TM 11-6625-239-35

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

Per C1, 26 July 1967, title of manual is changed to read as follows:

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ELECTRONIC MULTIMETERS
TS-505A/U [redacted] TS-505B/U AND
MULTIMETERS TS-505C/U
AND TS-505D/U

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Cover, pg 1

HEADQUARTERS, DEPARTMENT OF THE ARMY

28 August 1961

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WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the +170-volt plate circuits of V1, V2, and V3, on the 550-volt secondary of the power supply T1, or on the 115-volt ac line connections. Serious injury or death may result from contact with these points. This equipment contains selenium rectifiers. These rectifiers release poisonous compounds and fumes when they burn out or arc over. If this happens, provide adequate ventilation immediately and do not handle the rectifier until it cools. The fumes have a strong odor and should not be inhaled.

CAUTION

When Electronic Multimeter TS-505A/U is used to test circuits that are at a high potential above chassis ground, there is a possible shock hazard. Do not touch the case of the multimeter and the chassis of the equipment when circuits of this nature are under test.

Technical Manual No. 11-6625-239-35

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *28 August 1961*

ELECTRONIC MULTIMETERS TS-505A/U AND TS-505B/U AND MULTIMETERS TS-505C/U AND TS-505D/U

*This manual, together with TM 11-6625-239-12, 30 December 1960 supersedes TM 11-5511A, 25 August 1955, including C1, 21 February 1956; C2, 23 November 1956; C3, 2 January 1958; and C4, 5 November 1959.

CHAPTER 1
THEORY

Section I. GENERAL

1. Scope

a. This manual covers field and depot maintenance for Electronic Multimeter TS-505(*)/U. It includes instruction appropriate to fourth and fifth echelon for troubleshooting, testing, aligning, and repairing the equipment; and for replacing and repairing specified maintenance parts. It also lists tools, materials, and test equipment for fourth and fifth echelon maintenance. Detailed circuit operation is described in the theory section.

b. The complete technical manual for this equipment includes TM 11-6625-239-12, TM 11-6625-239-20P, and TM 11-6625-239-35P.

c. Forward comments concerning this manual to the Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: SIGMS-PA2d, Fort Monmouth, N.J.

Note.-For applicable forms and records, see paragraph 2, TM 11-6625-239-12.

2. Internal Differences in Models

Internal differences are listed in the chart below.

Item	A model	B model	C model	D model
Resistor R1 in A.C. PROBE.	Used.	Not used on some.	Not used.	Not used.
Transformer T1 COMMON test lead connects to pin 7 of T1 as GROUND reference.	Not used.	Not used.	Not used.	Used.
Differences in accuracy. (Accuracy indicated for frequencies between 500 kc and 500 mc using the rf adapter are design accuracies. Readings obtained when using the rf adapter are only approximate and should be used only as relative voltage indications.)	±5 percent of full scale on dc voltage; ±6 percent of full scale for ac sinusoidal input from 30 cps to 1 mc on ac range; ±6 percent of full scale for rf sinusoidal input from 500 kc to 500 mc, using rf adapter. (Error may exceed ±6 percent of full scale for rf sinusoidal input below 1 mc and about 200 mc using rf adapter.) ±4 percent of ohmmeter total arc length on ohms scale.	Same as for A model.	±5 percent of full scale on dc voltage; ±6 percent of full scale (on all ac ranges including rf) from 30 cps to 100 mc; ±8 percent of full scale from 100 mc to 500 mc; ±5 percent of ohmmeter total arc length on ohms scale.	Same as for C model.

Note. The meter scales are calibrated to indicate 0.707 of the peak voltage of a sine wave or a complex wave. For a sine wave, the meter indication is the root mean square (rms) value of the sine wave; but for a complex wave, the meter indication is not the rms value of the complex wave.

3. Block Diagram

The multimeter is used to measure alternating-current (ac) and direct-current (dc) voltages, and dc resistances in electrical and electronic equipments. The block diagram (fig. 1) is described in *a* through *m* below. For complete circuit details, refer to the overall schematic diagram (fig. 21).

a. FUNCTION Switch. FUNCTION switch S1 selects the particular circuit in the multimeter that will be used to measure the input voltage or resistance. In the OFF position, the FUNCTION switch disconnects the multimeter from the power source.

b. RANGE Switch. RANGE switch S2 selects the proper voltage-dividing or resistance network for the voltage or resistance to be measured.

c. Dc Amplifiers. Amplifiers V1 and V2 function mainly as an impedance-matching network to convert the high input impedance to a low impedance for the meter circuit. The gain of these amplifiers is unity.

d. Meter Coupling. Meter-coupling tube V3 is a twin triode, which couples the output from the plates of the dc amplifiers to the meter with negligible loading.

e. Voltage Regulators. Voltage regulator tubes V4 and V5 provide a low-resistance coupling from meter-coupling tube V3 to meter M1.

f. Power Supply. The power supply T1 secondaries and tube V7 provide the necessary operating potentials to the other tubes in the circuit and to the selenium rectifier (CR2), which supplies a dc voltage for the ohmmeter circuit.

g. D. C. Probe. The D. C. probe contains isolating resistor R3 incorporated in the probe to prevent capacitive loading by the multimeter for the circuit under test.

h. Rf Adapter. The radiofrequency (rf) adapter is used with the dc voltage measurement circuit to measure rf voltages of frequencies between 500 kilocycles (kc) and 500 megacycles (mc). A germanium diode and a coupling capacitor are incorporated within the rf adapter to rectify the applied rf voltage into a dc voltage.

Note. Readings obtained when using the rf adapter are approximate and should be used only as a relative voltage indication.

i. AC PROBE. The AC PROBE contains an isolating resistor to prevent capacitive loading by the multimeter of the circuit under test. Ac voltages at frequencies between 30 cycles per second (cps) and 1 mc may be measured through the AC PROBE.

Note. Resistor R1 is not used on Multimeters TS-505C/U and TS-505D/U nor is it used on all Electronic Multimeters TS-505B/U.

j. Ac Signal Rectifier. Ac signal rectifier V6A rectifies the ac input voltage being measured and supplies a pulsating dc voltage input to the dc amplifiers through the FUNCTION switch.

k. Balancing Diode. Balancing diode V6B supplies a bias voltage that is propor- proportional to the ac input voltage being measured. This voltage cancels the contact potential of ac signal rectifier V6A.

l. OHMS Probe. The OHMS probe provides an external connection for the ohmmeter circuit.

m. Selenium Rectifier. Selenium rectifier CR2 provides a source of dc voltage to the ohmmeter circuit. The dc voltage is applied in series across the unknown and the known resistance to be measured. The voltage drop across the unknown resistance is indicated by the meter as a resistance reading.

n. COMMON Probe. The COMMON test probe provides an external connection for ground or a common circuit for the multimeter.

o. Meter. Meter M1 is a 0-1 milliampere movement with the appropriate measurement scales (fig. 8) printed on the face.

4. D. C. Amplifier

The dc amplifier used in the multimeter has unity gain, high input impedance to prevent loading of the circuit under test, and a low output impedance for meter operation.

a. Figure 2 shows the dc amplifier connected for reading +D.C. voltages. This

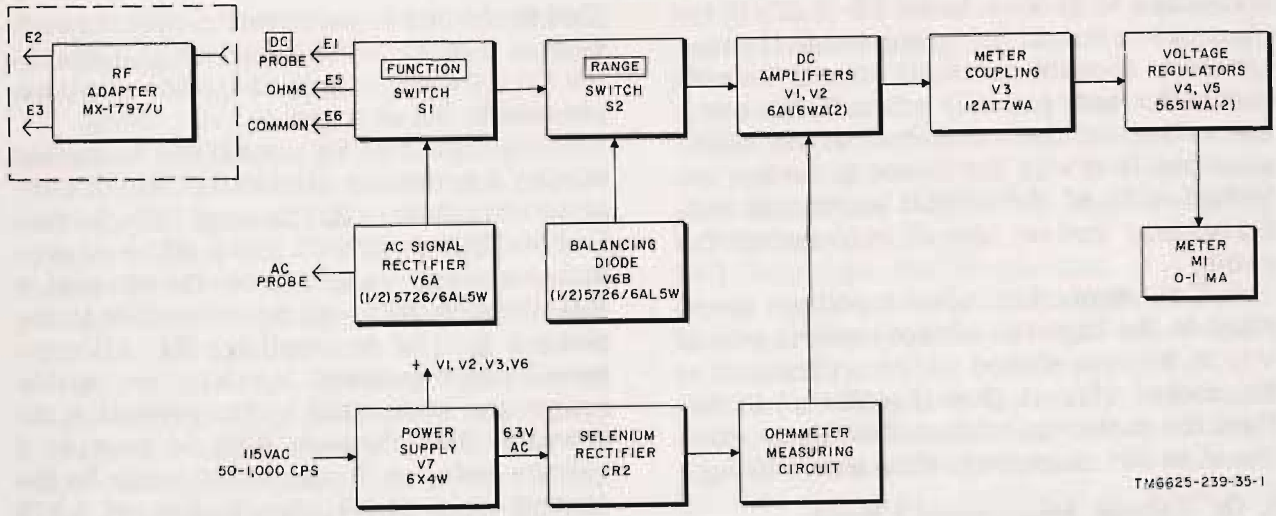


Figure 1. Electronics Multimeters TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U, block diagram.

circuit will be used to explain the dc amplifier operation.

b. In the no-signal condition, the grids of dc amplifiers V1 and V2 are at 0 volt. The grid of V1 is at 0 volt because of its connection to ground through the range resistors (fig. 3). The grid of V2 is at 0 volt because of the conduction from -82 volts through R47, voltage regulator V5 and meter coupling V3B to +170 volts. Since the stages have a common cathode resistor (R19) and equal plate load resistors (R14 and R16), they conduct an equal amount. ZERO ADJ. potentiometer R15 is used to correct any unbalance in the conduction of the two tubes. With equal conduction of V1 and V2, the plate voltages are equal and therefore the control grid voltages of V3A and V3B (pins 2 and 7, respectively) are equal; this causes the two halves of V3 to have equal conduction. As previously mentioned, the conduction through R47, V5, and V3B is sufficient to drop 82 volts across R47, placing the cathode of V5 at 0 volt. The cathode of V4 is at 0 volt because of its connection to ground. At this time the meter reading is zero because the - and + terminals of the meter are both at 0 volt.

c. A positive signal applied to the grid of V1 causes the plate voltage of V1 to drop. The negative-going voltage is direct-coupled to the screen grid of V2 and to the control grid (pin 2) of V3. At the same time, the cathode potential of V1 and V2 increases because of the increased conduction of V1 through R19. The conduction of V2 decreases because of the drop in screen grid voltage and the increased cathode voltage, raising the plate voltage. The rise in plate voltage is direct-coupled to the screen grid of V1 (pin 6) and to the control grid (pin 7) of V3. The positive-going voltage on pin 7 of V3 increases the conduction through R47, V5, and the B section of V3, thus raising the potential at the + terminal of the meter and causing the meter to deflect upscale.

d. The positive voltage at the + terminal of the meter is direct-coupled to the control grid of V2, tending to increase the conduction of V2. This counteracts the decrease in conduction caused by the negative-going screen grid voltage and the positive-going cathode voltage so that the overall gain of the amplifier is 1. Resistor R17 helps to keep the overall gain at 1 because as the plate voltage of V1 decreases and the plate voltage of V2 increases, current will flow from the plate of V1 through R17 and R16, thereby limiting the rise in the plate voltage of V2.

e. The negative-going voltage coupled to the pin 2 control grid of V3, which decreases the current through V4 and V3, has no effect on the meter operation because the negative terminal of the meter is connected to ground. In the TS-505D/U, the common bus is not grounded and is connected to the low potential side of the circuit under test (usually ground). However, the voltage at the + terminal of the meter goes positive with reference to the low potential side of the circuit under test and, therefore, meter operation remains the same.

f. To summarize, when a voltage is applied to the high impedance control grid of V1, it is reproduced at the + terminal of the meter circuit (low impedance) to deflect the meter an amount directly proportional to the magnitude of the input voltage.

5. Dc Voltage Measurement Circuit
(fig. 3)

a. All dc voltages to be measured are applied across the D. C. and COMMON probes. The D. C. probe is electrically shielded to prevent pickup of stray rf voltages near or at the test point. Resistor R3 is incorporated in the D. C. probe to prevent capacitive loading of the circuit under test.

b. Dc voltages being measured are coupled to the dc measurement circuit through section 1 of FUNCTION switch S1. Capacitor C5 bypasses to ground any ac variations present in the dc input.

c. Voltage being measured is applied across a precision attenuator, which consists of resistors R21 through R29. Section 2 of RANGE switch S2 picks off an appropriate voltage value from the attenuator R21 through R29 and connects this to the control grid of dc amplifier V1. All voltages being measured within any meter range are attenuated by the precision attenuator (R21 through R29) to provide a voltage between 0 and 1.875 volts to the control grid of V1. Application of 1.875 volts to the control grid of V1 will cause the meter pointer to deflect to full scale. Note that resistor R3, as well as the precision attenuator (R21 through R29), is in the attenuator circuit. Specific resistors used to attenuate voltages being measured within each RANGE switch position are listed in figure 3.

d. The function of the amplifier circuit is such that any voltage applied to the high-impedance input circuit is applied to the

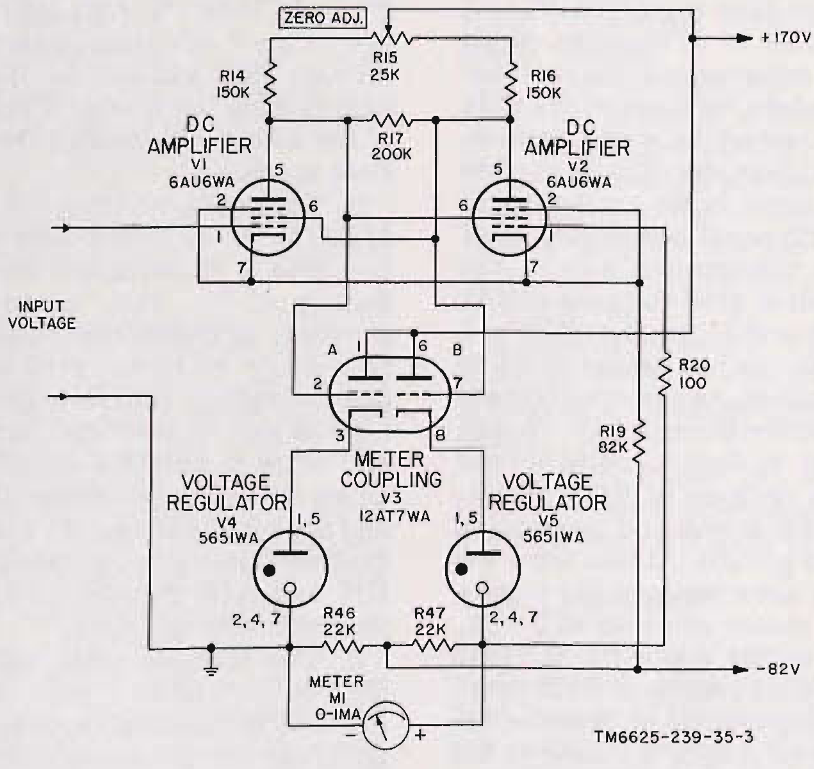


Figure 2. Amplifier, simplified schematic diagram.

control grid of tube V1 and is reproduced as a voltage across low-impedance voltage regulator tubes V4 and V5.

e. Section 3 of FUNCTION switch S1 controls the connections of input voltage to the meter. In the +D. C. position, the FUNCTION switch connects the positive terminal of the meter to the cathode of tube V5 and the negative terminal of the meter to ground. When a positive input voltage is applied to the grid of tube V1, the cathode of tube V5 becomes positive with respect to ground. Current is drawn from ground through the meter to the cathode of tube V5. This current flow causes the meter pointer to deflect upscale. The amount of deflection is directly proportional to the magnitude of the input voltage.

f. When a negative dc voltage is being measured, the input voltage at the control grid of V1 is negative and a negative voltage is produced at the cathode of V5. With the FUNCTION switch in the -D. C. position, the negative terminal is connected to the cathode of V5 and the positive terminal of the meter connects to ground; this reverses the connection of the meter terminals with respect to the +D. C. position. Current will flow from the cathode circuit of tube V5 through the meter to ground and cause the meter to deflect upscale. The amount of deflection is directly proportional to the magnitude of the input voltage.

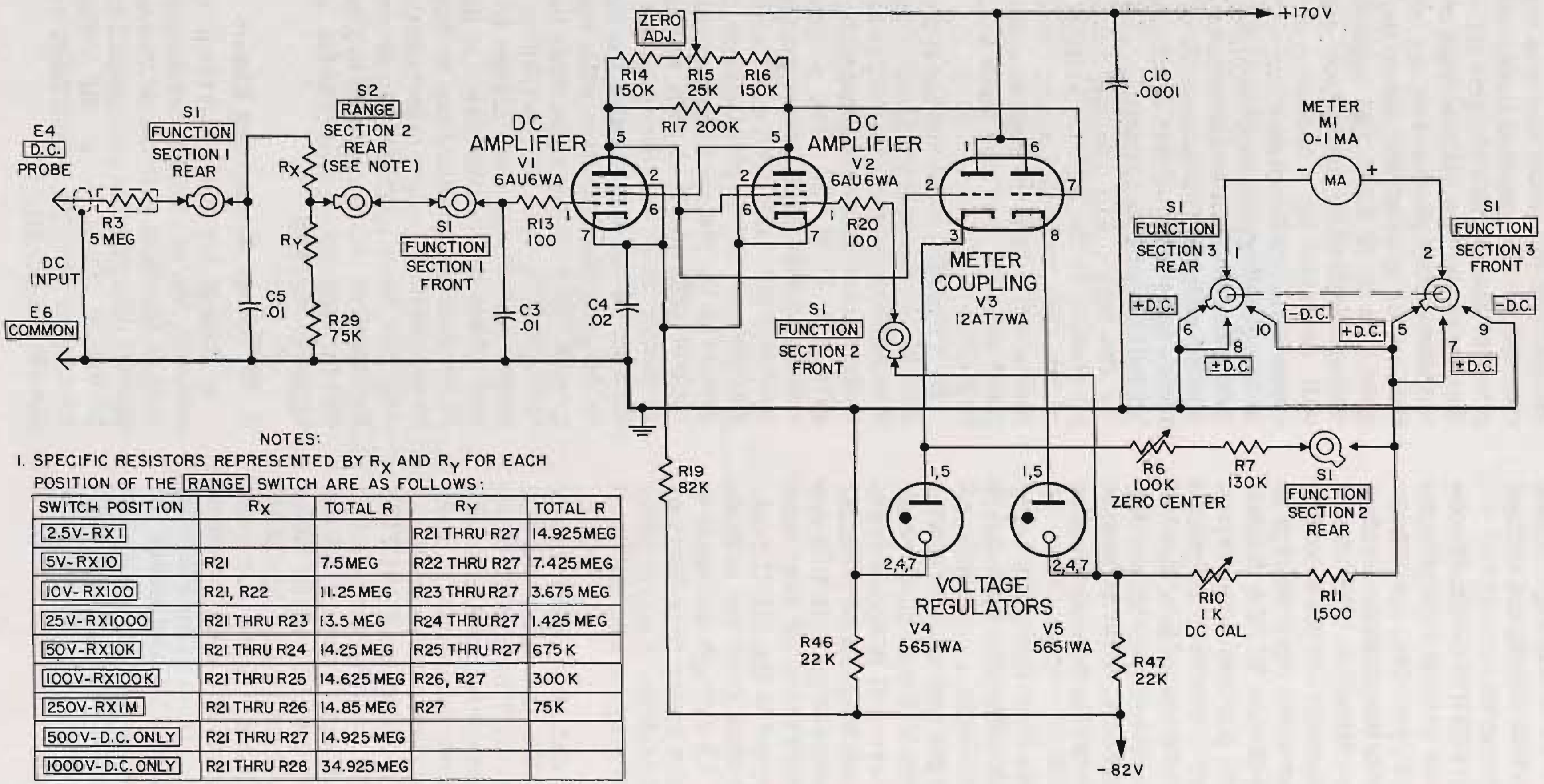
g. In the +D. C. and -D. C. positions of the FUNCTION switch, potentiometer R10 is in the meter circuit. This potentiometer is the dc calibration control and is used to compensate for minor variations in components, tubes, and meter movements.

h. In the ±D. C. position, the FUNCTION switch connects the positive terminal of the meter to the plate of V4 through R6 and R7 and the negative terminal of the meter to ground. With no input voltage applied to the control grid of tube V1, the plate voltage of V4 is such that 500 microamperes of current is drawn from ground through the meter to the plate of V4, and causes the meter pointer to deflect to midscale. The meter pointer is positioned at exact midscale by zero-centering potentiometer R6; this varies the amount of resistance in series with the meter and thus varies the current flow. A positive input voltage applied at the control grid of tube V1 decreases the plate voltage of V1; this negative-going plate voltage is coupled to the screen grid of V2 and to the control grid (pin 2) of V3A. The negative-going voltage applied to the screen grid of V2 will decrease the conduction of V2 and cause a rise in the plate voltage. This rise in plate voltage is coupled to the control grid (pin 7) of V3B and increases the conduction of V3B. This causes V5 to conduct more, and the top of R47 in the cathode of V5 will become more positive. The current for the meter will now have increased in proportion to the positive voltage of pin 1 of V1. The additional current through the meter will flow through resistors R10, fixed resistor R11 and tubes V5 and V3B to B+.

i. A negative input voltage at the control grid of V1 increases the plate voltage of V1; this positive-going plate voltage is coupled to the screen grid of V2 and to the control grid (pin 2) of V3A. The positive-going voltage applied to the screen grid of V2 will increase the conduction of V2 and cause a decrease in the plate voltage. This decrease in the plate voltage is coupled to the control grid (pin 7) of V3B; this decrease in plate voltage will decrease the current through V5 and R47 causing the top of R47 to become less positive with respect to ground. This causes an increase in current through R10, R11, R7 and R6 to B+. The increased voltage drop across R7 and R6 will cause the positive side of the meter to become less positive due to this change in potential. The current through the meter will now have decreased in proportion to the negative voltage applied to (pin 1) of V1 and the meter will deflect to the left for a negative reading.

