TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND

GENERAL SUPPORT MAINTENANCE MANUAL

ELECTRONIC VOLTMETERS ME-202A/U

(NSN 6625-00-709-0288)

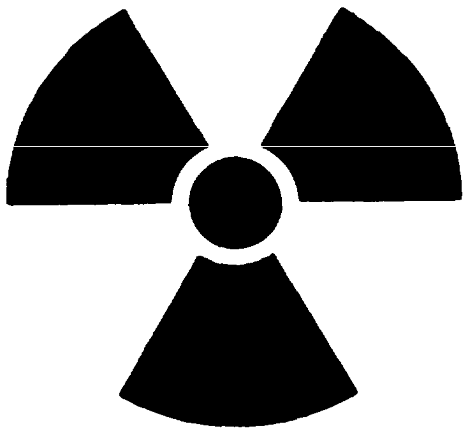
AND

ME-202B/U (NSN 6625-00-972-4046)

HEADQUARTERS, DEPARTMENT OF THE ARMY

JULY 1975

RADIATION HAZARD



STD-RW-2

Co60

Tube type 0A2 used in this test set contains radioactive material. This tube is potentially hazardous when broken; see qualified medical personnel and the Safety Director if you are exposed to or cut by broken tubes. Be extremely careful when replacing these tubes and follow the safety procedures in their handling, storage, and disposal. Never place radio active tubes in your pocket. Use extreme care not to break radioactive tubes while handling them.

Never remove radioactive tubes from cartons until ready to use them.

W A R N I N G

Be extremely careful when servicing the electronic voltmeter with the case removed. Voltages in the range of 800 volts dc are present in the 500-volt dc reference supply. All metal components on the dc vtvm printed circuit board will be at or near the potential indicated by the voltage readout dials. Always disconnect the power cord and discharge the filter capacitors before performing any servicing procedure.

D O N ' T T A K E C H A N C E S !

W A R N I N G

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

CAUTION

Refer to paragraph 3-4 for a full description of operating precautions.

CAUTION

The standard cell may freeze if subjected to below freezing temperature. The electrolyte will freeze at 1° F. and operation below 32° F. is definitely not recommended.

CAUTION

DO NOT ground the RECORDER OUTPUT terminals of the electronic voltmeter or the recorder input terminals. Accuracy of the electronic voltmeter will be completely degraded.

CAUTION

Use only anhydrous denatured ethyl alcohol when cleaning the insulators of the switches. Other cleaning solvents may react with the insulating material in these switches.

CAUTION

This equipment contains transistors. Observe all precautions given to prevent transistor damage. Be careful when making voltage and resistance measurements. Use tape or sleeving to insulate the entire test prod, except the extreme tip. A momentary short circuit can ruin a transistor. (For *example,* if the bias were shorted out, excessive current between the base and emitter would ruin the transistor.)

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *3 July 1975*

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

ELECTRONIC VOLTMETERS ME-202A / U

(NSN 6625-00-709-0288)

AND ME-202B / U (NSN 6625-00-972-4046)

*This manual supersedes TM 11-6625-537-15-1, 12 August 1966.

LIST OF ILLUSTRATIONS

LIST OF TABLES

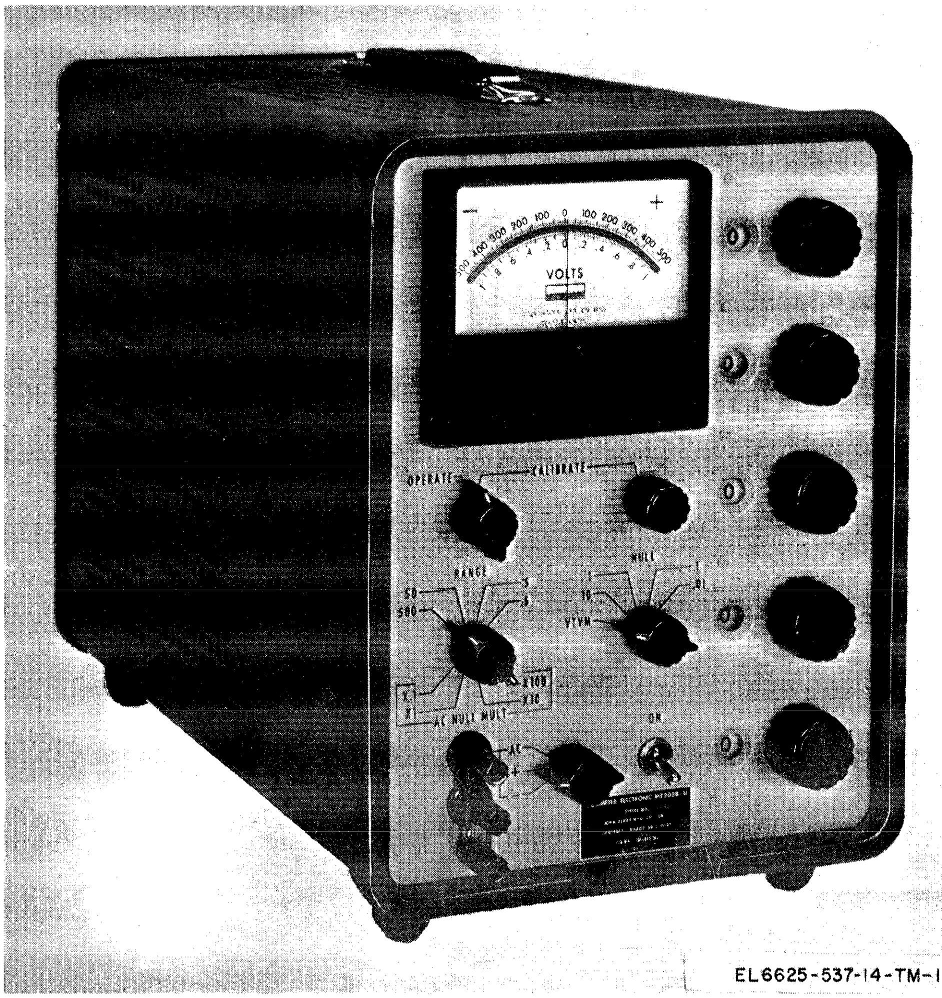

Figure 1-1. Electronic Voltmeter ME-202(*)/U.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual describes Electronic Voltmeters ME-202A/U and ME-202B/U, Electronic Voltmeter (*fig.* 1-1) and covers instructions for operation, installation, and operator's, organisational, and general support maintenance. No direct support maintenance is authorized.

b. Official nomenclature followed by (*) is used to indicate all models of equipment. Thus, Electronic Voltmeter ME-202(*)/U indicates Electronic Voltmeters ME-202A/U and ME-202B/U.

c. A list of references is contained in appendix A.

d. The maintenance allocation chart (MAC) appears m appendix C.

1-2. Indexes *of* Publications

a. *DA Pam 910-4.* Refer to the latest issue of DA Pam 310.4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. *DA Pam* 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO'S) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnal at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in AR 700-58/NAVSUPINST 4030.29/AFR 71-13/MCO P4030.29A, and DSAR 4145.8.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) *(SF 361) as* prescribed in AR 55-38/NAVSUPINST 4610.33A/AFR 75-18/MCO P4610.19B, and DSAR 4500.15.

1-4. Reporting of Errors

The reporting of errors, omissions, and recoin. mendations for improving this publication is authorized and encouraged. Submit reports on DA Form 2028 (Recommended Changes to Publications and Blank Forms) direct to Commander, US Army Electronics Command, ATTN: AMSEL-MA-Q, Fort Monmouth, NJ 07703.

1-5. Administrative Storage

The procedures for administrative storage are outlined in TM 740-90-1; however, the exact procedure in repacking for limited storage depends on the materials available and the conditions under which the equipment is to be stored,

1-6. Destruction of Army Materiel to Prevent Enemy Use

Destruction of the ME-202(*)/U will be undertaken only, when in the judgment of the unit commander concerned, such action is necessary in accordance with orders or policy established by the Army commander. This action will normally be required only when the equipment is in immediate danger of capture by enemy forces or abandonment on the battlefield. Refer to TM 750-244-2 for procedures to be followed when destruction of the equipment is ordered.

Section II. DESCRIPTION AND DATA

1-7. Purpose and Use

Electronic Voltmeter ME-202(*)/U is a portable, precision instrument capable of accurately measuring voltages between O and 500 volts direct current (dc) or 0.001 and 500 volts alternating current (at) and resistance between 1 megohm and 250,000 megohms. Voltages may be measured by using the electronic voltmeter either as a vacuum tube voltmeter or as a differential voltmeter.

1-8. Description

The Electric Voltmeter ME-202(*)/U is a single chassis unit enclosed in a metal case. The meter, operating controls and input connectors are mounted on the front panel. The adjustment of the front panel controls adjusts a precision dc internal voltage to equal the external voltage being measured; equality is indicated by a null on the panel meter; ac voltages are first converted to a dc voltage for measurement. The power fuse, recorder output connectors, recorder gain and adjustment, and the power supply cord are located on the back panel.

1-9. Tabulated Data

a. *Technical Characteristics.* The technical data for the Electronic Voltmeter ME-202(*)/U in-eluding ranges, accuracy and tolerances are listed in tables 1-1 through 1-7.

b. Stability of Reference Supply.

(1) ± *0.0025* percent for 10 percent change in line voltage.

(2) ± 0.005 percent per hour after 30-minute warmup (adjustable front panel CALIBRATE control).

c. Operating Temperature Range.

(1) Within dc specifications from 40° F. to 105 F. De-rate accuracy at 0.001 percent per °F. outside these limits to 35° F. and 110° F.

(2) Within ac specifications from 55° F. to 95° F. De-rate accuracy at 0.005 percent per °F. outside these limits to 35° F. and 110° F.

CAUTION

The standard cell may freeze if subjected to below freezing temperature. The electrolyte will freeze at 1° F. and operation below 32° F. is definitely not recommended.

d. *Calibration.* The 500-volt dc reference supply is calibrated against a built-in standard cell.

e. *Input Power. 115/230* vac, *50* to 440 Hz, 75 watts.

f. Number of Tubes. 8.

g. Weight. 28 lbs.

1-10. Items Comprising an Operable Equipment

Electronic Voltmeter ME-202(*)/U comprises an operable equipment.

*Table 1-1. Conventional Vacuum Tube Voltmeter Specifications**

Range	*Input impedance*	*Scale*
0 to ± *500* Vdc	*50* megohms	500-0-500
0 to ± 50 Vdc	50 megohms	50-0-50
0 to ± 10 Vdc	10 megohms	10-0-10
0 to ± 5 Vdc	50 megohms	5-0-5
0 t0 ± 1Vdc	10 megohms	1-0-1
0 to ± 0.5 Vdc	50 megohms	0.5-0-0.5
0 to ± 0.1 Vdc	10 megohms	0.1-0-0.1
0 to ± 0.01 Vdc	1 megohm	0.01-0-0.01
0 to 500 Vac	1 megohm 35 µµf	0-500
0 to 100 Vac	1 megohm 35 µµf	0-100
0 to 50 Vac	1 megohm 35 µµf	0-50
0 to 10 Vac	1 megohm 35 µµf	0-10
0 to 5 Vac	1 megohm 50 µµf	0-5
0 *to* 1 Vac	1 megohm 35 µ µf	0-1
0 to 0.5 Vac	1 megohm 50. µ µf	0-0.5
0 *to* 0.1 Vac	1 megohm 35 µµ f	0-0.1
0 *to* 0.01 Vac	1 megohm 50 µµ f	0-0.01
0 to 0.001 Vac	1 megohm 50 µ µ f	0-0.001

* Accuracy: 3 percent on all ranges

*Table 1-2. Differential Dc Voltmeter Specifications**

NOTE
Any NULL control setting may be used at any time although the listed settings are most useful

Input	*RANGE setting*	*NULL setting*	*Input resistance (per volt of input)*	
			At null	*At 1% off null*
50 to 500 Vdc	500	10	Infinite	*100* megohm
		1	Infinite	1,000 megohms
5 to 50 Vdc	50	1	Infinite	1,000 megohms
		.1	Infinite	10,000 megohms
0.5 to 5 Vdc	5	.1	Infinite	10,000 megohms
		.01	Infinite	10,000 megohms
0 to 0.5 Vdc	.5	.1	Infinite	10,000 megohms
		.01	Infinite	10,000 megohms

*Accuracy: ± 0.05 percent of input voltage from 0.1 to 500 Vdc, ± (0.05 percent +50 microvolts) below 0.1 Vdc.

Table 1-3. Differential AC Voltmeter Accuracy

Input voltage	*Frequency*	*Accuaracy*
0.5 to 500 Vac	20 Hz to 10 kHz	± 0.2%
	10 Hz to 20 Hz	± 0.5%
	5 Hz to 10 Hz	± 3%
0.001 to 0.5 Vac	20 Hz to 10 kHz	± 0.2% +25 uv
	10 Hz to 20 Hz	± 0.2% +25 uv
	5 Hz to 10 Hz	± 3% +25 uv

Table 1-4. Differential AC Voltmeter Specifications

NOTE
Any NULL control setting may be used at any time although the listed settings are most useful.

Input	*RANGE setting*	*NULL setting*	*Input Impedance*
50 to 500 Vac	500	1	1 megohm, 35µµf
		.1	1 megohm, 35µµf
		.01	1 megohm, 35µµf
5 to 50 Vac	50	1	1 megohm, 35 µµf
		.1	1 megohm, 35 µµf
		.01	1 megohm, 35 µµf
0.5 to 5 Vac	5	1	1 megohm, 50 µµf
		.1	1 megohm, 50 µµf
		.01	1 megohm, 50 µµf
0.001 to 0.5 Vac	.5	1	1 megohm, 50 µµf
		.1	1 megohm, 50 µµf
		.01	1 megohm, 50 µµf

Table 1-5. Voltage Readout Dial *Resolution*

RANGE setting	*NULL setting*	*Readout dial resolution*
500	any	0.01V (10 mv)
50	any	0.001V (1 mv)
5	any	0.0001V (100µv)
.1	any	0.00001V (10µv)

Table 1-6. Meter Resolution

Input uoltage	*RANGE* setting	*NULL setting*	*Meter resolution*	
DC	any	10	0.05V	(50 mv)
DC	any	1	0.005	(5 mv)
DC	any	.1	0.0005V	(500 uv)
DC	any	.01	0.00005V	(50 uv)
AC	500	1	0.5V	(500 mv)
AC	500	.1	0.05V	(50 mv)
AC	50	1	0.05V	(50 mv)
AC	500	.01	0.005V	(5 mv)
AC	50	.1	0.005V	(5 mv)
AC	5	1	0.005V	(5 mv)
AC	50	.01	0.0005V	(500 µv)
AC	5	.1	0.0005V	(500 µv)
AC	.5	1	0.0005V	(500 µv)
AC	5	.01	0.00005V	(50 µv)
AC	.5	.1	0.00005V	(50 µv)
AC	.5	.01	0.00005V	(50 µv)

Table 1-7. Stability of Meter Zero.

Line voltage change	*Line frequency*	*Stability*
10%	*50 to 120* Hz	± *0.5%* of full scale.
10%	120 to 440 Hz	± 1 % of full scale

CHAPTER 2

SERVICE UPON RECEIPT OF EQUIPMENT AND INSTALLATION

2-1. Unpacking

a. Packaging Data. The Electronic Voltmeter ME-202(*)/U is packed for shipment as shown in figure 2-1.

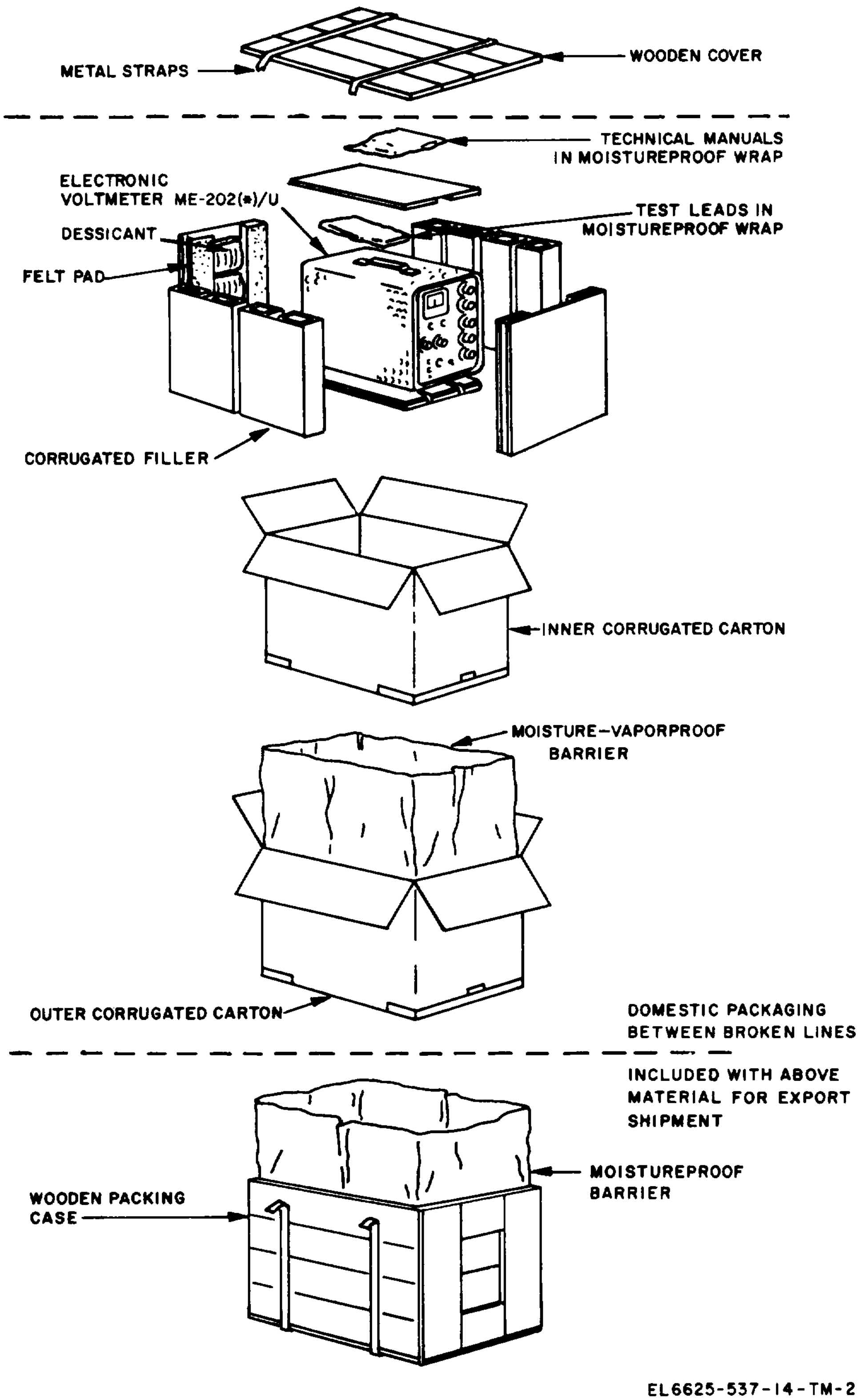

Figure 2-1. Electronic Voltmeter ME-202(*)/U, packaging diagram.

b. Removal *of Contents.*

(1) Domestic *packaging,*

(a) Slit seam along cover of outer corrugated carton. Fold back cover flaps, and open moisture-vaporproof barrier.

(b) Slit top seam of water-resistant, inner corrugated carton, and open it.

(c) Remove technical manuals.

(d) Remove equipment from inner carton.

(2) *Export packaging.*

(a) Cut and fold back metal straps.

(b] Remove nails from wooden cover of packing case with a nail-puller. Do not attempt to pry off wooden cover; equipment may be damaged.

(c) Open moistureproof barrier and expose outer corrugated carton.

(d) Proceed as described in (1) above.

2-2. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD form 6 (para 1-3 b).

b. Check the equipment against the component listing in the operator's manual and the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of TM 38-750. The equipment should be placed in service even though a minor assembly or part that does not affect proper functioning is missing.

c. Check to see whether the equipment has been modified. (Equipment which has been modified will have the MWO number on the front panel, near the nomenclature plate.) Check also to see whether all currently applicable MOW's have been applied. (Current MWO's applicable to the equipment are listed in DA Pam 310-7.)

2-3. Installation

NOTE

The following installation procedure must be made with the assistance of general support maintenance personnel.

a. The ME-202(*)/U is normally shipped ready for use on 115 volts. If operation on 230 volts is required, refer to instruction plate located on rear of chassis.

b. Make sure that the appropriate fuse is installed in the fuseholder on the rear panel (fig. 2-2); a 1.5 ampere slow-blowing fuse is required for 115 volt operation; a 0.75 ampere slow-blowing fuse is required for 230 volt operation.

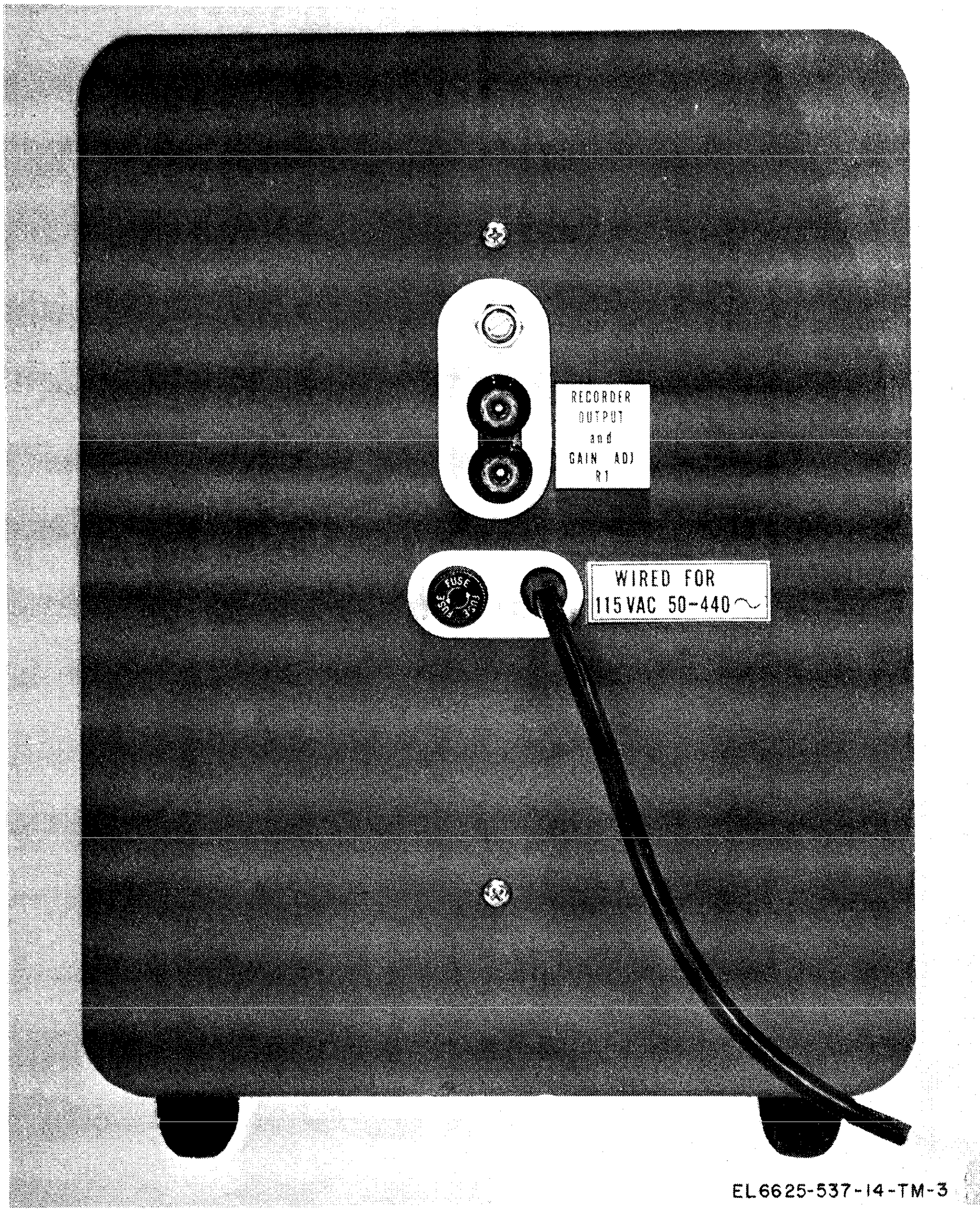

Figure 2-2. Electronic Voltmeter ME-202(*)/U, rear panel.

