multimeter AN/USM-486A uses digital adjustments to eliminate potentiometers in the instrument. The constants that the multimeter uses are stored in nonvolatile memory and are read on power-up of the instrument. One constant exists for each range on DCV, ACV and f, except for the 2 Vdc range, which has two constants, and the 750 Vdc range, which has none.

DESCRIPTION

The adjustment procedures cover:

- DC voltage adjustment (para 5-24),
- AC voltage adjustment (para 5-25),
- Frequency compensation adjustment (para 5-26),
- Resistance adjustment (para 5-27).

5-23. INITIALIZED SETUP.

NOTE

To ensure optimum performance of the multimeter, all adjustments should be done after replacement of any subassembly.

1. Verify that the LINE VOLTAGE switch position matches the local line voltage used (para 2-5).

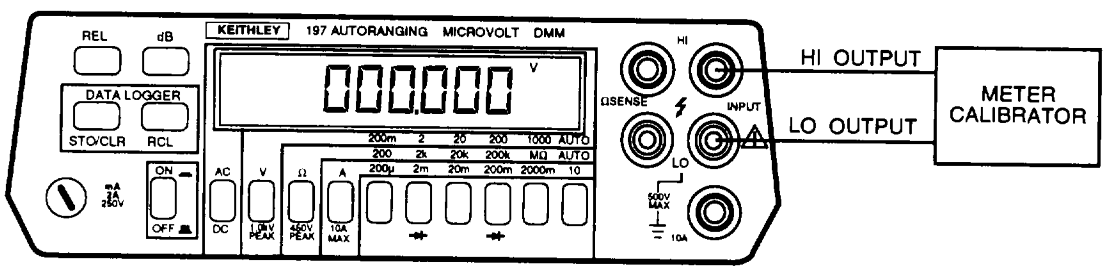
2. Plug multimeter ac power cord into ac power source.

3. Press the ON/OFF key to the ON position and allow the multimeter to warm up for five minutes.

4. Perform self diagnostic program (para 3-8).

5-24. DC VOLTAGE ADJUSTMENT.

1. Connect the equipment as shown.



2. Set up multimeter as follows:

- N/OFF key to ON (in).
- AC/DC key to DC (out).
- V (voltage) key to voltage (in).
- Press 200 mV manual range key.
- CALIBRATION switch (25, fig. 2-2) to ENABLED position.
- Press REL key and dB key simultaneously until "CAL" is displayed.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 1000 Vdc or peak ac (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous. The maximum voltages between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

3. Set meter calibrator to each applied dc voltage (+190.000 mV through 1000 V) as shown below. Adjust the displayed value of the multimeter calibrator voltage using the STO/CLR and RCL keys. The displayed value is increased with the STO/CLR key and decreased with the RCL key.

MULTIMETER RANGE (Vac)	APPLIED VOLTAGE (dc)	MULTIMETER DISPLAY
200 mV	+190.000 mV	190.000 mV
2 V	+1.90000 V	1.90000 V
2 V	-1.90000 V*	-1.90000 V
20 V	+19.0000 V	19.0000 V
200 V	+190.000 V	190.000 V
1000 V	+1000.00 V	1000.00 V

*With reversed leads from the meter calibrator.

4. To store the dc voltage calibration constants, simultaneously press the REL and dB keys until the message "Stor" is displayed.

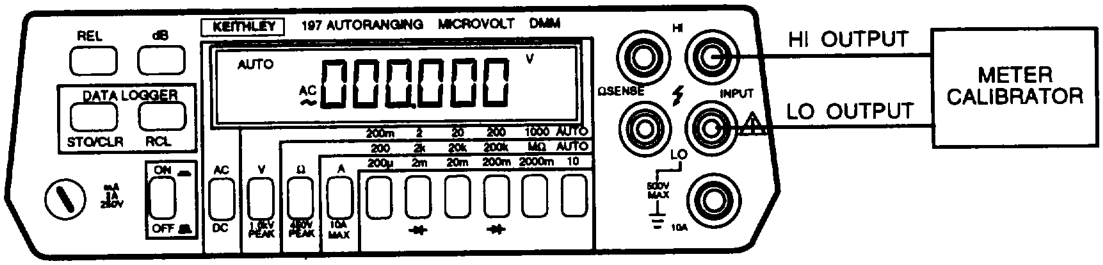
5. Move the CALIBRATION switch to DISABLED position.

6. Disconnect the test equipment.

7. Turn off all power.

5-25. AC VOLTAGE ADJUSTMENT.

1. Connect the equipment as shown.



2. Set up multimeter as follows:

- ON/OFF key to ON (in).
- AC/DC key to AC (in).
- V (voltage) key to voltage (in).
- Press 200 mV manual range key.
- CALIBRATION switch (25, fig. 2-2) to ENABLED position.
- Press REL key and dB key simultaneously until "CAL" is displayed.

WARNING

The maximum allowable voltage between LO INPUT and chassis ground is 500 V peak. Destruction of insulation, which could present a shock hazard, may occur if the 500 V maximum is exceeded.

CAUTION

The maximum allowable inputs are 750 VRMS, 1000 V peak (<10 seconds per minute on 200 mV and 2 V ranges); 300 VRMS continuous; 107 V•Hz. The maximum voltage between LO INPUT and chassis ground is 500 V peak. Exceeding these values may damage the instrument.

3. Set meter calibrator to output 190.000 mV at 500 Hz.

4. Adjust the displayed value of the multimeter to 190.000 mV using the STO/CLR and RCL keys. The displayed value is increased with the STO/CLR key and decreased with the RCL key.

5. Press dB and verify dB indicator lights.

6. Set meter calibrator to output 19.000 mV at 500 Hz.

7. Adjust the displayed value of the multimeter to 19.000 mV.

8. Press REL key and verify dB indicator goes out.

9. Set meter calibrator to remaining ac voltages (1.90000 V through 190.000 V) at a frequency of 500 Hz as shown below. Adjust the displayed value of the meter to the meter calibrator voltage using the STO/CLR and RCL keys.

MULTIMETER RANGE (Vac)	APPLIED VOLTAGE (ac)	METER CALIBRATOR FREQUENCY	MULTIMETER DISPLAY
200 mV	190.000 Mv	500 Hz	190.000 mV
200 mV*	19.000 mV	500 Hz	19.000 mV
2V	1.90000 V	500 Hz	1.90000 V
20 V	19.000 V	500 Hz	19.0000 V
200 V	190.000 V	500 Hz	190.000 V

*dB indicator must be on.

10. To store the ac voltage calibration constant, simultaneously press the REL and dB keys until the message "Stor" is displayed.

11. Move the CALIBRATION switch to DISABLED position.

12. Disconnect the test equipment.

13. Turn off all power.

5-26. FREQUENCY COMPENSATION ADJUSTMENT.