6. Rf Voltage Measurement Circuit

a. Except for the addition of the rf adapter, the rf voltage measurement circuit is identical with the dc measurement circuit described in paragraph 5 and illustrated in figure 3. Rf voltages are measured with the FUNCTION switch in the +D. C. position.



NOTES:

1. SPECIFIC RESISTORS REPRESENTED BY R_X AND R_Y FOR EACH POSITION OF THE RANGE SWITCH ARE AS FOLLOWS:

SWITCH POSITION	R_X	TOTAL R	R_Y	TOTAL R
2.5V-RX1			R21 THRU R27	14.925 MEG
5V-RX10	R21	7.5 MEG	R22 THRU R27	7.425 MEG
10V-RX100	R21, R22	11.25 MEG	R23 THRU R27	3.675 MEG
25V-RX1000	R21 THRU R23	13.5 MEG	R24 THRU R27	1.425 MEG
50V-RX10K	R21 THRU R24	14.25 MEG	R25 THRU R27	675 K
100V-RX100K	R21 THRU R25	14.625 MEG	R26, R27	300 K
250V-RX1M	R21 THRU R26	14.85 MEG	R27	75K
500V-D.C. ONLY	R21 THRU R27	14.925 MEG		
1000V-D.C. ONLY	R21 THRU R28	34.925 MEG		

2. ON THE TS-505D/U, THE COMMON TEST LEAD IS NOT CONNECTED TO CHASSIS GROUND.
3. RESISTOR R1 IS NOT USED ON MULTIMETER TS-505C/U, TS-505D/U, AND ON SOME ELECTRONIC MULTIMETERS TS-505B/U

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Figure 3. Dc voltage measurement circuit.

b. Figure 4 is a simplified schematic diagram of the rf adapter. When in use, the rf adapter is mechanically and electrically connected to the D. C. probe. Included in the rf adapter is germanium diode CR1 that acts as a half-wave rectifier to convert the rf voltage being measured to a pulsating dc voltage which is applied to the control grid of tube V1. Terminal E2 represents the rf adapter tip; terminal E3 represents the alligator clip attached to the adapter. When in use, terminal E2 of the rf adapter is connected to the high potential side of the voltage being measured, and terminal E3 is connected to the low potential side. The shield around the rf adapter is connected to the multimeter ground to prevent any stray voltage pickup. Both terminal E3 and the negative side of the germanium diode CR1 are thus connected to the multimeter ground.

Note. Readings obtained when using the rf adapter are approximate and should be used only as a relative voltage indication.

c. The negative half-cycle of the waveform applied to terminal E2 causes germanium diode CR1 to conduct, and thus charge capacitor C1. Positive half cycles of the waveform applied to terminal E2 cause capacitor C1 to discharge (fig. 3 and 4) through precision attenuators (R21 through R27 and R29) D. C. probe resistor R3 and rf adapter resistor R2. The charge obtained on capacitor C3 during discharge time is applied to the control grid of V1 through resistor R13 and causes a meter deflection proportional to the rf voltage applied to the rf adapter.

d. Because the voltage from the rf adapter to the control grid of tube V1 is dc, the meter reads the equivalent dc voltage, which is root mean square for a sine wave input, or 0.707 of the peak value of a complex wave. If the input waveform is not sinusoidal, the meter will not indicate an equivalent voltage.

e. Use of the rf adapter is limited to measurements of rf voltages not exceeding 40 volts rms. Higher voltages will damage germanium diode CR1.

7. Ac Voltage Measurement Circuit
(fig. 5)

a. Ac voltages at frequencies from 30 cps to 1 mc may be applied across the A.C. PROBE and the COMMON probe and measured by the ac voltage measurement circuit. The A.C. PROBE contains resistor R1, which is located at the point of measurement to prevent capacitive loading of the circuit under test.

Note. Resistor R1 is not used in some Multimeters TS–505B/U nor in any C or D models.

b. Ac signal rectifier V6A, capacitor C2, precision attenuator resistors R21 through R27 and R29, and capacitor C3 function as a half-wave rectifier and as a filter-voltage divider network to convert ac voltages to a dc voltage which is applied to the control grid of V1. Positive half cycles of the waveform applied to the A. C. PROBE charge capacitor C2 through the conduction of tube V6A. Negative half cycles of the waveform applied to the A. C. PROBE cause capacitor C2 to discharge through resistor R5 and through the precision attenuator (R21 through R27 and R29). Capacitor C3 (in conjunction with V6A) functions as a half-wave rectifier and as a filter-voltage divider network to convert ac voltages to dc voltage which is applied to the control

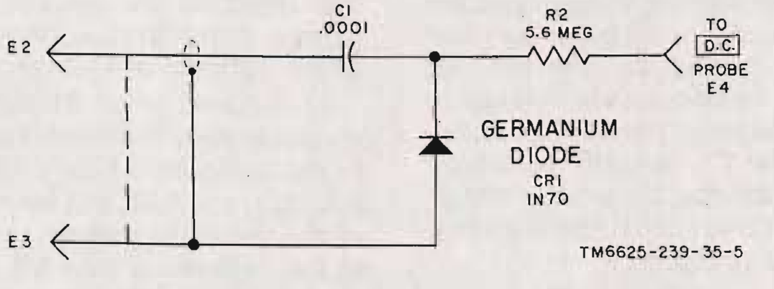


Figure 4. Rf probe, simplified schematic diagram.

grid of tube V1. Matching resistor R5 adjusts the total resistance of precision attenuator (R21 through R27 and R29) for ac voltage measurements.

c. When in the A. C. position, section 1 of FUNCTION switch S1 couples the dc input voltage from the precision attenuator (R21 through R27 and R29) to the control grid of tube V1. Section 2 of RANGE switch S2 selects an appropriate value of voltage from the precision attenuator (R21 through R27 and R29) to supply a voltage of between 0 and 1.875 volts to the control grid of V1. Specific resistors used to attenuate voltages being measured within each RANGE switch position are listed in figure 5.

d. Because of nonlinear characteristics of the ac signal rectifier for small ac voltages, a special scale is provided on the meter for measurements of ac voltages in the 0- to 2.5-volt range.

e. Ac signal rectifier V6A is continuously conducting, even with no voltage applied to the A. C. PROBE because of the contact potential on the plate and cathode of the tube. Current flows through tube V6A, resistor R5, and the precision attenuator (resistor R21 through R27 and R29) to ground; this applies a constant negative voltage to the control grid of V1. To cause the meter pointer to read 0 volt with no ac voltage applied to the A. C. PROBE, and to counteract the effect of the negative voltage applied to the control grid of tube V1, balancing diode V6B supplies a constant negative dc voltage, to the control grid of tube V2. This counteracts the negative voltage on the control grid of tube V1 by balancing the outputs of dc amplifiers V1 and V2. Section 1 of RANGE switch S2 selects the amount of the counteracting voltage applied to the control grid of tube V2 from the precision attenuator (resistors R30 through R36) so that the counteracting voltage is always equal to the negative voltage on the control grid of tube V1. Specific resistors used to establish the counteracting voltage supplied by tube V6B at each RANGE switch position are listed in figure 5.

f. The counteracting potential is developed across ac zero potentiometer R45. The potentiometer is adjusted to provide a voltage equal to the contact potential of tube V6A; this voltage keeps the meter pointer at zero.

g. In the A. C. position, section 3 of the FUNCTION switch connects the negative terminal of the meter to the cathode of tube V5 and the positive terminal of the meter to ground. With no dc input voltage applied to the control grid of tube V1, the voltage at the cathode of tube V5 is 0 volt with respect to ground. When a negative dc input voltage is applied to the control grid of tube V1, the cathode of tube V5 is driven negative with respect to ground. The current flow is from the cathode circuit of tube V5 through the meter to ground and causes the meter pointer to deflect upscale. The amount of deflection is proportional to the amount of input voltage.

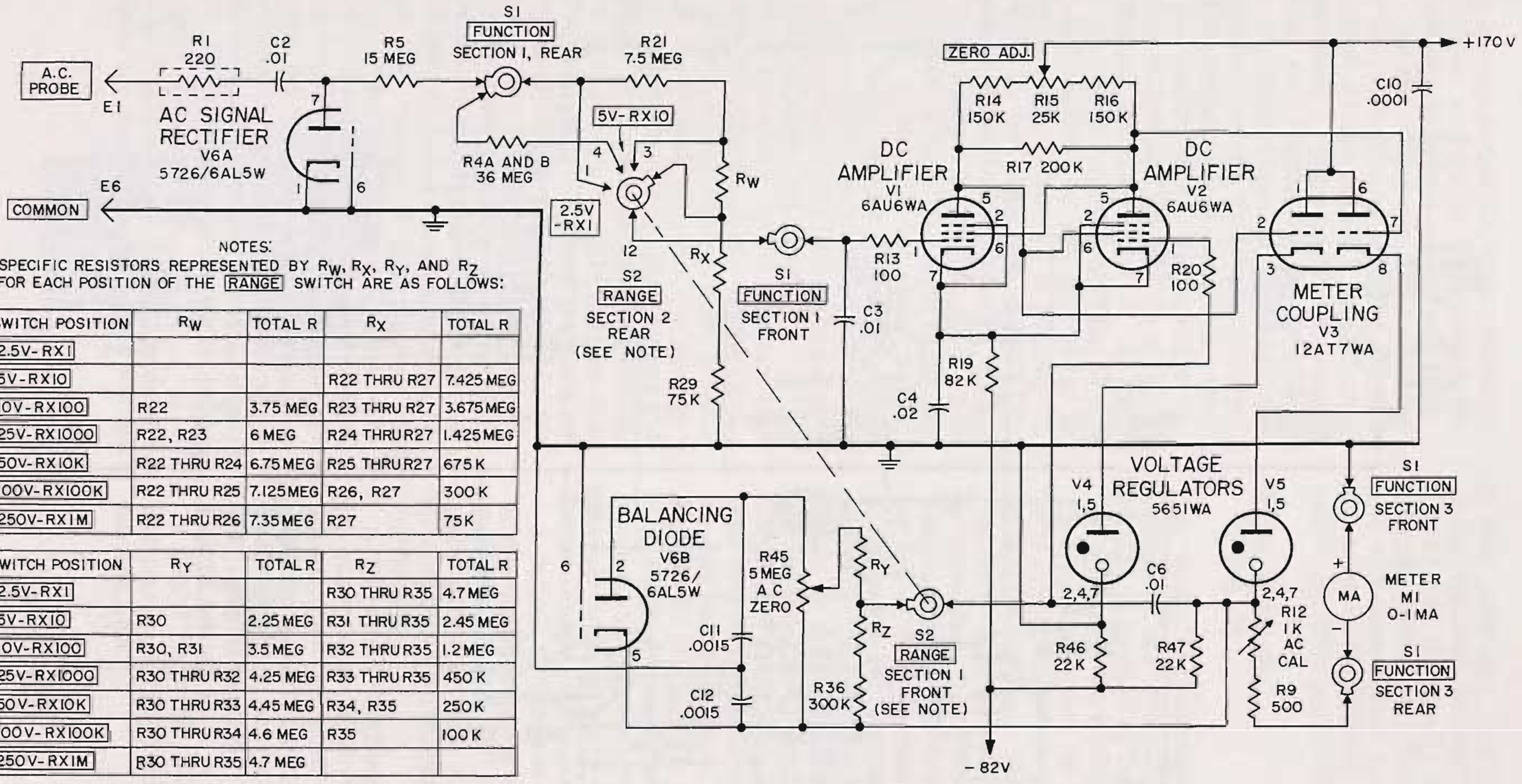
h. In the A. C. position of the FUNCTION switch, potentiometer R12 is connected in the meter circuit. Potentiometer R12 is the ac calibration control, and is used to compensate for minor variations in components, tubes, and meter movements.

8. Ohmmeter Resistance Measurement Circuit

(fig. 6)

a. Selenium rectifier CR2 receives a 6.3-volt ac input from the filament winding of transformer T1 and produces a dc output voltage across resistor R44 and filter capacitor C7. This filtered positive dc voltage is connected through one of seven precision resistors, section 1 of RANGE switch S2 and section 1 of FUNCTION switch S1, to the control grid of tube V1. With no connection between the OHMS and the COMMON probes, this positive dc voltage input to the control grid of tube V1 causes a positive voltage to be developed at the cathode of voltage regulator V5.

b. Section 3 of FUNCTION switch S1 connects the positive terminal of the meter to the cathode of tube V5 through resistors R8, R10, and R11, and the negative terminal of the meter to ground. A positive voltage at the cathode of tube V5, produced by the positive dc input voltage at the control grid of tube V1, causes current to flow from



NOTES:

1. SPECIFIC RESISTORS REPRESENTED BY R_W, R_X, R_Y, AND R_Z FOR EACH POSITION OF THE RANGE SWITCH ARE AS FOLLOWS:

SWITCH POSITION	R_W	TOTAL R	R_X	TOTAL R
2.5V-RX1				
5V-RX10			R22 THRU R27	7.425 MEG
10V-RX100	R22	3.75 MEG	R23 THRU R27	3.675 MEG
25V-RX1000	R22, R23	6 MEG	R24 THRU R27	1.425 MEG
50V-RX10K	R22 THRU R24	6.75 MEG	R25 THRU R27	675 K
100V-RX100K	R22 THRU R25	7.125 MEG	R26, R27	300 K
250V-RX1M	R22 THRU R26	7.35 MEG	R27	75 K

SWITCH POSITION	R_Y	TOTAL R	R_Z	TOTAL R
2.5V-RX1			R30 THRU R35	4.7 MEG
5V-RX10	R30	2.25 MEG	R31 THRU R35	2.45 MEG
10V-RX100	R30, R31	3.5 MEG	R32 THRU R35	1.2 MEG
25V-RX1000	R30 THRU R32	4.25 MEG	R33 THRU R35	450 K
50V-RX10K	R30 THRU R33	4.45 MEG	R34, R35	250 K
100V-RX100K	R30 THRU R34	4.6 MEG	R35	100 K
250V-RX1M	R30 THRU R35	4.7 MEG		

2. RESISTOR R1 IS NOT USED ON MULTIMETER TS-505C/U AND TS-505D/U, AND ON SOME ELECTRONIC MULTIMETERS TS-505B/U.
3. ON THE TS-505D/U, THE COMMON TEST LEAD IS NOT CONNECTED TO CHASSIS GROUND.

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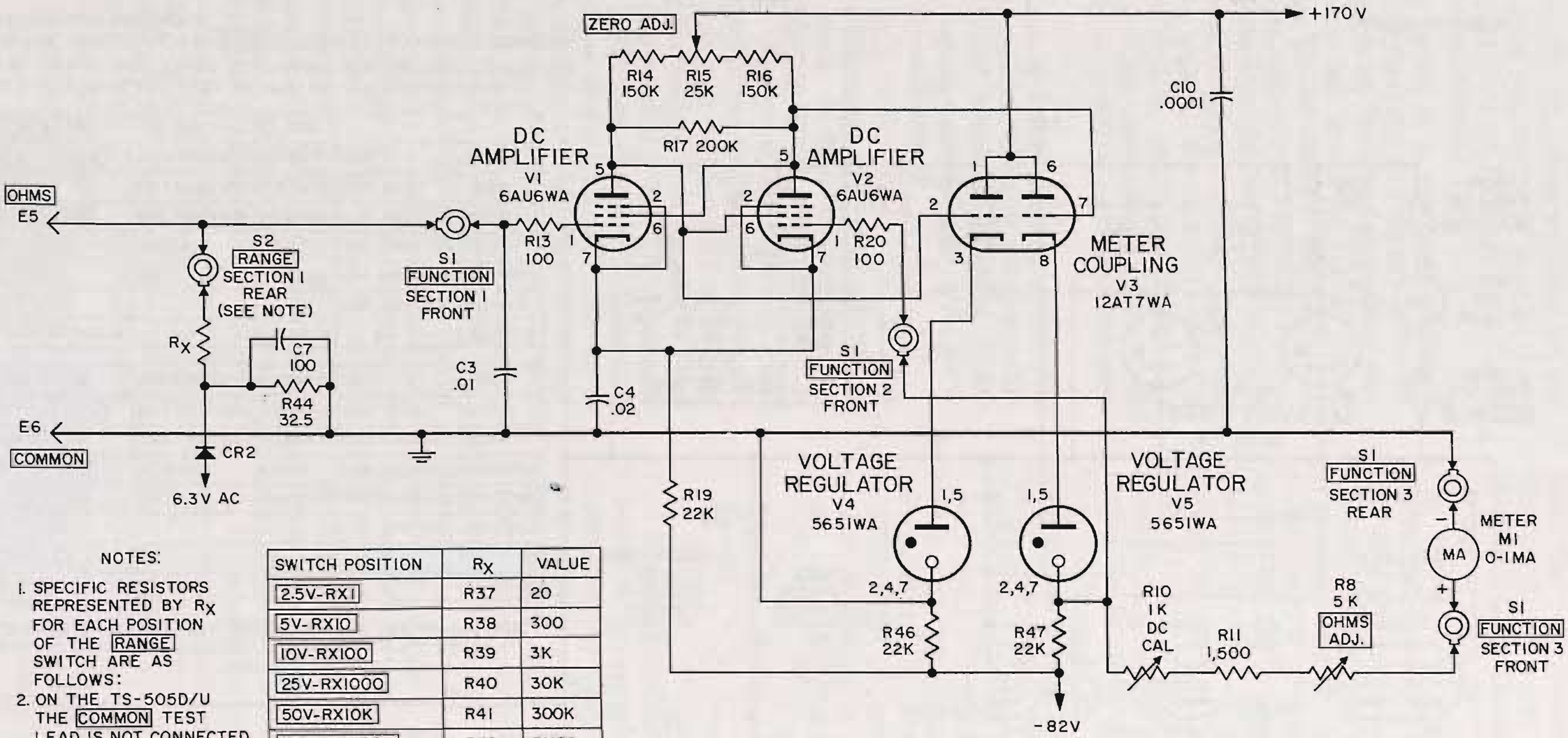
Figure 5. Ac voltage measurement circuit, simplified schematic diagram.



NOTES:

1. SPECIFIC RESISTORS REPRESENTED BY R_X FOR EACH POSITION OF THE RANGE SWITCH ARE AS FOLLOWS:
2. ON THE TS-505D/U THE COMMON TEST LEAD IS NOT CONNECTED TO CHASSIS GROUND.