WARNING

The round pin on the polarized three-prong power plug connects the instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect the pigtail on the adapter to a suitable ground.

c. Connect power plug to the power source for which the electronic voltmeter has been wired.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INSTRUMENTS

3-1. General

Before operating the ME-202(*)/U the operator must become thoroughly familiar with the controls and indicators. Do not operate the electronic voltmeter until the location, function, and use of each control and indicator are understood.

3-2. Operator Controls

Locations of the operator controls and indicators are shown in figure 3-1, Table 3-1 provides information on the function of each of the controls and indicators.

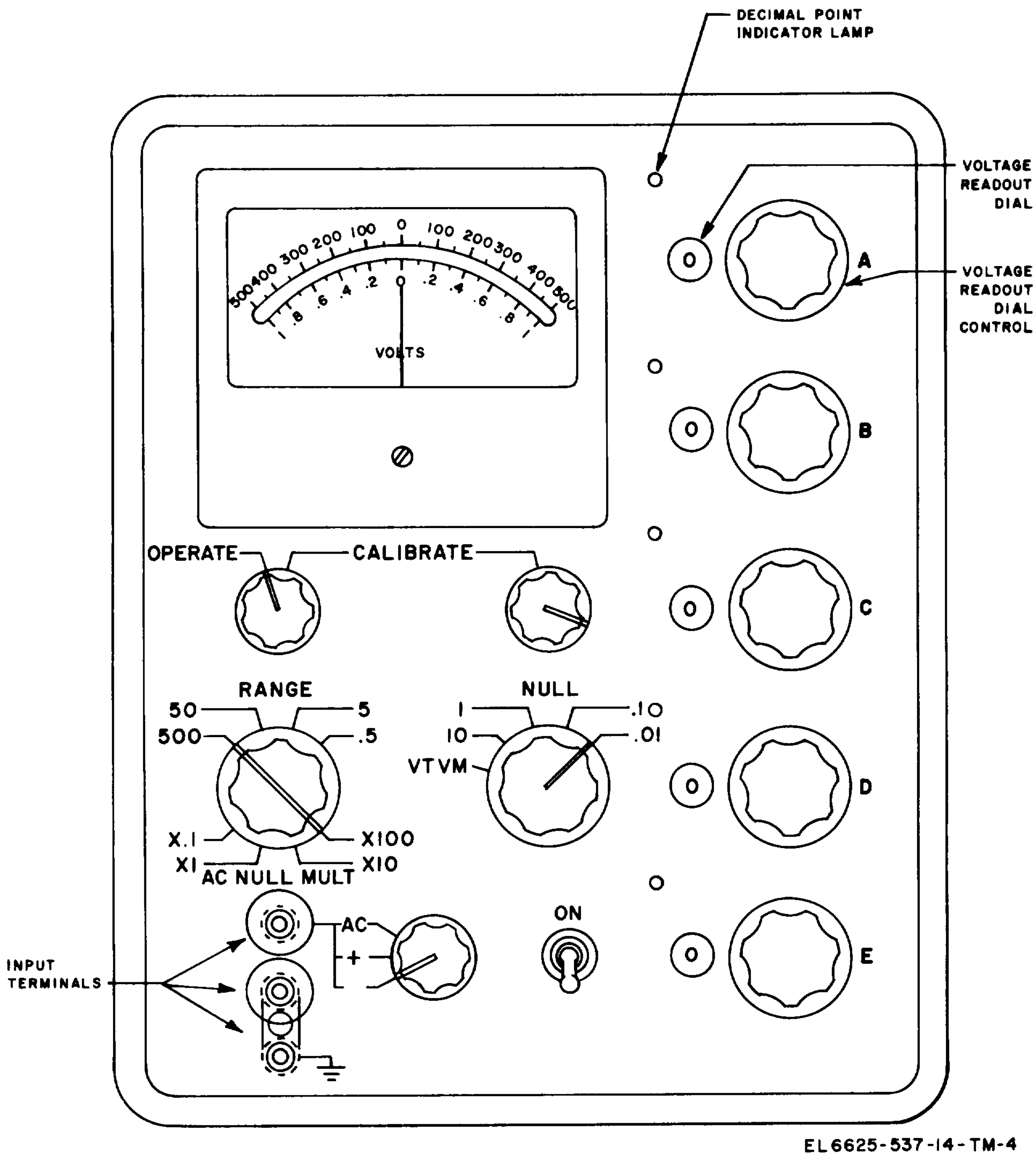

Figure 3-1. Electronic Voltmeter ME-202(*)/U, operating controls and indicators.

Table 3-1. Operator's Controls

NOTE

This table covers only items used by the operator; items used by higher level maintenance personnel are covered in instructions for the appropriate maintenance level.

Control, indicator or connector	*Function*
Input terminals.	Are provided for connecting ac or dc voltage to be measured. The polarity of the upper input terminal to lower input terminal when making dc measurements is controlled by the AC-dc polarity switch. These terminals are isolated from chassis ground.

Table 3-1. Operator's Controls–Continued

Control, indicator or connector	*Function*
Chassis ground terminal	*Used* for connecting to the chassis of the electronic voltmeter. A 0.47 μ f capacitor is connected from the middle input terminal to the chassis ground terminal. Since the chassis of the electronic voltmeter is always connected to ground through the third wire of the three-wire power cord, the external circuit should be checked for conflicts in grounding before connecting the middle input terminal to the chassis ground (bottom) terminal.
ON switch	Applies ac line voltage to the primary of the power transformer.
OPERATE-CALIBRATE control	Remains at the OPERATE position all times except when it is necessary to calibrate the internal 500-volt dc reference supply. When hold at CALIBRATE. a representative sample of the reference voltage is compared to the voltage of an internal standard cell and any difference is indicated on the VOLTS meter,
CALIBRATE control	Varies the output of the 500-volt dc reference supply. When the OPERATE-CALIBRATE switch is held at CALIBRATE, the reference supply is set accurately by adjusting the CALIBRATE control for zero VOLTS meter deflection,
RANGE control	a. Selects maximum input voltage ranges of 500, 50, 5, and 0.5 volts, and ac null multipliers of x100, x10, x1, and x.1 to be used, respectively, with each voltage range. Also selects the decimal point indicator lamps for each setting. *b.* When voltmeter is used as a dc vtvm (NULL switch is set to VTVM, AC-de polarity switch set to + or –), the proper signal from a voltage divider is connected to the meter circuit. c. When the voltmeter is used as a differential dc voltmeter (NULL switch not set to VTVM. AC-dc polarity switch set to + or -), the proper reference voltage is selected. *d.* When voltmeter is used as an ac vtvm (NULL switch is set to VTVM, AC-dc polarity switch set to AC) the proper signal from a voltage divider is connected to the meter circuit. e. When voltmeter is used as an ac differential voltmeter (NULL switch not set to VTVM, AC-de polarity switch set to AC), the proper AC NULL MULT (null voltage multiplier) is selected.
NULL control	*a.* Selects VTVM circuit or sensitivity of meter circuit. *b.* VTVM connects the input voltage to the meter circuit through a voltage divider selected by the RANGE switch. c. 10, 1, .1 and .01 are used to perform differential voltage measurements and connects to the meter circuit, to indicate the difference between the unknown voltage and a known internal reference voltage indicated by the voltage readout dials. *d.* For differential dc voltage measurements, the NULL control positions represent full scale differences between the unknown voltage and the known internal reference voltage indicated by the voltage readout dials. e. For differential ac voltage measurements, the NULL control setting times the AC NULL MULT indicated by the RANGE control, represents full scale differences between the unknown voltage and the known internal reference voltage indicated by the voltage readout dials.
A, B, C, D, and E voltage readout dials	Select the amount of internal reference voltage necessary to null the unknown voltage. These dials also provide an in-line readout of the reference voltage. Indicator A has a range from 0 to 4; indicators B through D, a range from 0 to 9; and indicator E, a range from 0 to 10.
Decimal point indicator lamps	Serve as decimal points for the voltage readout dials. When the RANGE switch is set to 500, the indicator above dial D will light; when set to 50, the indicator above dial C will light; when set to 5, the indicator above dial B will light; when set to .5, the indicator above dial A will light.
AC-de polarity control	*a.* Selects the ac, + dc or — dc mode of operation. *b.* When set to AC, the unknown voltage is converted to an equivalent dc voltage and applied to the voltage divider and meter circuits. c. When set to +, the upper input binding post is positive with respect to the common input binding post. *d. When set to +,* the upper input binding post is negative with respect to the common input binding post. The polarity of the known internal reference voltage, and the polarity of the VOLTS meter are reversed, and an 88 megohm resistance is connected between the common input terminal and chassis ground, when the AC-dc polarity switch is set to —.

Control, indicator or connector	Function
VOLTS meter	Indicates the voltage being measured in volts when used as a vtvm, Indicates the difference in volts between the unknown voltage and the internal reference voltage when used as a differential voltmeter. Upper scale 500-0-500 is used when the NULL switch is set to VTVM, At all other times, lower scale 1-0-1 is used.
Mechanical zero control	Sets meter to zero mechanically. This adjustment should be used only after the voltmeter has been turned off for at least 3 minutes, or when the internal meter terminals have been shorted.
RECORDER OUTPUT terminals (on rear panel, fig. 2-3)	Provided for attaching a recorder to monitor voltage excursions. Upper terminal wiIl be positive when VOLTS meter needle deflects to the left.
Gain ADJ RI control (on rear panel)	Varies the voltage level at the RECORDER OUTPUT terminals form O to approximately 20-millivolt full-scale deflection.

Section II. OPERATION UNDER USUAL CONDITIONS

3-3. Types of Operation

Electronic Voltmeter ME-202(*)/U may be used as a conventional vacuum tube voltmeter or as a differential voltmeter. It may be used to measure positive or negative dc voltages, to measure ac voltages, to observe excursions of a voltage about a nominal value, or to measure high resistances.

3-4. Operation Precautions

a. *General.* The precautions below must be observed to insure maximum accuracy before performing the following procedures,

(1) Preliminary starting procedure (para 3-5).

(2) Procedure for desired type of operation (para 3-7).

b. Tilting Electronic Voltmeter. The voltage of the internal standard cell will temporarily change if the electronic voltmeter has been inverted. The electronic voltmeter will not be able to measure voltages within specifications until the standard cell voltage returns to its normal value. Whenever the electronic voltmeter has been tipped more than 450, allow it to remain in a normal upright position for at least 30 minutes before performing any differential voltage measurements.

NOTE

Tilting will not affect accuracy of the electronic voltmeter when used as a conventional vtvm to measure ac or dc voltages.

c. *Ground Loop Precautions.* Potential differences are often found between different points on power system grounds. The potentials may cause current to flow from the power system ground, through the electronic voltmeter and the equipment under test and back to the power system ground. These ground loop currents may affect the accuracy of the electronic voltmeter. To avoid power system ground currents, *do not* connect the shorting link between the lower input terminal and the chassis ground terminal when the system being measured is grounded.

d. Use of Shorting Link. A 0.47 micro farad capacitor (C1) is connected from the middle input terminal to the chassis ground (lower) terminal. It is possible in some cases for C1 to acquire a charge and cause inaccurate indications. *For example, C1* will become charged through leakage resistance over a period of time if there is no external connection to the input terminals and the controls are set as follows: RANGE to 500, NULL to any position, AC-de polarity to + (positive), and voltage readout dials to several hundred volts. This condition may cause an error on measurements under 5 volts. Momentarily connecting the shorting link from the chassis ground terminal to the lower input terminal will discharge C1 and prevent any inaccurate indications.

e. *Recommended NULL Control Settings for Differential DC Measurements.* The following characteristics of the electronic voltmeter must be considered if the NULL and RANGE switch settings recommended in table 3-1 for differentially measured dc voltages are not used. When the RANG E switch is set to 500, the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. The unknown voltage would therefore have to be an exact multiple of 0.01 volt to obtain a null when the NULL switch is set to .1 or .01. Also, it is unlikely that an unknown voltage of a few hundred volts will be stable within 0.01 volt. A badly fluctuating line voltage may cause the electronic voltmeter to monitor the regulation of its own 500-volt dc reference supply. For example, when differentially measuring 500 volts, a 10 percent change in line voltage may cause the

500 volt dc reference to change as much as 0.0125 volt. This would cause the VOLTS meter to deflect 1/10 full scale if the NULL switch was set to .1, or to deflect full scale if the NULL switch was set to .01.

f. Effect of AC Components on DC Measurements. The electronic voltmeter will operate well within specifications when ac components of a few hundred Hertz (Hz) are present on the unknown dc voltage being measured. Ac components which are a multiple or submultiple of 60 Hz may cause the VOLTS meter needle to oscillate at the difference frequency. For example, a 60 Hz ac voltage that is 5 percent of the input voltage may cause an error of approximately 0.01 percent (which is well within specifications). A larger ac component can be tolerated at low frequencies other than 60 Hz. Additional filtering will be required if ac components which affect the accuracy are ever encountered.

g. *Effect of Distortion When Measuring Ac Volts.* When measuring ac voltages, the electronic voltmeter indicates a value which is 1.11 times the average of the input ac waveform. This value is the same as the root-mean-square (rms) value only if the input waveform is of a single frequency. Table 3-2 shows how the presence of harmonic distortion on the input voltage may cause the indication of the electronic voltmeter to vary from the true rms value. The error depends on the phase relationship between the harmonic and the fundamental and may be anywhere between maximum positive and maximum negative, including zero.

Table 3-2. Effect of Distortion When Measuring Ac Voltages

Harmonic	Percent distortion	Percent error Maximum positive	Percent error Maximum negatiue
Any even harmonic	0.1	0.000	0.000
	0.5	0.000	0.0001
	1.0	0.000	0.005
	2.0	0.000	0.020
Third harmonic	0.1	0.033	0.033
	0.5	0.167	0.168
	1.0	0.328	0.338
	2.0	0.667	0.687
Fifth harmonic	0.1	0.020	0.020
	0.5	0.099	0.101
	1.0	0.195	0.205
	2.0	0.380	0.420

h. Ac Voltage Errors Due to Grounding. A 0.47 microfarad capacitor (C1) is connected from the lower input terminal to chassis ground within the electronic voltmeter. The chassis is in turn connected to power system ground through the power cord. If it is desired to measure an ac voltage where the lower input terminal is not at ground potential, a line cord adapter must be used to isolate the electronic voltmeter chassis from power system ground. Otherwise, the 0.47 microfarad capacitor would place an ac load on the circuit being measured.

3-5. Preliminary Starting Procedure

a. Check that power switch is in the down position (OFF).

b. Set front panel controls as follows:

(1) Set RANGE control to 500.

(2) Set AC-de polarity control to +.

(3) Set voltage readout dials A, B, C, D and E to O.

(4) Set power switch to the up position (ON).

(5) Allow *voltmeter* to warm up for 10 minutes.

3-6. Initial Adjustments

a. Advance OPERATE-CALIBRATE control against spring tension to CALIBRATE, and adjust CALIBRATE control to obtain a zero VOLTS meter needle deflection. Release OPERATE-CALIBRATE control.

NOTE

Maximum accuracy when using the voltmeter as a differential voltmeter is obtained only when the calibration of the reference supply is carefully done. The reference supply may be adjusted whenever necessary without disturbing any control settings or removing the input or output connections by repeating step *a* above.

b. Adjust the reference supply prior to each specific measurement for best accuracy until voltmeter has warmed to an equilibrium temperature (approximately one half hour).

c. Allow one hour warmup time when making prolonged measurements so that the reference supply does not shift.

3-7. Operating Procedures

a. Operation as a Conventional Dc Vtum (Accuracy Within 3 Percent of Meter Reading). Dc voltages between O and 500 volts may be measured with the electronic voltmeter used as a conventional vtvm. Perform procedure in accordance with paragraph 3-5 and proceed with the following steps:

(1) Set voltage readout dials A, B, C, D, and E to O.

(2) Set AC-dc polarity switch to + (positive).

(3) Determine input voltage range and set NULL and RANGE controls as specified in figure 3-2. Select 500 volt range if value of voltage to be measured is unknown.

(4) Connect voltage to be measured to input terminals. Connect grounded side of input to lower input terminal.

(5) Read voltage from upper or lower VOLTS meter scale as required by figure 3-2. A VOLTS meter deflection to the left indicates that polarity of dc voltage is opposite that of the input terminals as indicated by the AC-de polarity control.

(6) Set NULL switch to VTVM and disconnect voltage from input terminals.

Input voltage Range	VOLTS *Meter* Full Scale Deflection	VOLTS Meter Scale	RANGE Setting	NULL Setting
0 to 500v dc	500-0-600	Upper	500	VTVM
0 to 50v dc	50-0-50	Upper	50	VTVM
*0 to 10v dc	10-0-10	Lower	Any	10
0 to 5v dc	5-0-5	Upper	5	VTVM
*0 to 1v dc	1 -0-1	Lower	Any	1
0 to 0.5v dc	0.5-0-0.5 (500mv)	Upper	.5	VTVM
*0 to 0.1 v dc	0.1-0-0.1(100mv)	Lower	Any	.1
* O 1o O.01 v dc	0.01-0-0.01(10mv)	Lower	Any	.01

*All five voltage readout dials must be set to O to *utilize* this *range.*

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Figure 3-2. *Dc Vtum ranges.*

b. Operation as a Differential Dc Voltmeter (Accuracy Within 0.05 Percent of Voltage Readout Dials). The electronic voltmeter is used as a differential dc voltmeter by comparing the unknown voltage with a known internal voltage. When the two voltages are equal, the VOLTS meter will indicate zero. The magnitude of the internal voltage is controlled by the voltage readout dials and is indicated by the voltage dial indicators. The value of the unknown voltage may be read directly on the indicators when the VOLTS meter indicates zero. When adjusting the voltage readout dials, VOLTS meter needle deflection to the right indicates that the unknown voltage is greater than the internal voltage and the voltage readout dials should be increased. The voltage readout dials should be decreased if the VOLTS meter needle deflects to the left.

(1) Perform initial operation in accordance with paragraph 3-5.

(2) Connect unknown dc voltage to input terminals. Connect grounded side of input to lower input terminal (middle terminal).

(3) Set RANGE control to lowest position that will allow an onscale VOLTS meter deflection. Note the approximate value of unknown voltage as indicated on upper VOLTS meter scale,

(4) If VOLTS meter deflects to the left, the unknown voltage is negative. Set AC-de polarity switch to – (negative). VOLTS meter deflects to the right.

(5) Set voltage readout dials A and B to correspond to the approximate value determined in (3) above, and set dials C, D, and E to O.

Examples:	*Voltage*	*A*	*B*	*(RANGE switch)*
	492 V dc	4	9	500
	155 V dc	1	5	500
	65 V dc	0	6	500
	35 V dc	3	4	50
	2.1 V dc	2	1	5
	0.125 V dc	1	2	.5

NOTE

Set voltage readout dials slightly below the approximate value as indicated in the example.

(6) Set NULL switch to 10.

(7) Advance voltage readout dial B until VOLTS meter needle deflects to left and then back one step to return needle to right side.

(8) Set NULL control to each succeeding

lower position, adjusting voltage readout dials C through E as required to maintain zero VOLTS meter needle deflection, until the desired accuracy is obtained. Refer to table 1-2 for recommended settings to be used.

(9) Determine accurate voltage reading from voltage readout dials; be sure to note location of decimal indication.

Examples: Voltage readout dials A, B, C, D, and E indicate 3, 8, 6, 5, and 9, respectively. If the RANGE switch was on 500, the decimal indicator between C and D would be illuminated and the voltage measured would be 386.59 volts dc. If the RANGE control was on 5 and the decimal indicator between A and B illuminated, the voltage measured would be 3.8659 volts dc.

(10) Set NULL control to VTVM and disconnect voltage from input terminals.

c. *Operation as a Conventional Ac Vtum (Accuracy Within* 3 *Percent of Meter Readings).* Ac voltages between O and 500 volts may be measured with the electronic voltmeter when used as a conventional vtvm. The unknown ac voltage is converted to an equivalent dc voltage which is displayed as a root-mean-square (rms) value on the VOLTS meter. The VOLTS meter indication may be in error, as explained in paragraph 3-4, if the input voltage is not of a single frequency. Perform initial operation in accordance with paragraph 3-5 and proceed with the following steps:

(1) Set voltage readout dials A, B, C, D, and E to O.

(2) Set AC-de polarity switch to AC.

(3) Determine input voltage range and set NULL and RANGE switches as specified in figure 3-3. Select 500-volt range if approximate value of voltage to be measured is unknown.

(4) Connect voltage to be measured to input terminals. Always connect grounded side of input to lower input terminal.

(5) Read voltage from 0-500 or 0-1 scale on the VOLTS meter as required by figure 3-3. VOLTS meter will deflect to the right when measuring all ac voltages.

Input Voltage Range	VOLTS Meter Full Seal. Deflection	RANGE Setting	AC NULL MULT	.L setting
o *to* 500v 0c	0-500	500		VTVM
*o to 100v ac	o-100	500	XI00	I
o to 50v ac	0-50	50		VTVM
I* to 1O v ac	0-10	500 50	XI00 X10	,1 I
o to 5v oc	0-5	5		VTVM
* o 1o o. 1v oc	o-I	500 50 5	X100 Xlo xl	.01 .1 I
o to 0.5v ac	O - 0.5(500mv)	.5		VTVM
*o to o. lv ac	O-O.l(100mv)	50 5 .5	Xlo xl X.1	.01 .1 I
* O to o.0lv ac	O- O. 01(1Omv)	5 .5	xl X.1	,01 .1
*o to o.oolv ac	O-o.oolv ac	.5	X.1	.01

*All five voltage readout dials must be set to O to utilize this range. (Full scale is determined by multiplying the NULL switch setting by the AC NULL MULT indicated by the RANGE switch.)

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Figure 3-3. Ac utum ranges.

d. Operation as Differential A c Voltmeter Accuracy Within 0.2 Percent of Voltage Readout Dials. The electronic voltmeter is used as a differential ac voltmeter by converting the unknown ac voltage to a proportional dc voltage which is then compared with a known internal voltage, When the two voltages are equal, the VOLTS meter will indicate zero. The magnitude of the internal voltage is controlled by the voltage readout dials and is indicated by the voltage readout dial indicators. The root-mean-square (rms) value of the unknown ac voltage may be read directly on the indicators when the VOLTS meter indicates zero. The voltage readout dial indication may be in error, as explained in paragraph 3-4, if the input voltage is not of a single frequency. When adjusting the voltage readout dials, VOLTS meter needle deflection to the right indicates that the unknown voltage is greater than the internal voltage and the voltage readout dials should be increased. The voltage readout dials should be decreased if the VOLTS meter needle deflects to the left.

(1) Perform initial operation in accordance

(2) Set AC-de polarity switch to AC.

(3) Connect unknown ac voltage to input terminals. Connect grounded side of input to lower input terminal (middle terminal).