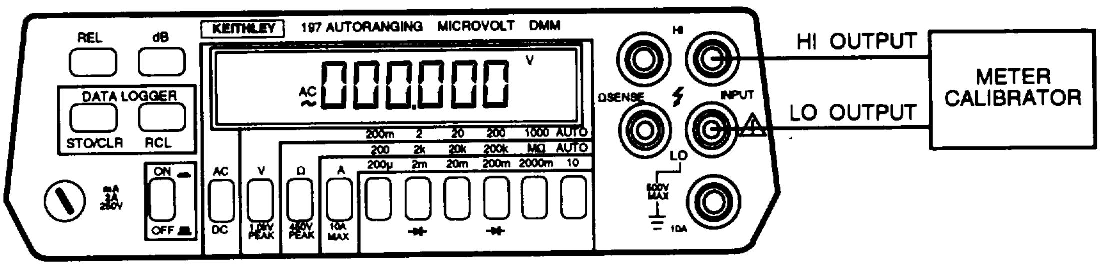
WARNING

This test requires the use of live circuits, high voltages, and exposed voltage points. To avoid personal injury or death, do not come in contact with circuits, voltages or voltage points exposed when performing this adjustment.

1. Remove upper cover (para 5-14).

2. Plug multimeter ac power cord into ac power source.

3. Connect the equipment as shown.



4. Set up multimeter as follows:

   - ON/OFF key to ON (in),
   - AC/DC key to AC (in),
   - V (voltage) key to voltage (in),
   - 1000 V manual range key (in).

5. Apply voltage of 500.00 Vac at 500 Hz with meter calibrator. Set this as multimeter's zero [enable REL mode (para 2-22)].

6. Set the meter calibrator output to 500.00 Vac at 20 kHz. With an alignment tool adjust C103 (fig. FO-4) until a reading of 0000.00 $\pm$ 150 counts is displayed. Verify that reading remains within 150 counts when the alignment tool is removed.

7. Press REL key.

8. Apply voltage of 100.00 Vac at 500 Hz with the meter calibrator.

9. Press the 200 V manual range key.

10. Set this voltage as the multimeter's new zero [enable REL mode (para 2-22)].

11. Set the meter calibrator output for 100.00 Vac at 20 kHz. Adjust C105 (fig. FO-4) until a reading of 0000.00:200counts is displayed. Verify the reading remains within 200 counts when the alignment tool is removed.

12. Press REL key.

13. Apply voltage of 10.00 Vac at 500 Hz with the meter calibrator.

14. Press the 20 V manual range key.

15. Set this voltage as the multimeter's new zero [enable REL mode (para 2-22)].

16. Set the meter calibrator output at 10.00 Vac at 20 kHz. Adjust C107 (fig. FO-4) until a reading of 00.0000 $\pm$ 200 counts is displayed. Verify the reading remains within 200 counts when the alignment tool is removed.
17. Press REL key.

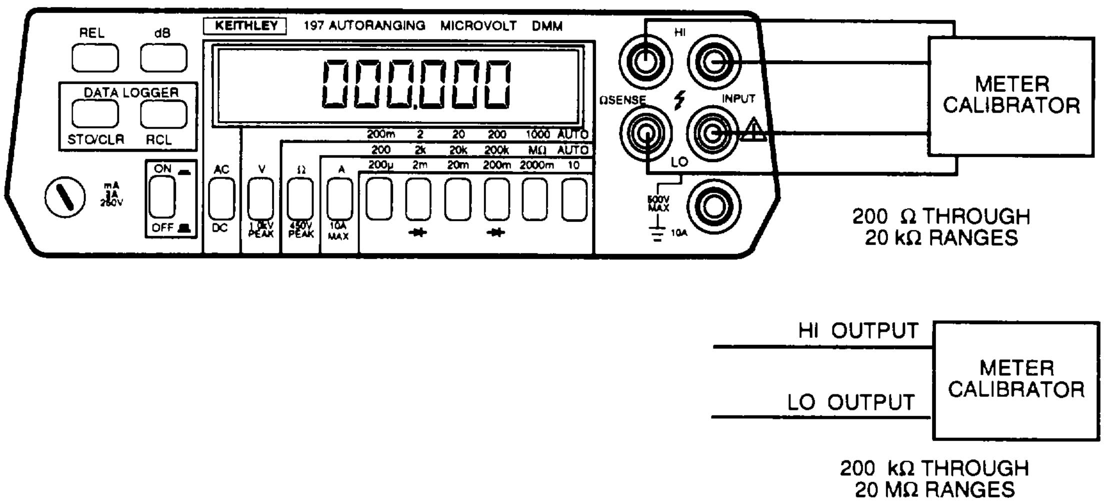
18. Disconnect the test equipment.

19. Turn off all power.

20. Install upper cover (para 5-14).

5-27. RESISTANCE ADJUSTMENT.

1. Connect the equipment as shown.



2. Set up multimeter as follows:

   - ON/OFF key to ON (in).
   - AC/DC key to DC (out).
   - Ω (ohms) key to ohms (in).
   - Press 2009' manual range key.
   - CALIBRATION switch (25, fig. 2-2) to ENABLED position.
   - Press REL key and dB key simultaneously until "CAL" is displayed.

3. Select each range and applied resistance as shown below. Zero 200Ω through 20 Ω ranges using the REL mode (para 2-22).

   Adjust the displayed value of the meter to the meter calibrator resistance using the STO/CLR and RCL keys. The displayed value is increased by pressing the STO/CLR key and decreased by pressing the RCL key.

MULTIMETER RANGE	APPLIED RESISTANCE	MULTIMETER DISPLAY
200Ω	190Ω	190.000Ω
200Ω	190Ω	190.000 Ω
2kΩ	1.9 kΩ	1.90000kΩ
200 kΩ	190 kΩ	190.000 kΩ
2 MΩ	1.9 MΩ	1.90000 MΩ
20 MΩ	19 MΩ	19.0000 MΩ

4. To store the resistance calibration constants, simultaneously press the REL key and the dB key until the message "Stor" is displayed.

5. Move the CALIBRATION switch to DISABLED position.

6. Disconnect the test equipment.

7. Turn off all power.

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

For preparation for storage or shipment information, refer to Chapter 3, Section V.

APPENDIX A
REFERENCES

A-1. **SCOPE.** This appendix list all forms, field manuals, technical manuals, and miscellaneous publications referenced in this manual.

A-2. FORMS.

Product Quality Deficiency Report ……………………………………………………………………..….Form SF 368
Recommended Changes to Publications and Blank Forms ……………………………………..DA Form 2028
Report of Discrepancy (ROD) ………………………………………………………………………....Form SF 364
Transportation Discrepancy Report (TDR……………………………………….………………..Form SF 361

A-3. TECHNICAL MANUALS.

Procedures for Destruction of Electronics Materiel to Prevent Enemy Use
(Electronics Command) ……………………………………………………………………………..TM 750-244-2
The Army Maintenance Management System (TAMMS) Users Manual…………………………DA Pam 750-8
Unit and Intermediate Direct Support and General Support, Repair Parts, and
Special Tools List for Digital Multimeter AN/USM-486A …………………………………TM 11-6625-3277-24P

A-4. MISCELLANEOUS.

Abbreviations for use on Drawings, Specifications, Standards and in
Technical Documents ……………………………………………………………………………...MIL-STD- 12D
Interactive Electronic Technical Manual for Calibration and Repair Requirements
for the Maintenance of Army Materiel……………………………………………………………………..EM 0022
Common Table of Allowances for Expendable/Durable Items (Except Medical,
Class V, Repair Parts and Heraldic Items)…………………………………… ……………...…….CTA 50-970
Consolidated Index of Army Publications and Blank Forms …………………………….……DA Pam 25-30
First Aid.………………………………………………………………………………………………..…..FM 4-25.11
Safety Requirements for Maintenance of Electrical and Electronics Equipment …………….…………TB 385-4

APPENDIX B
MAINTENANCE ALLOCATION CHART (MAC)

Section I. INTRODUCTION

B-1. GENERAL.

a. This appendix provides a general explanation of all maintenance and repair functions authorized at various maintenance levels for the Digital Multimeter AN/USM-486A.