SWITCH POSITION	R_X	VALUE
2.5V-RX1	R37	20
5V-RX10	R38	300
10V-RX100	R39	3K
25V-RX1000	R40	30K
50V-RX10K	R41	300K
100V-RX100K	R42	3MEG
250V-RX1M	R43	30MEG

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Figure 6. Ohmmeter circuit, simplified schematic diagram.

ground, through the meter, to the cathode of tube V5. This current flow causes the meter pointer to deflect a full-scale reading of ∞ on the OHMS scale. The meter pointer is adjusted to read exactly ∞ by rotating OHMS ADJ. control R8, which varies the resistance in series with the meter.

c. When the OHMS and the COMMON probes are shorted together, current flows from ground, through the COMMON probe, the OHMS probe, and section 1 of switch S2, to the positive end of the resistor selected by switch S2. The voltage supplied by selenium rectifier CR2 is dropped across precision resistor R_X (fig. 6) selected by switch S2, so that the voltage at the control grid of tube V1 is now 0 volt. By action of the amplifier circuit, the potential at the cathode of tube V5 is also 0 volt with respect to ground. With 0 volt at the cathode of tube V5, no current flows through the meter, and the meter pointer deflects to zero. The meter pointer is set at the exact zero scale reading by adjusting ZERO ADJ. control R15 to balance the output of dc amplifiers V1 and V2.

d. When a resistor to be measured is connected between the OHMS and the COMMON probes, current flows from ground, through the COMMON probe, the resistor being measured, the OHMS probe, and through the precision resistor selected by section 1 of switch S2. This current flow causes a voltage drop across the resistor being measured and across precision resistor R_X (fig. 6) selected by switch S2. The voltage drop across the resistor being measured is applied to the control grid of tube V1 and causes a deflection of the meter pointer. The amount of deflection of the meter pointer is directly proportional to the value of voltage applied to the control grid of tube V1. Resistances being measured that are high compared to resistor R_X will have a higher voltage drop, which will cause a greater deflection of the meter pointer. The meter will therefore read a high value of resistance.

e. The most accurate resistance measurements are made when the meter pointer is near midscale. Therefore, as the value of the unknown resistor is increased, the value of R_X should also increase by RANGE switch S2. The specific resistor and resistance value (represented by R_X) selected by RANGE switch S2 at each switch position are listed in figure 6.

9. Power Supply
(fig. 7)

a. Power transformer T1 steps up line voltage to approximately 550 volts. This voltage is applied to the plates of tube V7 for full-wave rectification. Transformer T1 also steps down the line voltage to 6.3 volts ac for the tube heaters, for pilot light I1, and for selenium rectifier CR2.

b. The output of rectifier V7 is filtered by capacitors C8, C9, and resistor R48. The negative side of the power supply (center top of high voltage winding on T1) is connected to the junction of resistors R46 and R47. The positive output of the power supply is applied to the plate circuits of dc amplifiers V1 and V2 and to meter coupling tube V3. With respect to the common bus, the positive voltage is +170 volts dc and the voltage of center tap transformer T1 is -82 volts dc.

c. Fuses F1 and F2 are placed in the primary circuit of transformer T1 to prevent damage to the transformer if shorting occurs in the multimeter.

d. Switch S1, section 4, is a double-pole, single-throw snap switch, used to turn the multimeter on or off. It is part of FUNCTION switch S1 and is actuated when the switch is rotated clockwise to operate the multimeter.

e. Selenium rectifier CR2 converts the 6.3 volts ac from the filament winding of transformer T1 to a pulsating dc. This output is filtered by capacitor C7 and resistor R44, and is applied to the ohmmeter resistance network attenuator through RANGE switch S2.

f. Pilot light I1 indicates whether the multimeter is on. The light is covered by a colored lens.

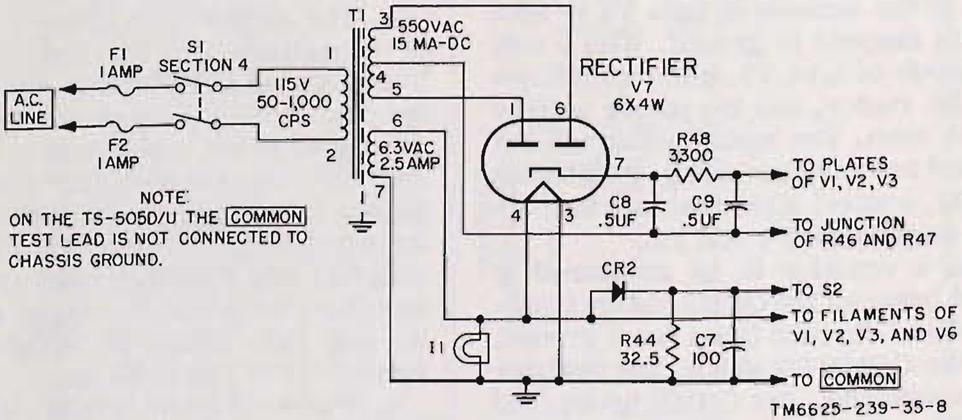


Figure 7. Power supply, simplified schematic diagram.

CHAPTER 2
TROUBLESHOOTING

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: **During servicing of the multimeter, certain points throughout the chassis of the multimeter operate at voltages above 300 volts. When handling or testing any part of the multimeter while it is connected to the power source, be extremely careful of the 550-volt secondary of T1 and the 115-volt ac line connections.**

10. General Instructions

Troubleshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field maintenance and depot procedures are not complete in themselves but supplement the procedures described in TM 11-6625-239-12. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques.

11. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective multimeter is to sectionalize the fault. Sectionalization means tracing the fault to a major component. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and resistance.

b. Component Sectionalization and Localization. Listed below is a group of tests arranged to reduce unnecessary work when tracing a trouble to a specific part. The simple tests are used first. Those that follow are more complex. Follow the procedure in the sequence given.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All meter readings or other visual signs should be observed, and an attempt made to sectionalize the fault to a particular component.

(2) *Checking for shorts.* The B+ and filament supply circuits should be checked (para 13) for possible shorts before the equipment is tested with the power applied. These measurements prevent further damage to the equipment from possible short circuits.

(3) *Operational test.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help to determine the exact nature of the fault. The equipment performance checklist (TM 11-6625-239-12) is a good operational test.

(4) *Troubleshooting chart.* The trouble symptoms listed in the chart (para 15) will aid in localizing trouble to a component part.

(5) *Intermittent troubles.* In all these tests, the possibility of intermittent trouble should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment; it is possible that some external condition may cause the trouble. Check the wiring for loose connections by moving the wires and the components gently with an insulated tool, such as a pencil or

a fiber rod. This may show where a faulty connection or component is located.

12. Test Equipment Required

The following chart lists test equipment required for troubleshooting Multimeter TS-505(*)/U, the associated technical manuals, and the assigned common names. If these equipments are not available, equipments with similar characteristics may be substituted.

Test equipment	Technical manual	Common names
Test Set, Electron Tube TV-7/U	TM 11-6625-274-12 and TM 11-6625-274-35	Tube tester
Test Set, Electron Tube TV-2/U	TM 11-6625-316-12	Tube tester
Meter Test Set TS-682A/GSM-1	TM 11-2535B	Meter test set
Multimeter AN/URM-105	TM 11-6625-203-12 and TM 11-6625-203-35	Multimeter
Tool Equipment TE-113	None	Tool equipment
Instrument Tool Equipment TK-21/G	None	Instrument tool equipment

Section II. UNIT TROUBLESHOOTING

Caution: Do not attempt removal or replacement of parts before reading the instructions in paragraph 18.

13. Checking Filament and B+ Circuits for Shorts

a. When to Check. Check the multimeter for short circuits before applying power. A blown fuse is a sign of overheated components or of a defective part in the power supply. These tests can be performed when the multimeter is being serviced and the nature of the abnormal symptom is not known, and when abnormal symptoms reported from operational tests indicate possible power supply troubles. These tests will prevent damage to the power supply.

b. Condition for Tests. Prepare for the short-circuit tests as follows:

(1) Remove the multimeter from its case (TM 11-6625-239-12).

(2) Remove all tubes; check to see that the A. C. LINE cord is disconnected from the power source, that the FUNCTION switch is set at the +D.C. position, and that the RANGE switch is set at the 2.5V-RX1 position. Mark tubes V1 and V2 so that they can be returned to their original tube sockets.

c. Measurements. Check the resistance between the plate and filament tube socket pins and ground. If the measured resistance values differ more than 10 percent from those specified in figure 9, check the circuit being measured for shorted components or wires. If a short in the B+ circuit is suspected, check capacitors C8 and C9 for shorts, and test all tubes for shorted elements.

14. Gassy Tube Checks

a. The performance and accuracy of the multimeter largely depends on the degree of balance between the dc amplifiers V1 and V2. Small variations in the characteristics of tubes V1 and V2, which will cause unbalance, may be compensated for by potentiometer R18 and ZERO ADJ. control R15, provided the tubes are not gassy.

b. Check for gas in tubes V1 and V2 as follows:

(1) Connect the multimeter A.C. LINE cord into the ac power source. Turn the FUNCTION switch to the +D.C. position and allow the multimeter to warm up for 10 to 15 minutes.

(2) Turn the ZERO ADJ. control (R15) to its mechanical center. Turn the RANGE switch to the 2.5V-RX1

position. Connect the D.C. probe and the COMMON probe tips together.

(3) Loosen the locknut on the potentiometer R18 (fig. 8). Use a screwdriver and turn potentiometer R18 until the meter pointer is within one-half scale division of zero. Wait approximately 1 minute between settings.

(4) After the adjustment has been made, tighten the locknut on potentiometer R18. Be careful not to disturb the setting of the meter pointer and the setting of the potentiometer.

(5) Set the meter pointer to zero by turning the ZERO ADJ. control.

(6) Turn the FUNCTION switch to the -D.C. position. The meter pointer should read zero within plus or minus one scale division.

(7) If the meter pointer has shifted more than plus or minus one scale division, allow the multimeter to operate for several hours; then repeat the instructions given in (1) through (6) above. If the shift of the meter pointer is still greater than one scale division from zero, replace tubes V1 and V2. Check the replacement tubes by repeating the instructions in (1) through (6) above.

15. Localizing Troubles

a. General. In the troubleshooting chart (*c* below), procedures are outlined for sectionalizing troubles to the power supply or to the multimeter. Parts locations are indicated in figures 11, 12, and 13. Voltage and resistance measurements are shown in figures 9 and 10. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When trouble has been localized to a particular stage, use voltage and resistance measurements to isolate the trouble to a particular part.

b. Use of Chart. The troubleshooting chart is designed to supplement the operational checks detailed in TM 11-6625-239-12. If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item. If operational symptoms are not known, begin with item 1 of the equipment performance checklist (TM 11-6625-239-12) and proceed until a symptom of trouble appears.

Caution: **If operational symptoms are not known, or if they indicate the possibility of a short-circuit within the multimeter, make the short-circuit checks described in paragraph 13 before applying power to the equipment.**

c. Troubleshooting Chart.

Item	Switch position		Symptom	Probable trouble	Correction
	FUNCTION switch	RANGE switch			
1	Any, except OFF.	Any.	Pilot light does not light; no movement of meter needle; line voltage normal.	A.C. LINE cord is not properly inserted in socket.	Insert correctly.
				Burned-out fuse F1 or F2.	Replace defective fuse (fig. 12).
				Defective A.C. LINE cord.	Replace or repair cord.
				Defective switch S1.	Replace or repair switch (para 19*d*).
				Defective transformer T1.	Replace transformer (para 19*c*).
				Short across filament winding of transformer T1.	Locate and remove short (para 17).
				Pilot lamp burned out.	Replace pilot lamp I1 (fig. 13).

Item	Switch position		Symptom	Probable trouble	Correction
	FUNCTION switch	RANGE switch			
2	+D.C.	Any.	Meter pointer does not move during initial warmup period; pilot light is on.	Defective tube V1, V2, V3, V4, V5, or V7.	Check tubes; replace defective tube or tubes (fig. 11).
				Poor contact at tube socket X1, X2, X3, X4, X5, or X7.	Replace and tighten contacts of sockets; replace defective socket or sockets (fig. 13).
					Meter burned-out. Replace meter (para 19*e*).
				Defective potentiometer R10.	Replace potentiometer (para 19*i*).
				Defective or dirty switch deck.	Clean or replace defective switch (para 19*d*).
				Line voltage low.	Apply correct line voltage.
				No voltage at cathode of tube V7.	Check transformer T1 (para 17); replace if defective.
3	+D.C.	2.5V-RX1	Meter pointer is near zero but cannot be adjusted to zero with ZERO ADJ. control R15.	Potentiometer R18 improperly calibrated, or defective.	Calibrate (para 22); replace potentiometer R18 if defective (para 19*i*).
				Potentiometer R15 defective.	Replace potentiometer R15 (para 19*i*).
				Line voltage too high or too low.	Apply correct line voltage.
				Defective tube, V1, V2, V3, V4, or V5 (fig. 11).	Check tubes; replace defective tube or tubes (fig. 11).
				Resistor R14 or R16 open or shorted; resistor R11 shorted.	Replace defective resistor (fig. 13).
4	+D.C.	1000V-D. C. ONLY.	Meter pointer drifts off scale.	Resistor R29 open. (Control grid of tube V1 to ground should measure 75,000 ohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace resistor R29 (fig. 11); clean switch contact or replace switches (para 19*d*).
	+D.C.	500V-D.C. ONLY.		Same probable fault as in item 1 above.	Same as item 1 above.
5	+D.C.	250V-RX1M.		Resistor R27 open. (Control grid of tube V1 to ground should measure 150,000 ohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace resistor R27 (fig. 11); clean switch contact or replace switches (para 19*d*).
6	+D.C.	100V-RX100K.		Resistor R26 open. (Grid of tube V1 to ground should measure 375,000 ohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace R26 (fig. 11); clean switch contact or replace switches (para 19*d*).
7	+D.C.	50V-RX10K.		Resistor R25 open. (Control grid of tube V1 to	Replace resistor R25 (fig. 11); clean switch contact

Item	Switch position		Symptom	Probable trouble	Correction
	FUNCTION switch	RANGE switch			
				ground should measure 750,000 ohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	or replace switches (para 19*d*).
8	+D.C.	25V-RX1000.		Resistor R24 open. (Control grid of tube V1 to ground should measure 1.5 megohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace resistor R24 (fig. 11); clean switch contact or replace switches (para 19*d*).
9	+D.C	10V-RX100.		Resistor R23 open. (Control grid of tube V1 to ground should measure 3.75 megohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace resistor R23 (fig. 11); clean switch contact or replace switches (para 19*d*).
10	+D.C.	5V-RX10.		Resistor R22 open. (Control grid of tube V1 to ground should measure 7.5 megohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace resistor R22 (fig. 11); clean switch contact or replace switches (para 19*d*).
11	+D.C.	2.5V-RX1.		Resistor R21 open. (Control grid of tube V1 to ground should measure 15 megohms.) Dirty or open contact on switch S1, section 1, or switch S2, section 2.	Replace resistor R21 (fig. 11); clean switch contact or replace switches (para 19*d*).
12	+D.C.	2.5V-RX1.	Application of 2.5 volts ±1 percent to meter results in error greater than 5 percent.	Potentiometer R10 set incorrectly, or defective.	Refer to paragraph 21*d*. Replace potentiometer R10 paragraph 19*i*.
				Resistor R17 open	Replace resistor R17 (fig. 13).
				Resistors R21 through R29 are not within 1 percent of correct value.	Replace defective resistor or resistors (fig. 11).
				Meter M1 error greater than ±2 percent.	Replace meter (para 19*e*).
13	+D.C.	500V-D.C. ONLY.	Apply approximately 500 volts between D.C. and COMMON probes, and then turn FUNCTION switch to 1000V-D.C. ONLY position. Meter pointer does not read 500 volts on 1000-V range.	Resistor R28 short-circuited.	Repair or replace switch S2, section 2 (para 19*d*); replace resistor R28 (fig. 11).

Item	Switch position		Symptom	Probable trouble	Correction
	FUNCTION switch	RANGE switch			
14	±D.C.	Any position.	Meter pointer not at midscale.	Potentiometer R6 defective or set incorrectly. Resistor R7 open or shorted.	Replace potentiometer R6. Refer to paragraph 19*i* and 22*a*. Replace resistor R7 (fig. 13).
15	±D.C.	See item No. 4 above.	Meter pointer drifts until off scale.	Same as item No. 4.	Same as item No. 4.
16	-D.C.	See item No. 4.	Meter pointer drifts until off scale.	Same as item No. 4	Same as item No. 4.
17	-D.C.	2.5V–RX1	Meter pointer set to zero on -D.C. indicates negative when switched to -D.C. and cannot be set to zero with ZERO ADJ. control (R15).	Tube V1 or V2 gassy . . .	Refer to paragraph 14.
18	+D.C., ±D.C., or-D.C.	Any.	No deflection of meter pointer with dc voltage applied.	Resistor R3 open . . . . . . Loose mechanical connection between resistor R3 lead and D.C. probe tip. Test lead open . . . . Dirty or open contact on switch S1 or S2.	Replace resistor R3. Inspect resistor lead and tighten probe tip. Replace test lead. Clean switch contact or replace defective switch (para 19*d*).
19	+D.C., ±D.C., or -D.C.	Various.	Meter pointer shifts when changing setting or RANGE switch.	Tube V1 or V2 gassy . . .	Refer to paragraph 14.
20	+D.C., ±D.C., or -D.C.	Any.	Meter pointer deflects in wrong direction.	Meter leads reversed . . .	Reverse meter leads.
21	+D.C., ±D.C., or -D.C.	Any.	Meter pointer unstable; for constant input voltage, meter indication keeps changing.	Tube V1 or V2 gassy . . . Resistor R17 open	Refer to paragraph 14. Replace resistor R17 (fig. 13).
22	+D.C., ±D.C., or -D.C.	Any.	Application of low frequency (approx. 30 cps) to D.C. probe causes meter pointer to vibrate.	Capacitor C3 or C5 open .	Replace capacitor C3 or C5 (fig. 11).
23	+D.C.	Any position up to 50-V-RX10K.	Apply rf voltage up to 40 volts, 1 to 500 mc. No deflection of meter pointer.	Capacitor C1 open or shorted. Germanium diode CR1 open or shorted. Resistor R2 open	Replace capacitor C1. Replace germanium diode CR1. Replace resistor R2.
24	A.C.	2.5V-RX1.	Meter pointer cannot be set to zero with potentiometer R15 or R45 (no input voltage to A.C. PROBE).	Potentiometer R12 incorrectly set, or defective. Potentiometer R15 or R45 defective. Resistor R21, R22, R23, R24, R25, R26, R27, or	Refer to paragraph 19*i* and 23. Replace potentiometer R15 or R45 (para 19*i*). Replace defective resistor (fig. 11).

Item	Switch position		Symptom	Probable trouble	Correction
	FUNCTION switch	RANGE switch			
				R29 open or shorted, or of incorrect value.	
25	A.C.	Any.	No meter pointer deflection with ac voltage applied to A.C. PROBE.	Capacitor C2 open	Replace capacitor C2 (fig. 13).
				Tube V6 burned-out.	Replace tube V6 (fig. 11).
				Resistor R1 open	Replace resistor R1 (fig. 21).
				Note. Resistor R1 is not used on Multimeters TS-505C/U and TS-505D/U, nor on some Electronic Multimeters TS-505B/U.	
				Dirty or open contact on switch S1 or S2.	Clean switch contact or replace defective switch (para 19*d*).
26	A.C.	Any.	Meter pointer deflects with dc voltage applied to A.C. PROBE.	Capacitor C2 defective . .	Replace capacitor C2 (fig. 13).
27	A.C.	Any.	Potentiometer R12 will not adjust meter for calibrating.	Potentiometer R12 defective.	Replace potentiometer (para 19*i*).
28	A.C.	Any.	Meter pointer deflects positive with no input voltage; rotation of potentiometer R45 has no effect.	Tube V6B inoperative . . .	Replace tube V6 (fig. 11).
				Capacitor C11 or C12 shorted.	Replace defective capacitor (fig. 13).
				Resistor R21, R22, R23, R24, R25, R26, R27, or R29 open or shorted, or of incorrect value.	Replace defective resistor (fig. 11).
29	A.C.	Any.	Meter pointer deflects negative with no input voltage; rotation of potentiometer R45 has no effect.	Tube V6 inoperative	Replace tube V6 (fig. 11).
				Resistor R5 open	Replace resistor R5 (fig. 13).
				Potentiometer R45 defective.	Replace potentiometer R45 (para 19*i*).
30	OHMS.	Any.	Meter pointer does not deflect toward full scale.	Capacitor C3 or C7 shorted.	Replace capacitor C3 or C7 (fig. 11).
				Dirty or open contacts on switch S1 or S2.	Clean switch contact or replace switch (para 19*d*).
				Selenium rectifier CR2 defective.	Replace selenium rectifier CR2 (fig. 11).
31	OHMS.	2.5V-RX1.	Meter pointer drifts upscale.	Resistor R37 open	Replace resistor R37 (fig. 12).
		5V-RX10.		Resistor R38 open	Replace resistor R38 (fig. 12).
		10V-RX100.		Resistor R39 open	Replace resistor R39 (fig. 12).
		25V-RX1000.		Resistor R40 open	Replace resistor R40 (fig. 11).
		50V-RX10K.		Resistor R41 open	Replace resistor R41 (fig. 11).
		100V-RX100K		Resistor R42 open	Replace resistor R42
				Resistor R42 open	(fig. 11).
		250V-RX1M.		Resistor R43 open	Replace resistor R43 (fig. 11).