(4) Set RANGE switch to lowest position that will allow an on-scale VOLTS meter deflection. Note approximate value of unknown voltage as indicated on upper VOLTS meter scale.

(5) Set voltage readout dials A and B to correspond with the approximate value determined in (4) above, and set dials C, D, and E to O.

Examples:	*Voltage*	*A*	*B*	*(RANGE switch*
	492 Vac	4	9	500
	155 \'ac	1	5	500
	65 Vac	0	6	500
	35 Vac	3	4	50
	2.1 Vac	2	1	5
	0.125 Vac	1	2	.5

NOTE

Set voltage readout dials slightly below the appropriate value as indicated in the example.

(6) Set NULL switch to 10.

(7) Advance voltage readout dial B until VOLTS meter needle deflects to left and then back one stop to return needle to right side.

(8) Set NULL switch to each succeeding lower position, adjusting voltage readout dials C through E as required to maintain zero VOLTS meter needle deflection until the desired accuracy is obtained. Refer to table 1-3 for recommended settings to be used.

(9) Determine accurate reading from voltage readout dials; be sure to note location of decimal indication.

Examples: Voltage readout dials A, B, C, D, and E indicate 3, 8, 6, 5, and 9, respectively. If the RANGE switch was on 500, the decimal indicator between C and D would be illuminated and the voltage measured would be 386.59 volts ac. If the RANGE switch was on 5 and the decimal indicator between A and B illuminated, the voltage measured would be 3.8659 volts dc.

(10) Set NULL switch to VTVM and disconnect voltage from input terminals.

e. *Observation of Excursions of Voltage about a Nominal Value.* The electronic voltmeter can be used to observe excursions of a voltage about a given value such as the variations in the output voltage of a dc power supply. Perform initial operation in accordance with paragraph 3-5 and proceed with the following steps:

(1) Set AC-de polarity switch to desired position corresponding to voltage to be measured.

(2) Connect voltage to be monitored to input terminals. Always connect grounded side of input to lower input terminal.

(3) Set RAN GE control to lowest position that will allow an onscale VOLTS meter deflection. Note approximate value of voltage to be monitored as indicated on upper VOLTS meter scale. When monitoring a dc voltage, set AC-de polarity switch to + (positive) or – (negative) as required, to obtain VOLTS meter needle deflection to the right.

(4) Set voltage readout dials to correspond to approximate value of voltage to be observed.

(5) Set NULL control to lowest position that will allow voltage excursions to remain on scale.

(6) Read voltage excursions from lower scale of VOLTS meter. When monitoring dc voltages, full scale right and left VOLTS meter deflections are equal to the setting of the NULL control. When monitoring ac voltages, full scale right and left VOLTS meter deflections are equal to the setting of the NULL control multiplied by the AC NULL MULT indicated by RANGE control setting, Full scale ac deflections for recommended settings of the RANGE and NULL control are shown in figure 3-3. Voltage under observation has increased when VOLTS meter deflects to right, and decreased when VOLTS meter deflects to left.

Example: With the electronic voltmeter connected to a 450 volts dc power supply, and set UP to observe voltage excursions, the following indications were observed:

RANGE control set at 500
NULL control set at 10
Voltage readout dials set at 4,4, 5, 5, 0
VOLTS meter needle (varying) .2-O

This would indicate that the actual output of the dc power supply being observed was 445.5 volts dc. The excursions about the nominal were – 2 volts dc which meant that the output voltage varied from 445.5 to 443.5 volts dc. This information would be used to determine that the output was stable within 0.5 percent.

(7) Set NULL control to VTVM and disconnect voltage from input terminals.

f. Recording Voltage Excursions about a Nominal Value. Provisions to connect a recorder to the electronic voltmeter are included on the rear panel. If a recorder is to be used to record voltage excursions, carefully complete the following steps:

(1) Select a recorder with at least 10,000 megohms leakage resistance to ground. An isolation amplifier with at least 10,000 megohms resistance to ground may be used to adapt the electronic voltmeter to recorders with excessive leakage resistance.

CAUTION

Do not ground the RECORDER OUTPUT terminals of the electronic voltmeter or the recorder input terminals, Accuracy of the electronic voltmeter will be completely degraded,

(2) Connect recorder to RECORDER OUTPUT terminals of electronic voltmeter,

(3) Perform initial operation in accordance with paragraph 3-5.

(4) Check for excessive leakage as follows:

(a) Connect a dc voltage to input of electronic voltmeter and differentially measure its potential (para 3-7 *b*).

(b) Alternately connect and disconnect recorder leads from RECORDER OUTPUT terminals of electronic voltmeter while observing VOLTS meter. More than one small scale division deflection indicates that excessive leakage to ground has been introduced by the recorder and will degrade the accuracy of the electronic voltmeter.

(c) Disconnect dc voltage from input terminals.

(5) Adjust electronic voltmeter controls as follows:

(a) Set RANGE control to 50.

(b) Set NULL control to 10.

(c) Set AC-de polarity control to + (positive).

(d) Set Voltage readout dials to 10,000.

(6) Short electronic voltmeter input terminals together. VOLTS meter will deflect full scale.

(7) Adjust electronic voltmeter GAIN ADJ control (fig. 2-2) to obtain desired recorder deflection corresponding to fun-scale deflection of electronic voltmeter

(8) Remove short from electronic voltmeter input terminals.

(9) The electronic voltmeter and recorder are now ready for combined use. Proceed as instructed in paragraph 3-7 e.

g. Measurement of High Resistance. The electronic voltmeter may be used to measure high resistances between 1 and 250,000 megohms. In this application, a known voltage (E), indicated by the voltage readout dials, is applied to a series circuit consisting of the unknown resistance (Rx), and the input resistance (10 megohms) of the voltmeter circuit. The voltage (Em) across the 10 mehohm resistance is indicated by the VOLTS meter. The value of the unknown resistance may be exactly determined from the following equation:

$$Rx \text{ (megohms)} = 10 \left(\frac{E}{Em} - 1 \right)$$

Proceed with the following steps to rapidly determine the value of an unknown resistance:

(1) Perform initial operation in accordance with paragraph 3-5.

(2) Set RANGE switch to 500 and NULL switch to 10.

(3) Connect unknown resistance to input terminals of electronic voltmeter. Use short isolated leads to prevent measuring leakage resistance between leads.

(4) Adjust voltage readout dials to obtain full-scale deflection of VOLTS meter (meter will deflect left). Set NULL switch to 1 or .1 if full scale deflection cannot be obtained with NULL control set to 10. Determine value of unknown resistance as shown in table 3-3 when fullscale deflection is obtained.

(5) If full-scale deflection cannot be obtained, set NULL control to .1 and voltage readout dials to maximum. Note the VOLTS meter indication on lower scale, full scale is 0.1 volt. Determine unknown resistance from the following equation:

$$Rx \text{ (megohms)} = 10 \frac{E}{Em}$$ where:

Rx is the unknown resistance

E is the voltage indicated by the voltage readout dials

Em is VOLTS meter indication.

Example: Voltage readout dials A, B, C, D and E are set to 4, 9, 9, 9, 10, VOLTS meter needle is on .34. This information could be used to determine that E is 500, Em is 0.034, and that Rx is 143,000 megohms.

(6) Disconnect resistance from input terminals.

Table 3-3, Measurement of High Resistance

Range of unknown resistance	*NULL setting*	*To obtain ualue of resistance in megohms*
1 to *500* megohms	10	Subtract 10.00 from setting of voltage readout dials.
500 to 5,000 megohms	1	Subtract 1.00 from setting of voltage readout dials and multiply result by 10.
5,000 to 50,000 megohms	.1	Multiply setting of voltage readout dials by 100.

Section Ill. OPERATION UNDER UNUSUAL CONDITIONS

3-8. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of electronic equipment. Instructions and precautions for operation under such adverse conditions follow.

a. Handle equipment carefully.

b. Keep equipment warm and dry. If electronic voltmeter is not kept in a heated inclosure, construct an insulated box for the equipment.

c. Make certain the equipment is warmedup sufficiently before attempting to use it. This may take 10 to 15 minutes, depending on the temperature of the surrounding air.

d. When equipment which has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room temperature. When the electronic voltmeter has reached room temperature, dry it thoroughly.

3-9. Operation in Tropical Climates

When operated in tropical climates, electronic equipment may be installed in tents, huts, or, where necessary, underground dugouts. When equipment is installed below ground, and when it is set up in swamp areas, moisture conditions are more acute than normal in the tropics, Ventilation usually is very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the ambient air. To minimize this condition, place lighted electric bulbs under the equipment,

3-10. Operation in Desert Climates

The main problem with equipment operation in desert areas is the large amount of sand and dust that enters the moving parts of the equipment. Therefore, cleaning and servicing intervals shall be shortened according to local conditions.

CHAPTER 4

OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section 1. OPERATOR AND ORGANIZATIONAL TOOLS AND EQUIPMENT

4-1. Tools and Test Equipment

Tools and test equipment authorized for use by the operator and organizational repairman for the ME-202(*)/U are listed in section III of appendix C of this manual.

4-2. Special Tools and Test Equipment

There are no special tools or test equipment required for operator and organizational maintenance.

4-3. Lubrication Instructions

There are no lubrication requirements.

Section 11. OPERATOR AND ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-4. General

To insure that the ME-202(*)/U is always ready for operation, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed and described in tables 4-1, 4-2, and 4-3. The item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit will be noted for future correction to be made as soon as operation has ceased, Stop operation immediately if a deficiency is noted during operation which would damage the equipment. Record all deficiencies together with the corrective action taken as prescribed in TM 38-750.

4-5. Scope of Operator's and Organizational Maintenance

a. General.

(1) Operator preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to maintain the equipment in serviceable condition. Operator preventive maintenance is performed daily and weekly; specific procedures are provided in table 4-1.

(2) Organizational preventive maintenance is performed on a monthly and quarterly basis; specific procedures are provided in tables 4-2 and 4-3.

(3) The preventive maintenance checks and services described in tables 4-1, 4-2 and 4-3 outline inspections to be made at specific intervals and are designed to help maintain equipment in serviceable condition. They indicate what items should be checked and how they should be checked.

(4) Organizational maintenance consists of preventive maintenance, troubleshooting (table 4-4) and replacement of authorized repair parts.

(5) Defects that cannot be corrected must be reported to personnel at a higher maintenance category. Records and reports of repair and preventive maintenance must be made in accordance with procedures given in TM 38-750.

b. Preventive Maintenance Checks and Service Periods. Preventive maintenance checks and services for an operating electronic voltmeter are required on a daily and weekly (table 4-l), a monthly (table 4-2), and a quarterly basis (table 4-3). These checks must be performed during the specified intervals. In addition, the daily checks and services must be performed under the special conditions listed below:

(1) When electronic voltmeter is initially installed.

(2) When the electronic voltmeter is returned after higher category maintenance repair.

(3) At least once each week if the electronic voltmeter is maintained in a standby condition.

Table 4-1. Operator/Crew Preventive Maintenance Checks and Services

D-Daily
Time required: 2.0

W-Weekly
Time required: 0,8

Interval and Sequence No. D	W	Item to be inspected procedure	Work time (M/H)
1		COMPLETENESS ('heck that equipment is complete.	0.1
2		EXTERIOR SURFACES Clean the exterior surfaces, including the panel and meter glass. Check the meter glass and indicator lenses for cracks.	0.1
3		CONNECTORS Check the tightness of all connectors.	0,1
4		CONTROLS AND INDICATORS \While performing the operating checks, observe that the mechanical action of each knob and switch is smooth and free of external or internal binding, and that there is no excessive looseness. Also check the meter for stuck or bent pointer.	0.2
5		OPERATION" During operation, he alert for any unusual performance or condition.	1.5
	1	CABLES Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, stripped, or torn excessively.	0.1
	2	HANDLE Inspect handle for looseness. Replace or tighten as necessary	0.1
	3	METAL, SURFACES Inspect exposed metal surfaces for rust, and corrosion. Clean and touch up paint as required.	0.4
	4	BATTERY AND COMPARTMENT Inspect the battery for loose terminals and leakage. Check the compartment for corrosion.	0.2

Table 4-2. *Organizational Preuentive Maintenance Checks and Services (Monthly)*

M-Monthly
Total manhours required: 1.5

Sequence No.	Item to be inspected procedure	Work time (M/H)
1	PLUCKOUT ITEMS Inspect the seating of pluckout items. Make certain that tube clamps grip tube bases tightly.	0.4
2	TRANSFORMER TERMINALS Inspect the terminals on the power transformer. All nuts must be tight. There should be no evidence of dirt or corrosion.	0.1
3	TERMINAL BLOCKS Inspect the terminal blocks for loose connections and cracked or broken insulation.	0,1
4	RESISTORS AND CAPACITORS Inspect the resistors and capacitors for cracks, blistering, or other deterimental defects.	0.5
5	INTERIOR Clean the interior of the chassis and cabinet.	0.1
6	JACKS Inspect jacks for snug fit and good contact.	0.1
7	GASKETS AND INSULATORS Inspect gaskets, insulators, bushings and sleeves for cracks, snipping, and excessive wear.	0.2

Table 4-3. Organizational Preventive Maintenance Checks and Services (Quarterly)

Q-Quarterly
Total manhours required: 0.3

Sequence No.	Item to be inspected procedure	Work time (M/H)
I	PUBLICATIONS See that all publications are complete. serviceable, and current (DA Pam 310-4).	0,1
2	MODIFICATIONS Check DA Pam 310-7 to determine if new applicable MWO'S have been" published. ALL URGENT MWO's must be applied immediately. All NORMAL MWO'S must be scheduled.	0.1
3	SPARE PARTS ('heck all spare parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	0.1

4-6. Cleaning

a. Exterior of Equipment. Inspect the exterior of the equipment. The exterior surfaces should be free of dust, dirt, grease, and fungus.

(1) Remove the dust and the loose dirt with a clean soft cloth.

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame, Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

(2) Remove the grease, fungus, and ground-in dirt from the case; use a cloth dampened (not wet) with trichloroethane.

(3) Remove the dust or dirt from the plugs and the jacks with a brush.

CAUTION

Do not press on the meter face (glass) when cleaning; the meter may become damaged.

(4) Clean the front panel, the meter, and the control knobs; use a soft, clean cloth. If dirt is difficult to remove, dampen the cloth with water; mild soap may be used for more effective cleaning.

b. Interior of Equipment. Perform the procedures given in (1) through (5) below to remove the dust and any foreign matter and to prevent leakage.

(1) Remove the two securing screws at the rear of the electronic voltmeter and pull the chassis out of the case.

(2) Blow out the dust and any foreign matter from the electronic voltmeter with a low-pressure dry air blower. Be sure that the binding posts, the wiring, and all the switches are completely free of dust and foreign matter.

(3) Clean the binding posts, the insulators, and the front panel with a rag saturated in anhydrous denatured ethyl alcohol.

CAUTION

Use only anhydrous denatured ethyl alcohol when cleaning the insulators of the switches. Other cleaning solvents may react with the insulating material in these switches.

(4) When necessary, wash the exposed insulating material of all switches with a small, stiff, bristled brush and the anhydrous denatured ethyl alcohol.

(5) After washing, recoat the exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 50 and 200 centistokes (10 percent solution of 100 viscosity grade Dow Corning 200 in anhydrous denatured ethyl alcohol). This solution will prevent any leakage due to moisture on these surfaces. Do not apply grease or other lubricants to switch wafers.

4-7. Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB 746-10.

Section III. TROUBLESHOOTING

4-8. Visual Inspection

When the equipment fails to operate properly, turn off the power and check for the conditions listed below. Inspection will save repair time and may also avoid further damage. Do not check any item with the power on.

a. Wrong settings of switches and controls.

b. Damaged, disconnected, or poorly connected power cord.

c. Burnt-out fuse. (This condition usually indicates some other fault.)

4-9. Troubleshooting

The troubleshooting chart (table 4-4) provides a procedure for the systematic check of equipment by the organizational repairman. All the corrective measures that can be performed are given in the Corrective action column. When using the troubleshooting chart, follow each step in the order given. If the corrective measures indicated do not restore the equipment performance, troubleshooting is required by a higher maintenance repair category. Note on the repair tag how the equipment performed and the corrective measures that were taken.

Table 4-4, Organizational Troubleshooting

Malfunction	*Probable cause*	*Corrective action*
1. Decimal indicator lamps do not light.	Defective lamps, or defective fuse F1.	Replace defective lamp(s) (para 4-1 la). If no lamps light, replace fuse F1.
2. CALIBRATE control has no effect on VOLTS meter needle.	Defective chopper.	Check for a slight buzzing sound: if there is no buzzing, chopper must be replaced by general support maintenance personnel.
3. VOLTS meter needle deflects more than one-tenth of full scale when controls are set as follows: RANGE 500 NULL .1 Voltage readout dials 49000	Dirt in circuit board connectors or in switch contacts causing excessive electrical leakage.	Clean instrument to remove contamination.
4. VOLTS meter needle deviates from zero when controls are set as follows: RANGE .5 NULL .01 Voltage readout dials o	ZERO ADJ control improperly set.	Adjust ZERO ADJ control R227 (para 4-llb).

Section IV. ORGANIZATIONAL MAINTENANCE OF ELECTRONIC VOLTMETER ME-202(*)/U

4-10. Replacement of Fuse

If the electronic voltmeter is completely inoperative, the fuse is probably defective. Replace the defective fuse with a new one. If the new fuse blows when power is applied, repair at higher maintenance level is required. Replace the fuse as follows:

a. Turn the fuseholder cap on the rear panel counterclockwise to unlock the cap.

b. Pull out the fuseholder cap and the defective fuse.

c. Remove the defective fuse and replace it with a new one.

4.11. VOLTS Meter Zero Adjustment

The electrical zero of the VOLTS meter may require adjustment as indicated by the troubleshooting tables, or when changing from 60-Hz to 400-Hz input power, Proceed as follows:

a. Connect the electronic voltmeter to a 115-volt source. If the electronic voltmeter is wired for 230-volt operation, connect to a 230-volt source.

b. Mechanically zero VOLTS meter control with mechanical adjustment screw on meter case.

c. Set ON switch to ON and allow at least a 20 minute warmup.

d. Set controls as follows:

(1) RANGE–.5.

(2) NULL– .01.

(3) Voltage readout dials – 0.

e. Adjust ZERO ADJ, R227, for zero VOLTS meter deflection. R227 is in the lower right corner of the printed circuit board on the left side of the cabinet when facing the front panel and is accessible through the ventilation holes in the cabinet. Use an insulated screwdriver to prevent accidental shorting to ground.

CHAPTER 5

FUNCTIONING OF EQUIPMENT

Section 1. BLOCK DIAGRAM ANALYSIS

5-1. General
(fig. 5-1)

Electronic Voltmeter ME-202 (*)/U is a precision voltmeter used to accurately measure ac or dc potential between O and 500 volts, It basically consists of a dc vacuum tube voltmeter (vtvm, a O- to 500-volt dc reference, a null and range divider, an ac-to-dc converter, and a low voltage supply. These units are shown in the block diagram and are discussed in a through e below. The electronic voltmeter functions as a conventional vtvm when the NULL switch is set to VTVM, and as a differential voltmeter when the NULL switch is set to 10, 1, .1, or .01. The functioning of the electronic voltmeter is presented in paragraphs 5-2 through 5-6. The explanation is supported by block diagrams and partial schematic diagrams. See figure FO-6 for a complete schematic diagram of the electronic voltmeter.

a. Dc Vtum. The dc vtvm indicates the difference between the input voltage and the O- to 500-volt dc reference in the electronic voltmeter mode. In the vtvm mode, the dc vtvm indicates the value of the unknown voltage directly on the VOLTS meter.

b. O- to 500-volt Dc Reference. The O- to 500-volt dc reference is obtained from a 500-volt dc power supply and a voltage divider. The 500-volt power supply is a conventional series-regulated supply with a single regulation stage. The output of the supply is set to 500 volts by using the dc vtvm to compare a precise sample of the output voltage with the voltage of standard cell B 1. The 500-volt power supply also provides B + to the ac-to-dc converter.

c. *Null and Range Divider.* The null and range divider selects the magnitude of input voltage to the de vtvm. The output of the divider is controlled by the RANGE and NULL switches.

d. Ac-to-Dc Converter.The ac to dc converter converts all ac input voltages to a dc voltage which is proportional to 1.11 times the average value of the input waveform. If the input ac is of a single frequency, the dc output of the converter will be proportional to the root-mean-square (rms) value of the input. The converter provides a dc output of 5 volts when full range voltage is applied to the electronic voltmeter in each range. The output of the converter is applied to the dc vtvm in the vtvm mode of operation, or compared to O- to 500-volt dc reference in the differential voltmeter mode.

e. *Low Voltage Supply.* The low voltage supply provides B + to the dc vtvm and filament voltage as required.

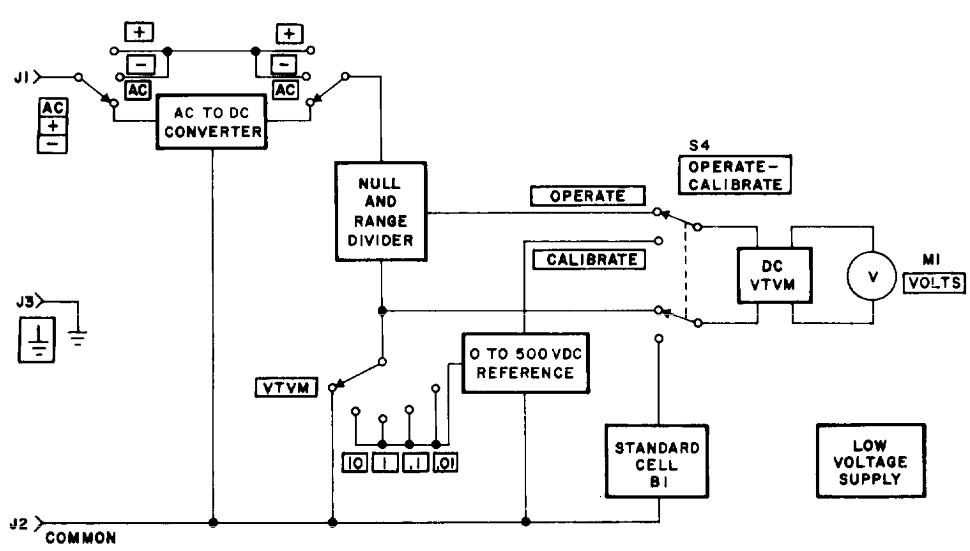

Figure 5-1. Electronic Voltmeter ME-202(*)/'U, block diagram.

5-2. Description of Operating Modes

a. Dc Measurements (fig. 5-2).

(1) *Dc vtvm mode.* The electronic voltmeter operates in the dc vtvm mode when the NULL switch is set to VTVM and the AC-de polarity switch is set to + (positive) or — (negative). Levels B and C of NULL switch S3 connect null and range divider R301 through R310 to the input terminals. The output of the null and range divider is 0.010 volt when a voltage corresponding to the RANGE switch setting is applied to the input terminals. RANGE switch S2C applies the output of the null and range divider to the dc vtvm where the value of the unknown voltage is indicated directly on the VOLTS meter, Full scale deflection of the VOLTS meter corresponds to the setting of the RANGE switch. The VOLTS meter will deflect to the right if the polarity of the voltage at the input terminals is as indicated by the AC-de polarity switch, VOLTS meter MI is a zero center meter. Therefore, the setting of the AC-de polarity switch is not critical in the dc vtvm mode. Levels A and B of AC-de polarity switch S5, are used to reverse the polarity of VOLTS meter M I to obtain meter deflection to the right before proceeding to the dc differential mode of operation.