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 levels.

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced in 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 to established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics to prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), preserve, drain, or paint or to replenish fuel, lubricants, chemical fluids, or gases.

d. Adjust. 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 an item to bring about optimum or desired performance.

f. Calibrate. To determine the cause and corrections to be made or adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Calibration consists of comparing 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 on other maintenance functions. Install may be the act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) to allow the proper functioning of the 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 (inspect, test, service, adjust, align, calibrate, and/or replace) including fault location/troubleshooting, removal/installation and disassembly/assembly procedures, and maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), item, or system.

j. Overhaul. That periodic 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 material 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. EXPLANATIONS OF COLUMNS IN THE MAC, SECTION II.

a. Column 1, Group Number. Column 1 lists functional group code numbers that 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 noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the items listed in column 2.

d. Column 4, Maintenance Level. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the level 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 level of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different levels, appropriate work time figures will be shown for each level. 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 maintenance allocation chart. The symbol designations for the various maintenance levels are as follows:

UNIT
C -- Operator/crew
O -- Organizational maintenance

INTERMEDIATE
F -- Direct support maintenance
H -- General support maintenance
L -- Specialized repair activity

DEPOT
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 REMARKS, SECTION III.

a. Column 1, Reference Code. The tool and test equipment code correlates with a code used in the MAC, Section II, Column 5.

b. Column 2, Maintenance Level. The lowest level 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 II.

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 (MAC) FOR DIGITAL MULTIMETER AN/USM-486A

(1)	(2)	(3)	(4) Maintenance Level					(5)	(6)
			UNIT		DIRECT SUPPORT	GEN. SUPPORT	DEPOT		
Group Number	Component/Assembly	Maintenance Function	C	O	F	H	D	Tools and Equipment	Remarks
00	DIGITAL	INSPECT		0.1					
	MULTIMETER	TEST		0.1				1	A
	AN/USM-486A	SERVICE		0.1					B
		REPAIR		0.2					C
		REPLACE		0.2					
		TEST				0.8		3-13	D
		REPAIR				0.1			E
		CALIBRATE				1.0			F
01	DIGITAL	TEST		0.1				1	
	MULTIMETER	REPAIR		0.2				2	G
	ASSEMBLY Al	REPLACE		0.2					
		TEST				0.4		3-13	
		REPAIR				0.6			H
0101	MOTHERBOARD	TEST				0.8		3-13	
	ASSEMBLY	REPAIR				0.4		4	I
	A1A1	REPLACE					1.0		

Section III. TOOLS AND TEST EQUIPMENT FOR DIGITAL MULTIMETER AN/USM-486A

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	O	Multimeter, Digital	6625-01-265-6000	AN/PSM-45A
2	O	Tool Kit, Electronic Equipment	5180-00-064-5178	TK-101/G
3	H	Multimeter, Digital	6625-01-221-9367	AN/GSM-64D
4	H	Tool Kit, Electronic Equipment	5180-01-195-0855	TK-17
5	H	Double (Banana) Plug Assembly (2 required)	4931-00-438-7005	7913130
6	H	Oscilloscope	6625-01-258-0022	2430AOPT46
7	H	Generator, Signal	4931-01-085-4229	8640B
8	H	Adapter, Connector (N male to BNC female)	5935-01-067-2925	M55339/21-0564
9	H	Adapter, Connector (BNC Tee)	5935-00-926-7523	M55339/17-00274
10	H	Dummy Load, Electrical (BNC Plug, 51 ohms)	5985-00-546-6347	MX-554/U-51
11	H	Calibrator, Meter	6625-01-332-2803	5700A/CT
12	H	Amplifier, Transconductance	6625-01-332-6987	5220A/CT
13	H	Amplifier, Precision Power	6625-01-332-6988	5215A/CT

Section IV. REMARKS FOR DIGITAL MULTIMETER AN/USM-486A

REFERENCE CODE	REMARKS
A	Operational test.
B	Service is accomplished by the recharging of batteries.
C	Repair is limited to replacement of Test Lead Set, ac Line Cord, and Transit Case.
D	Performance test.
E	Repair is limited to replacement of RF Probe.
F	Perform calibration using Technical Bulletin listed in TB 43-180.
G	Repair is limited to replacement of Fuse AIFI.
H	Repair is limited to replacement of ac Power Connector AIA3 and Display Panel Assembly A1A2.
I	Repair is limited to replacement of Fuse A1A1F2, Fuse AlAIF3, Battery Pack Charging Assembly A1A1A1, and Battery Pack A1A1BA1.

APPENDIX C
COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LIST

Section I. GENERAL

C-1. SCOPE.

This appendix lists the components of end item and basic issue items for the multimeter to help you inventory items required for safe and efficient operation.

C-2. GENERAL.

The Components of End Item and Basic Issue Items Lists are divided into the following sections:

a. Section II. Components of End Item. This listing is for informational purposes only and is not authority to requisition replacements. These items are part of the end item. 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). No basic issue items are required.

C-3. EXPLANATION OF COLUMNS.