Item	Switch position		Symptom	Probable trouble	Correction
	FUNCTION switch	RANGE switch			
		Any.		Resistor R44 open	Replace resistor R44 (fig. 11).
32	OHMS.	Any.	Full clockwise rotation of OHMS ADJ. control does not bring meter pointer to ∞.	Selenium rectifier CR2 defective.	Replace selenium rectifier CR2 (fig. 11).
				Line voltage too low . .	Apply correct line voltage.
				Potentiometer R10 defective.	Replace potentiometer R10 (para 19*i*).
				OHMS ADJ. potentiometer R8 defective.	Replace potentiometer R8 (para 19*i*).
33	Any, except OFF.	2.5V-RX1.	No B+ at cathode of tube V7; pilot light glows.	Tube V7 defective	Replace tube V7 (fig. 11).
				Capacitor C8 shorted . .	Replace capacitor C8 (fig. 11).
				High voltage winding of transformer T1 open or shorted.	Replace transformer T1 (para 19*c*).
34	Any, except OFF.	2.5V-RX1.	No B+ at plates of tube V3; pilot light glows.	Capacitor C9 shorted . .	Replace capacitor C9 (para 19*c*).
				Resistor R48 open	Replace resistor R48 (fig. 11).
				Tube V7 defective	Replace tube V7 (fig. 11).

16. Isolating Trouble Within Stage

When trouble has been localized to a stage by means of the troubleshooting chart (para 15), use the following techniques to isolate the defective part.

a. Test the tube involved, either with the Tube Tester TS-TV-2/U or by substituting a similar type of tube that is known to be operating normally.

b. Take voltage measurements at the tube socket (fig. 9) and other points related to the stage in question (fig. 10).

c. If voltage readings are abnormal, take resistance readings (fig. 9 and 10) to isolate open and short circuits. Refer also to the dc resistance of the power transformer (para 17).

d. Use the wiring diagram (fig. 20) to trace circuits and to isolate the faulty component.

17. Dc Resistance of Transformer T1

The dc resistance of the transformer windings and terminals of the multimeter are listed below:

Transformer	Terminals	Ohms
T1	1-2	34
	3-4	740
	3-5	1,480
	4-5	740
	6-7	0.2

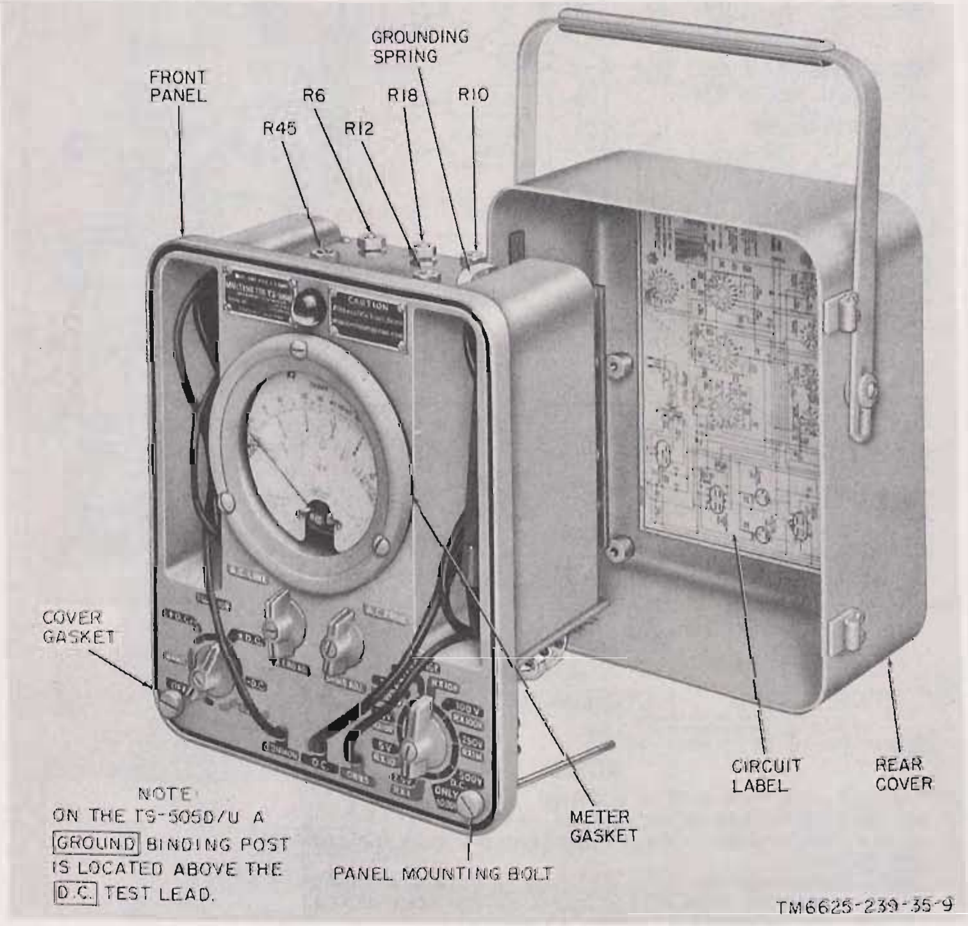
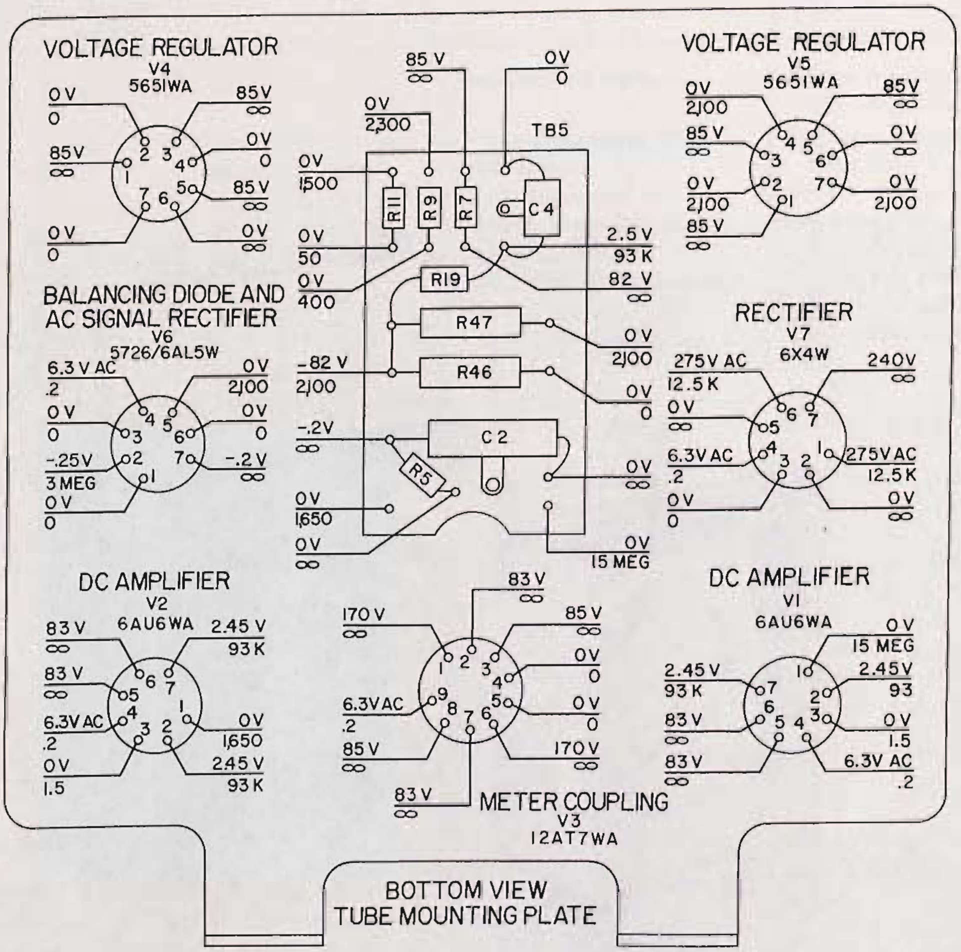


Figure 8. Multimeter removed from case.

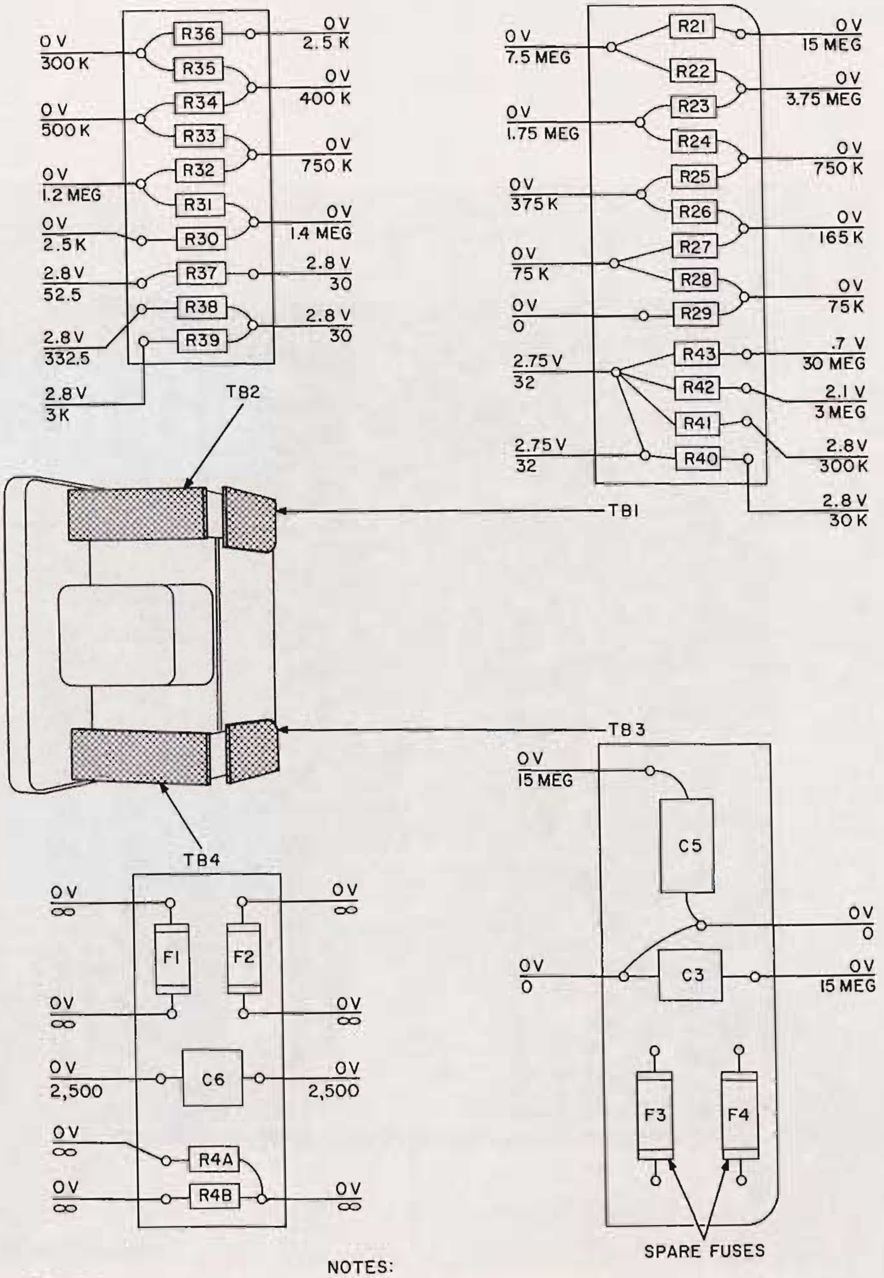


NOTES:

1. TUBE SOCKETS VIEWED FROM BOTTOM.
2. ALL POTENTIOMETERS AT MECHANICAL CENTER.
3. MEASUREMENTS MADE BETWEEN DESIGNATED POINTS AND [COMMON] (SEE NOTE 11)
4. [RANGE] SWITCH POSITION [2.5 V-RX1], [FUNCTION] SWITCH POSITION [+D.C.]
5. ALL MEASUREMENTS MADE WITH 20,000 OHMS-PER-VOLT METER.
6. VOLTAGE MEASUREMENTS DC EXCEPT AS NOTED.
7. LINE VOLTAGE 115 VOLTS AC 60 CYCLE.
8. ∞ INDICATES INFINITE RESISTANCE.
9. RESISTANCES IN OHMS UNLESS OTHERWISE SPECIFIED.
10. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
11. ON THE TS-505D/U THERE ARE NO CONNECTIONS FROM THE COMMON TEST LEAD TO THE CHASSIS GROUND. THE COMMON TEST LEAD, CONNECTED TO PIN 7 OF TRANSFORMER T1, IS THE GROUND REFERENCE. A GROUND BINDING POST IS AVAILABLE FOR CONNECTING THE CASE TO EARTH GROUND.

TM6625-239-35-10

Figure 9. Multimeter, tube socket voltage and resistance diagram.



NOTES:

1. RANGE SWITCH POSITION 2.5 V-RX1, FUNCTION SWITCH POSITION +D.C.
2. MEASUREMENTS MADE BETWEEN DESIGNATED POINTS AND CHASSIS GROUND. (COMMON TEST LEAD ON THE TS-505D/U)
3. ALL MEASUREMENTS MADE WITH 20,000 OHMS-PER-VOLT METER.
4. VOLTAGE MEASUREMENTS DC.
5. LINE VOLTAGE 115 VOLTS AC 60 CYCLES.
6. ∞ INDICATES INFINITE RESISTANCE.
7. RESISTANCES IN OHMS UNLESS OTHERWISE SPECIFIED.
8. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.

TM6625-239-35-11

Figure 10. Multimeter, terminal board, voltage and resistance diagram.

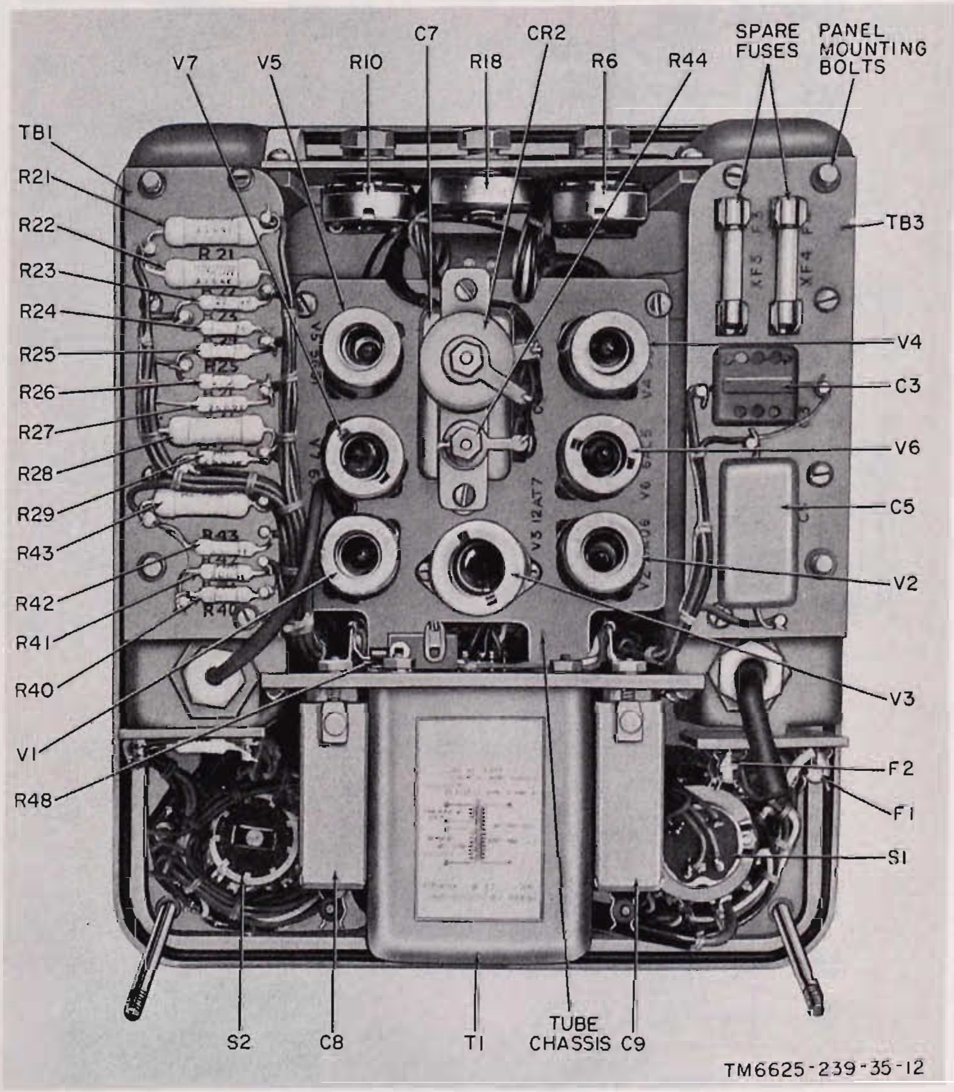


Figure 11. Multimeter, case removed (rear view).

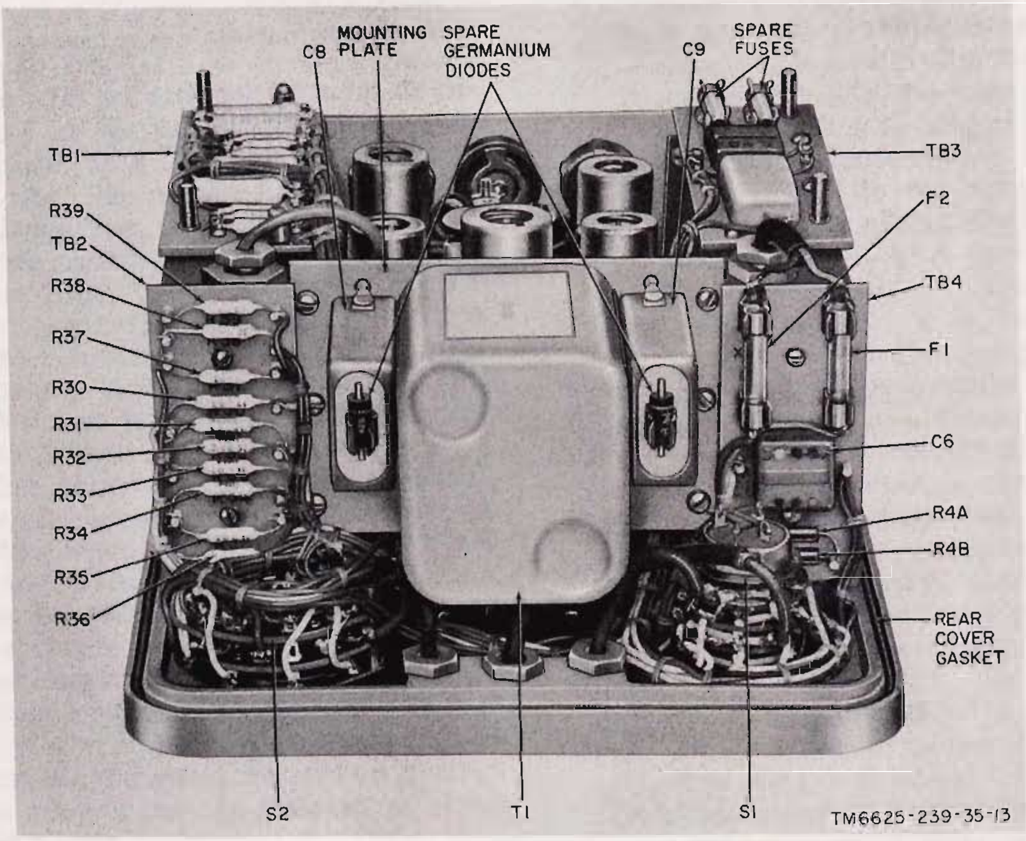


Figure 12. Multimeter, case removed (bottom view).

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CHAPTER 3
REPAIRS AND ALIGNMENT

Section I. REPAIRS

18. General Parts Replacement Techniques

Note. Some resistors used in the multimeter have smaller tolerances than those used in most electronic equipments. Resistors R1, R3, R21 through R29, and R31 through R44 are precision resistors with tolerance of ±1 percent. If these resistors require replacement, use a resistor with the exact value and tolerance as those of the one removed.