(2) *Dc differential mode.* The electronic voltmeter operates in the dc differential mode when the NULL switch is set to 10, 1, .1, or .01, and the AC-de polarity switch is set to + (positive) or – (negative). Levels B and C of null switch S3 connect null and range divider R305 through R310 and the O- to 500-volt dc reference to the input terminals. Levels D and C of AC-de polarity switch S5 control the polarity of the O- to 500-volt dc reference to be in opposition to the input volt age, The difference between the input voltage and the O- to 500-volt dc reference is developed across the null and range divider. NULL switch S3A applies the output of the null and range divider to the dc vtvm where the difference between the unknown voltage and the O- to 500-volt dc reference is displayed on the VOLTS meter. Full scale deflection of the VOLTS meter corresponds to the setting of the NULL switch. Levels A and B of AC-de polarity switch S5 control the polarity of the VOLTS meter, The meter needle will deflect to the right when the input voltage is greater than the O- to 500-volt dc reference. The unknown voltage is measured by adjusting the value of the O- to 500-volt dc reference until the VOLTS meter indicates zero deflection. The unknown voltage is then equal to the reference voltage indicated on the front panel voltage readout dials. Capacitor Cl is connected between the common input terminal and chassis ground to bypass eddy currents from the power transformer. Level E of AC-de polarity switch S5 connects 88 megohms resistance in parallel with C 1 when differentially measuring negative dc voltages to prevent charge accumulation on Cl from affecting accuracy.

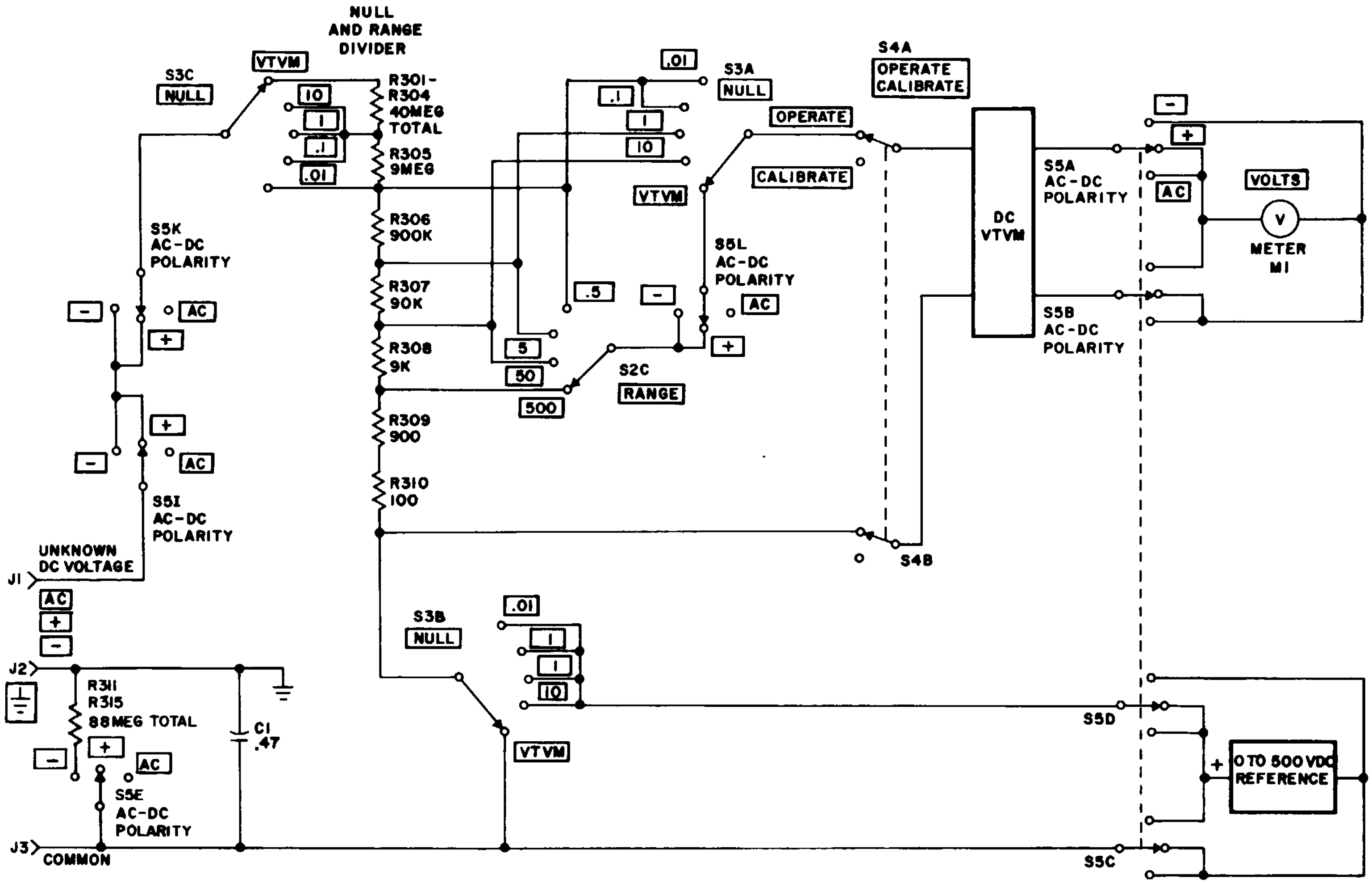

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Figure 5-2. Dc measurements circuit, simplified schematic diagram.

b. *Ac Measurements* (fig. FO-2).

(1) *Ac utum mode.* The electronic voltmeter operates in the ac vtvm mode when the NULL switch is set to VTVM and AC-de polarity switch is set to AC. Levels I and K of AC-de polarity switch S5 connect the ac-to-dc converter to the input terminals. The ac-to-dc converter provides an output of 5 volts dc when the maximum voltage for each range is applied to the input terminals. Levels B and C of NULL. switch S3 apply the output of the ac-to-dc converter to null and range divider R301 through R31O. A fixed output (1/500) of the null and range divider is selected by S5L and applied to the dc vtvm, VOLTS meter MI deflects to the right and indicates the value of the unknown voltage directly. Full scale deflection corresponds to the setting of the RANGE switch.

(2) *Ac differential mode.* The electronic voltmeter operates in the ac differential mode when the NULL switch is set to 10, 1, ,1, or .01, and the AC-de polarity switch is set to AC. Levels I and K of AC-de polarity switch S5 connect the ac-to-dc converter to the input terminals. The ac - to-dc converter provides an output of 5 volts dc when the maximum voltage for each range is applied to the input terminals. Levels B and C of NULL switch S3 connect null and range divider R301 through R31O and an opposing O- to 5-volt dc reference to the converter output. The O- to 5-volt dc reference is obtained from the 500-volt dc reference supply by levels C, D, G, and H of AC-dc polarity switch S5. The difference between the converter output and the reference voltage is developed across the null and range divider. NULL switch S3A selects the output of the null and range divider and applies it to the dc vtvm where the difference between the converter output and the reference is displayed on the VOLTS meter. Full scale deflection of the VOLTS meter corresponds to the setting of the NULL switch multiplied by the AC NULL MULT indicated by the position of the RANGE switch. The VOLTS meter deflects to the right when the converter output is greater than the reference voltage. The unknown voltage is measured by adjusting the value of the reference voltage until the VOLTS meter indicates zero deflection. The unknown voltage is then equal to the reference voltage indicated on the front panel readout dials.

Section II. CIRCU IT FUNCTIONING

5-3. Dc Vtvm (fig. 5-3)

a. General. The dc vtvm consists of a drift-free dc amplifier and a meter. The input voltage is converted to a square wave by a chopper and passed through three stages of voltage amplification. The amplified square wave is synchronously rectified by the chopper and applied directly to the VOLTS meter. The amplifier stages use high negative current feedback to increase stability and to reduce changes in gain as characteristics of individual tubes change due to aging. For full-scale deflection, a 0.010 volt input signal will cause 100 microampere to flow through the VOLTS meter.

b. Operation. The input is passed through double section low pass filter R201, C201, R202, and C202. Voltage limiter V201 prevents an overvoltage from being applied to the dc vtvm. Resistors R225, R226, ZERO ADJ R227, and Capacitor C213 electrically zero VOLTS meter MI by maintaining the input at zero potential with respect to the filaments of V202 and V203. The input voltage is applied to the grid of V202 by R203, C203 and R204. Cathode bias for V202 is developed by R207 and C205. The output of V202 is developed across R206 and coupled to V203A by C208. Resistor R212 is the plate load for * V203A. The output of V203A is coupled to V203B by C21O and R214. Negative current feedback from the cathode of V203B is coupled to the cathode of V202 by R211. The output of V203B is developed across R215 and coupled to VOLTS meter Ml by C211. When chopper CK1 provides a contact across pins 1 and 7 during time tl, the output of V203B flows through M 1 and feedback resistors R218 and R219. The voltage actually applied to the grid of V202 then is the difference between the input voltage and the feedback voltage. The amount of feedback voltage and the net gain of the three amplifier stages is adjusted by VTVM GAIN ADJ, R219. Resistor R230 is connected in parallel with R218 and R219 by S3D and S5J to increase the net gain of the three amplifiers in the .O1-ac null range. This compensates for the change in output impedance of the ac-to-dc converter when NULL switch S3C is set to .01. (See figure FO-2.) When chopper CK1 provides a contact across pins 6 and 7 during time t2, R217 effectively shorts the output of V203B. The chopper therefore acts as a synchronous rectifier by allowing only negative going pulses from the output of V203B during time t1 to be applied to VOLTS meter M1. Capacitor C212 filters the pulses obtained from V203B. Levels A and B of AC-de polarity switch S5 control the polarity of VOLTS meter M 1. The rectified output of V203B is also applied to RI, R222, and R223. The voltage across GAIN ADJ control R1 is available at RECORDER OUTPUT jacks J4 and is proportional to the deflection of VOLTS meter M 1. A maximum of 0.020 volt, corresponding to full-scale deflection, is available. Back-to-back diodes CR202 and CR203 will conduct to prevent any overvoltage accidentally applied at J4 and J5 from damaging meter Ml. Capacitor C215 filters out any ac noise introduced at J4 and J5.

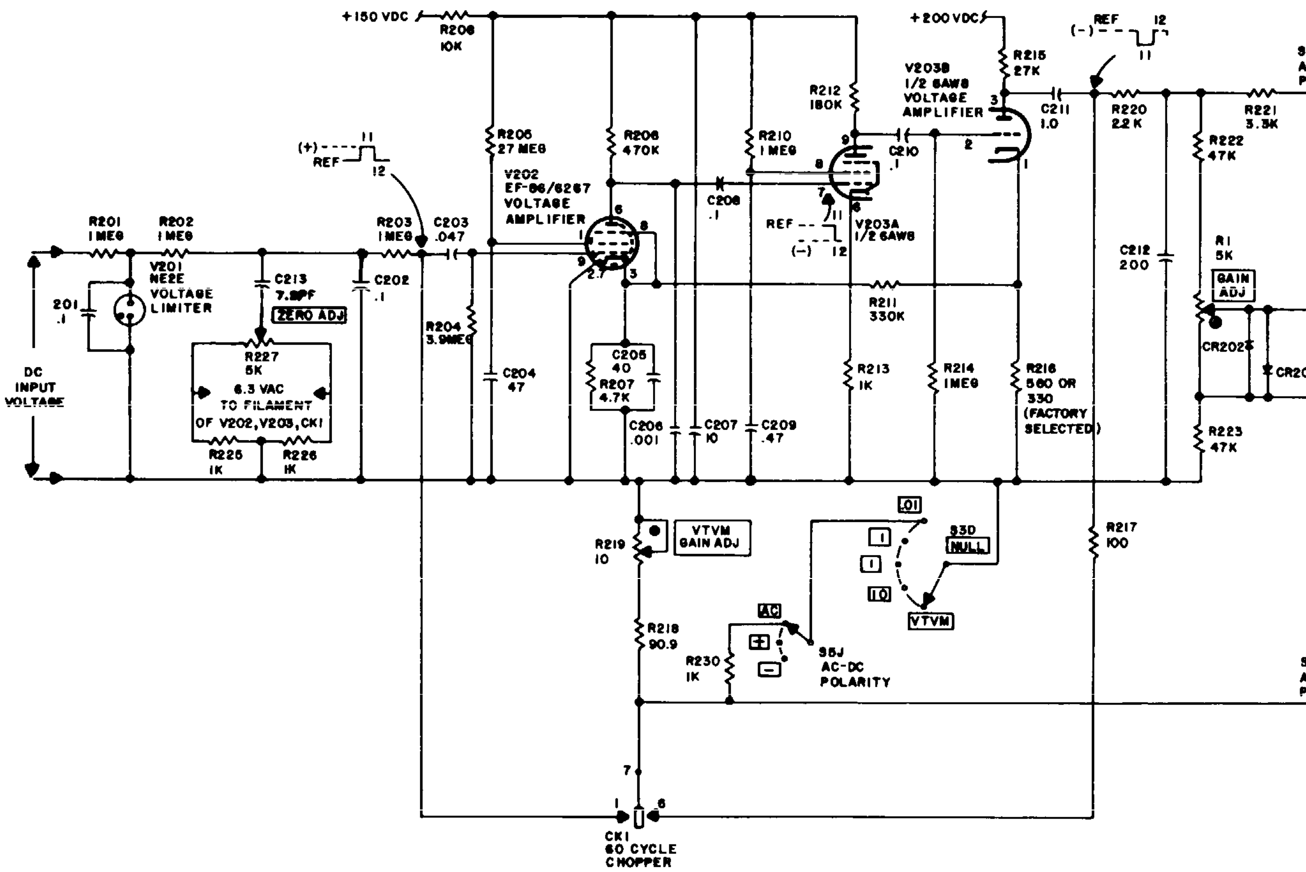

Figure 5-3. Dc vtvm, simplified schematic diagram.

5-4. Reference Supply, O- to 500-Volt Dc

a. Block Diagram (fig. 5-4). The O- to 500-volt dc reference supply consists of a 500-volt dc reference supply, a reference voltage range divider and a precision voltage divider. The 500-volt dc reference supply is a conventional series regulated power supply with single stage regulation, It is calibrated by comparing a portion of the output with the voltage of a standard cell. The reference range voltage divider uses resistor divider networks to obtain voltages of 50, 5, and 0.5. These voltages are selected by the RAN GE switch and applied to the precision voltage divider which divides the input reference voltage into 500 equal steps.

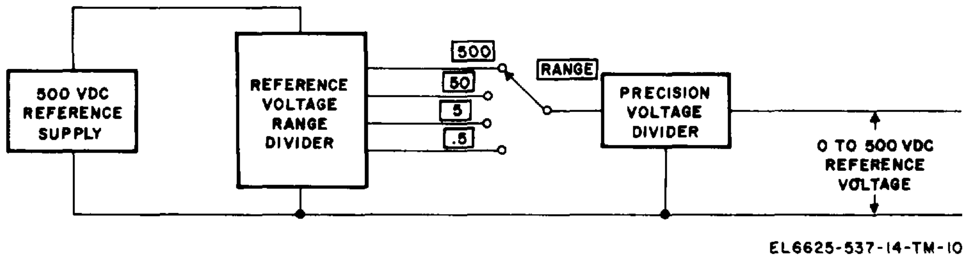

Figure 5-4. 0- to 500- volt dc reference supply, block, diagram.

b. 500- *Volt Dc Reference Supply* (fig. FO-3]. Voltage from a 284 volt secondary winding of power transformer T1 is converted to approximately 700 volts pulsating dc by a half-wave voltage doubler. During the positive half cycle, CR101, CR102, and CR103 conduct to charge C 101 to the peak output voltage of the secondary. During the negative half-cycle, CR106 and CR107 conduct to charge C102. Resistors R109 and R110 maintain equal voltages across C101 and C102 to prevent dielectric breakdown. The voltage applied to the plate of series passing tube V101 is the total of the voltages across C101 and C102. The grid of series passing tube V 101 is controlled by differential amplifiers V104 and V105. Amplifier V104 compares the voltage of reference tube V102 with a sample of the output voltage obtained from divider string R123, C106, R124, R121 and CALIBRATE R2. The output voltage sample, along with the output of the power supply, is adjusted by CALIBRATE control R2. Capacitor C106 in the divider string decreases the sensitivity of the regulator circuit to very rapid changes in output voltage to prevent oscillation within the supply. The outputs of V104 are applied to a second differential amplifier V 105. Plate voltage for one-half of V 105 is obtained directly from the output voltage of the power supply. Plate voltage for the other half of V 105 is obtained from the unregulated dc through dropping resistors R114, R118, and R119. Capacitor C105 and resistor R 119 act as the plate load. Regulator V103 will conduct to prevent the entire unregulated dc voltage from being applied to V105 if V101 ever fails. The output of V105 is applied to the control grid of series passing tube V101. Voltage divider R102 and R101 maintains the filaments of V101 and V105 at approximately 400 volts dc to prevent breakdown within the tubes. The output of the power supply is set to 500 volts by comparing a precise sample of the output voltage, obtained from divider string R316, R317, REF CAL ADJ R318, and R319, with the voltage of standard cell B1. In the CALIBRATE position, levels A and B of OPERATE-CALIBRATE switch S4 connect the dc vtvm to indicate the difference between the standard cell voltage and the divider string. REF CAL ADJ R318 allows the divider string to be calibrated. When properly adjusted, the output of the 500 -volt dc reference supply is 500 volt dc (+0.2). Regulation of the power supply is ±0.0025 percent for a 10-percent change in line voltage.

c. *Reference Voltage Range Divider* (fig. 5-5). The reference voltage range divider consists of resistance divider networks selected by RANGE switch S2F and AC-de polarity switch S5G. For the dc mode of operation, the output of the reference voltage range divider is 500, 50, 5, or 0.5 volts as determined by the setting of the RANGE switch. Level E of RANGE switch S2 connects the selected voltage divider resistor string to the output of the 500-volt dc reference supply and level F connects the selected divider string to the precision voltage divider. When RANGE switch S2 is set to 500, the output of the 500-volt dc reference supply is directly connected to the precision voltage divider and R322 is connected across the output of the power supply to maintain a minimum load on the power supply. Resistors 50 VDC ADJ R323, 5 VDC ADJ R326, and 0.5

VDC ADJ R329 adjust the output level for the 50, 5, and 0.5-volt ranges, respectively, In the ac mode of operation, levels G and H of AC-de polarity switch S5 bypass RANGE switch S2 and fix the output of the reference voltage range divider at 5 volts.

d. Precision *Vo/tage Divider* (fig. 5-5). The precision voltage divider divides the output of the reference voltage range divider (500, 50, 5, or 0.5 volts) into 500 equal increments. The precision voltage divider consists of five Kelvin -Varley decade resistor strings, R401 through R449, and switches S6 through S1O. The position of switches S6 through S 10 is indicated by voltage readout dials A through E, respectively, on the front panel. The strings connected to S7, S8, S9, and S 10 parallel two resistors of the preceding string. Between the two wipers of S6 then, there is a total resistance of 40K (80K paralleled by 80 K). If 500 volts is applied to the precision voltage divider, a total of 100 volts will then appear across the wipers of S6, 10 volts across the wipers of S7, 1.0 volt across the wipers of S8, O.. volt across the wipers of S9, and 0.01 volt across each resistor selected by S1O. The wirewound resistors comprising the precision voltage divider are matched to provide an overall divider accuracy of 0.01 percent. A filter consisting of R331 and C301 or C302 is connected across the output of the precision voltage divider by level D of RANG E switch S2 to eliminate any electrical noise introduced by the wirewound resistors in the precision voltage divider and reference voltage range divider,

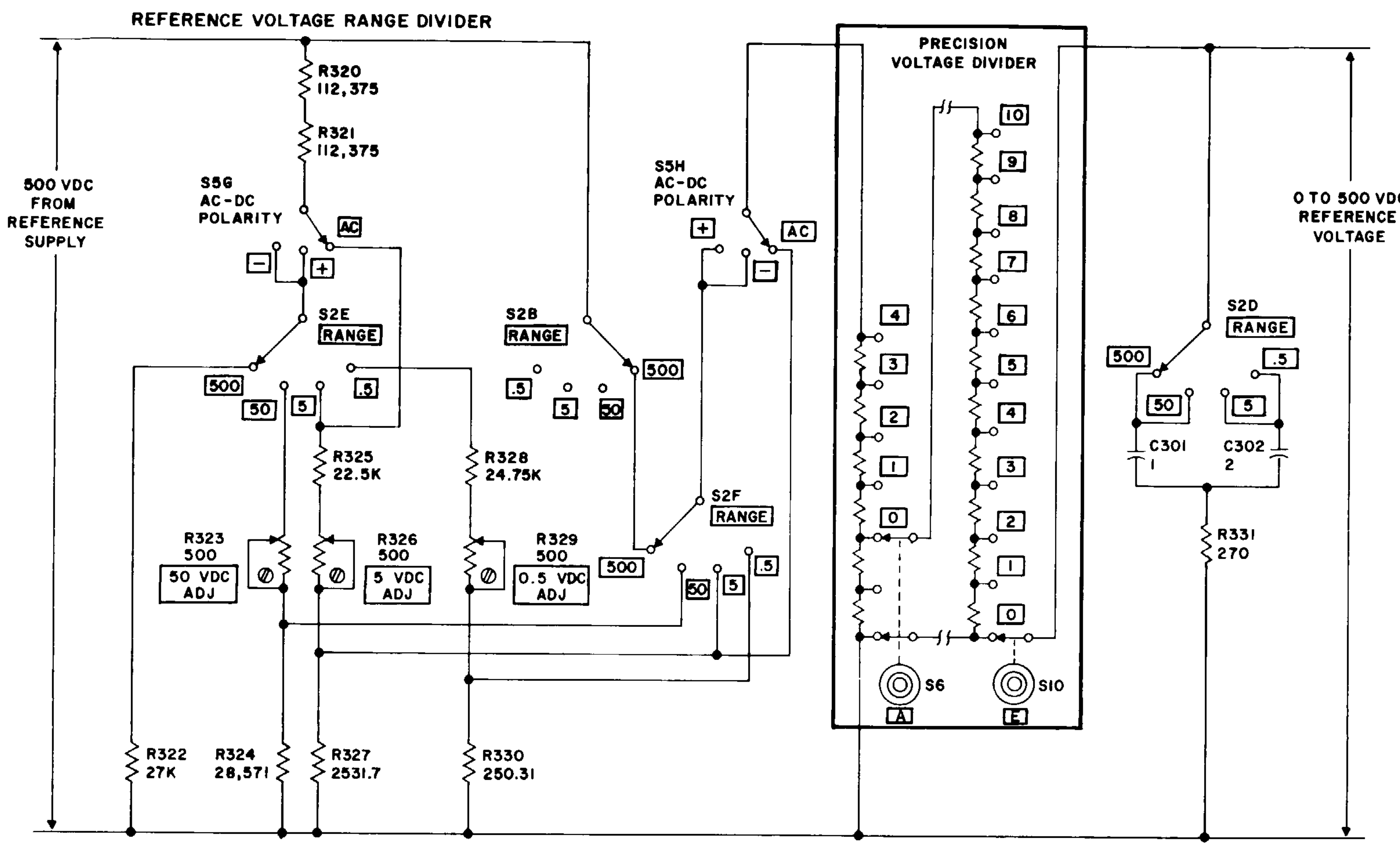

Figure 5-5. Reference voltage range divider and precision voltage divider, simplified schematic diagram.