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

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

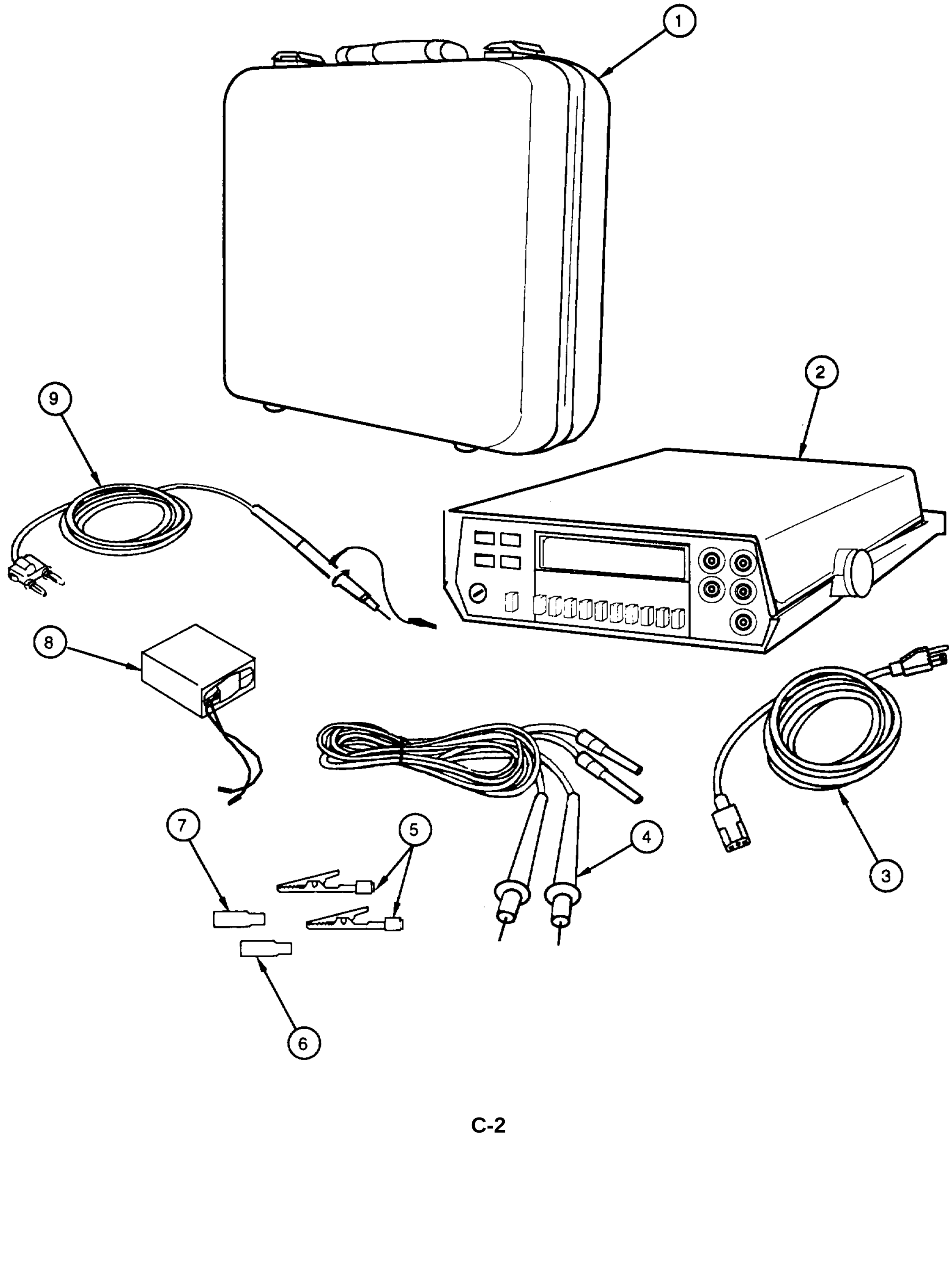
b. Column (2) - National Stock Number Indicates the national stock number assigned to the item and will be used for requisitioning purposes.

c. Column (3) - Description and Usable on Code. Indicates the federal item name (in all capital letters) followed by a minimum description when needed. The last line for each item indicates the CAGEC (commercial and government entity code) (in parentheses) and the part number.

d. Column (4) - Unit of Issue. Indicates how the item is issued for the National Stock Number shown in column two.

e. Column (5) - Quantity Required. Indicates the quantity of the item authorized to be used on/with the equipment.

Section II. COMPONENTS OF END ITEM



(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGEC and Part Number	(4) U/M	(5) QTY Reqd
1		ELECTRICAL TEST EQUIPMENT CASE, (80164),1684	EA	1
2		DIGITAL MULTIMETER ASSEMBLY, (80164), 197-M	EA	1
3		AC LINE CORD, (80164), CO-7	EA	1
4		TEST LEAD SET, (7E255), 5486-2	EA	1
5		ALLIGATOR CLIP, (76545), #6OCBRASS/TBO	EA	2
6	5975-00-503-1440	ELECTRIC CABLE NIPPLE (BLACK), (76545), #62BLACK	EA	1
7	5975-00-613-9064	ELECTRIC CABLE NIPPLE (RED), (76545), #62RED	EA	1
8		BATTERY PACK, (80164), BA-40	EA	1
9		PROBE ASSEMBLY, (80164), 197-M-600A	EA	1

APPENDIX D
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

D-1. SCOPE.

This appendix lists expendable items that you will need for multimeter operation, unit, direct support, and general support maintenance. This listing is for information only and is not the authority to requisition the listed items. These items are authorized to you by CTA 50-970, Expendable/Durable Items (except medical, class V, and heraldic items and repair parts).

D-2. EXPLANATION OF COLUMNS.

a. Column (I) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the item (for example, "Use cleaning compound, item 5, App. D.").

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

c. Column (3) - National Stock Number. This column indicates the national stock number assigned to the item. This information will be used for requisitioning purposes.

d. Column (4) - Description. This column indicates the federal item name and, if required, a minimum description to identify the item. The last line for each item indicates the CAGEC (in parenthesis) followed by the part number if available.

e. Column (5) - Unit of Measure (U/M). This column indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (for example, 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 LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	C	6810-00-983-8551	Alcohol, Isopropyl, TT-I-735 (Commercial Grade) (81348)	QT
2	C	8305-00-267-3015	Cloth, Cheesecloth, Cotton, Lintless, CCC-C-440, Type II, Class 2 (81348)	YD
3	C	7930-00-068-1669	Detergent, General Purpose (81348)	CO