Caution: **Do not attempt removal or replacement of parts before reading the instructions in *a* through *f* below. Be careful when the multimeter is out of the case; dangerous voltages are exposed.**

a. If the multimeter has been operating for some time, use a cloth when removing the metal tube shields. Use a tube puller to remove the tubes, so as to prevent burning the hand or fingers. Label tubes V1 and V2 to insure replacement in the same tube socket.

b. When removing parts from the panel, remove all packing glands that secure the connecting leads. Be careful not to kink or strain any wires or leads.

c. Do not overtighten the screws or packing glands when assembling the mechanical couplings.

d. When changing a component that is held by screws, always replace the washers. Be sure that the rubber O-rings are installed before the installation of the packing glands.

e. Careless replacement of parts often makes new faults inevitable. Note the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a wafer switch or a power transformer, has a number of connections, tag each lead before removing it.

(2) Be careful not to damage other leads by pushing or pulling them out of the way.

(3) Do not use a large soldering iron to solder small resistors or ceramic capacitors. Overheating of a small part may damage or change the value of the part.

(4) Do not allow drops of solder to fall into the chassis, because they may cause shorts.

(5) A carelessly soldered connection may create new faults. Make well-soldered joints, because a poorly soldered joint is one of the most difficult faults to find.

(6) When a part is replaced, the new part must be placed exactly in the original position. A part that has the same electrical value but different physical size may cause trouble in high-frequency circuits. The multimeter contains a number of precision resistors that must be replaced by identical replacement parts. Note particularly the proper grounding; use the same ground as in the original wiring. Failure to observe these precautions may result in improper operation or in instability.

(7) Do not disturb the setting of potentiometer R6, R10, R12, R18, or R45 (fig. 8) unless it definitely has been determined that the trouble is caused by maladjustment of one or more of these potentiometers.

19. Removal and Replacement of Units

For this operation, refer to paragraph 31, TM 11-6625-239-12.

a. Terminal Boards.

(1) To remove terminal boards TB1, TB2, TB3, and TB4 (fig. 12), proceed as follows:

(a) Remove the front panel and chassis assembly.

(b) Remove the terminal boards by removing the retaining screws

from the tapped holes in the panel casting.

(2) To reassemble and install all the terminal boards, reverse the disassembly procedures given in (1) above.

b. Mounting Plates (fig. 12 and 13).

(1) To remove the mounting plates, proceed as follows:

(a) Remove the front panel and chassis assembly.

(b) Remove the mounting plates by removing the retaining screws from the tapped holes in the panel casting.

(2) To reassemble and install the mounting plates, reverse the disassembly procedures given in (1) above.

c. Power Transformer T1 and Power Supply Filter Capacitors C8 and C9 (fig. 11).

(1) To remove the power transformer and power supply filter capacitors, proceed as follows:

(a) Remove the front panel and chassis assembly.

(b) Remove the retaining nuts from the underside of the mounting plates. These nuts are secured to studs on the power transformer and on the power supply filter capacitors.

(2) To reassemble and install power transformer T1 and power supply filter capacitors C8 and C9, reverse the disassembly procedure given in (1) above.

d. FUNCTION and RANGE Wafer Switches S1 and S2 (fig. 13).

(1) To remove the wafer switches, proceed as follows:

(a) Remove the front panel and chassis assembly (*a* above).

(b) Remove the FUNCTION or RANGE switch control knob.

Note. Carefully mark the wires connected to the wafers with tags to avoid wrong connections when the new wafer switch is installed.

(2) To reassemble and install the wafer switches, reverse the disassembly procedures given in (1) above.

e. Meter M1.

(1) To remove meter M1, proceed as follows:

(a) Remove the front panel and chassis assembly.

(b) Remove the three screws on the TS-505A/U model only. (On all other models of the TS-505(*)/U, there will be six screws.)

(c) Pull the meter out of the panel to expose the two wires on the back of the meter.

Note. Do not attempt to repair the meter. If the meter is defective, replace it. When replacing the meter, observe the proper polarity when reconnecting the two wires on the back.

(2) To reassemble and install meter M1, reverse the disassembly procedures given in (1) above.

f. Potentiometer Mounting Plate (fig. 13).

(1) To remove the potentiometer mounting plate, proceed as follows:

(a) Remove the front panel and chassis assembly.

(b) Remove the mounting plate screws from the tapped holes in the panel casting.

(2) To reassemble and install the potentiometer mounting plate, reverse the disassembly procedure given in (1) above.

g. Tube Chassis (fig. 11).

(1) To remove the tube chassis, proceed as follows:

(a) Remove the front panel and chassis assembly.

(b) Remove the tube chassis by removing the retaining screw from the tapped holes in the panel casting.

(2) To reassemble and install the tube chassis, reverse the disassembly procedures given in (1) above.

Note. Before reassembly, inspect the O-rings in the back of the packing glands (fig. 13) and those surrounding the shafts

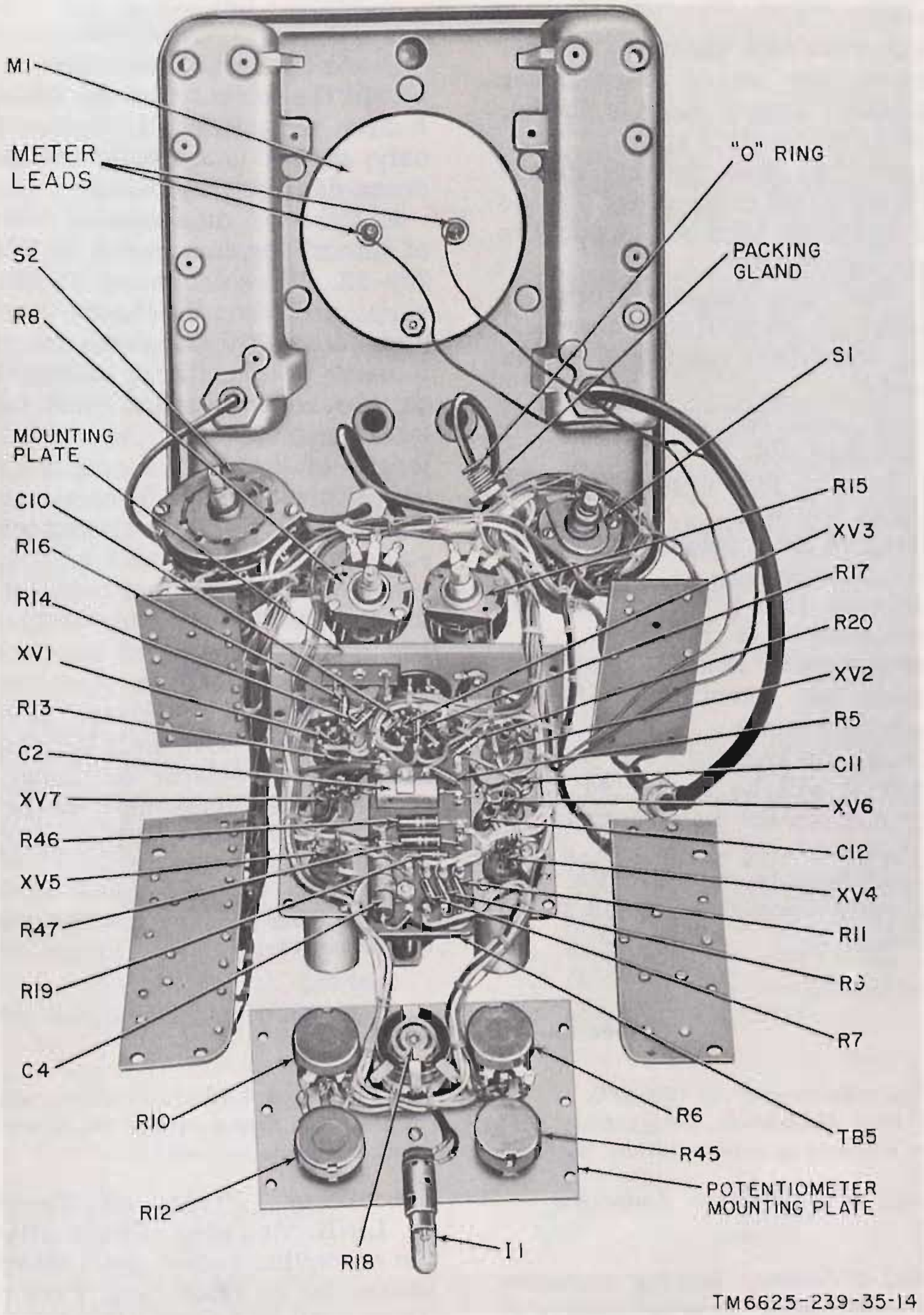

Figure 13. Multimeter, showing parts and subassemblies removed from panel.

of the four front-panel controls for cracking, peeling, or signs of deterioration. Replace these O-rings if necessary.

h. Tube Chassis (Internal). To remove the internal parts of the tube chassis, proceed as follows:

(1) Remove the front panel and chassis assembly.

(2) Remove the potentiometer (*i* below).

(3) Remove the terminal boards (*a* above).
(4) Remove the tube chassis (*g* above).
(5) Remove the power transformer and power supply filter (*c* above).
(6) Remove the control knobs.
(7) Remove the five packing glands from the panel casting (fig. 13) and pull the leads through the panel to allow ample slack.
(8) Lift the tube chassis from the casting. Be careful to avoid damaging the wires connected to the chassis.

i. Potentiometers R6, R8, R10, R12, R15, R18, and R45 (fig. 13).

(1) To remove potentiometers, proceed as follows:
  (a) Remove the front panel and chassis assembly.
  (b) Remove the potentiometer mounting plate (*f* above).
  (c) Remove the hexagonal nut that holds the potentiometer to the mounting plate.
  (d) Unsolder and tag each wire so that it will be connected properly when the potentiometer is replaced.
(2) To reassemble, reverse the disassembly procedure given in (1) above.

20. Replacement of Components in Test Probes

Caution: Be careful not to force or strain the parts or leads. When installing button capacitor C1, tighten fingertight only; do not use a tool for tightening because damage may result.

a. For the disassembly and assembly of the rf adapter, refer to TM 11-6625-239-12. If replacement of R2 is necessary, unsolder the leads from the stub plate assembly and from the solder lug. Remove the insulating tubing, but do not cut the resistor leads until the replacement resistor has been cut to the exact length of that of the original part. This will insure proper fit upon assembly. Be sure to install the insulating tubing before soldering a lead to the lug.

b. For the disassembly and assembly of the D.C. probe refer to TM 11-6625-239-12. If replacement of R3 is necessary, follow the procedure given in *a* above. When soldering a resistor, be careful not to apply excessive heat because this will damage the resistor or change its value.

c. For the disassembly of the COMMON and OHMS Probes and A.C. PROBE, refer to TM 11-6625-239-12.

Note. When replacing resistor R1, which is used on the TS-505A/U and on some TS-505B/U models, use an exact replacement.

Section II. CALIBRATION

Note. Electronic Multimeters TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U are calibrated during manufacture. After calibration, the controls are locked in place and further calibration is not required unless tubes are replaced or it is definitely known that calibrations are to be made.

21. Calibration of Dc Voltage Measuring Scales

a. Removal of Cover. During calibration of the multimeter, it is necessary to remove the cover to expose the calibration controls. To do this, use the following procedure:

(1) Unscrew the six panel-mounting bolts on the front panel (fig. 8).
(2) Slide the panel assembly out of the back cover. The potentiometer plate is on the top side of the multimeter.

b. Warmup Procedure. Connect the A. C. LINE cord plug of the multimeter into the powerline socket (98-132-volt, single-phase, 50 to 1,000 cps). Turn the FUNCTION switch to the +D. C. position and allow the multimeter to warm up from 10 to 15 minutes.

Note. On the TS-505D/U, connect the GROUND binding post to a suitable ground, such as a water pipe.

c. Adjustment for Zero Deflection.

(1) Set the ZERO ADJ. control to its mechanical center.

(2) Connect the D. C. and COMMON probe tips together.
(3) Turn the RANGE switch to the 2.5V-RX1 position.
(4) Loosen the locknut on coarse zero adjustment control R18 (fig. 8).
(5) Turn coarse zero adjustment control R18 to the right or left 1/4 turn. Wait 1 minute for a meter indication.
(6) Turn the control for further resetting, as necesssay. Wait 1 minute between each setting. Turn control R18 until meter pointer is within one-half scale division of zero.
(7) Tighten the locknut on control R18. Be careful not to disturb the setting of the control.
(8) Set the meter pointer to zero reading by turning the ZERO ADJ. control on the front panel.

Note. If the meter pointer cannot be set at zero by the rotation of the ZERO ADJ. control on the front panel, refer to item 24, paragraph 15*c* for the corrective procedure.

d. Adjustment for Full-Scale Deflection.
(1) Leave the FUNCTION switch on the +D. C. position and the RANGE switch on the 2.5V-RX1 position.
(2) Loosen the locknut on the dc calibration control R10.
(3) Apply 2.5 volts dc ±1 percent across the D. C. and COMMON probes. Use Meter Test Equipment AN/GSM-1B as the voltage source.
(4) Turn the dc calibration control R10 and wait 1 minute for a meter indication. The meter pointer should read full-scale deflection when correct adjustment has been made.
(5) When the procedure indicated in (1) through (4) above is completed, disconnect the probes from the power source.
(6) Tighten the locknut on the dc calibration control R10. Be careful not to disturb the setting of the control.

Note. If the meter pointer cannot be set to full-scale deflection after the resetting of the dc calibration control R10, refer to item 2, paragraph 15*c* for the corrective procedure.

22. Calibration of Dc Voltage, Zero Center Scale

Before beginning the procedures in this paragraph, calibrate the DC voltage measuring scale (para 21) and then proceed as follows:

a. Adjustment for Zero Centering.
(1) Turn the FUNCTION switch to the ±D. C. position. Turn the RANGE switch to the 2.5V-RX1 position.
(2) Connect the D. C. and the COMMON probe tips together.

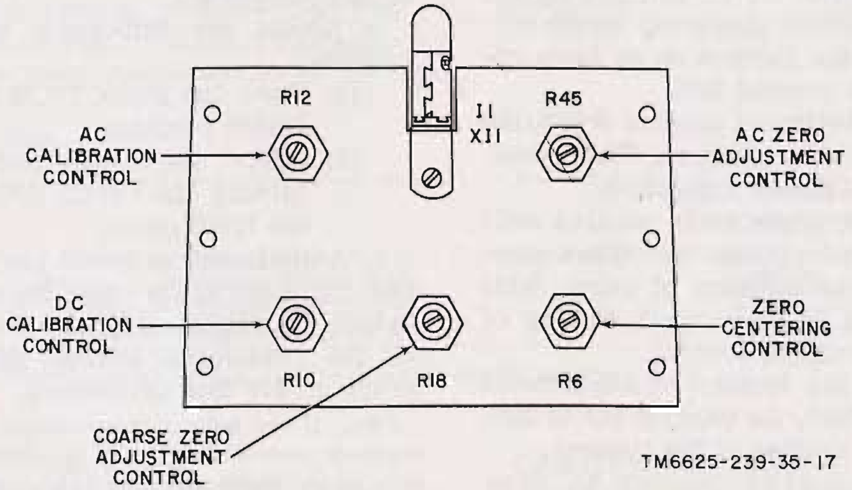

Figure 14. Electronic Multimeter TS-505(*)/U, calibration adjustment controls.

(3) Loosen the locknut on zero-centering control R6 (fig. 16).

(4) Turn zero-centering control R6 and wait 1 minute for a meter indication. The meter pointer should rest in the center of the scale.

(5) Turn the zero-centering control R6 until the meter pointer rests in the center of the scale. Wait 1 minute between each setting of this control for a meter setting.

(6) Tighten the locknut on zero-centering control R6. Be careful not to disturb the setting of the control.

Note. If the meter pointer cannot be set at the center of the scale, refer to item 14, paragraph 15*c*, for corrective procedures.

b. Adjustments. There are no adjustments for full-scale deflection.

23. Calibration of Ac Voltage Measuring Scales

Before beginning the procedures in this paragraph, calibrate the dc voltage measuring scale (para 22) and then proceed as follows:

a. Adjustment for Zero Deflection.

(1) Turn the FUNCTION switch to the A. C. position. Turn the RANGE switch to the 2.5V-RX1 position.

(2) Set the ZERO ADJ. control to its mechanical center.

(3) Connect the A. C. PROBE tip and the COMMON probe tip together.

(4) Loosen the locknut on ac zero adjustment control R45.

(5) Turn adjustment control R45 to the right or left, 1/4 turn. Wait 1 minute for a meter indication.

(6) Turn the adjustment control until the meter pointer is within one-half scale division of zero. Wait 1 minute between each setting of the adjustment control.

(7) Tighten the locknut on adjustment control R45. Be careful not to disturb the setting of the control.

(8) Set the meter pointer to zero reading by turning the ZERO ADJ. control on the front panel.

b. Adjustment for Full-Scale Deflection.

(1) Leave the FUNCTION switch on the A. C. position and turn the RANGE switch to the 5V-RX10 position.

(2) Loosen the locknut on ac calibration control R12.

(3) Apply 5 volts ac at 60 cps ±1 percent across the A. C. PROBE and the COMMON probe points. Use Meter Test Equipment AN/GSM-1B as the voltage source.

(4) Turn ac calibration control R12 and wait 1 minute for a meter indication. Meter pointer should read full-scale deflection when the correct adjustment has been made.

(5) When the procedure indicated in (1) through (4) above is completed, disconnect the probes from the power source.

(6) Tighten the locknut on ac calibration control R12. Be careful not to disturb the setting of the control.

Note. If the meter pointer cannot be set to full-scale deflection after the resetting of ac calibration control R12, refer to items No. 24 and 27, paragraph 15*c* for the corrective procedure.

24. Calibration of Resistance Scale

Calibrate the dc voltage measuring scale (para 22) before beginning the procedures in this paragraph.

a. Adjust for full-scale deflection as follows:

(1) Turn the FUNCTION switch to the OHMS position.

(2) Adjust the meter pointer to ∞ by turning the OHMS ADJ. control on the front panel.

b. Adjustment is made for zero deflection for each scale when the equipment is in use. No single adjustment will calibrate all the resistance scales. Refer to paragraph 23 for this procedure.

Note. If the meter pointer cannot be set for full-scale or zero deflection of the resistance scales, refer to the troubleshooting chart (para 15*c*).

CHAPTER 4

FINAL TESTING

Section I. FOURTH ECHELON TESTING PROCEDURES

25. General

a. Testing procedures are prepared for use by Signal Field Maintenance Shops and Signal Service Organizations responsible for fourth echelon maintenance of signal equipment to determine the acceptability of repaired signal equipment. These procedures set forth specific requirements that repaired signal equipment *must* meet before it is returned to the using organization. The testing procedures may also be used as a guide for testing equipment repaired at third echelon if the proper tools and test equipment are available. A summary of the performance standards is given in paragraph 34.

b. Each test depends on the preceding one for certain operating procedures and, where applicable, for test equipment calibrations. Comply with the instructions preceding each chart before proceeding to the chart. Perform each test in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Test equipment control setting* and *Equipment under test control setting* columns; then perform each specific test procedure and verify it against its performance standard.

26. Test Equipment and Materials

a. General. All test equipment, materials, and other equipment required to perform the testing procedures given in this section are listed in the following charts and are authorized under TA 11-17 and TA 11-100(11-17), or are repair part items of the subject equipment authorized for stockage at fourth echelon level.

b. Test Equipment.

Nomenclature	Federal stock number	Technical reference
Meter Test Equipment AN/GSM-1(*)[a]	6625-224-7700	TM 11-2535A TM 11-2535B[b]
Light Assembly, Electric MS-1292/PAQ	6695-537-4470	TM 11-5540

[a] Indicates Meter Test Equipment AN/GSM-1B or AN/GSM-1C.

[a] Applies to Meter Test Set TS-682A/GSM-1 (p/o AN/GSM-1C) only.

c. Materials.

Material	Federal stock number
Resistor, 300K ohms ±1%, 1/2 w[a]	5905-542-8438
Resistor, 3 megohms ±1%, 1/2 w[a]	5905-502-9027
Resistor, 30 megohms ±1%, 1/2 w[a]	5905-502-9030

[a] Not required if Resistor, Decade ZM-16/U or ZM-16A/U (p/o AN/GSM-1C) is used.