5-5. Ac-to-Dc Converter (fig. FO-4)

a. General. All ac voltages measured by the electronic voltmeter are first converted to an equivalent dc voltage by the ac-to-dc converter. Levels I and K of AC-de polarity switch *S 5* connect the converter between the input terminal and the null and range divider. The converter provides a dc output of 5 volts when full range voltage is applied to the input terminals in each range. The dc output voltage is proportional to the average value of the applied ac voltage. The output is calibrated to indicate the rms value of a pure sinewave (single frequency ac voltage). The converter consists of three resistance-capacitance-coupled amplifier stages with high negative feedback. Input attenuators and predetermined amounts of negative feedback are used to obtain a dc output of 5 volts when full range voltage is applied to the input terminals in each range.

b. Amplifier Operation. Tubes V501, V502A, and V502B form three resistance-capacitance-coupled amplifier stages with high negative feedback. The input is applied to the grid of V501 by C503, C504, R504, and R505. Cathode bias for V501 is developed by R513 and C522. The output of V501 is coupled to the grid of V502A by R514, C508, R515, C509, R518, and R519. Cathode bias for V502A is developed by R522, C513, R523, and C514. The output of V502A is coupled to the grid of V502B by R524, C511, R525, C512, R526, and R527. The grid of V502B is clamped to the common input terminal by CR503. Negative feedback from the plate of V502B is applied to the cathode of V502A by R532. The output of V502B is coupled through C516. Full-wave rectification is provided by CR501 and CR502 to develop a voltage across R539 which is applied a negative feedback to the grid of V501. The amount of feedback is selected by level I of RANGE switch S2. Half-wave rectification by CR501 develops an output voltage across R536 through R539, C517, and C518 which is proportional to the average value of the input ac voltage. The amplifier achieves a midband loop gain of approximately 70 decibels dB with a virtually flat frequency response from 20 Hz to 10 kHz.

c. *Converter Operation, .5- Volt Ac Range.* Levels G and H of RANGE switch S2 connect the input voltage directly to the amplifier. Operation of the amplifier is explained in *b* above. A negative feedback network, consisting of C519, R540, and C520, selected by S21 allows sufficient overall gain so that a 5-volt dc output will be obtained when 0.5 volt ac is applied to the input terminals. The output of the converter at 400 Hz is adjusted by 0.5 VAC GAIN ADJUST R536 at the converter output. The converter output at 10 kHz is adjusted by 0.5 VAC HF TRIM C519 in the feedback network.

d. Converter Operation, 5- Volt Ac Rang{ Levels G and H of RANGE switch S2 connect the input voltage directly to the amplifier. Operation of the amplifier is explained in *b* above. The negative feedback network selected by S21 consists of R541, R542, and C521. This feedback network is also used for the 50 and 500 positions of RANGE switch S2. The output of the converter at 400 Hz is adjusted by 5 VAC GAIN ADJ R541 in the feedback network, The converter output at 10 kHz *is* adjusted by 5 VAC HF trim C504 in the grid circuit of V501. The output of the converter is 5 volts dc when 5 volts ac is applied to the input terminals.

e. *Converter Operation, 50- Volt Ac Range.* Level G of RANGE switch S2 connects the input terminal to 10:1 attenuator R501, R502, R503, C501, R544, and C502. The attenuator output is applied to the amplifier by S2H. The attenuator output at 400 Hz is adjusted by 50 VAC AT. TENUATOR R503. At 10 kHz the output is adjusted by 50 VAC HF TRIM C501. The attenuator output will be 5 volts ac when 50 volts ac is applied to the input terminals. Operation of the amplifier is as explained in *b* and *d* above to obtain a 5 volt dc output from the converter.

f. Converter Operation, 500- Volt Ac Range. Level G of RANGE switch S2 connects the input terminal to 100:1 attenuator R543, R533, R535, R534, C523, C524, and C525. The attenuator output is applied to the amplifier by S2H. The attenuator output at 400 Hz is adjusted by 500 VAC ATTENUATOR R534. At 10 kHz the output is adjusted by 500 VAC HF TRIM C523. The attenuator output is 5 volts ac when 100 volts ac is applied to the input terminals, Operation of the amplifier is explained in *b* and *d* above to obtain a 5-volt dc output from the converter.

5-6. Low Voltage Supply (fig. 5-6)

a. General. The low voltage supply provides positive 200 and 150 volts dc to the dc vtvm, and filament voltage for all tubes and the decima, point indicator lamps.

b. Input Power, The power transformer primary contains two windings. These windings are parallel connected for 115-volt operation, and series connected for 230. volt operation. Terminals on top of the transformer are used to connect the primary windings. The primary circuit is controlled by ON switch S1 and protected by a fuse. A 1.5-ampere fuse is used for 115-volt operation, and a 0.25-ampere fuse is used for 230-volt operation.

c. *Positive 200- and 150-Volt Supply.* Positive 00 and 150 volts for the dc vtvm is obtained from a 190-volt secondary winding. The ac voltage is half-wave rectified by CR201 and filtered by R228, R229, C214A, and C214B, Positive 200 volts for V203B is obtained directly from the anode of CR201, Positive 150 volts for V202 and V203A is obtained from the plate of regulator V204.

d. Reguluted Filament Supply. An 18-volt center tapped winding is used to provide a regulated 5.9-volt dc supply for the filaments of V501 and V502 in the ac-to-dc converter, and for V104 in the 500-volt dc reference supply. The ac voltage is full-wave rectified by CR103 and CR104 and filtered by C103. Transistor Q3 senses the difference between the dc output voltage and a reference voltage obtained from V102 in the 500. volt dc reference supply, The output of Q1 is applied to the base of Q2. A positive going signal on the base of Q2 will cause the internal resistance of Q2 and Q3 to increase. When the output voltage is higher than normal, Q1 will become forward biased causing the voltage drop across Q3 to increase and restore the voltage to normal. The regulated output voltage is between 5.6 and 6.1 volts and will vary no more than 0.020 volt for an input voltage change of 102 to 128 volts.

e. *Unregulated Filament Supply.* There are three unregulated filament supplies. A 6.3-volt secondary winding provides filament voltage to V202, V203 and chopper CK1 in the dc vtvm. A 5-volt secondary winding is used to light the decimal indicator lamp (PL1 through PL4) selected by level A or RANGE switch S2. A second 6.3-volt winding (not shown in figure 5-6) provides filament voltage for V101 and V105 in the 500-volt dc reference supply. The filaments of these tubes are operated at approximately 400 volts dc potential to prevent internal high-voltage breakdown.

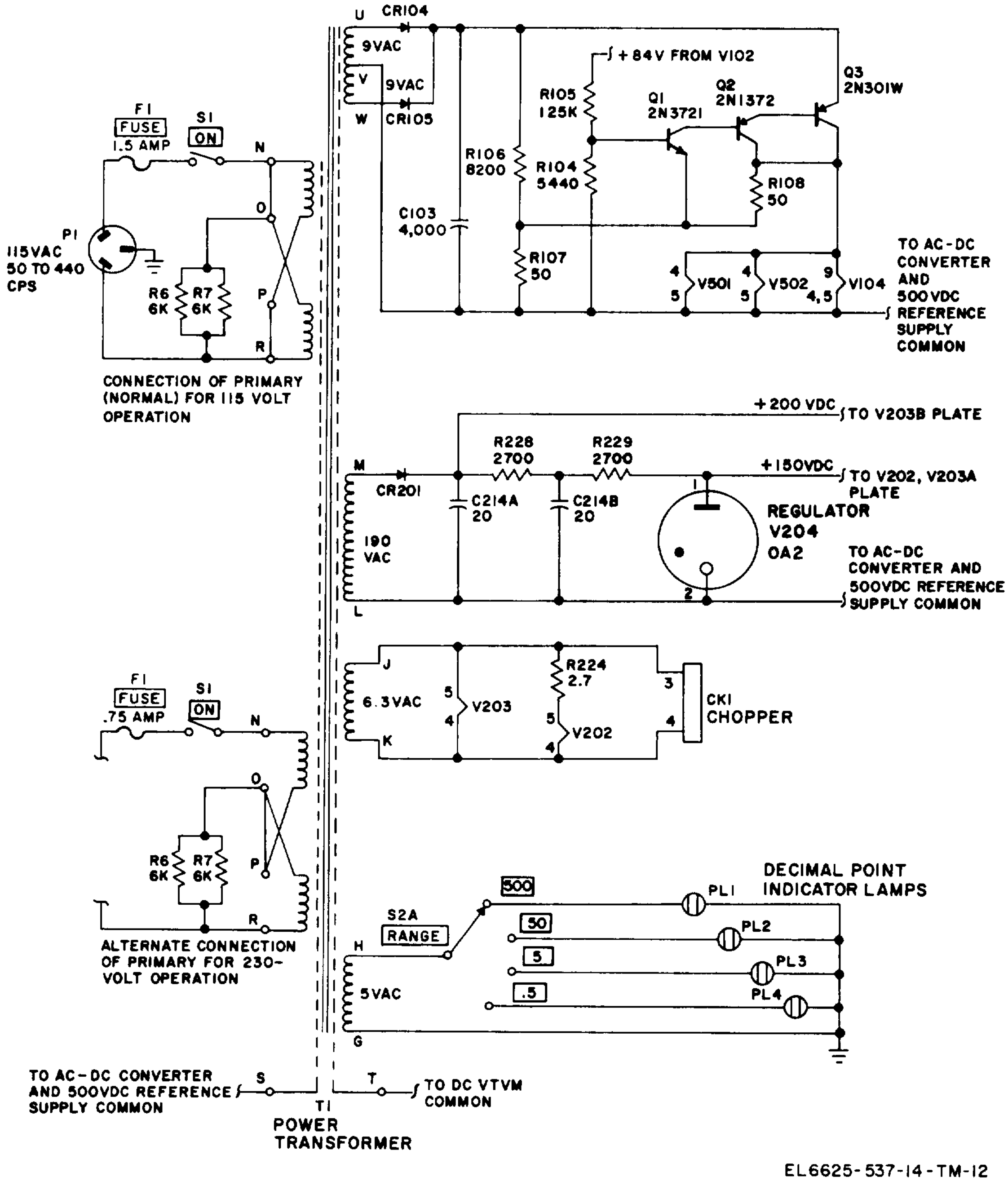

Figure 5-6. Low voltage power supply, simplified schematic diagram.

CHAPTER 6

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section 1. GENERAL

6-1. Scope

The procedures for troubleshooting and maintenance of the electronic voltmeter are contained in subsequent sections of this chapter. Where applicable, the procedures include instructions for making voltage and resistance measurements and instructions for replacing components when the procedure is not obvious.

WARNING

Be extremely careful when servicing the electronic voltmeter with the case removed, Voltages in the range of 800 volts are present in the 500-volt dc reference supply. All metal components on the dc vtvm printed circuit board will be at or near the potential indicated by the voltage readout dials. Always disconnect the power cord and discharge the filter capacitors before performing any servicing procedures.

6.2. Voltage and Resistance Measurements

Use resistor, inductor, and capacitor color codes (fig. FO-1) or the complete schematic diagram (fig. FO-6) to determine component values and compare them with readings taken. Normal voltage and resistance measurements at tube and transistor sockets are contained in (fig. FO-5). Dc resistance data for the power transformer are listed in (fig. 6-l).

CAUTION

This equipment contains transistors. Observe all precautions given to prevent transistor damage. Be careful when making voltage and resistance measurements. Use tape or sleeving to insulate the entire test prod, except the extreme tip. A momentary short circuit can ruin a transistor. (*For example,* if the bias were shorted out, excessive current between the base and emitter would ruin the transistor.)

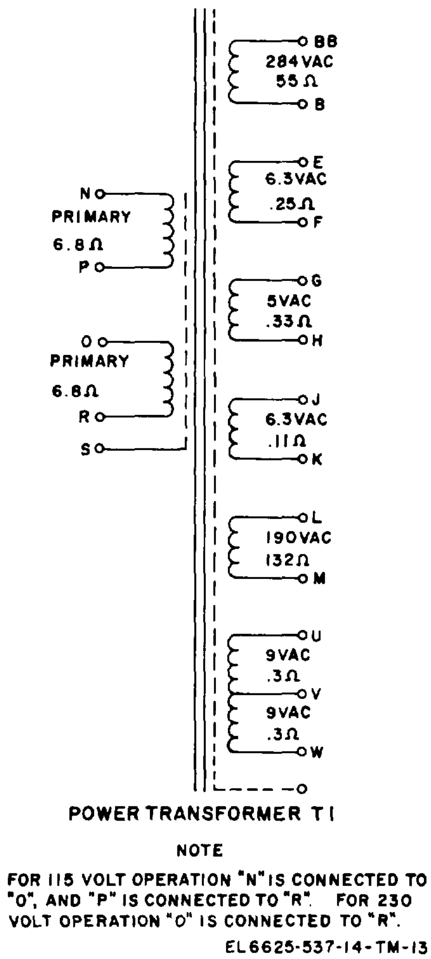

Figure 6-1. Power transformer winding dc resistance data.

Section II. GENERAL SUPPORT TOOLS AND EQUIPMENT

6-3. Common Tools and Test Equipment for General Support

Tools, test equipment, and accessories authorized for use by general support maintenance personnel for the electronic voltmeter are listed in the Maintenance Allocation Chart in appendix C.

6-4. Special Tools and Equipment for General Support

No special tools and equipment are required for general support maintenance.

Section III. TROUBLESHOOTING

6-5. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective electronic voltmeter is to sectionalize the fault by tracing the fault to the circuit responsible for the abnormal operation. The second step is to localize the fault by tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned out resistors and arcing or shorted transformers, can often be located by sight, smell, or hearing. The majority of faults however must be isolated by checking voltagea and resistances.

b. *Sectionalization.* The electronic voltmeter can be divided into four circuits; the dc vtvm, the O- to 500-volt dc reference, the ac-to-dc converter, and the low voltage supply. The first step in tracing trouble is to locate the circuit at fault by the following methods:

(1) *Visual inspection.* Visual inspection is used to locate faults with testing or measuring circuits. All meter readings or other indications should be observed and analyzed in an attempt to isolate the fault to a particular circuit. An understanding of the operation of the electronic voltmeter is particularly helpful when analyzing a fault.

(2) *Operation tests.* Operational tests frequently indicate the general location of trouble. In many instances the tests will help to determine the exact nature of the fault,

c. *Localization.* After the trouble has been sectionalized to a particular circuit, the next step is to localize the specific component or components responsible for the improper operation. The tests listed below will aid in isolating the trouble.

(1) Troubleshooting chart. The symptoms listed in the troubleshooting chart (table 6-1) will aid in isolating the fault to a specific component.

(2) *Intermittent troubles.* The possibility of intermittent troubles should not be overlooked when trying to isolate faults. Intermittent troubles can often be made to appear by gently tapping or jarring the equipment. Wiring and internal connections are typical sources of intermittent troubles.

6-6. Troubleshooting Sequence

Troubleshooting of the electronic voltmeter is accomplished using the overall schematic diagram (fig. FO-6), the voltage and resistance measurements (fig. FO-5), and the troubleshooting chart (table 6-1). Component locations are shown in figures 6-2 through 6-12. Man y troubles in the electronic voltmeter can be quickly isolated by scanning the list of symptoms in the troubleshooting chart.

6-7, Troubleshooting Chart

The troubleshooting chart (table 6-1) lists probable causes corresponding to malfunction indications noted during operational checks. Voltage and resistance measurements should be used to supplement the troubleshooting chart and isolate the trouble to a particular part.

NOTE

When the probable cause for malfunction cannot be isolated during operational checks, the reference to ' 'out of calibration" indicates that a higher level of maintenance is required, and that the equipment should be returned to the depot for maintenance.

Table 6-1, Troubleshooting

Malfunction	*Probable cause*	*Corrective action*
1. Power fuse F1 blown	a. Improper fuse installed	*a.* Insure that correct jumpers are installed on power transformer terminals and that proper fuse is installed (fig. 5-6).
	b. Short within instrument	*b.* Make resistance reading at the following points. Readings below the values noted in figure FO-5 are indications of short circuits.

Table 6-1. Troubleshooting-Continued

Malfunction	*Probable cause*	Corrective action
		Check wiring for shorts and loose connections. Power transformer winding dc resistance data is given in figure 6-1. *Tube* — *Pins* Viol — 4,5 V105 — 4,5,9 V202 — 4,5 V203 — 4,5 V501 — 4 V502 — 4
2. Calibrate control must be continually reset: 500 volt dc reference supply is drifting.	a. V102, V104, or V105 faulty.	a. Check V102, V104, and V105 by replacement. Some output voltage drift may be noted when replacing V104 or V105. This drift will normally disappear after the tube has aged a bit. When replacing V 102, use a type OG3 tube which has been aged for at least 150 hours, to obtain stable operation,
	b. One of the sampling string resistors (R123, R124) is changing valve rapidly as the electronic voltmeter warms up,	*b.* Locate faulty resistor (fig. FO-4) by heating slightly with a warm soldering iron held near the resistor. Hold OPERATE-CALIBRATE switch at CALIBRATE and observe VOLTS meter indication while heating resistor. Replace faulty resistor.
3. VOLTS meter cannot be nulled by adjusting CALIBRATE control while OPERATE-CALIBRATE switch is held at CALIBRATE.	a. Out of calibration........	*a.* Refer to depot maintenance personnel.
	b. One of the sampling string resistors (R123, R124, *or* R121) has shifted in value.	*b.* Observe stability by periodically setting OPERATE-CALIBRATE switch to CALIBRATE and noting VOLTS meter deflection. Replacement of resistor is not necessary if 500-volt dc reference supply remains stable.
4. VOLTS meter cannot be nulled by adjusting 500 VDC ADJ R121 (fig. 6.7) during calibration.	Excessive aging of V 102	Check V 102 by replacement. Use a type OG3 tube which has been aged at least 150 hours.
5. Differential measurements are out of tolerance on one dc range other than the 500-volt range,	A resistor on the reference range divider printed circuit board is out of tolerance.	Replace faulty resistor (fig. 6-8), *Range* — *Resistor* 50 — R324 5 — R325 or R327 .5 — R328 or R330
6. Measurements are out of tolerance on all ac ranges and on the 50-, 5-, and .5-volt dc ranges.	R320 or R321 has shifted in value (fig. 6-8).	Replace faulty resistor.
7. Measurements are out of tolerance on any range when voltage readout dialas are set to any position other than 49 99&	One of the resistors in the precision voltage divider is out of tolerance,	Perform precision voltage divider fault isolation {para 6-8).
0. Voltmeter is out of specification on all vtvm ranges.	a. Dc vtvm out of calibration.	*a.* Refer to depot maintenance personnel.
	b. Faulty resistor in null and range divider string (R301 through R31O).	b. Check and replace faulty resistor,
9. VOLTS meter cannot be eat for zero deflection by adjusting VTVM ZERO ADJ R227.	*a.* Moisture or dirt on printed circuit boards or switches.	a. Clean instrument (para 4-6).
	b. Faulty component	*b.* Locate faulty component by performing voltage and resistance measurements on terminals of V202 and V203. See figure FO-5 for nominal values.

Table 6-1. Troubleshooting–Continued

Malfunction	*Probable cause*	Corrective action
	c. V202 or V203 faulty	c. Check V202 and V203 by replacement.
	d. Chopper CK1 faulty	d. Check CK1 by replacement.
10. VOLTS meter cannot be set for full scale deflection by adjusting VTVM GAIN ADJ R219.	*a.* V202 or V203 faulty	*a.* Check V202 by V203 by replacement.
	b. Chopper CK1 faulty	*b.* Check CK 1 by replacement.
	c. Faulty component	c. Locate faulty component by performing voltage and resistance measurements on terminals of V202 and V203. See figure FO-5 for normal value.
11. Meter rattle, drift, or error is observed on all null ranges.	a. V202 or V203 faulty	*a.* Check V202 or V203 by replacement.
	b. Chopper CK1 faulty	*b.* Check chopper by replacement.
	c. Moisture or dirt on printed circuit boards or switches.	c. Clean instrument (para 4-6).
12. Measurements are out of tolerance on 500-vok ac range only.	a. Out of calibration	*a.* Refer to depot maintenance personnel.
	b. One or more resistors in 500-volt ac attenuator (R543, R533, R535) has shifted in value.	*b.* If attenuator does not remain stable, locate and replace faulty resistor.
13. Measurements are out of tolerance on 50-volt ac range only.	*a.* Out of calibration	*a.* Refer to depot maintenance personnel.
	b. One or more resistors in 50-volt ac attenuator (R501, R544, R502) has shifted in value.	*b.* If attenuator does not remain stable, locate and replace faulty resistor.
14. Measurements are out of tolerance on all ac ranges,	*a.* Out of calibration	*a.* Refer to depot maintenance personnel.
	b. V501 or V502 faulty	*b.* Check V501 and V502 by replacement.
	c. Faulty component	c. Locate faulty component by taking voltage and resistance measurements at pins of V501 and V502. See figure FO-5 for normal values.
15. Measurements out of tolerance at a specific frequency.	*a..* Out of calibration	*a.* Refer to depot maintenance personnel,
	b. Faulty frequency compensation capacitor.	*b.* Locate and replace faulty capacitor. *Affected range* — *Capacitor* All — C504 500 only — C523, C524, C525 50 only — C501 , C502 500, 50, and 5 — C521 .5 only — C519, C520
16. Continuity exists between common input terminal and chassis ground terminal.	Moisture or dirt accumulation within instrument.	Clean instrument (para 4-6).
17. Filament voltage for V104, V501, and V502 is not within 5,6 and 6.1 vdc.	Transistor Q1, Q2, or Q3 defective.	Isolate faulty transistor by performing voltage measurements at transistor terminals. See figure FO-5 for normal voltage values.
18. Filament voltage for V104, V501, and V502 varies more than 0.020 Vdc as line voltage is varied.	V102 faulty. .	Check V 102 by replacement. Use a type OG3 which has been aged for at least 150 hours.
19. Voltage at pin 7of Viol (unregulated dc for 500-volt dc reference supply) is not within 685 and 869 volts.	*a.* Faulty component	*a.* Locate faulty component by performing resistance measurements at pins 7, 9, and 2 of V101 and pin 1 of V104. See figure FO-5 for normal values.
	b. V101 faulty.	*b.* Check V101 by replacement.

Table 6-1. Troubleshooting-Continued

Malfunction	*Probable cause*	*Corrective* action
20. Voltage at pin 3 of V101 (series regulator output) is not within 470 and 530 volts dc.	a. Faulty component	a. Adjust .500 VDC ADJ R121 and CALIBRATE control. If voltage at pin 3 at V101 cannot be set to .500 volts, locate faulty component by performing voltage and resistance measurements on terminals of V101. V102. V104, and 1'105. See figure FO-.5 for normal values.
	b. V101 faulty	b. Check V101 by replacement,
21. Voltage at pin 3 of V101 (regulated output of 500-volt dc reference supply) varies more than 0.025 volt dc as line voltage is varied.	V102 or V104 faulty	("heck \102 and V104 by replacement. Use a type 0G3 which as been aged 150 hours when replacing V102.
22. Voltage at pin 3 of V1OI (regulated output of 500-volt dc reference supply) is erratic while chassis is being tapped.	V101, VI02, VI04, or V105 is microphonics.	Isolate faulty tube by gently tapping, Replace faulty tube.
23. Ripple voltage at pin 3 of V101 (regulated output of 500-volt dc reference supply) is greater than 0,003 volt ac.	Faulty component	Check components in rectifier filter network.
24. Voltage at pin 5 of V204 (B+ to dc vtvm) is not within 140 and 168 volts dc.	a. Short within instrument	*a.* Locate faulty component by performing voltage and resistance measurements on terminals of V202, V203. and V204
	h. V204 faulty	b. Check V204 by replacement,
25. Voltage at pin 5 of V204 (B+ to dc vtvm varies more than 3 volts dc as line voltage is varied.	V204 faulty	Check V204 by replacement,
26. Ripple voltage at pin 5 of V204 (B+ to dc vtvm) is greater than 0,015 volt ac.	Faulty component	Check CR201 , R228, R229, C214A, and C214B in rectifier filter network,
27 Random excursions of VOLTS meter needle are greater than one-quarter small scale division.	Moisture or dirt on printed circuit boards or switches.	Clean instrument (para 4-6).
28. VOLTS meter excursions are greater than one-quarter small scale division as line voltage is varied.	*a.* V204 faulty ***b.*** V202 or V203 faulty c. CK 1 faulty	*a.* Check V204 by replacement. *b.* Check V202 and V203 by replacement. c. Check CK1 by replacement.
29. \'OLTS meter needle deflects more than one-tenth full scale when controls are set as follows: RANGE 500 NULL .01 Voltage readout dials 490.00	Moisture or dirt on printed circuit boards.	Clean instrument (para 4-6).
30. VOLTS meter needle deflects more than six small scale divisions when controls are set as follows: RANGE .5 NULL .01 Voltage readout dials 0. AC-de polarity AC	Moisture or dirt on printed circuit boards or switches.	Clean instrument (para 4-6)
31. VOLTS meter does not deflect within one-half small scale division of full scale to left when AC-de polarity switch is set to – sign (negative) after deflecting full scale to right with AC-de polarity switch set to + (positive).	VOLTS meter movement out of adjustment.	Zero VOLTS meter needle by adjusting mechanical adjustment screw on meter face. Replace VOLTS meter if mechanical adjustment has no effect.