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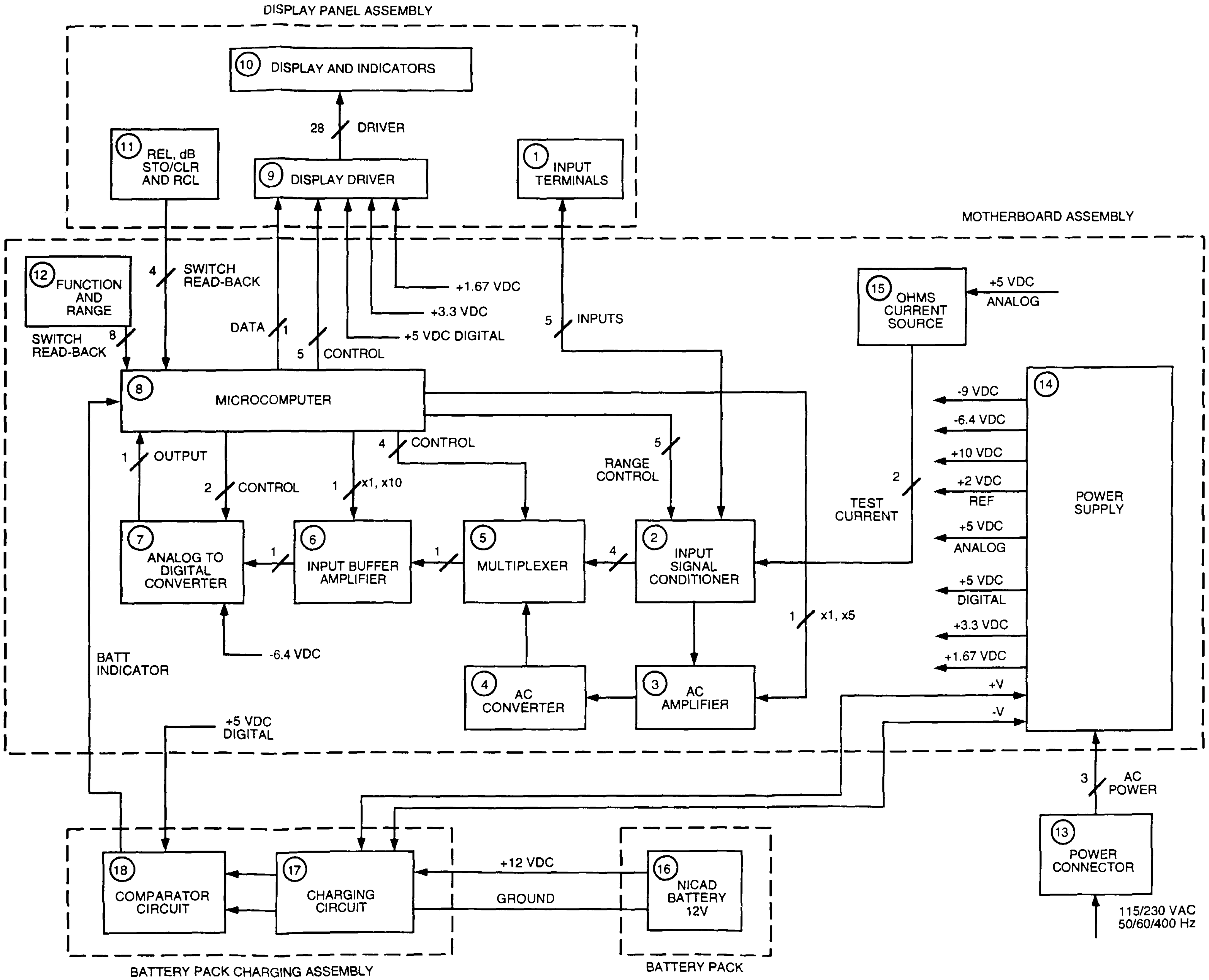
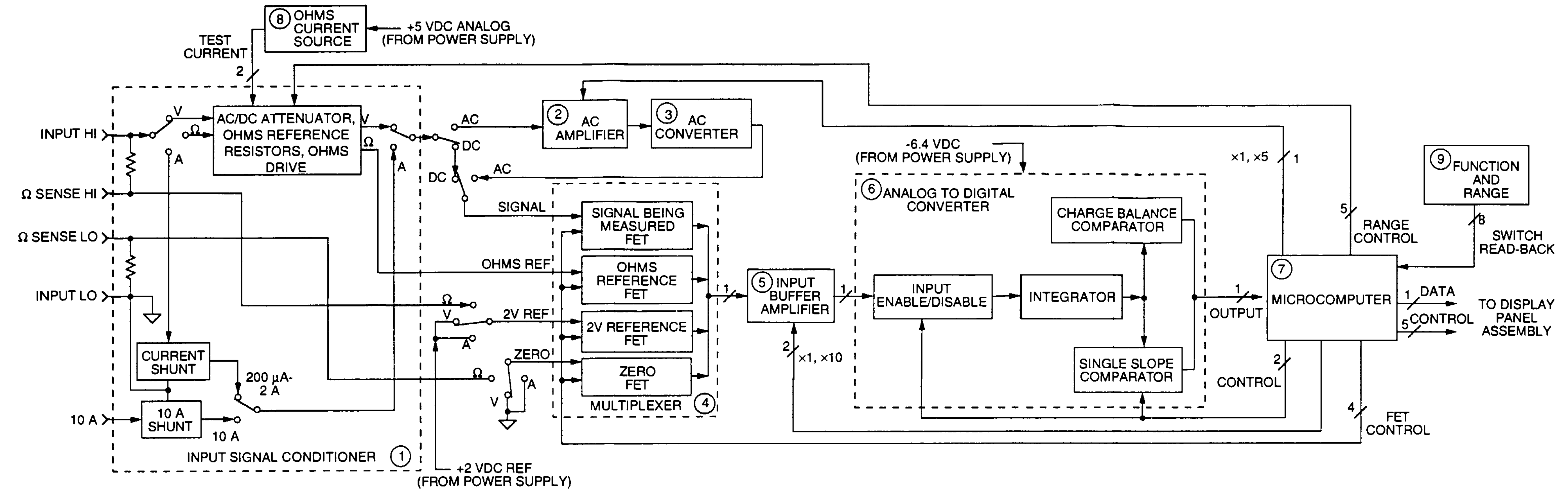