27. Special Requirements

The location and labeling of certain controls and test jacks differ on Meter Test Set TS-682/GSM-1 (p/o AN/GSM-1B) and Meter Test Set TS-682A/GSM-1 (p/o AN/GSM-1C). Reference to controls, control settings, and test jacks in the charts applies to Meter Test Set TS-682/GSM-1 (meter test set). The corresponding controls, control settings, and test jacks for

Meter Test Set TS-682A/GSM-1 are included in parentheses, immediately below or adjacent to those for the TS-682/GSM-1. Meter Test Set TS-682/GSM-1 is shown on the illustrations. If Meter Test Set TS-682A/GSM-1 is used, make connections to corresponding test jacks where physical location is different and to the jack of nearest voltage or current value where a test jack of the specified voltage or current does not appear.

28. Modification Work Orders

No modification work orders pertinent to this equipment were in effect on the date of this change. A listing of current modification work orders will be found in DA Pamphlet 310-4.

29. Moistureproofing and Fungiproofing

Areas, parts, and connections disturbed by repair and/or testing will be checked for proper moistureproofing and fungiproofing (mfp). It is advisable to check the condition of the mfp varnish after repairs have been completed, but before the chassis has been assembled in its watertight case, to eliminate having to disassemble the equipment for inspection purposes only.

30. Physical Tests and Inspection

a. Test Equipment. Light Assembly, Electric MX-1292/PAQ.

b. Test Connections and Conditions. Remove the front cover from the equipment under test. Remove the test leads and the A.C. LINE cord from their respective compartments. Do not connect the A.C. LINE cord of the multimeter or the electronic multimeter to a power source until instructed to do so in the test procedure. The chassis must be removed from the case in order to check the condition of the mfp varnish (step No. 5 below). To remove the chassis from the case, unscrew the six panel-mounting bolts on the front panel and slide the chassis out of the case. Prepare Light Assembly, Electric MX-1292/PAQ for operation by connecting the mercury vapor lamp and installing the wide transmission filter.

c. Procedure.

Step No.	Test equipment control setting	Equipment under test control setting	Test procedure	Performance standard
1	None.	Controls may be in any position.	*a.* Inspect multimeter or electronic multimeter case, front panel, case gasket, and front cover for damage, loose, or missing parts, and condition of paint. *Note.* Touchup painting is recommended instead of refinishing whenever practicable. The GROUND binding post (on TS-505D/U only) will not be painted or polished with abrasives.	*a.* No damage, loose parts, or missing parts evident. External surfaces intended to be painted should not show bare metal. Panel lettering must be legible. The case gasket should not be cut, torn, or deteriorated.
			b. Inspect test leads and A.C. LINE cord for cuts, abrasions, burns, and evidence of deterioration.	*b.* Test leads and A.C. LINE cord must be in good condition with no cuts, abrasions, or burns extending through the insulation. Probes must not be damaged, and shell of D.C. probe should rotate freely.
			c. Operate ZERO ADJ. and OHMS ADJ. controls of multimeter or electronic multimeter throughout limits of travel, and RANGE FUNCTION switches to each of their indicated positions.	*c.* Controls and switches should operate smoothly without binding or excessive looseness. Knobs should be tight and properly indexed. Switch detents should be positive.
			d. With multimeter or electronic multimeter placed in a normal position (upright or supported by handle), note position of meter pointer.	*d.* Meter pointer should be straight and should lie directly over zero marks on the left edge of meter scales.
2	None.	FUNCTION switch: OFF. RANGE switch: 2.5V-RX1.	*a.* Connect multimeter or electronic multimeter A.C. LINE cord to source of power (98-132 volts ac, 50-1,000 cycles).	*a.* None.
			b. Set FUNCTION switch to +D.C. and note pilot light indicator jewel. *Note.* Allow multimeter or electronic multimeter to warm up for at least 10 minutes before proceeding.	*b.* Pilot lamp should light.
			c. Hold probe tips of D.C. and COMMON leads together and adjust ZERO ADJ. control until meter pointer indicates zero.	*c.* Setting of ZERO ADJ. control should be within center half of its limits of travel.
			d. While holding probe tips together, set FUNCTION switch to ±D.C. and note meter indication.	*d.* Meter pointer should indicate center on ACV & DCV scale, ±1 scale division.
			e. While still holding probe tips together, set FUNCTION switch to -D.C. and note meter indication.	*e.* Meter pointer should indicate zero on ACV & DCV scale, ±1 scale division.
			f. While still holding probe tips together, set RANGE switch to each remaining switch position. Note meter indication at each position.	*f.* Meter pointer should indicate zero on ACV & DCV scale, ±1 scale division at each switch position.
3	None.	FUNCTION switch: A.C. RANGE switch: 2.5V-RX1.	*a.* Hold probe tips of A.C. PROBE and COMMON leads together and adjust ZERO ADJ. control until meter pointer indicates zero.	*a.* Setting of ZERO ADJ. control should be within the center half of its limits of travel.
			b. While still holding probe tips together, set RANGE switch to each remaining switch position (except 1000V-D.C. ONLY position). Note meter indication at each position.	*b.* Meter pointer should indicate zero on ACV & DCV scale, ±1-1/2 scale divisions at each switch position.
4.	None.	FUNCTION switch: OHMS. RANGE switch: 2.5V-RX1.	*a.* Adjust OHMS ADJ. control until meter pointer is directly over the infinity mark (∞) on OHMS scale.	*a.* None.
			b. Hold probe tips of OHMS and COMMON leads together and adjust ZERO ADJ. control until meter pointer indicates zero.	*b.* None.
			c. Separate probe tips and repeat *a* above.	*c.* None
			d. Note settings of OHMS ADJ. and ZERO ADJ. controls. *Note.* Remove A.C. LINE cord of multimeter or electronic multimeter from power source before performing next step.	*d.* Controls should be set within the center half of their limits of travel.
5	MX-1292/PAQ: 245 V. FOR M.V. LAMP switch: OFF.	Controls may be in any position.	*a.* Remove chassis of multimeter or electronic multimeter from its watertight case.	*a.* None.
			b. Turn on mercury vapor lamp (switch labeled 245 V. FOR M.V. LAMP) and expose to direct rays of lamp that portion of the equipment under test that has been repaired or otherwise disturbed. *Note.* There should be no mfp varnish on multimeter or electronic multimeter switch contacts or fuse clips.	*b.* All parts, wires, and chassis surfaces should show continuous coverage. *Note.* Mfp varnish glows gray-green under mercury vapor lamp.
			c. Replace chassis of multimeter or electronic multimeter in its case before proceeding to next test.	*c.* None.

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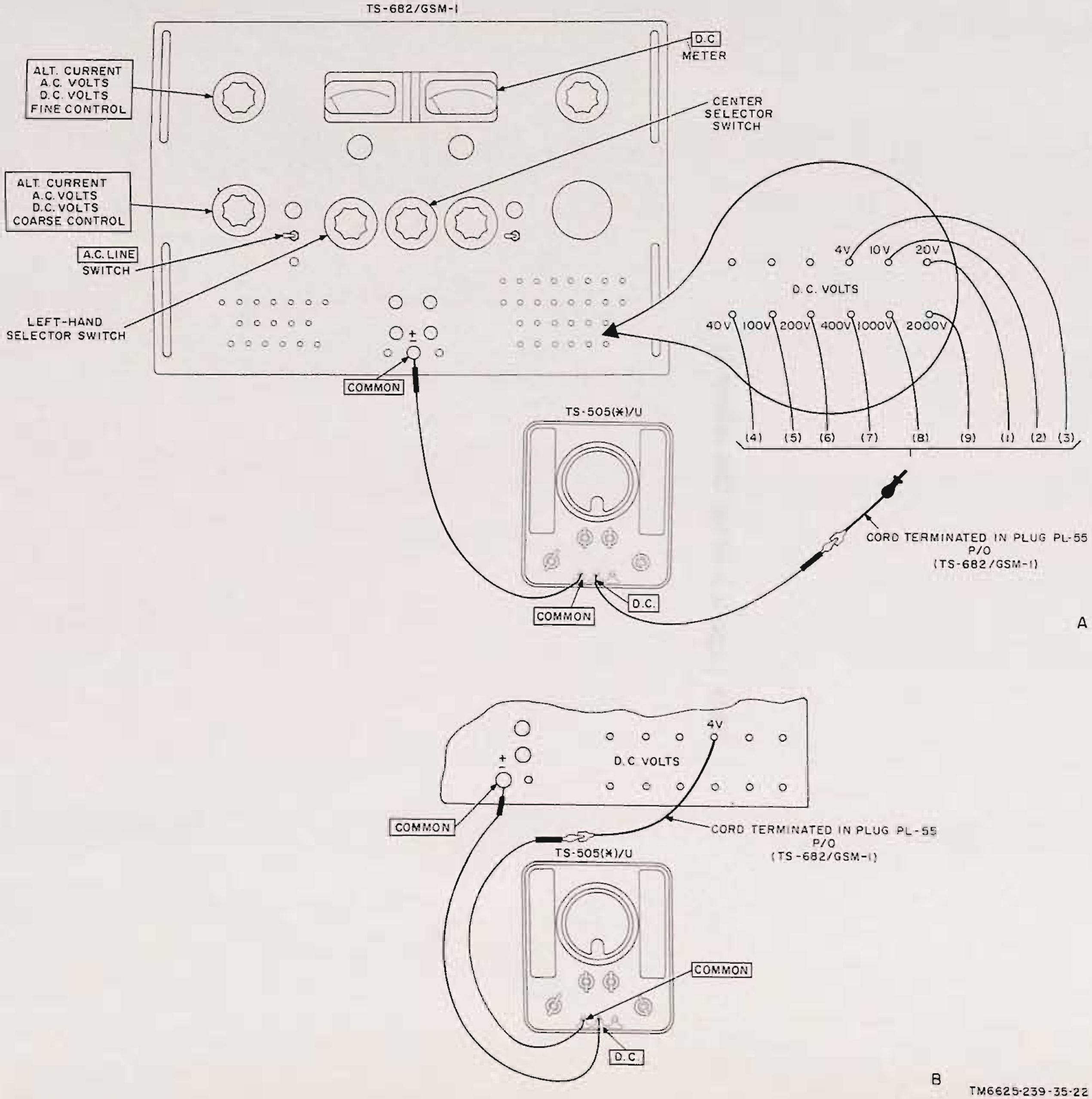

Figure 15. Dc voltage function test.

	Left-hand selector switch: 100 MW D.C. TO 400 V.D.C. (0.1V TO 500 V.D.C.). Center selector switch: A.C.V.-D.C.V. (D.C. VOLTS & MA). Right-hand selector switch: (A model only): AC & DC VOLTS. BATTERY switch: OFF. A.C. LINE switch: ON.		D.C. probe to (1). *c.* Adjust ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set until meter of multimeter or electronic multimeter indicates full scale on ACV & DCV scale. *d.* Tap glass of D.C. meter of meter test set gently with the fingers and note indication. *Note.* If TS-682A/GSM-1 is used, press BUZZER switch and note indication on DC MICROAMPERES meter. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*c.* None. *d.* DC meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 2.375 to 2.625 volts.
2	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 5V-RX10.	*a.* Connect the equipment as shown in figure 15. Connect D.C. probe to (2). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM 1) of meter test set should indicate from 4.75 to 5.25 volts.
3	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 10V-RX100.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (3). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 9.5 to 10.5 volts.
4	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 25V-RX1000.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (4). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 23.75 to 26.25 volts.
5	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 50V-RX10K.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (5). *b.* Repeat *c* and *d* of step No. 1. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 47.5 to 52.5 volts.
6	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 100V-RX100K.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (6). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on the TS-682A/GSM-1) of meter test set should indicate from 95 to 105 volts.
7	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 250V-RX1M.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (7). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) on meter test set should indicate from 237.5 to 262.5 volts.
8	TS-682/GSM-1: Left-hand selector switch: 1000 V.D.C.	FUNCTION switch: +D.C. RANGE switch: 500 V.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (8). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) on meter test set should indicate from 475 to 525 volts.
9	TS-682/GSM-1: Left-hand selector switch: 2000 V.D.C.	FUNCTION switch: +D.C. RANGE switch: 1000V-D.C. ONLY.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (9). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) on meter test set should indicate from 950 to 1,050 volts.
10	TS-682/GSM-1: Left-hand selector switch: 100 MV D.C. TO 400 V.D.C. (0.1V TO 500 VDC).	FUNCTION switch: -D.C. RANGE switch: 2.5V-RX1.	*a.* Connect equipment as shown in B, figure 15. *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 2,375 to 2,625 volts.

31. Dc Voltage Function Test
(fig. 15)

a. Test Equipment. Meter Test Set TS-682/GSM-1 (p/o AN/GSM-1B) or Meter Test Set TS-682A/GSM-1 (p/o AN/GSM-1C).

b. Test Connections and Conditions. Connect the A.C. LINE cord of the multimeter or the electronic multimeter to a power source (98 to 132 volts ac, 50 to 1,000 cps) but make no other connections until instructed to do so in the test procedure.

c. Procedure.

Step No.	Test equipment control setting	Equipment under test control setting	Test procedure	Performance standard
1	TS-682/GSM-1: ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL: maximum counterclockwise. ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL: maximum counterclockwise. Left-hand selector switch: 100 MW D.C. TO 400 V.D.C. (0.1V TO 500 V.D.C.). Center selector switch: A.C.V.-D.C.V. (D.C. VOLTS & MA). Right-hand selector switch: (A model only): AC & DC VOLTS. BATTERY switch: OFF. A.C. LINE switch: ON.	FUNCTION switch: +D.C. RANGE switch: 2.5V-RX1.	*a.* Hold probe tips of D.C. and COMMON leads of multimeter or electronic multimeter together and adjust ZERO ADJ. control until meter pointer indicates zero. *b.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (1). *c.* Adjust ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set until meter of multimeter or electronic multimeter indicates full scale on ACV & DCV scale. *d.* Tap glass of D.C. meter of meter test set gently with the fingers and note indication. *Note.* If TS-682A/GSM-1 is used, press BUZZER switch and note indication on DC MICROAMPERES meter. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* None. *c.* None. *d.* DC meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 2.375 to 2.625 volts.
2	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 5V-RX10.	*a.* Connect the equipment as shown in figure 15. Connect D.C. probe to (2). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM 1) of meter test set should indicate from 4.75 to 5.25 volts.
3	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 10V-RX100.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (3). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 9.5 to 10.5 volts.
4	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 25V-RX1000.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (4). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 23.75 to 26.25 volts.
5	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 50V-RX10K.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (5). *b.* Repeat *c* and *d* of step No. 1. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) of meter test set should indicate from 47.5 to 52.5 volts.
6	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 100V-RX100K.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (6). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on the TS-682A/GSM-1) of meter test set should indicate from 95 to 105 volts.
7	Same as step No. 1.	FUNCTION switch: +D.C. RANGE switch: 250V-RX1M.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (7). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) on meter test set should indicate from 237.5 to 262.5 volts.
8	TS-682/GSM-1: Left-hand selector switch: 1000 V.D.C.	FUNCTION switch: +D.C. RANGE switch: 500 V.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (8). *b.* Repeat *c* and *d* of step No. 1 above. *Caution:* **Turn** ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL **and** ALT. CURRENT A. C. VOLTS D. C. VOLTS COARSE CONTROL **maximum counterclockwise before proceeding.**	*a.* None. *b.* D.C. meter (DC MICROAMPERES on TS-682A/GSM-1) on meter test set should indicate from 475 to 525 volts.
9	TS-682/GSM-1: Left-hand selector switch: 2000 V.D.C.	FUNCTION switch: +D.C. RANGE switch: 1000V-D.C. ONLY.	*a.* Connect equipment as shown in A, figure 15. Connect D.C. probe to (9).	*a.* None.

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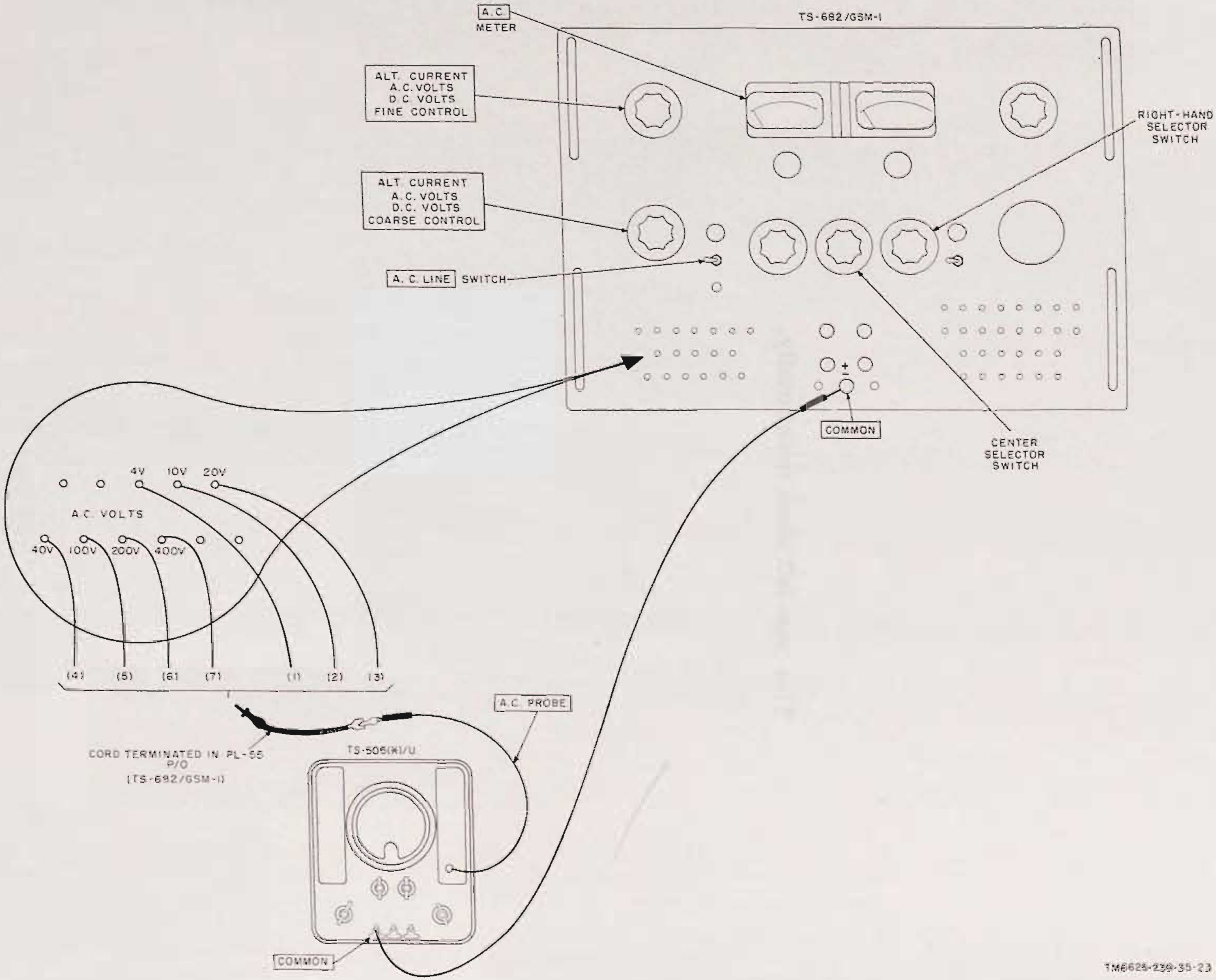

Figure 16. Ac voltage function test.

32. Ac Voltage Function Test
(fig. 16)

a. Test Equipment. Meter Test Set TS-682/GSM-1 (p/o AN/GSM-1B) or Meter Test Set TS-682A/GSM-1 (p/o AN/GSM-1C).

b. Test Connections and Conditions. Connect the A.C. LINE cord of the multimeter or the electronic multimeter to a source of power (98 to 132 volts ac, 50 to 1,000 cps) but make no other connections until instructed to do so in the test procedure.

c. Procedure.