Table 6-1. Troubleshooting–Continued

Malfunction	*Probable cause*	*Corrective action*
32. REF CAL ADJ R318 cannot be adjusted to null VOLTS meter.	***a.*** Faulty resistor in calibration sampling string R316 through R319.	***a.*** Check and replace faulty resistor.
	b. Faulty standard cell R1	b. Check standard cell for between 1.0190 and 1.0196 volts. Replace if voltage is out of tolerance. CAUTION Use only a null type meter to avoid damaging the standard cell. The standard cell is isolated from all internal circuits by the OPERATE-CALIBRATE switch, The plug to the standard cell should be removed before performing any voltage or resistance measurements on the OPERATE-CALIBRATE switch to pre. vent accidental shorting and damage to the cell, NOTE Normal- service life of the standard cell is 8 to 15 years. End of service life is usually marked by an increase in temperature hysteresis effect. That is, reading errors in excess of 0.025 percent will result when the same voltage is read when the differential voltmeter is cold and at normal operating temperature

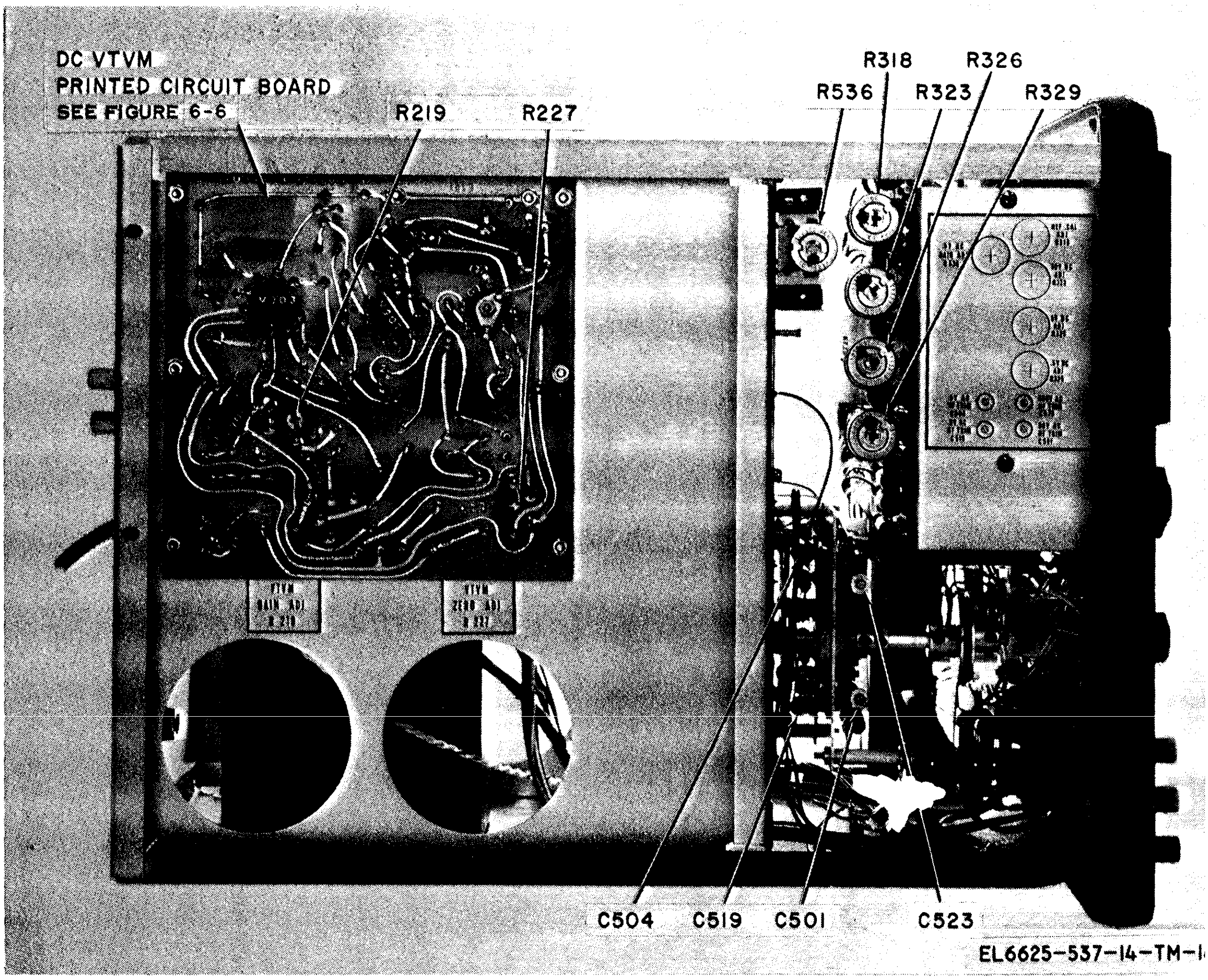
DC VTVM
PRINTED CIRCUIT BOARD
SEE FIGURE 6-6
R219
R227
R318
R326
R536
R323
R329
C504
C519
C501
C523
EL6625-537-14-TM-1

Figure 6-2.

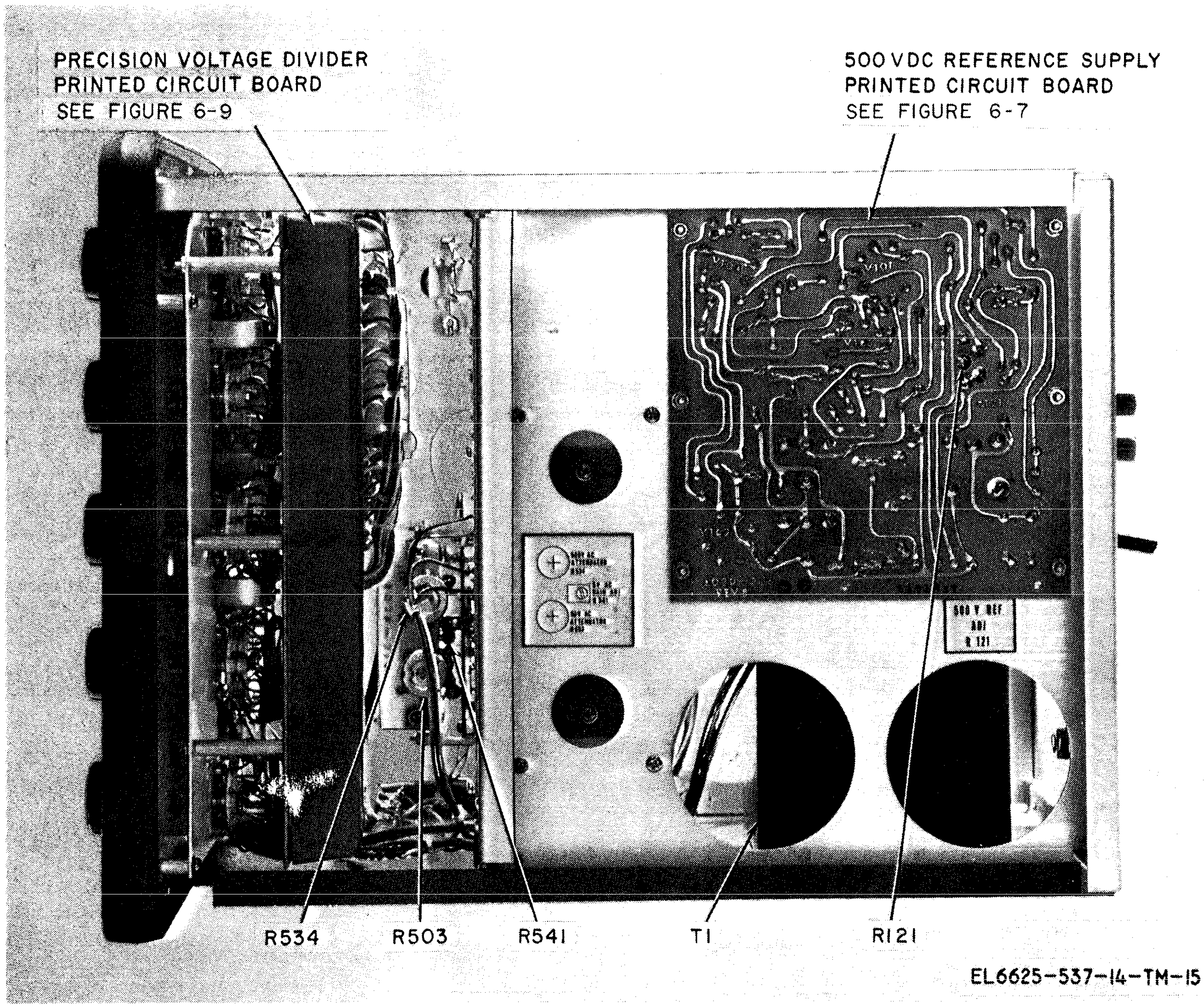
PRECISION VOLTAGE DIVIDER
PRINTED CIRCUIT BOARD
SEE FIGURE 6-9
500 VDC REFERENCE SUPPLY
PRINTED CIRCUIT BOARD
SEE FIGURE 6-7
R534
R503
R541
T1
R121
EL6625-537-14-TM-15

Figure 6-3.

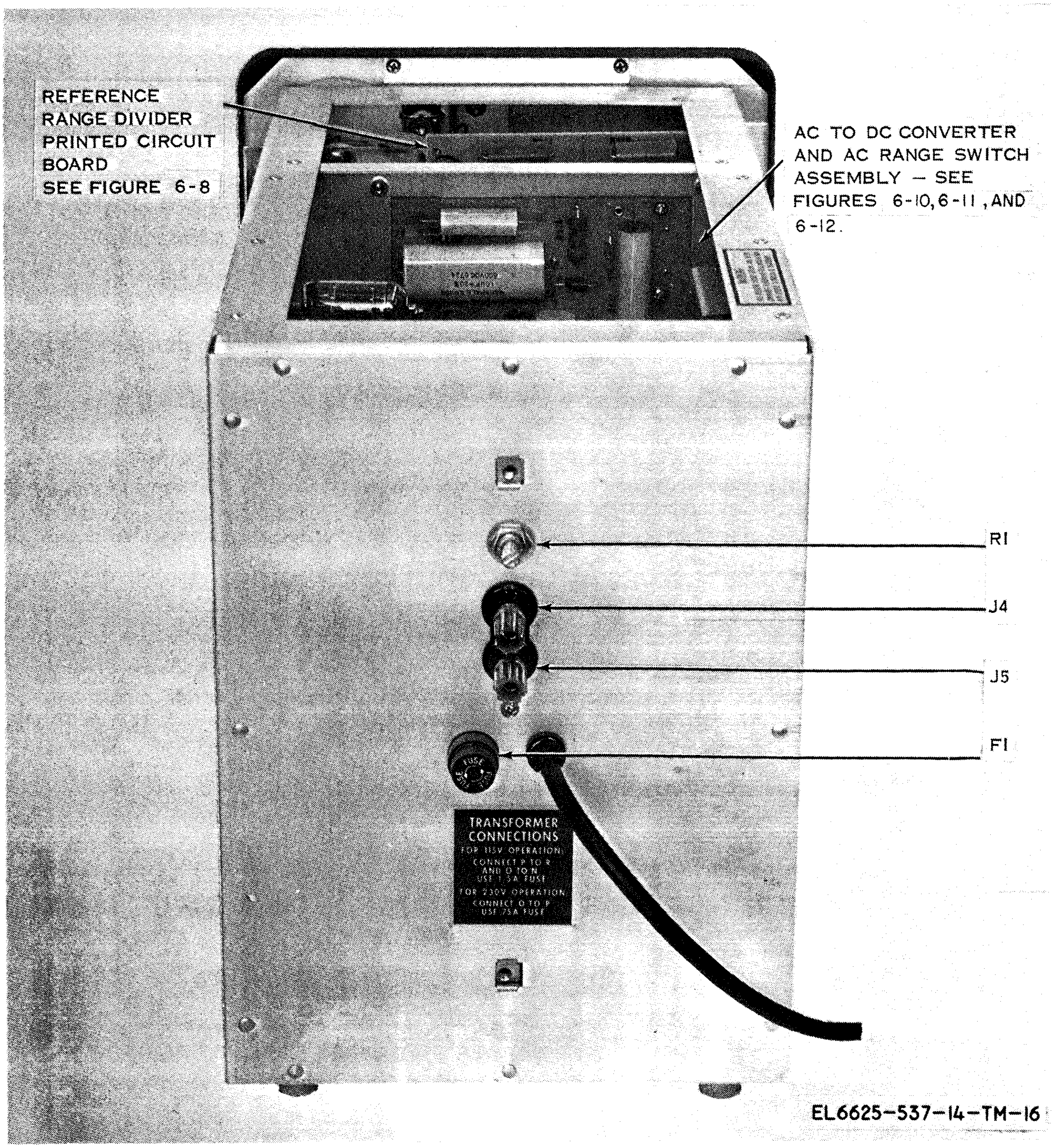

Figure 6-4. Electronic voltmeter, rear view showing component location.

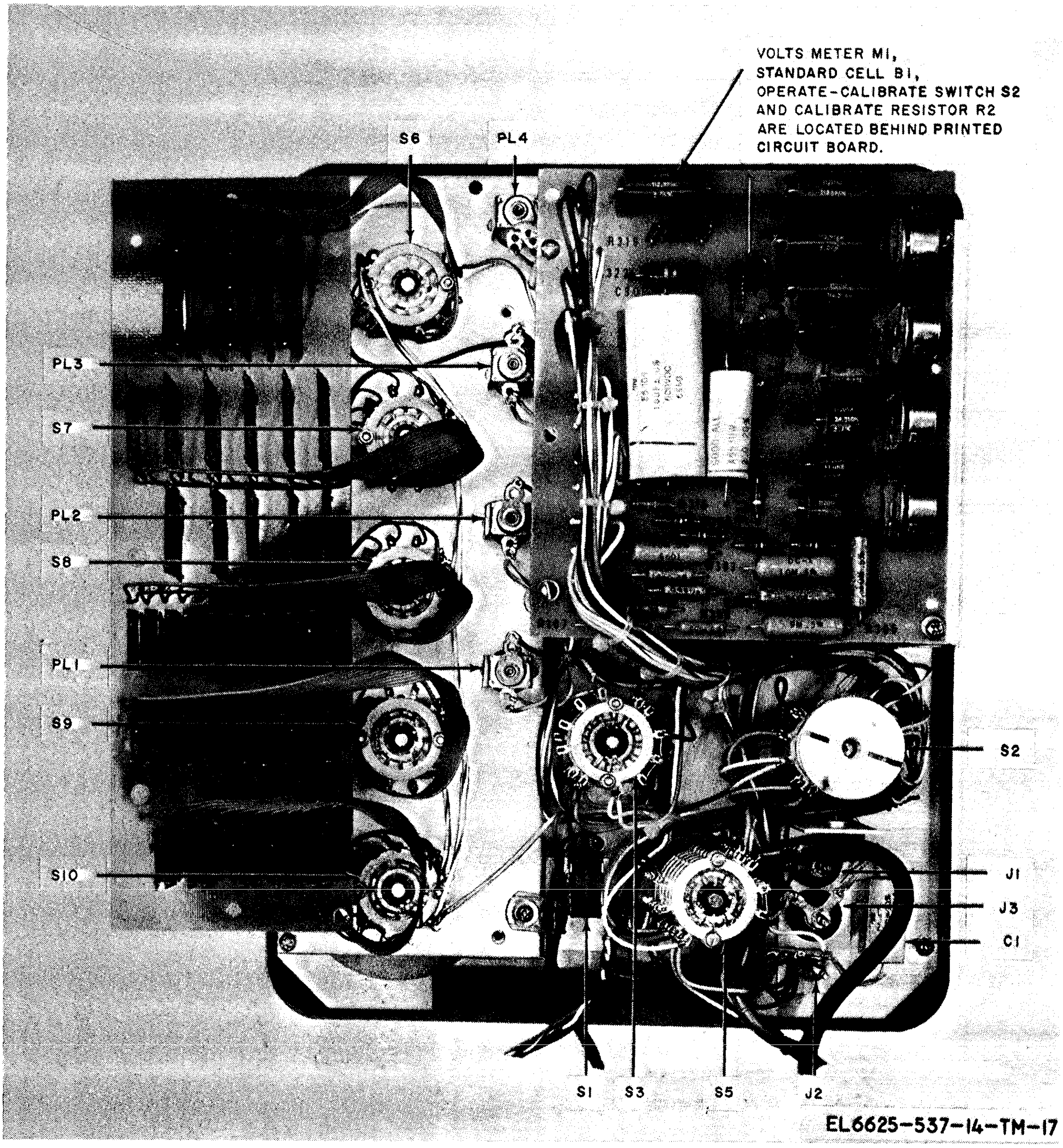

Figure 6-5. Electronic voltmeter, front panel, rear view, showing component location.

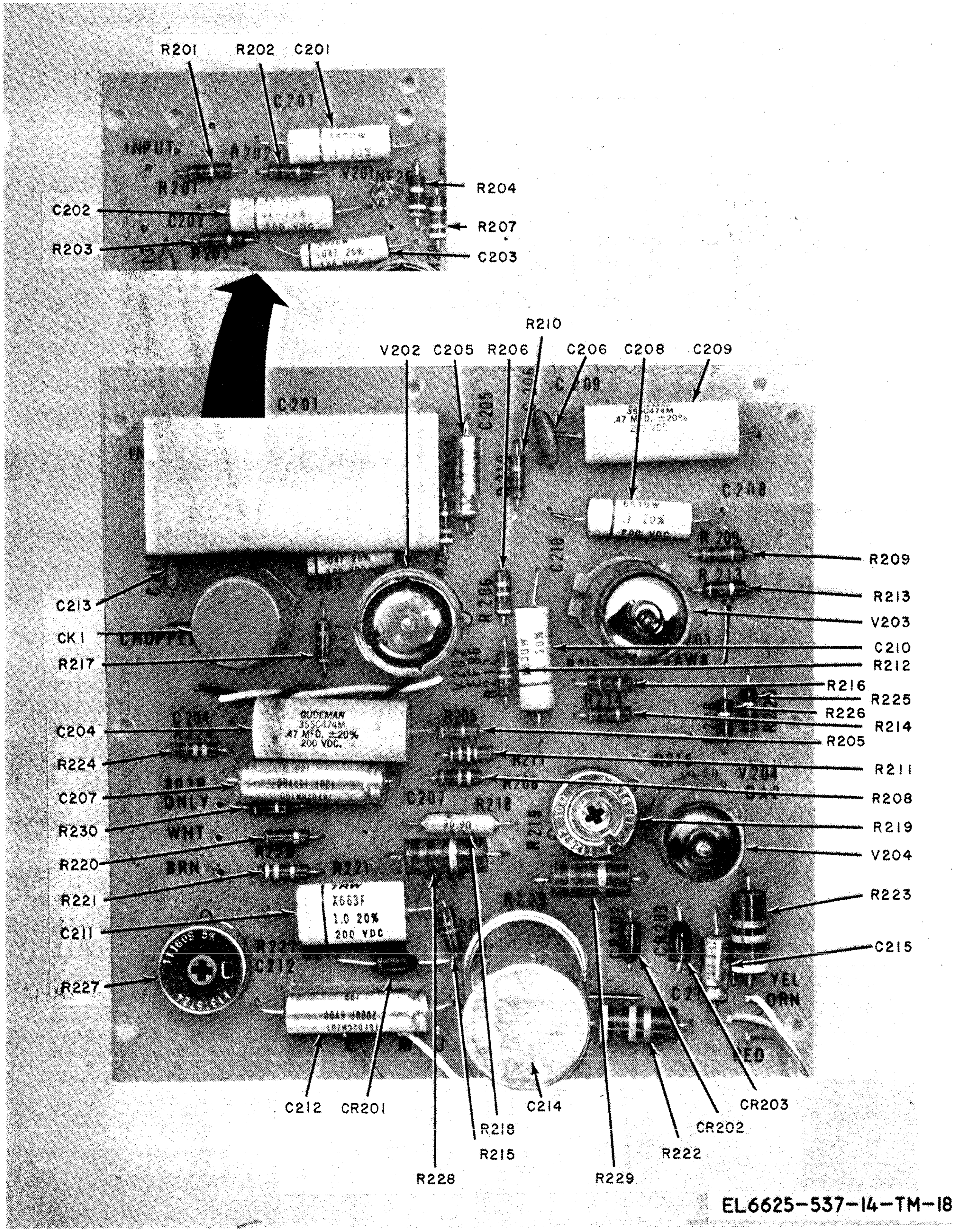

Figure 6-6. Dc vtvm printed circuit board, showing component location.