Figure FO-1. Digital Mutimeter AN/USM-486A Functional Block Diagram



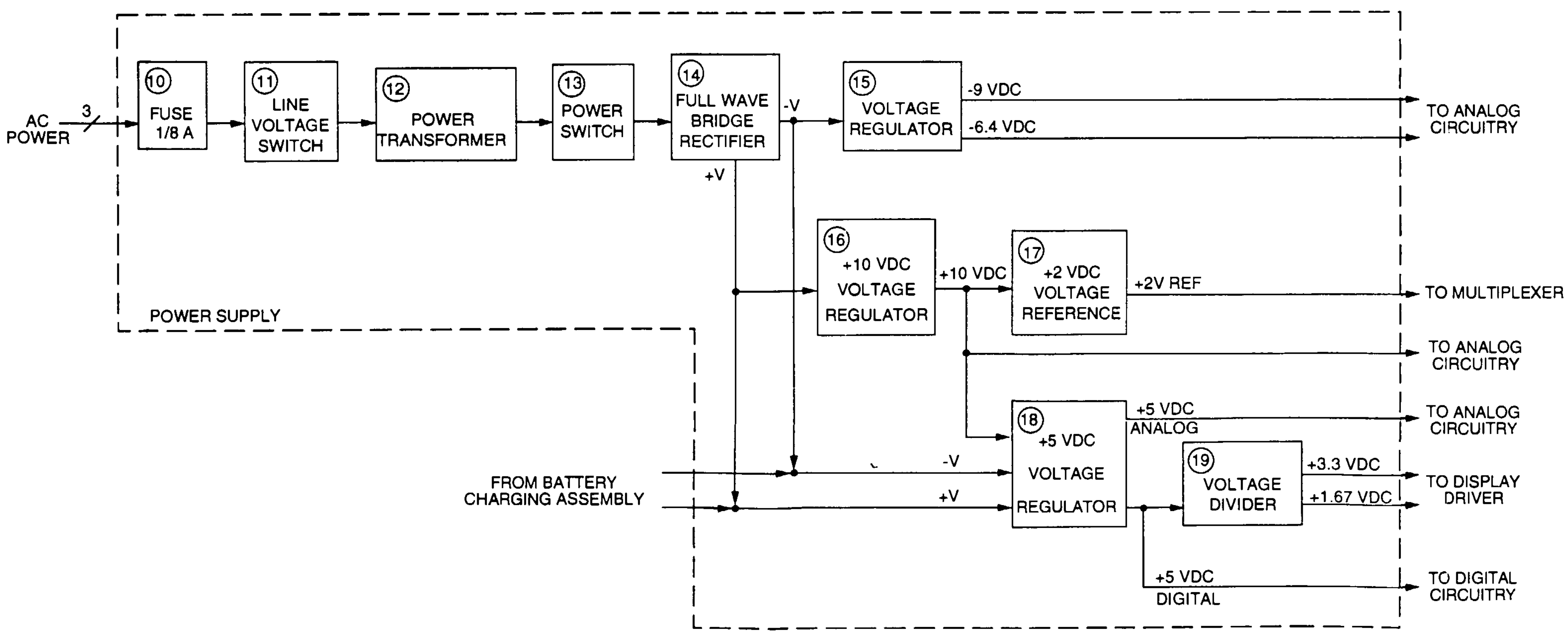
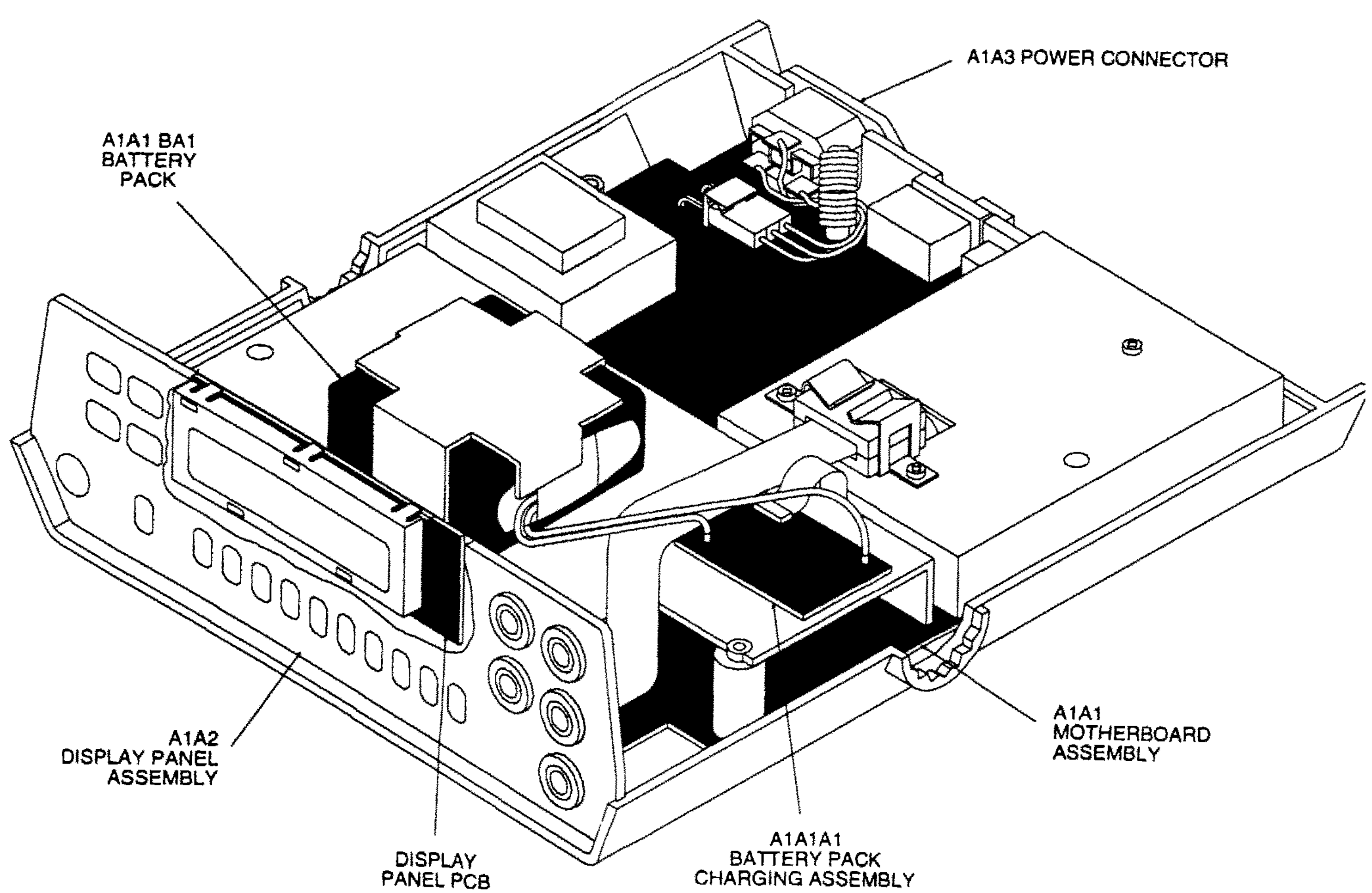
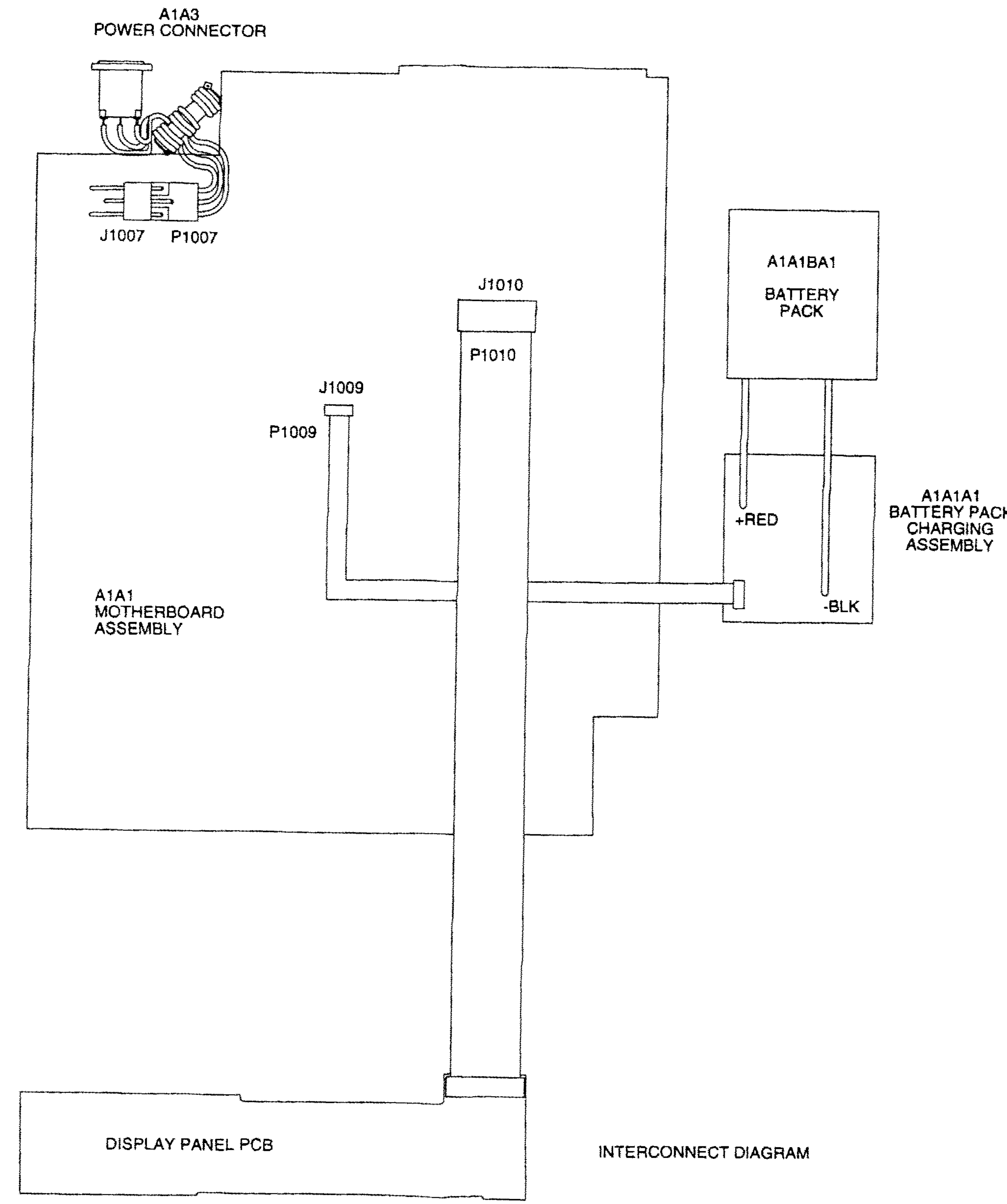