	Test equipment control setting	Equipment under test control setting	Test procedure	Performance standard
1	TS-682/GSM-1: ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL: maximum counterclockwise. ALT CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL: maximum counterclockwise. Center selector switch: A.C.V.-D.C.V. (AC VOLTS). Left-hand selector switch: A.C.V. (ALL OTHER AC & DC SCALES). Right-hand selector switch (A model only): AC & DC VOLTS. A.C. LINE switch: ON. BATTERY switch: OFF.	FUNCTION switch: A.C. RANGE switch: 2.5V-RX1.	*a.* Hold probe tips of multimeter or electronic multimeter COMMON AND A.C. PROBE leads together and adjust ZERO ADJ. control until pointer on meter of multimeter or electronic multimeter indicates zero. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (1). *c.* Adjust ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set until multimeter or electronic multimeter indicates full scale (2.5 volts) on blue, 2.5 VOLTS AC ONLY scale. Note indication on A.C. meter of meter test set. *Note.* If TS-682A/GSM-1 is used, press BUZZER switch and note indication on left-hand meter. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None. *c.* A.C. meter (AC MILLIAMPERES on TS-682A/GSM-1) on meter test set should indicate from 2.35 to 2.65 volts.
2	Same as step No. 1.	FUNCTION switch: A.C. RANGE switch: 5V-RX10.	*a.* Repeat *a* of step No. 1 above. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (2). *c.* Repeat c of step No. 1 above. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None. *c.* A.C. meter (AC MILLIAMPERES on TS-682A/GSM-1) on meter test set should indicate from 4.7 to 5.3 volts.
3	Same as step No. 1.	FUNCTION switch: A.C. RANGE switch: 10V-RX100.	*a.* Repeat *a* of step No. 1 above. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (3). *c.* Repeat *c* of step No. 1 above. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None. *c.* A.C. meter (AC MILLIAMPERES on TS-682A/GSM-1) of meter test set should indicate from 9.4 to 10.6 volts.
4	Same as step No. 1.	FUNCTION switch: A.C. RANGE switch: 25V-RX1000.	*a.* Repeat *a* of step No. 1 above. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (4). *c.* Repeat *c* of step No. 1 above. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None. *c.* A.C. meter (AC MILLIAMPERES on TS-682A/GSM-1) of meter test set should indicate from 23.5 to 26.5 volts.
5	Same as step No. 1.	FUNCTION switch: A.C. RANGE switch: 50V-RX10K.	*a.* Repeat *a* of step No. 1 above. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (5). *c.* Repeat c of step 1 above. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None. *c.* A.C. meter (AC MILLIAMPERES on TS-682A/GSM-1) of meter test set should indicate from 47 to 53 volts.
6	Same as step No. 1.	FUNCTION switch: A.C. RANGE switch: 100V-RX100K.	*a.* Repeat *a* of step No. 1 above. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (6). *c.* Repeat c of step No. 1 above. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None. *c.* A.C. meter (AC MILLIAMPERES on the TS-682A/GSM-1) of meter test set should indicate from 94 to 106 volts.
7	Same as step No. 1.	FUNCTION switch: A.C. RANGE switch: 250V-RX1M.	*a.* Repeat *a* of step No. 1 above. *b.* Connect equipment as shown in figure 16. Connect A.C. PROBE to (7). *c.* Repeat c of step No. 1 above. *Caution:* Turn ALT. CURRENT A.C. VOLTS D.C. VOLTS FINE CONTROL and ALT. CURRENT A.C. VOLTS D.C. VOLTS COARSE CONTROL on meter test set maximum counterclockwise before proceeding.	*a.* None. *b.* None *c.* A.C. meter (AC MILLIAMPERES on TS-682A/GSM-1) of meter test set should indicate from 235 to 265 volts.

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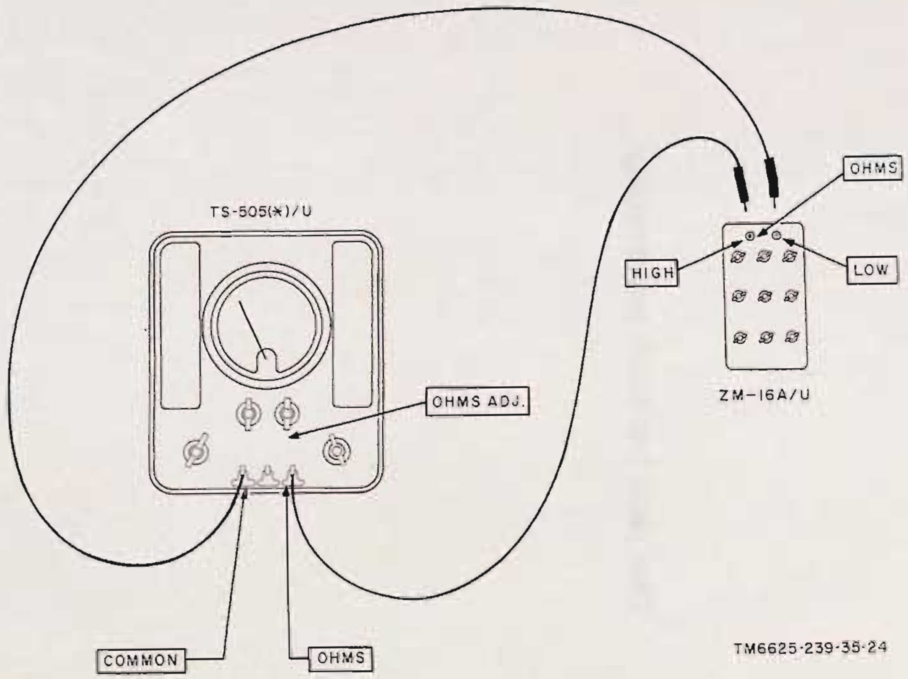


Figure 17. Ohmmeter function test.

33. Ohmmeter Function Test
(fig. 17)

a. Test Equipment and Materials.

(1) Resistor, Decade ZM-16(*)/U (p/o AN/GSM-1C) or Decade Resistor TS-679(*)/U (p/o AN/GSM-1B).

(2) Resistor, 300K ohms ±1%.

(3) Resistor, 3 megohms ±1%.

(4) Resistor, 30 megohms ±1%.

Note. Resistor, Decade ZM-16(*)/U indicates ZM-16/U or ZM-16A/U; Decade Resistor TS-679(*)/U indicates TS-679/U or TS-679A/U.

b. Test Connections and Conditions. Connect the multimeter or the electronic multimeter A. C. LINE cord to a power source (98 to 132 volts ac, 50 to 1,000 cps) but make no other connections until instructed to do so in the test procedure. Panel markings for the TS-679(*)/U are in parentheses immediately below the panel markings of the corresponding controls on the ZM-16(*)/U.

c. Procedure.

Step No.	Test equipment control setting	Equipment under test control setting	Test procedure	Performance standard
1	ZM-16(*)/U: X10: 3 (TENS: 3). Set all other switches to zero.	FUNCTION switch: OHMS. RANGE switch: 2.5V-RX1.	*a.* Adjust OHMS ADJ. control on multimeter or electronic multimeter until meter pointer lies over infinity mark ( ) on OHMS scale. *b.* Hold probe tips of COMMON and OHMS leads together and adjust ZERO ADJ. control until meter pointer indicates zero. *c.* Repeat *a* above. Connect equipment as shown in figure 17. Note indication on meter of multimeter or electronic multimeter.	*a.* None. *b.* None. *c.* None. *d.* *TS-505A U and TS-505B/U.* Meter pointer should indicate 1.25 volts on the *2.5 ACV and DCV scale,* ±1 scale division. *TS-505C/U and TS-505D/U.* Meter pointer should indicate 1.25 volts on the *2.5 ACV and DCV scale,* ±1-1/4 scale division.
2	ZM-16(*)/U: X100: 3 (HUNDREDS: 3). Set all other switches to zero.	FUNCTION switch: OHMS. RANGE switch: 5V-RX10.	Repeat *a* through *d* of step No. 1 above.	Same as *d* of step No. 1 above.
3	ZM-16(*)/U: X1000: 3 (THOUSANDS: 3). Set all other switches to zero.	FUNCTION switch: OHMS. RANGE switch: 10V-RX100.	Repeat *a* through *d* of step No. 1 above.	Same as *d* of step No. 1 above.
4	ZM-16(*)/U: X10000: 3 (TEN THOUSANDS: 3). Set all other switches to zero.	FUNCTION switch: OHMS. RANGE switch: 25V-RX1000.	Repeat *a* through *d* of step No. 1 above.	Same as *d* of step No. 1 above.
5	ZM-16(*)/U: X100000: 3. Set all other switches to zero. *Note.* If ZM-16(*)/U is not available, use 300K-ohm precision resistor as a standard for this step.	FUNCTION switch: OHMS. RANGE switch: 50V-RX10K.	*a.* Repeat *a* through *c* of step No. 1 above. *b.* Connect equipment as shown in figure 17. If ZM-16(*)/U is not available, connect multimeter or electronic multimeter leads to 300K-ohm precision resistor. Note indication on meter of multimeter or electronic multimeter.	*a.* None. *b.* Same as *d* of step No. 1 above.
6	ZM-16(*)/U: X1 MEG: 3. Set all other switches to zero. *Note.* If ZM-16(*)/U is not available, use 3-megohm precision resistor as a standard for this step.	FUNCTION switch: OHMS. RANGE switch: 100V-RX100K.	*a.* Repeat a through c of step No. 1 above. *b.* Connect equipment as shown in figure 17. If ZM-16(*)/U is not available, connect multimeter or electronic multimeter leads to 3-megohm precision resistor. Note indication on meter of multimeter or electronic multimeter.	*a.* None. *b.* Same as *d* of step No. 1 above.
7	ZM-16(*)/U: X10 MEG: 3. Set all other switches to zero. *Note.* If ZM-16(*)/U is not available, use 30-megohm precision resistor as a standard for this step.	FUNCTION switch: OHMS. RANGE switch: 250V-RX1M.	*a.* Repeat a through c of step No. 1 above. *b.* Connect equipment as shown in figure 17. If ZM-16(*)/U is not available, connect multimeter or electronic multimeter leads to 30-megohm precision resistor. Note indication on meter of multimeter or electronic multometer.	*a.* None. *b.* Same as *d* of step No. 1 above.

34. Performance Standard Summary

1. Dc Voltage Function Test

a. +D.C.

Function		Performance standard
(1)	2.5 V scale	2.375 to 2.625 volts
(2)	5 V scale	4.75 to 5.25 volts
(3)	10 V scale	9.5 to 10.5 volts
(4)	25 V scale	23.75 to 26.25 volts
(5)	50 V scale	47.5 to 52.5 volts
(6)	100 V scale	95 to 105 volts
(7)	250 V scale	237.5 to 262.5 volts
(8)	500 V scale	475 to 525 volts
(9)	1000 V scale	950 to 1050 volts

b. -D.C.

Function	Performance standard
2.5 V scale	2.375 to 2.625 volts

2. Ac Voltage Function Test

Function		Performance standard
a.	2.5 V scale	2.35 to 2.65 volts
b.	5 V scale	4.7 to 5.3 volts
c.	10 V scale	9.4 to 10.6 volts
d.	25 V scale	23.5 to 26.5 volts
e.	50 V scale	47 to 53 volts
f.	100 V scale	94 to 106 volts
g.	250 V scale	235 to 265 volts

3. Ohmmeter Function Test

	Performance standard
All ranges, center scale indication (1.25-volt on 2.5 ACV & DCV scale).	*TS-505A/U and TS-505B/U* ±1 scale division on ACV & DCV scale. *TS-505C/U and TS-505D/U* ±1-1/4 scale divisions on ACV & DCV scale.

Section II. FINAL TESTING

35. Purpose of Final Testing

The tests outlined in this section are designed to measure the performance capabilities of a repaired equipment. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation, equivalent to that of new equipment.

36. Test Equipment Required for Final Testing

Test equipment	Technical manual	Common names
Electron Tube Test Set TV-2/U	TM 11-6625-316-12	Tube tester
Multimeter AN/URM-105	TM 11-6625-203-12 and TM 11-6625-203-35	Multimeter
Meter Test Equipment AN/GSM-1B	TM 11-2535A	Meter test set
Resistor Decade ZM-16/U	TM 11-5102	Resistor decade

37. Testing Dc Voltage Measurements Circuit

a. Connect the multimeter, set the controls, and zero-adjust the meter pointer as described in paragraph 15, TM 11-6625-239-12.

b. Apply 2.5 volts dc ±1 percent across the D.C. and COMMON probes. The meter pointer should read full scale within ±5 percent.

c. Repeat the procedures given in *b* above for each position of the RANGE switch and apply maximum voltage for each range setting (5 volts on the 5V-RX10 position, the 10V-RX100 position, etc). In all instances, the meter pointer should read full scale ±5 percent.

38. Testing Ac Voltage Measurements Circuit

Note. On the TS–505D/U, connect the GROUND binding post to a suitable ground such as a water pipe.

a. Connect the multimeter and zero-adjust the meter pointer as described in paragraph 15, TM 11-6625-239-12.

b. Turn the RANGE switch to the 2.5V-RX1 position.

c. Apply 2.5 volts ±1 percent at 60 cps across the A.C. PROBE and the COMMON probe. The 60 cps must have less than 0.5 percent distortion. The meter pointer should read full scale ±6 percent.

d. Repeat the procedure given in *c* above for the following position of the RANGE switch: 5V-RX10, 10V-RX100, 25V-RX1000, 50V-RX10K, 100V-RX100K, and 250V-RX1M. Apply maximum voltage for each range setting. In all instances, the meter pointer should read full scale ±6 percent.

39. Testing Rf Adapter

Note. Test the dc voltage measurement circuit as described in paragraph 37 before attempting the test of the rf adapter.

a. Connect the multimeter, set the controls, and adjust the meter pointer as described in paragraph 18, TM 11-6625-239-12.

b. Plug the D.C. probe tip into the end of the rf adapter.

c. Apply 2.5 volts ±1 percent at 5 mc between the rf adapter tip and the alligator clip. The 5 mc must have less than 0.5 percent distortion. The meter pointer should read full scale.

d. Repeat the procedure given in *c* above for the 5V-RX10, 10V-RX100, and 25V-RX1000 positions of the RANGE switch, and apply maximum rated voltage for each range setting. In all instances, the meter should read full scale.

e. Turn the RANGE switch to the 50V-RX10K position and apply 40 volts ±1 percent at 5 mc between the rf probe tip and the alligator clip. The meter pointer should read 40 volts.

Note. Readings obtained when using the rf adapter are approximate and should be used only as a relative voltage indication.

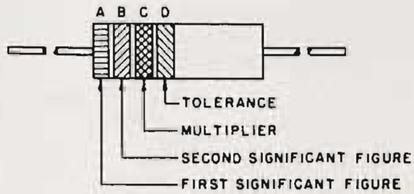
40. Testing Ohmmeter Circuit

a. Connect the multimeter and adjust the meter pointer as described in paragraph 20, TM 11-6625-239-12.

b. Check the accuracy of the ohms calibration by measuring standard resistors known to be accurate within 1 percent. Measure a standard resistor on each resistance setting of the RANGE switch. Use an appropriate resistor within the range of each switch setting. In all instances, the meter reading should be accurate within 4 percent of full scale (total arc length).

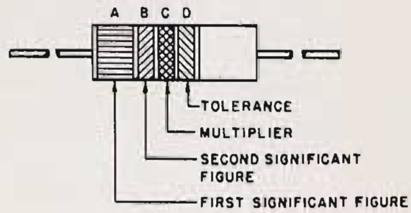
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS



BAND A— Double Width Signifies Wire-wound Resistor

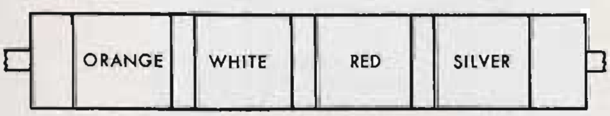
COLOR CODE TABLE

BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING

BAND

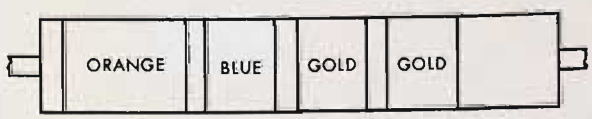
A B C D*



3 9 X100 ± 10%

BAND

A B C D*



3 6 X0.1 ± 5%

NOMINAL RESISTANCE	3,900 Ohms	3.6 Ohms
RESISTANCE TOLERANCE	± 10 percent	± 5 percent

STD-R2

*If Band D is omitted, the resistor tolerance is ±20%, and the resistor is not Mil-Std.

Figure 18. MIL-STD resistor color-code markings.

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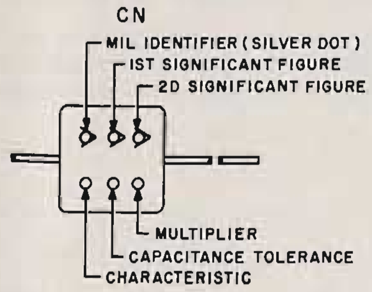
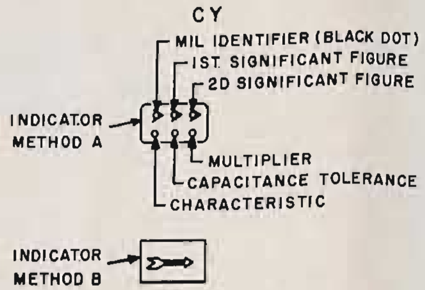
COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

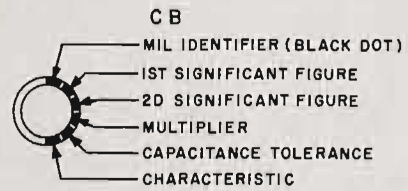
arious-Dielectrics, Styles CM, CN, CY, and CB



PAPER-DIELECTRIC

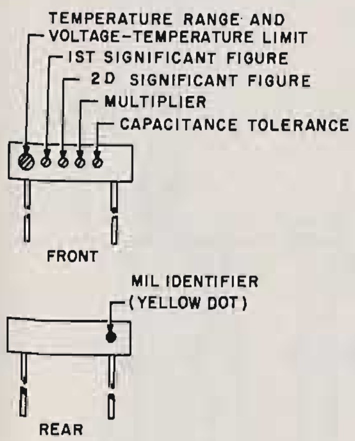


GLASS-DIELECTRIC, GLASS CASE

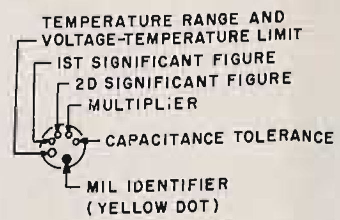


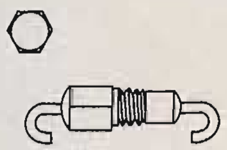
MICA, BUTTON TYPE

ramic-Dielectric (General Purpose) Style CK

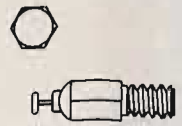


RADIAL LEAD

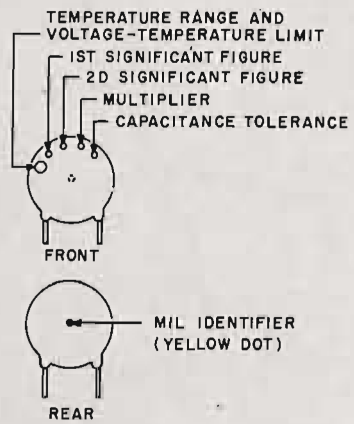




FEED-THROUGH

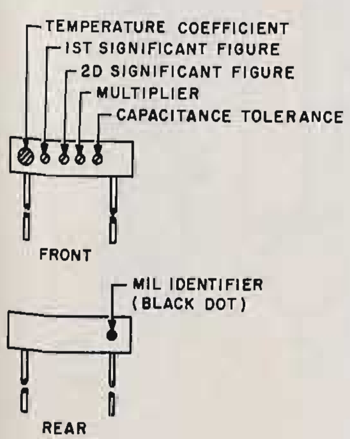


STAND-OFF

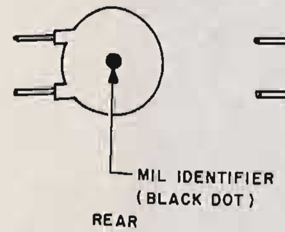


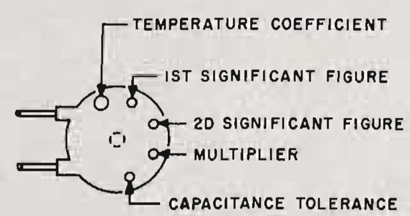
DISK-TYPE

ramic-Dieletric (Temperature Compensating) Style CC



RADIAL LEAD





DISK-TYPE

COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

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

TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

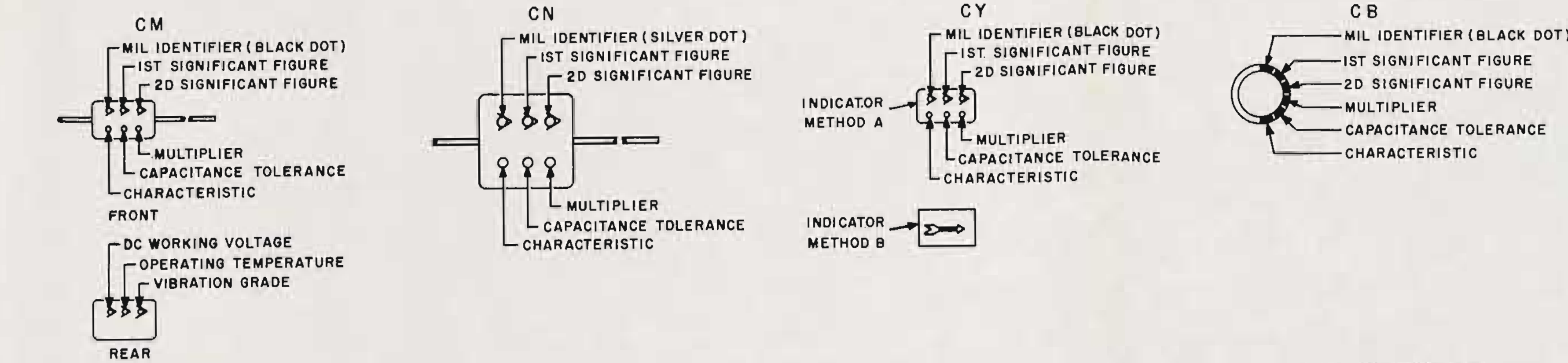
1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.