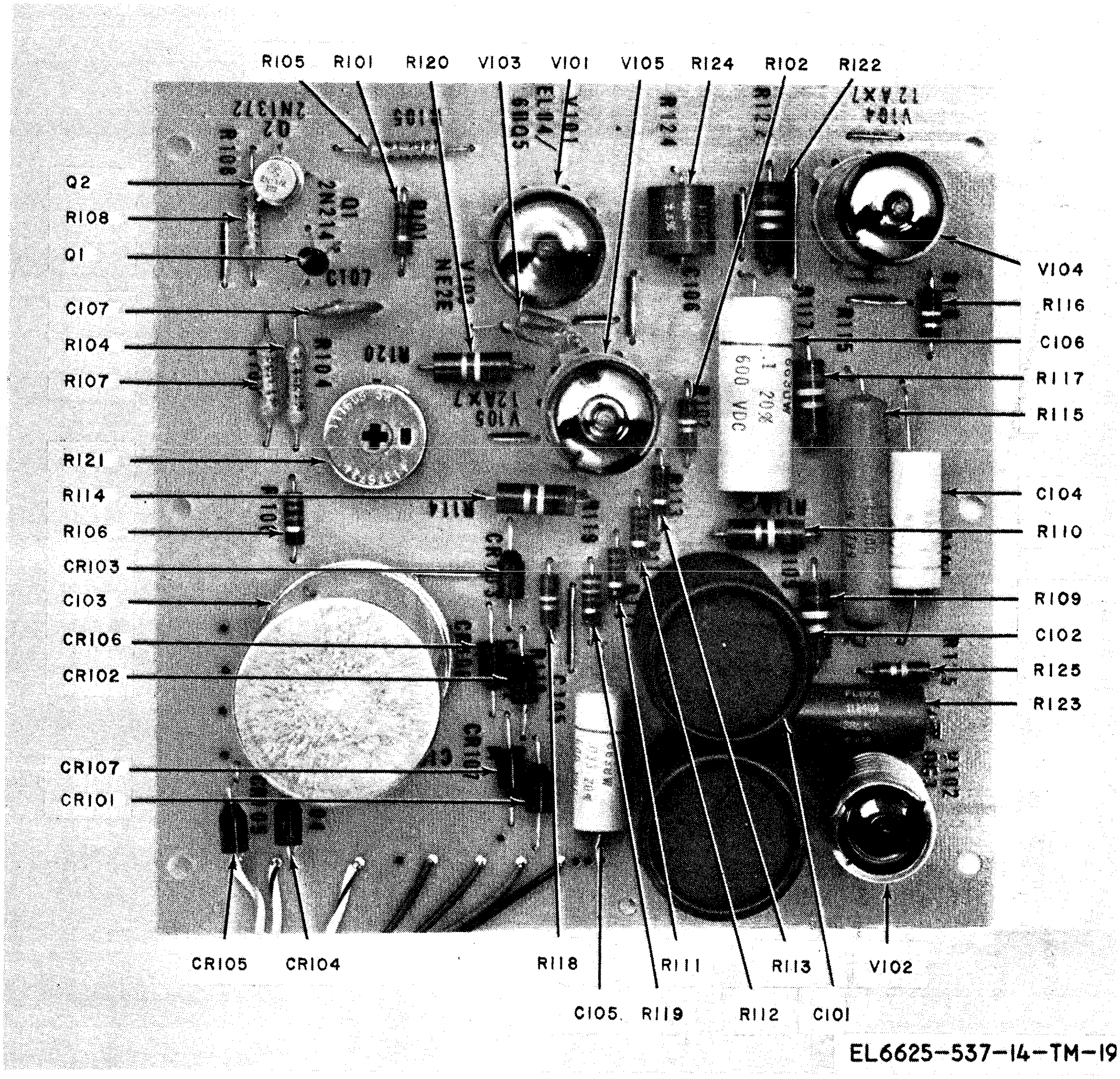

Figure 6-7. 500-volt dc reference supply printed circuit board, showing component location.

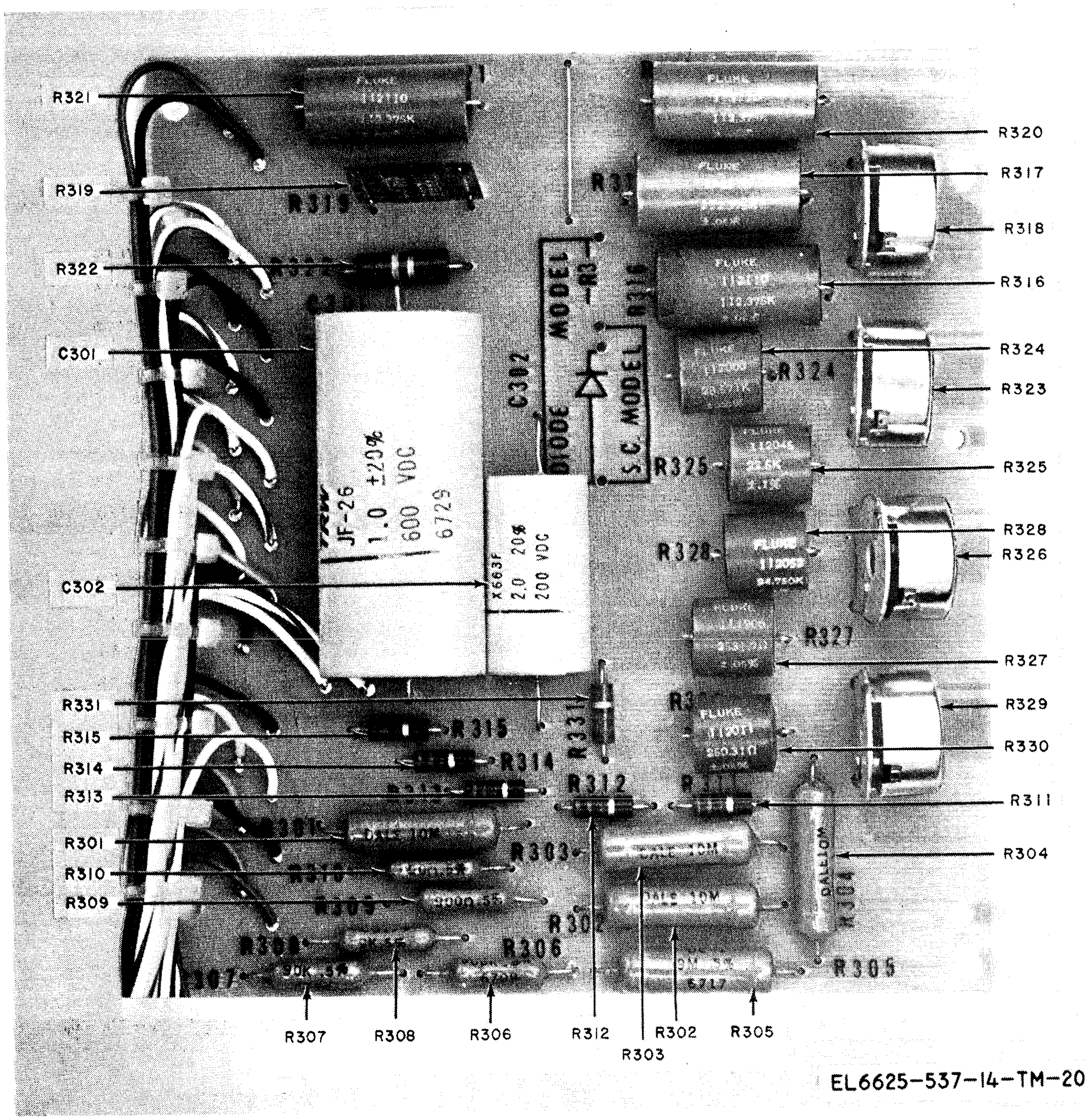

Figure 6-8. Reference range divider printed circuit board, showing component location.

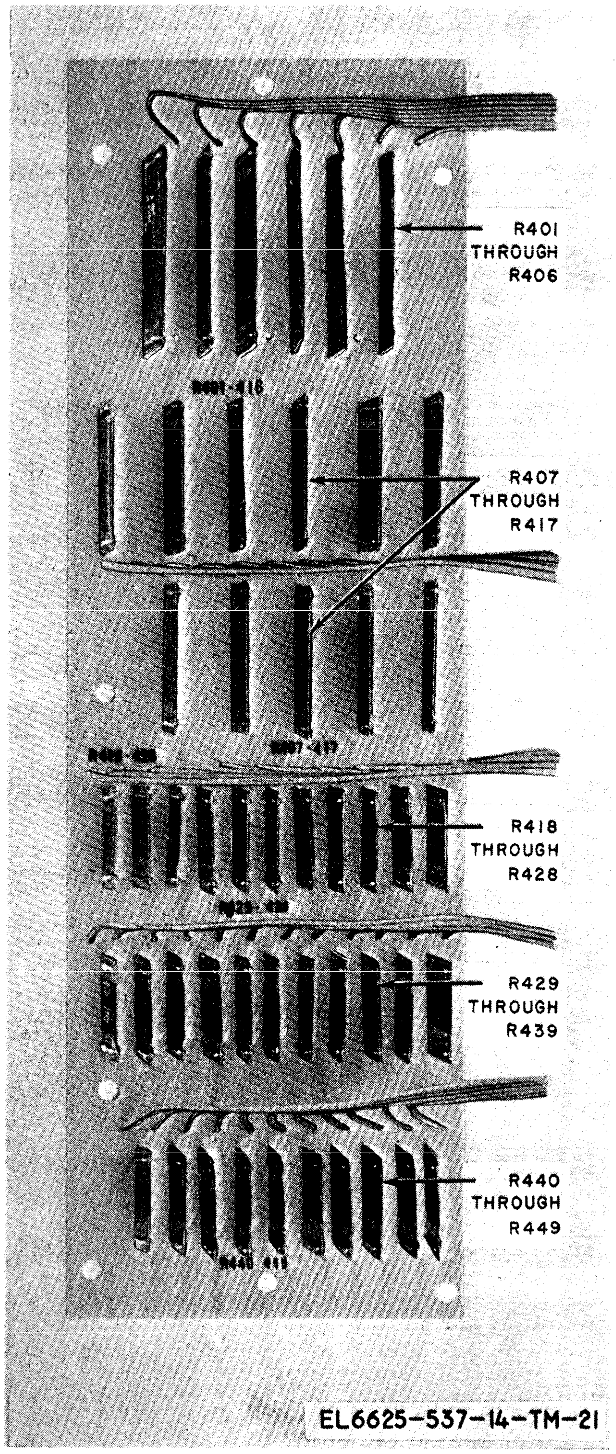

Figure 6-9. Precision voltage divider printed circuit board, showing component location.

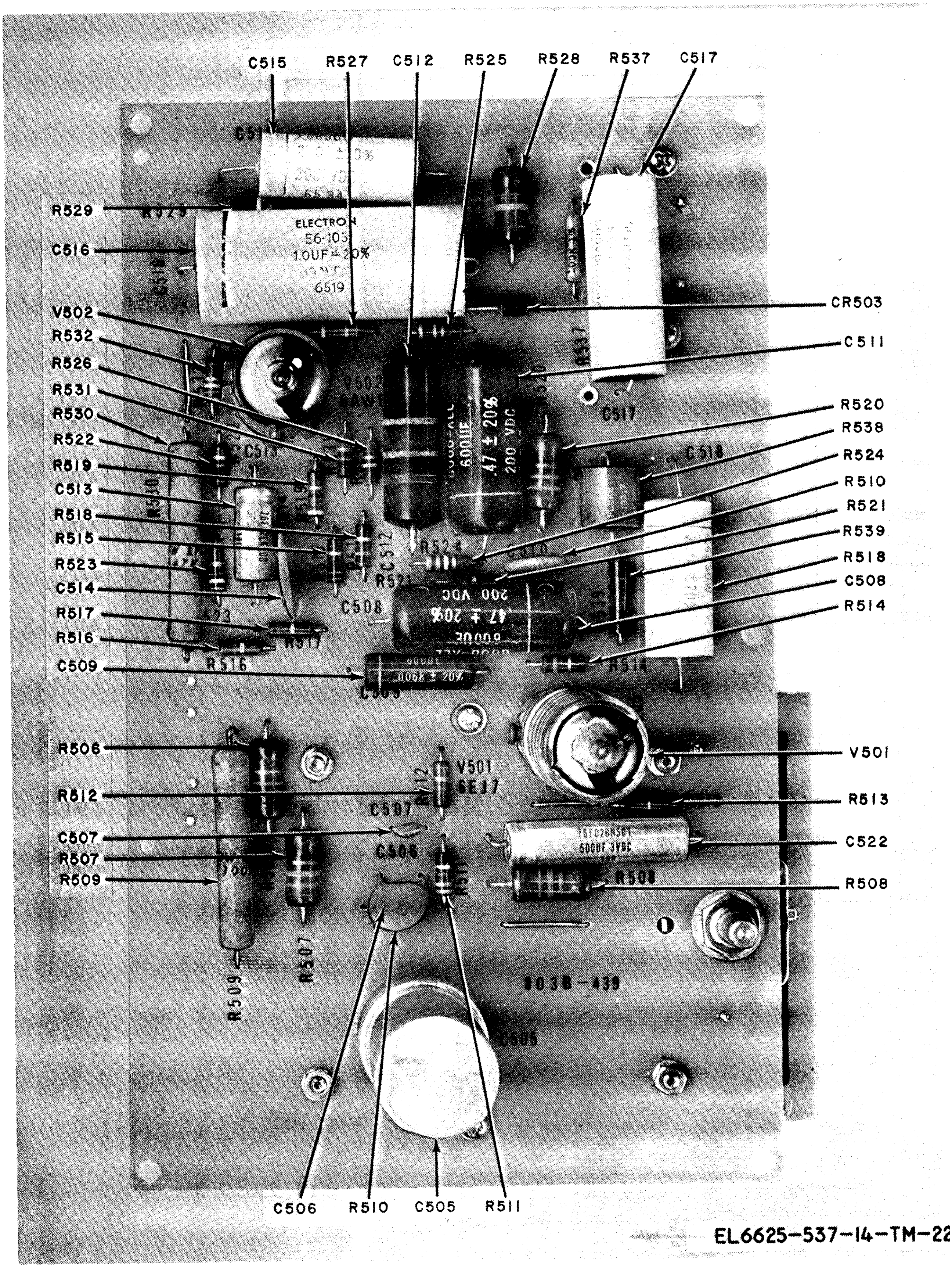

Figure 6-10. Ac-to-dc converter and ac range switch assembly, front view, showing component location.

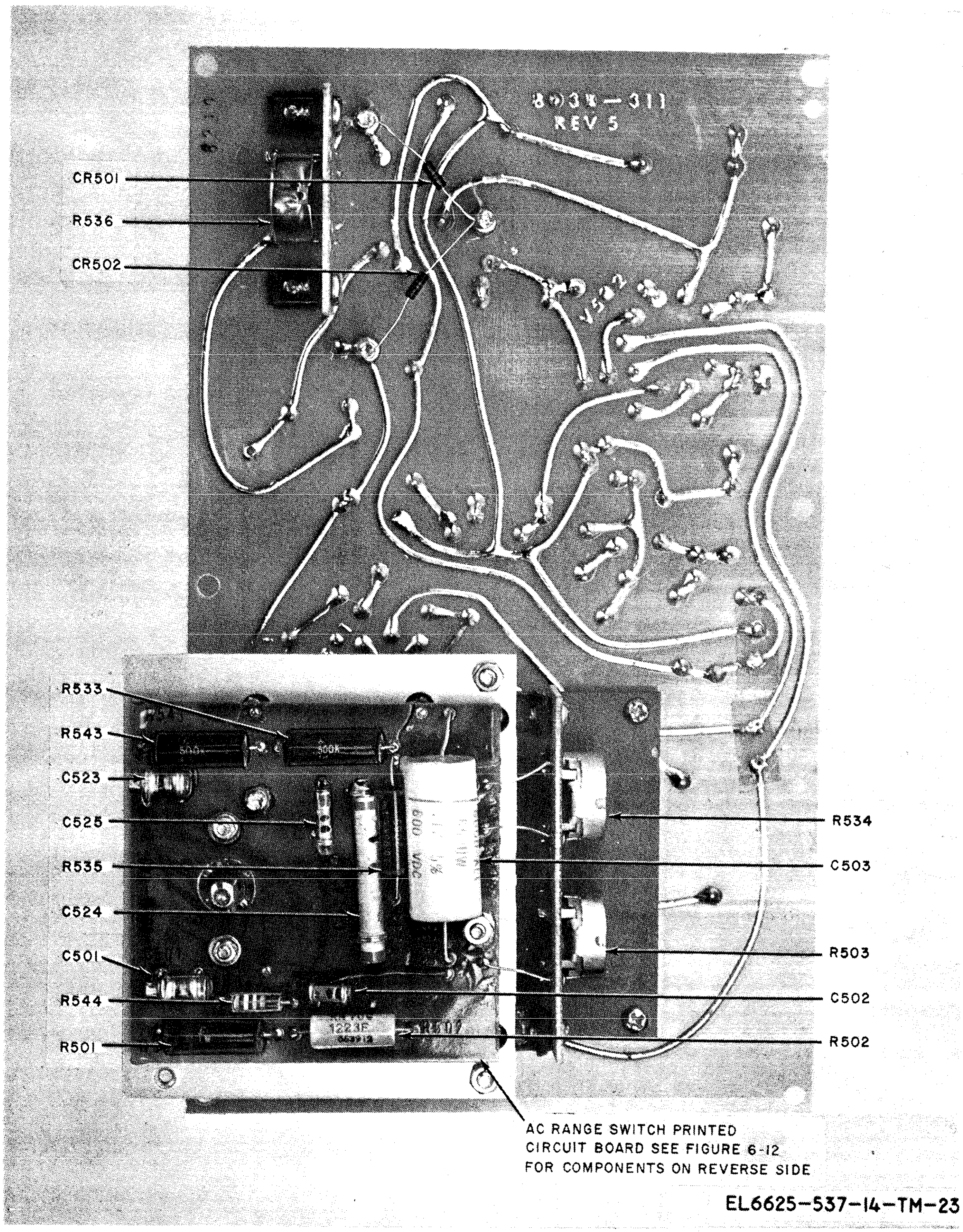

Figure 6-11. Ac-to-dc converter and ac range assembly, rear view, showing component location.

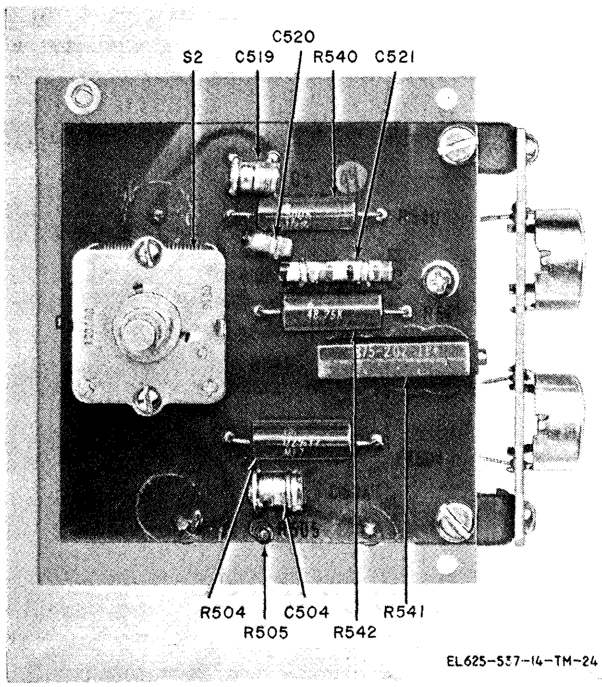

Figure 6-12. Ac range switch printed circuit board, showing component location.

Section {V. MAINTENANCE OF THE ELECTRONIC VOLTMETER ME-202(*)/U

6-8 I **Fault Indication**

The precision voltage divider is considered to be faulty when differential voltage measurements are out of tolerance on any range when the voltage readout dials are set to any position other than 49 **99 1 0**

6-9. Equipment Required for Fault Isolation

Fault isolation of the precision divider consists of taking voltage readings across the resistors within the divider. Use another electronic voltmeter to make the measurements listed in table **6-2.**

6-10. **Test Procedure**

a. Remove two screws at the rear and slide the voltmeter from its case.

b. Remove four screws and separate the front panel from the chassis. Gently lay the front panel face down in front of the chassis.

CAUTION

The card resistors on the precision voltage divider printed circuit board can be damaged by touching the resistance wire.

c. Remove the cover from the precision voltage divider printed circuit board.

d. Set controls as follows:

RANGE . . .	...500
NULL	.VTVM
AC-de polarity . +	(positive)
Voltage readout dials	..499.9 10
O N . . . , , ,	ON (up position)

e. Allow at least 10 minutes warmup. Hold OPERATE-CALIBRATE switch at CALIBRATE and adjust CALIBRATE control to null VOLTS meter.

f. Measure the voltage across each resistor on the precision voltage divider printed circuit board. See figure 6-9 for component location. A faulty resistor is indicated if the voltage across the resistor exceeds the maximum voltage difference specified in table 6-2.

6-11. General Parts Replacement Techniques

All parts of Electronic Voltmeter ME-202(*)/U can be reached and replaced without special procedures. Do not attempt to replace any of the precision wirewound resistors with ordinary power resistors, Nichrome resistors, carbon or deposited carbon resistors, or metal film resistors. Use only approved components when making repairs, After replacing components on the printed circuit boards, coat any uncoated areas around R305 through R31O on the reference range resistor printed circuit board, and around

V202 and chopper CK1 on the dc vtvm printed circuit board with Humi-Seal IBI2 (manufactured by Columbia Technical Corp., Woodside, N, Y.) to prevent moisture accumulation, When replacing tube V104 or V105 (12AX7), some drift of the 500-volt dc reference supply may be noted. This drift will normally disappear after the tube has aged a bit. When replacing V102, use a type 0G3 which has been aged for at least 150 hours to obtain stable operation. The electronic voltmeter should be recalibrated after replacing any components.

Table 6-2. Test Procedure for Fault Isolation

Resistor	*Nominal* resistor voltage	*Maximum voltage difference– each* resistor
R401 and R402	50	.01
R403 and R406	100.5	.02
R407 and R408	5	.001
R409 and R417	10	.002
R418 and R419	.05	.0001
R420 thru R428	1	.0002
R429 and R430	.05	.00001
R431 thru R439	.01	.00002
R440 thru R449	.001	.0000O1

6-12, Replacement of Decimal Point Indicator Lamps

a. Disconnect power cord from power source.

b. Remove screws at back of cabinet and slide instrument out of case.

c. Remove screws that hold front panel assembly to chassis.

d. Being careful to avoid wiring damage, gently lift front panel assembly from instrument and place face down in front of instrument.

e. Remove screws holding range resistor printed circuit board and precision voltage divider printed circuit board to front panel assembly,

f. Push these printed circuit boards aside enough to allow access to decimal lamp holders.

g. Remove decimal lamp holder from bracket by applying pressure to each side of holder,

h. Remove cardboard shield and replace bulb.

i. Place card board shield over bulb and replace holder in bracket.

j. Install range resistor printed circuit board and precision voltage divider printed circuit board on front panel assembly.

k. Install front panel assembly on chassis,

L Replace instrument in case and install screws at back of cabinet.

m. Allow electronic voltmeter to remain in normal upright position for at least 8 hours before operation. This will allow voltage of standard cell to return to normal after being tipped.

APPENDIX A

REFERENCES

The following publications contain information applicable to the operation and maintenance of ME-202(*)/U.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals **(Types** 7,8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies and Equipment Used by the Army.
SC-5180 -91-CL-R07	Sets, Kits, and Outfits Component List Tool Kit, Electronic Equipment TK-105/G (FSN 5180-610-8177),
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 11-6625.200-15	Operator's Organizational, DS, GS, and Depot Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-316-12	Operator and Organizational Maintenance Manual: Test Sets, Electron Tube TV-2/U, T'V-2A/U, TV-2B/U, and TV-2C/U.
TM 11-6625-320-12	Operator and Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U, and ME-30E/U.
TM 11-6625-539-15	Operator, Organizational, Field, and Depot Maintenance Manual: Transistor Test Set TS-1836/U.
TM 11-6625-683-15	Operator, Organization, Direct Support, General Support, and Depot Maintenance Manual: Signal Generator AN/URM .127
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

APPENDIX C

MAINTENANCE ALLOCATION

Section 1. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for ME-202(*)/U. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a, Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and /or electrical characteristics with established standards through examination.

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

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean, preserve, drain, paint, or to replenish fuel/lubricants /hydraulic fluids of compressed air supplies.

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

e. *Align.* To adjust specified variable elements of an item to about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. *Install.* The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment/system.

h. Replace. The act of substituting a ser. viceable like-type part, subassembly, model (component or assembly) for an unserviceable counterpart.

i. *Repair.* The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module/component/assembly, end item or system.

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

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

C-3. Column Entries

a. Column 1, *Group Number.* Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies and modules with the next higher assembly.