Figure FO-2. Motherboard Functional Block Diagram

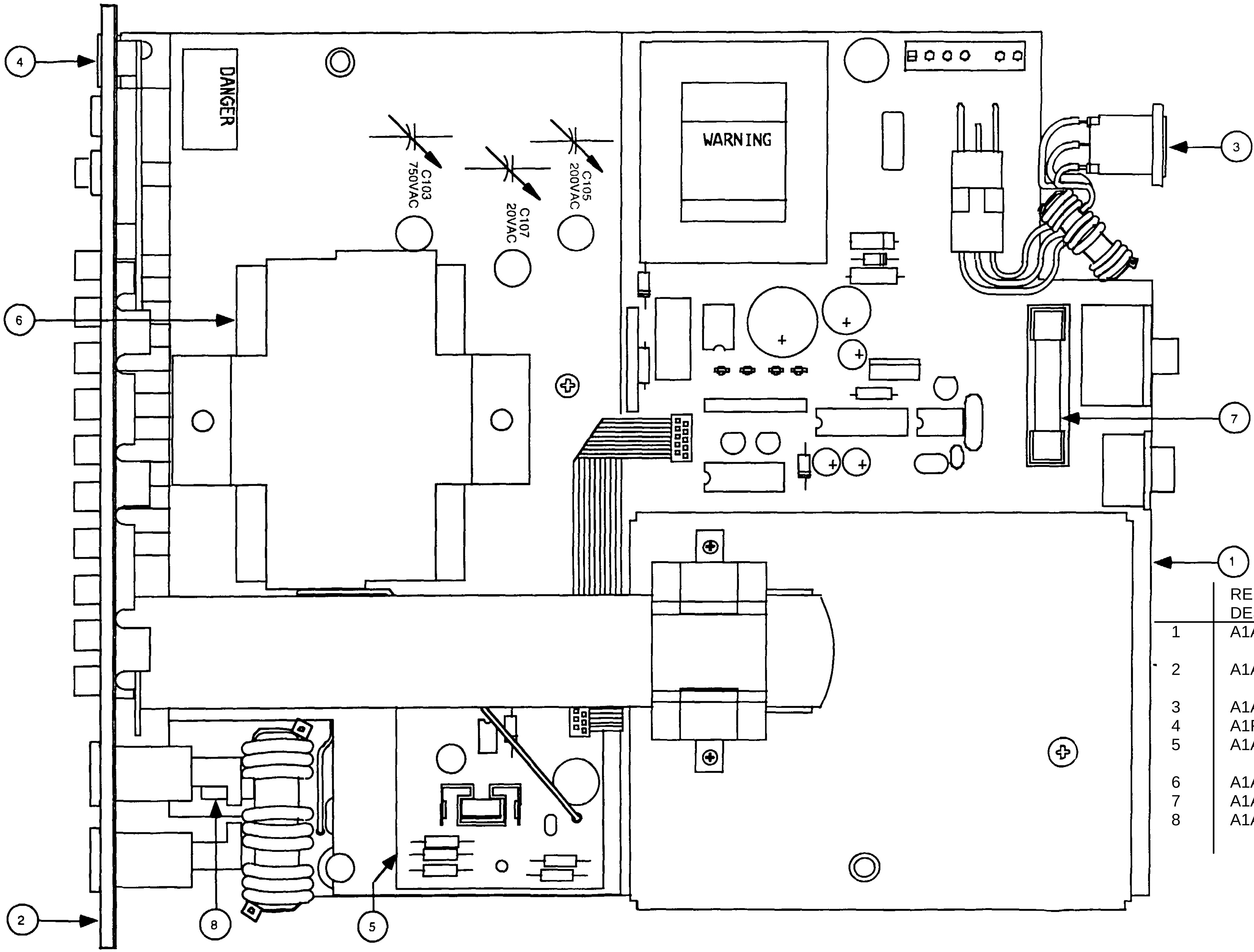


OVERALL LOCATOR DIAGRAM



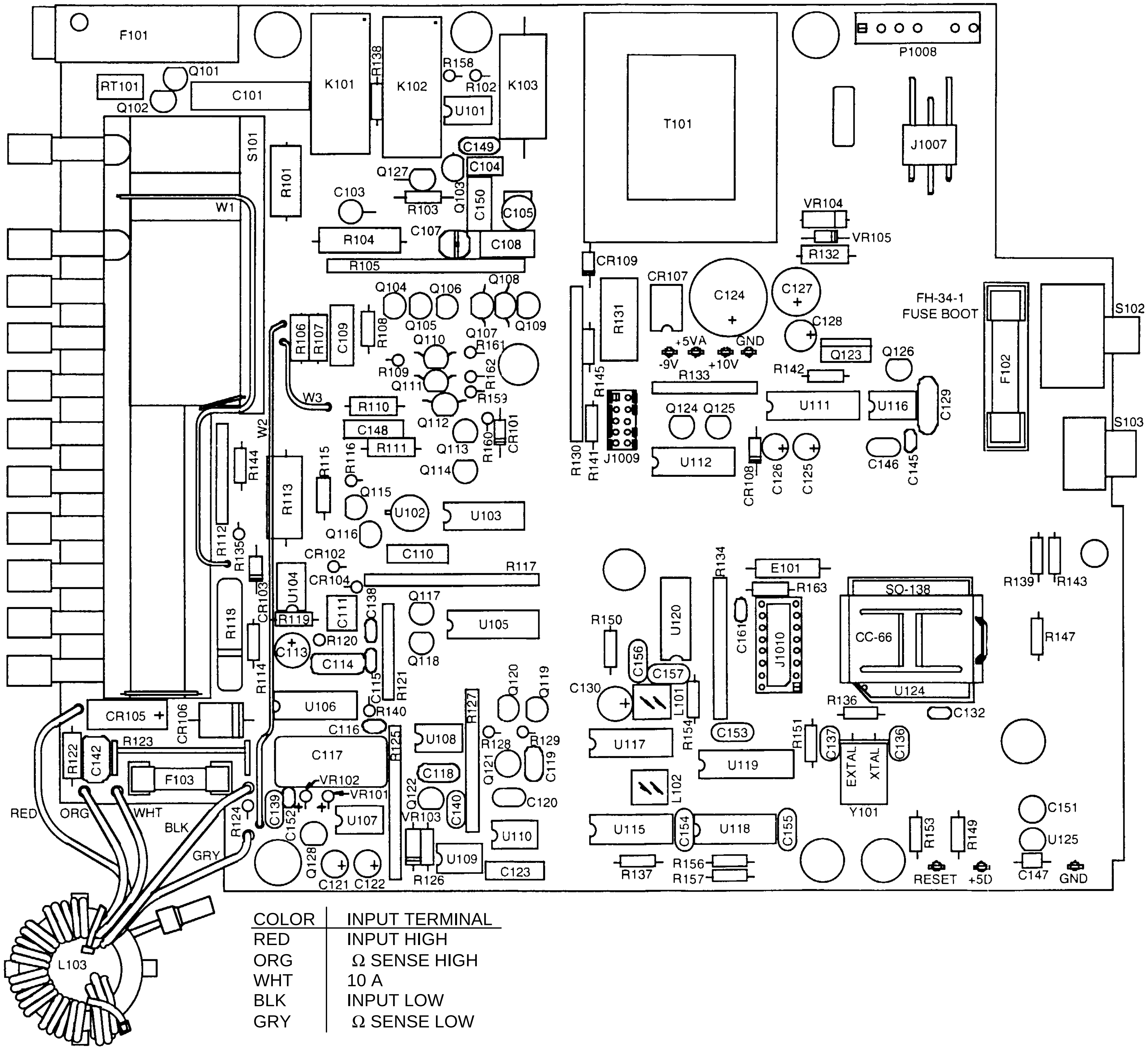
INTERCONNECT DIAGRAM

Figure FO-3. Overall Locator and Interconnect Diagrams



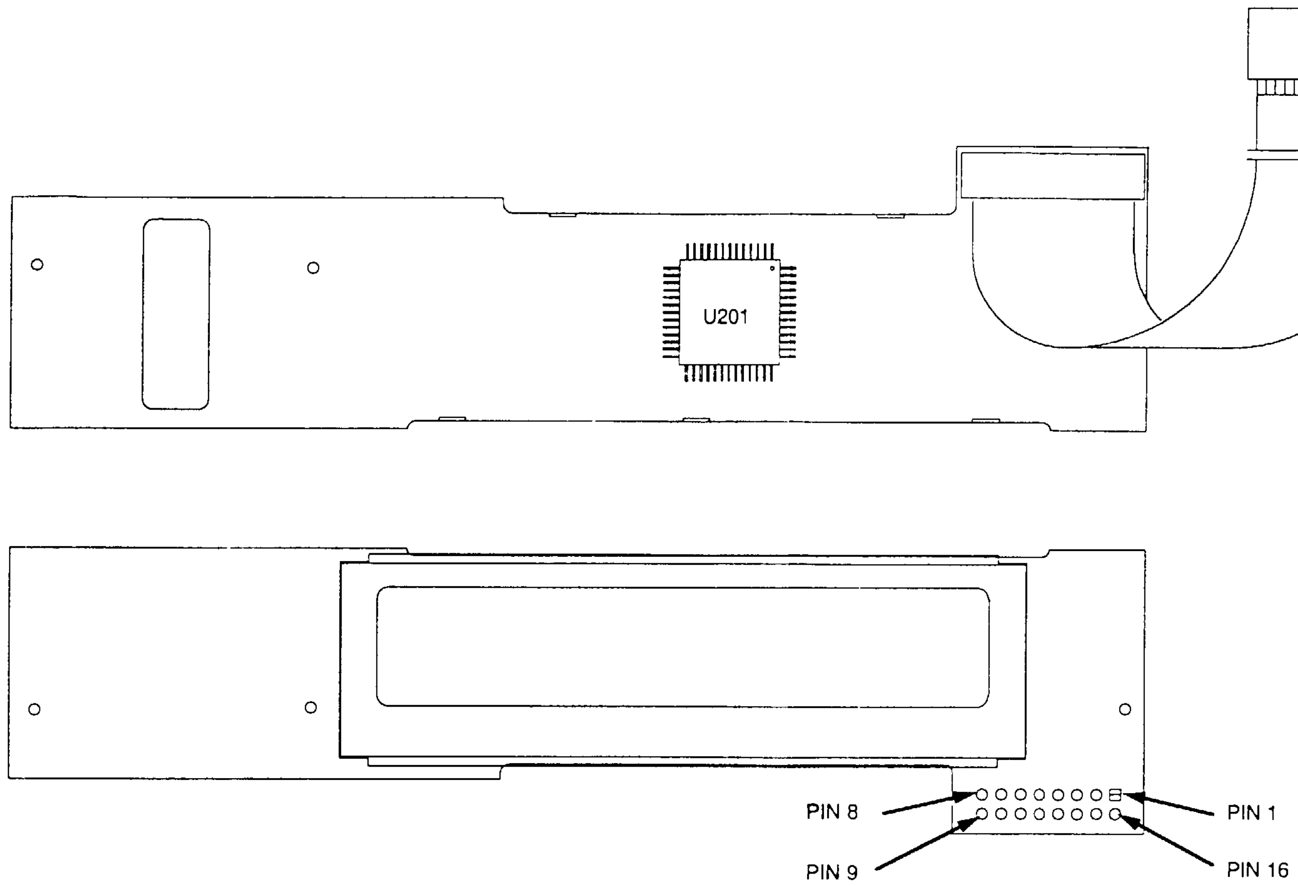
	REFERENCE DESIGNATOR	DESCRIPTION
1	A1A1	MOTHERBOARD ASSEMBLY
2	A1A2	DISPLAY PANEL ASSEMBLY
3	A1A3	POWER CONNECTOR
4	A1F1	FUSE
5	A1A1A1	BATTERY PACK CHARGING ASSEMBLY
6	A1A1BA1	BATTERY PACK
7	A1A1F2	FUSE
8	A1A1F3	FUSE

Figure FO-4. Multimeter Assembly Locator

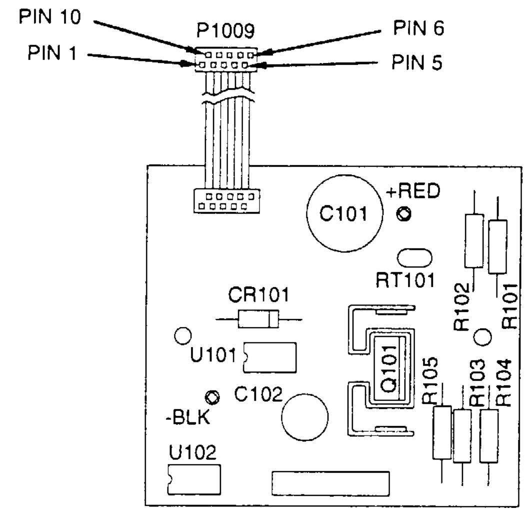


COLOR	INPUT TERMINAL
RED	INPUT HIGH
ORG	Ω SENSE HIGH
WHT	10 A
BLK	INPUT LOW
GRY	Ω SENSE LOW

Figure FO-5. Motherboard Assembly Component Locator



DISPLAY PANEL ASSEMBLY COMPONENT LOCATOR



BATTERY PACK CHARGING ASSEMBLY COMPONENT LOCATOR

Figure FO-6. Display Panel Assembly and Battery Pack Charging Assembly Component Locators

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Official: Chief of Staff

Milton H. Hamilton

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
07747

Distribution:

To be distributed in accordance with DA Form 12-32-E, Block 3351 for TM 11-6625-3277-14 applicable to the TEMOD System.

***U. S. GOVERNMENT PRINTING OFFICE:1995-633-220/00040**

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.

EXAMPLE

* *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)* Commander, U.S. Army Aviation and Missile Command ATTN: AMSAM-MMC-MA-NP Redstone Arsenal, AL 35898	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*) Commander, U.S. Army Aviation and Missile Command ATTN: AMSAM-MMC-MA-NP Redstone Arsenal, AL 35898	**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.)*

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