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 item listed in column 2.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest 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 category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of man-hours specified by the " worktime" 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, troubleshooting time and quality assurance/quality control time in ad. ditional to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column are as follows:

c Operator/crew
() organizational
F Direct support
II General support
l) Depot

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

C-4. Tool and Test Equipment Requirements (Table 1)

a. *Tool or Test Equipment Reference Code.* The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. *Maintenance Category.* The codes in this column indicate the maintenance category allocated the tool *or* test equipment.

c. *Nomenclature.* This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NA TO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. *Tool Number.* This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

SECTION II MAINTENANCE ALLOCATION CHART FOR VOLTMETER, ELECTRONIC ...)/U

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT
				O	F	H	D	
W	VOLTMETER, ELECTRONIC ME-202(*)/U	Inspect		0.5				
		Test				1.0		2 thru 5, 7 and 8
		Service		0.5				9
		Adjust		0.5				9
		Repair		0.5				8
		Repair				1.<		1 thru 6,8
		Overhaul					2.0	

TABLE I. TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR
VOLTMETER, ELECTRONIC ME-202(*)/U

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	H,D	GENERATOR, SIGNAL AN/URM-127	6625-00-783-5965	
2	H,D	MULTIMETER ME-26B/U	6625-00-646-9409	
3	H, D	VOLTMETER, ELECTRONIC ME-202A/U	6625-00-709-0288	
4	H,D	VOLTMETER, ELECTRONIC ME-30E/U	6625-00-643-1670	
5	H,D	TEST SET TRANSISTOR TS-1836/u	6625-03-893-2628	
6	D	TEST SET, ELECTRONIC TUBE TV-2C/U		
7	H	TEST SET, ELECTRONIC TUBE TV-7D/U	6625-00-820-O064	
8	H, D	TOOL KIT, ELECTRONIC EQUIPTMENT TK-105/G	5180-00-610-8I77	
9	0	TOOLS AND TEST EQUIPTMENT NORMALLY AVAILABLE TO THE OPERATOR-USER BECAUSE OF HIS ASSIGNED MISSION.		

INDEX

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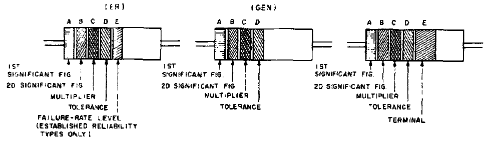


COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE 1
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS.

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM.
BLACK	0	BLACK	0	BLACK ..	1			BROWN. .	M=1.0	
BROWN	1	BROWN	1	BROWN	10			RED	P=0.1	
RED	2	RED . .	2	RED	100			ORANGE..	R=0.01	
ORANGE .	3	ORANGE	3	ORANGE..	1,000			YELLOW..	S=0.001	
YELLOW .	4	YELLOW...	4	YELLOW	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE. .	.. ..	SOLD-ERABLE
GREEN	5	GREEN .	5	GREEN.	100,000	GOLD...	±5			
BLUE. ...	6	BLUE.... .	6	BLUE ...	1,000,000	RED .	±2 (NOT AP-PLICABLE TO ESTABLISHED RELIABILITY).			
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7							
GRAY	8	GRAY.	8	SILVER...	0.01					
WHITE .	9	WHITE	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE-RATE LEVEL (PERCENT FAILURE PER 1,000 HOURS) ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL.

RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

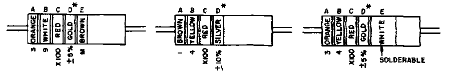
SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS   10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED, IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING

(ER)   (GEN)



NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±5%
FAILURE RATE LEVEL M

NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

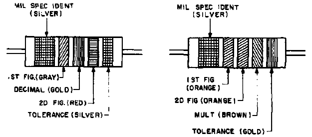
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

COMPOSITION-TYPE RESISTORS

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2 UH ± 10%   (B) 330 UH ± 5%

COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF OF THE CODING FOR AN 8.2UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330 UH INDUCTOR ARE ILLUSTRATED.

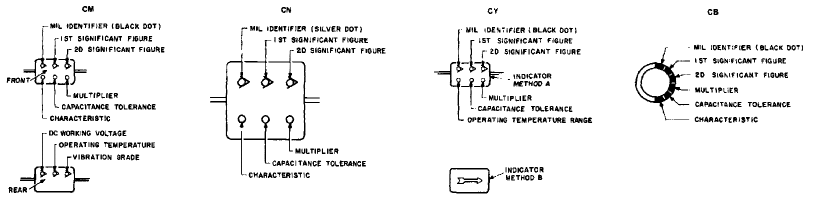
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

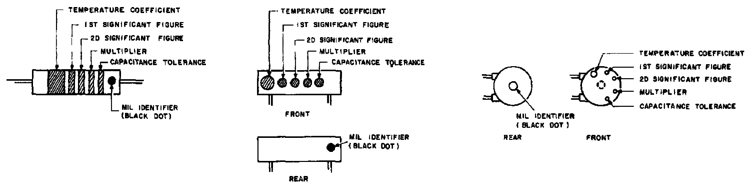
MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.



MICA-DIELECTRIC   PAPER-DIELECTRIC   GLASS-DIELECTRIC, GLASS CASE   MICA, BUTTON TYPE



AXIAL LEAD   RADIAL LEAD   DISK-TYPE

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS.

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB.

COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY CB	0	0	1			±20%	±20%		A			-55° TO +70°C	10-55Hz
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				-55° TO +85°C	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				-55° TO +125°C	10-2,000Hz
GREEN		5	5		±5%				F			500		
BLUE		6	6										-55° TO +150°C	
PURPLE (VIOLET)		7	7											
GRAY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN			0.01	±10%	±10%	±10%	±10%						

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC.

COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	-30	1	1	10	±1%		
RED	-80	2	2	100	±2%	±0.25 UUF	
ORANGE	-150	3	3	1,000			
YELLOW	-220	4	4				
GREEN	-330	5	5		±5%	±0.5 UUF	
BLUE	-470	6	6				
PURPLE (VIOLET)	-750	7	7				
GRAY		8	8	0.01*			
WHITE		9	9	0.1*	±10%		
GOLD	+100			0.1		±1.0 UUF	
SILVER				0.01			

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.

2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-25D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.

3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.

4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

* OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE.

ESC-FM 913-73

Figure FO-1. Color code markings for MIL-STD resistors, capacitors indicators.

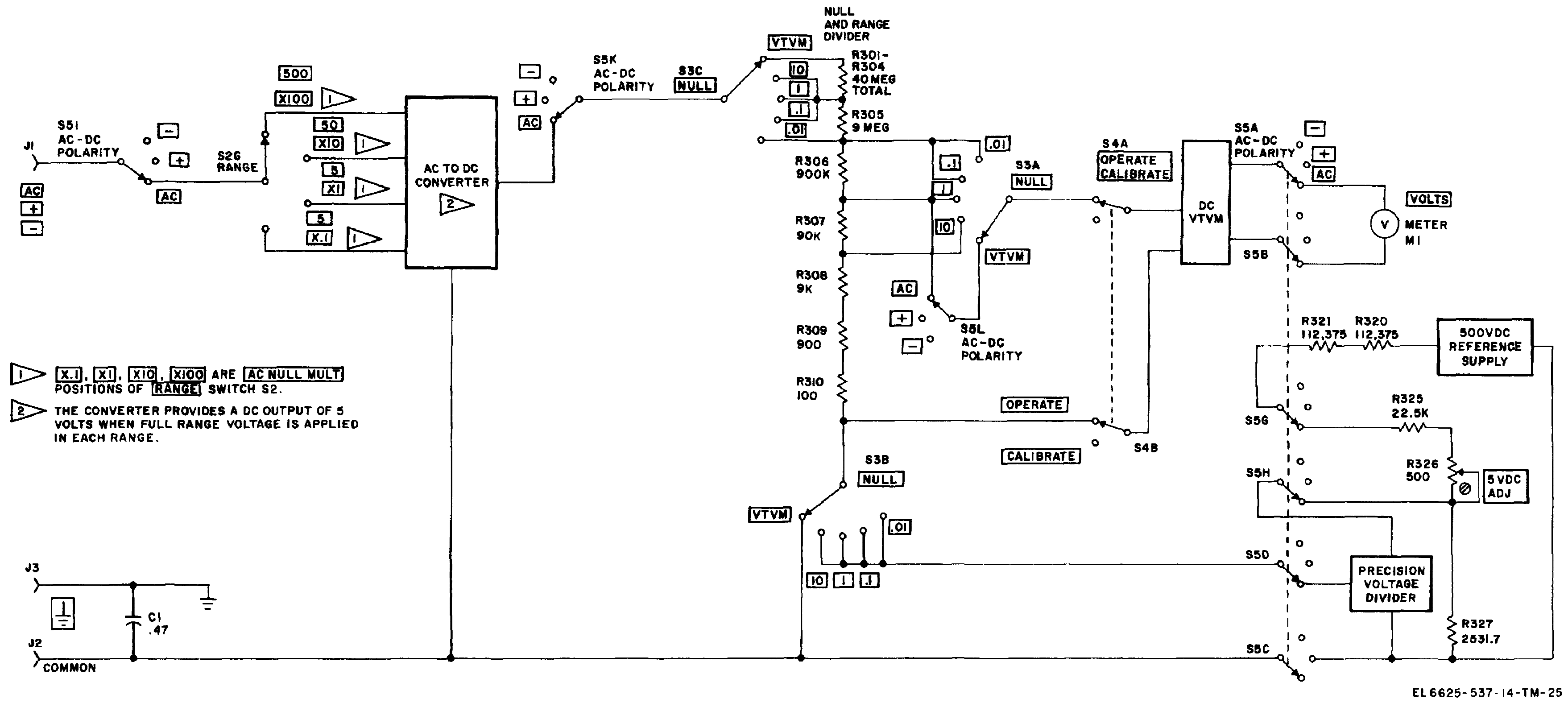


Figure FO-2. AC measurements circuit, simplified schematic diagram.

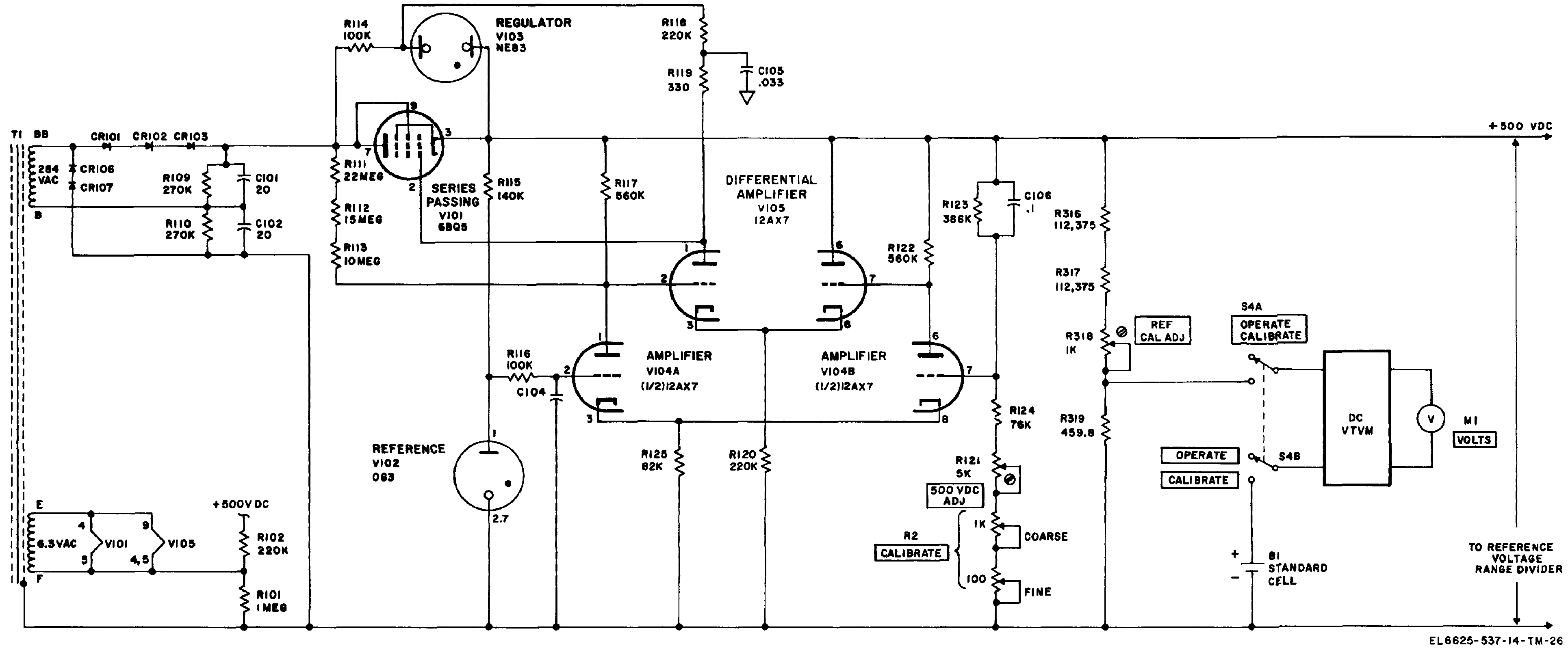
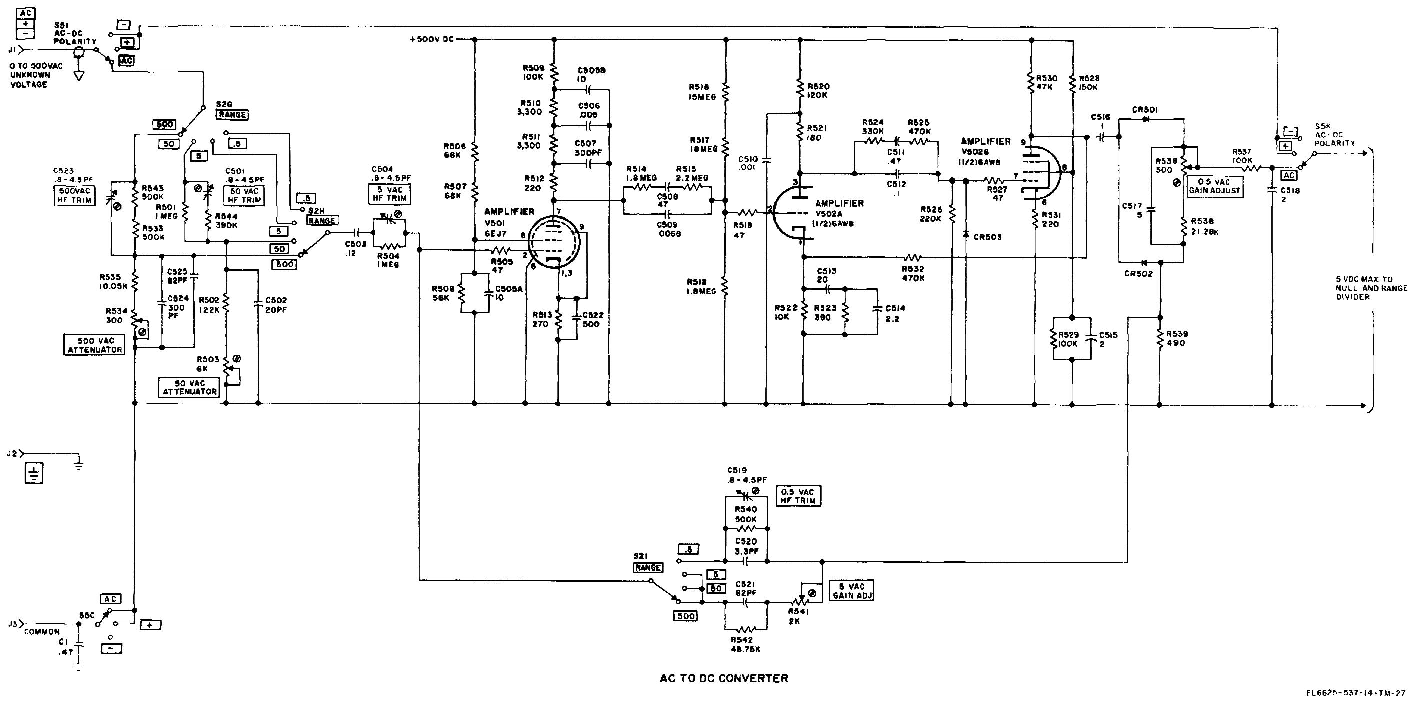
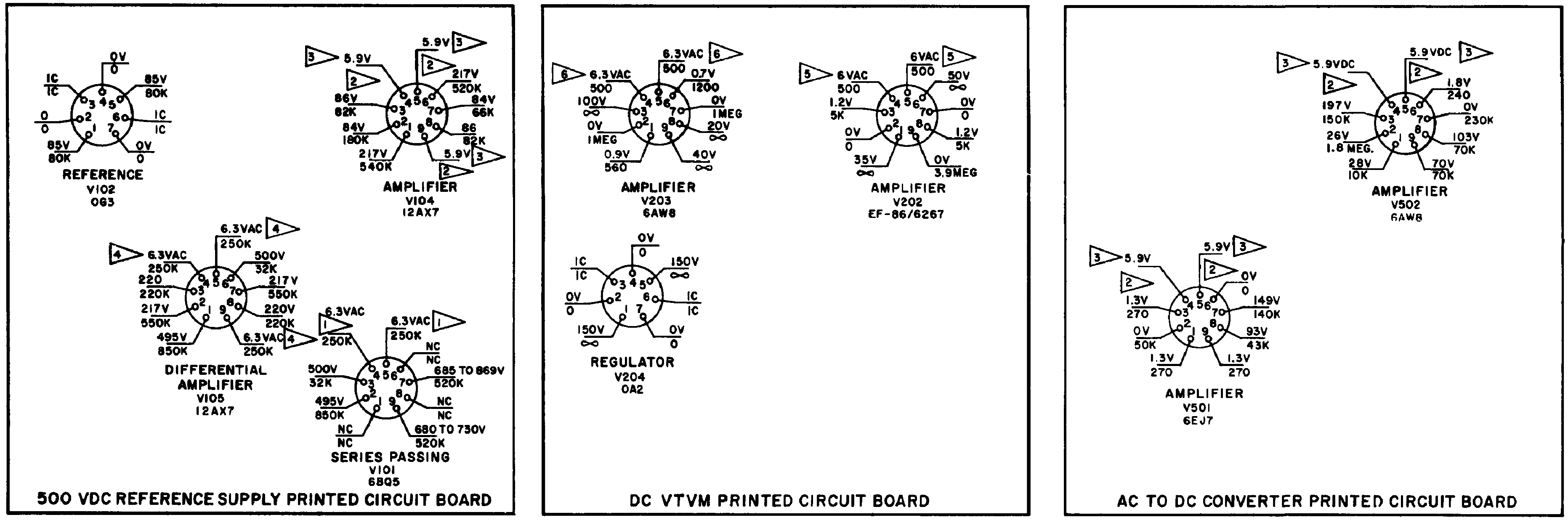


Figure FO-3. 500-volt dc reference supply, simplified schematic diagram.



FO-4. AC-to-dc converter, simplified schematic diagram.



	Q1	Q2	Q3
E	3.0V	9.3V	9.7V
B	3.5V	9.2V	9.3V
C	9.2V	5.8V	5.8V

TRANSISTOR TERMINALS

NOTES

1. LINE VOLTAGE AT 115 VOLTS.
2. ALL READINGS ARE TO THE COMMON INPUT TERMINAL UNLESS OTHERWISE NOTED.
3. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED.
4. ALL VOLTAGE READOUT DIALS SET TO ZERO.
5. AC-DC POLARITY SWITCH SET TO +.
6. NULL SWITCH SET TO VTVM.
7. RANGE SWITCH SET TO 500.
8. NC INDICATES NO CONNECTION.
9. IC INDICATES INTERNAL CONNECTION.
10. ∞ INDICATES INFINITE RESISTANCE.
11. RESISTANCE READINGS ARE TAKEN WITH POWER DISCONNECTED AND TUBES REMOVED. VOLTAGE READINGS ARE TAKEN WITH TUBES IN PLACE.
12. ALL VOLTAGES MEASURED WITH VTVM HAVING 10 MEGOHMS INPUT RESISTANCE.

[1] FILAMENT OF V101 IS OPERATED AT 410 VDC WITH RESPECT TO COMMON INPUT TERMINAL. FILAMENT VOLTAGE IS 6.3VAC BETWEEN PINS 4 AND 5.

[2] A TRANSISTORIZED VOLTAGE REGULATOR IS CONNECT TO PINS 4, 5 AND 9 OF V104, 4 AND 5 OF V501, AND 4 AND 5 OF V502. DO NOT MAKE RESISTANCE MEASUREMENTS AT THESE TERMINALS.

[3] REGULATED DC FILAMENT VOLTAGE. NOMINAL VOLTAGE SHOULD BE BETWEEN 5.6 AND 6.1 VDC AND SHOULD NOT VARY MORE THAN 0.020V AS LINE VOLTAGE IS VARIED BETWEEN 102 AND 128 VAC.

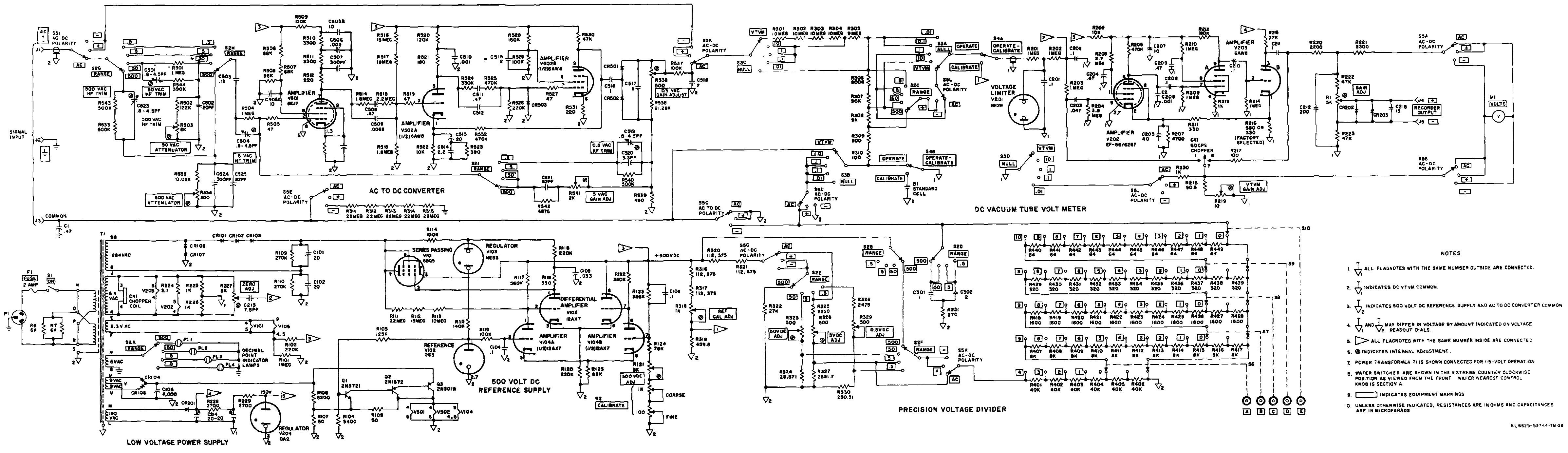
[4] FILAMENT OF V104 IS OPERATED AT 410 VDC WITH RESPECT TO COMMON INPUT TERMINAL. FILAMENT VOLTAGE IS 6.3 VAC BETWEEN PINS 4, 5 AND 9.

[5] FILAMENT VOLTAGE FOR V202 IS 6 VAC BETWEEN PINS 4 AND 5.

[6] FILAMENT VOLTAGE FOR V203 IS 6.3 VAC BETWEEN PINS 4 AND 5.

EL6625-537-14-TM-28

FO-5. Tube and transistor socket voltage and resistance diagram.



FO-6. Voltmeter, Electronic ME-202(*)/U schematic diagram.

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