STD-C2

Figure 19. MIL–STD capacitor color-code markings.

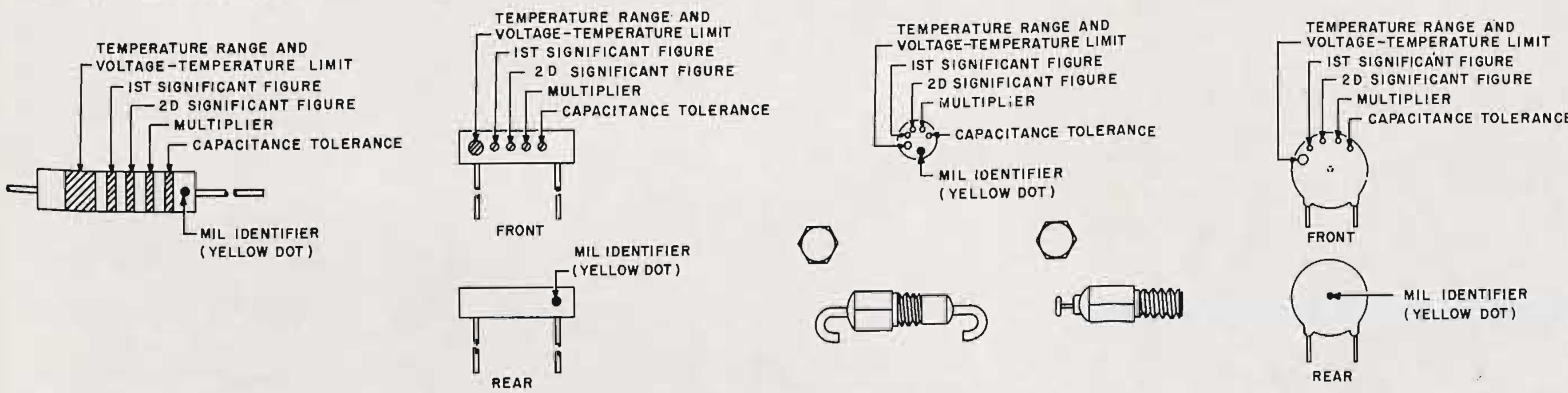
COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



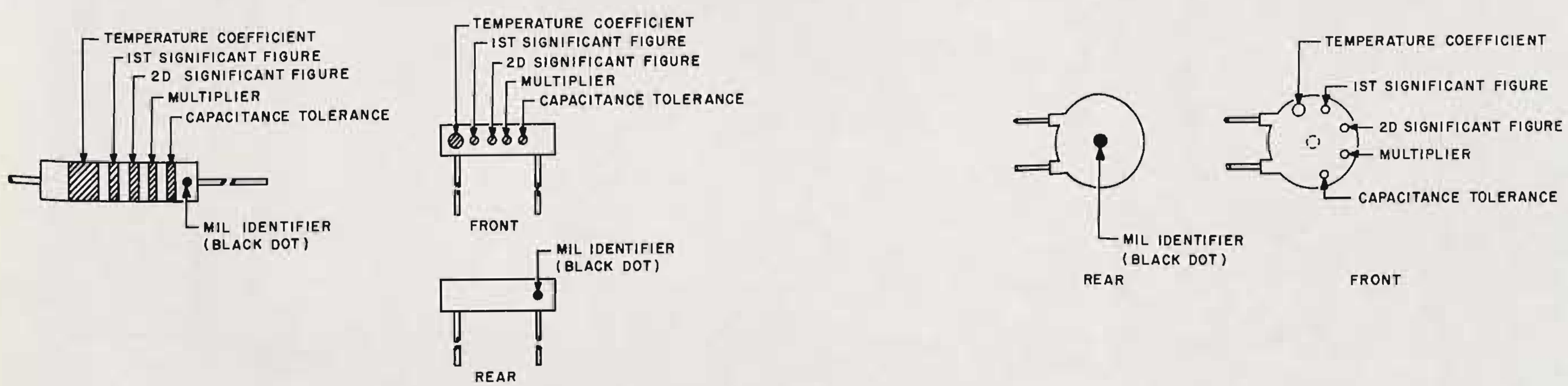
MICA-DIELECTRIC — PAPER-DIELECTRIC — GLASS-DIELECTRIC, GLASS CASE — MICA, BUTTON TYPE

GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



AXIAL LEAD — RADIAL LEAD — FEED-THROUGH — STAND-OFF — DISK-TYPE

GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC



AXIAL LEAD — RADIAL LEAD — DISK-TYPE

COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]				DC WORKING VOLTAGE
					CM	CN	CY	CB	CM	CN	CY	CB	CM
BLACK	CM, CY CB	0	0	1			± 20%	± 20%		A			
BROWN		1	1	10					B	E		B	
RED		2	2	100	± 2%		± 2%	± 2%	C		C		
ORANGE		3	3	1,000		± 30%			D			D	300
YELLOW		4	4	10,000					E				
GREEN		5	5		± 5%				F				500
BLUE		6	6										
PURPLE (VIOLET)		7	7										
GREY		8	8										
WHITE		9	9										
GOLD				0.1			± 5%	± 5%					
SILVER	CN				± 10%	± 10%	± 10%	± 10%					

TABLE II – For use with Group II, General Purpose, Style CK

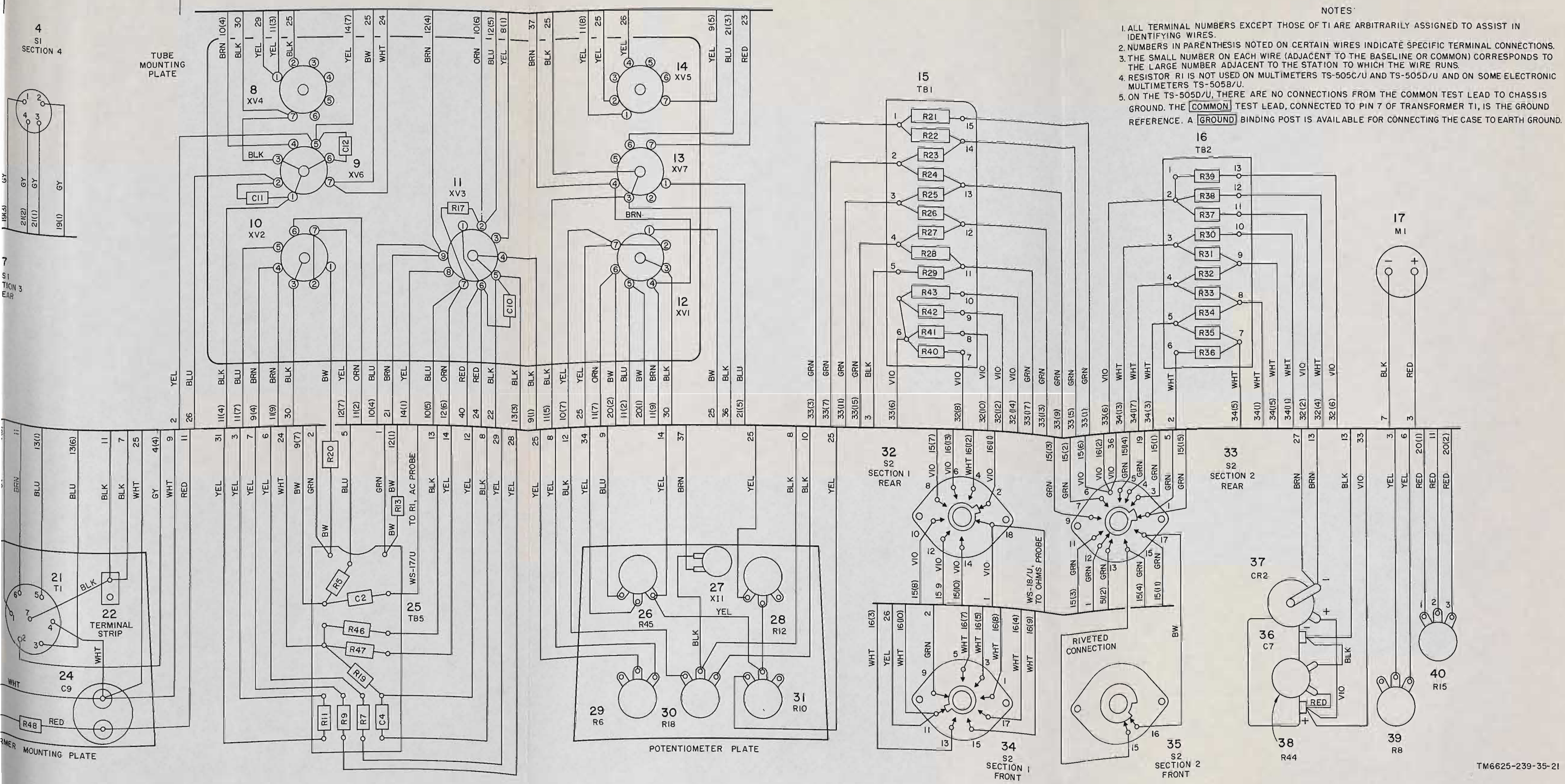
COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Ten

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MU
BLACK	0	0	0	
BROWN	−30	1	1	
RED	−80	2	2	
ORANGE	−150	3	3	
YELLOW	−220	4	4	
GREEN	−330	5	5	
BLUE	−470	6	6	
PURPLE (VIOLET)	−750	7	7	
GREY		8	8	
WHITE		9	9	
GOLD	+100			
SILVER				

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–91, MIL–C–11272, and MIL–C–1
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.

Figure 19. MIL–STD capacitor color-code markings.



NOTES

1. ALL TERMINAL NUMBERS EXCEPT THOSE OF T1 ARE ARBITRARILY ASSIGNED TO ASSIST IN IDENTIFYING WIRES.
2. NUMBERS IN PARENTHESIS NOTED ON CERTAIN WIRES INDICATE SPECIFIC TERMINAL CONNECTIONS.
3. THE SMALL NUMBER ON EACH WIRE (ADJACENT TO THE BASELINE OR COMMON) CORRESPONDS TO THE LARGE NUMBER ADJACENT TO THE STATION TO WHICH THE WIRE RUNS.
4. RESISTOR R1 IS NOT USED ON MULTIMETERS TS-505C/U AND TS-505D/U AND ON SOME ELECTRONIC MULTIMETERS TS-505B/U.
5. ON THE TS-505D/U, THERE ARE NO CONNECTIONS FROM THE COMMON TEST LEAD TO CHASSIS GROUND. THE COMMON TEST LEAD, CONNECTED TO PIN 7 OF TRANSFORMER T1, IS THE GROUND REFERENCE. A GROUND BINDING POST IS AVAILABLE FOR CONNECTING THE CASE TO EARTH GROUND.

Figure 20. Electronic Multimeters TS-505A/U, TS-505B/U, and TS-505D/U, wiring diagram.

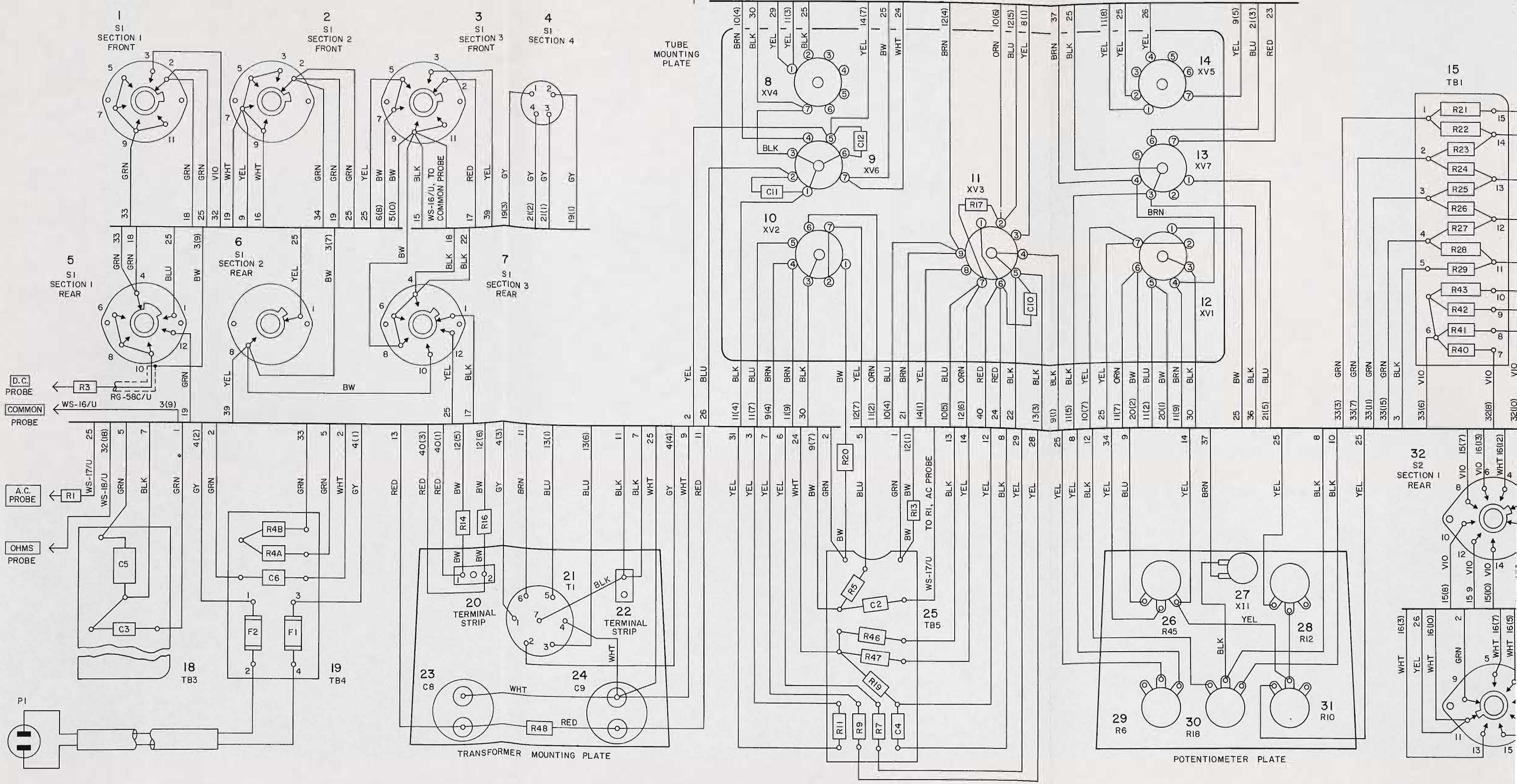
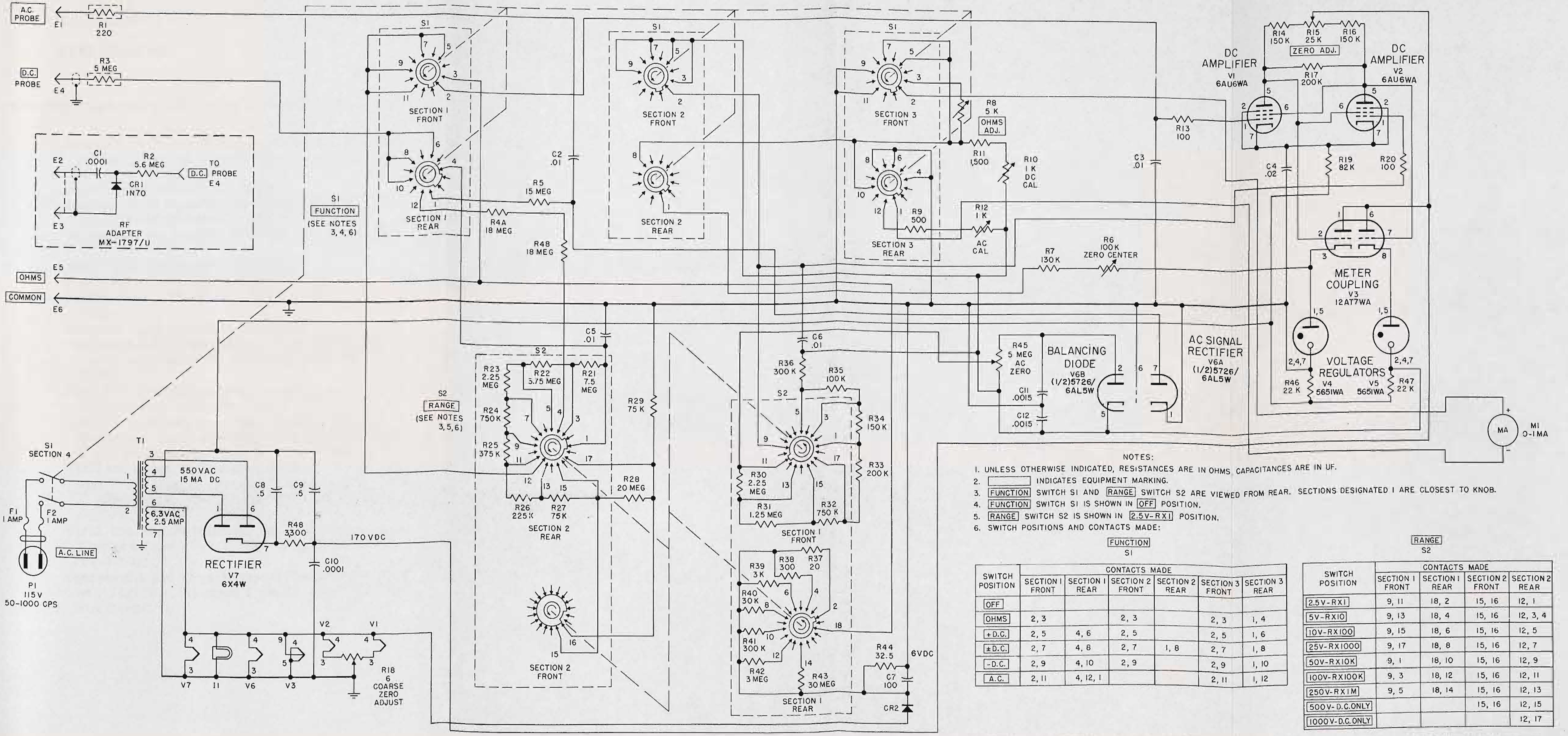


Figure 20. Electronic Multimeters TS-505A/U, TS-505B/U, and TS-505D/U, wiring diagram.



NOTES:

1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF.
2. [ ] INDICATES EQUIPMENT MARKING.
3. [FUNCTION] SWITCH S1 AND [RANGE] SWITCH S2 ARE VIEWED FROM REAR. SECTIONS DESIGNATED 1 ARE CLOSEST TO KNOB.
4. [FUNCTION] SWITCH S1 IS SHOWN IN [OFF] POSITION.
5. [RANGE] SWITCH S2 IS SHOWN IN [2.5V-RX1] POSITION.
6. SWITCH POSITIONS AND CONTACTS MADE:

[FUNCTION]
S1

SWITCH POSITION	CONTACTS MADE					
	SECTION 1 FRONT	SECTION 1 REAR	SECTION 2 FRONT	SECTION 2 REAR	SECTION 3 FRONT	SECTION 3 REAR
[OFF]						
[OHMS]	2, 3		2, 3		2, 3	1, 4
[+D.C.]	2, 5	4, 6	2, 5		2, 5	1, 6
[±D.C.]	2, 7	4, 8	2, 7	1, 8	2, 7	1, 8
[-D.C.]	2, 9	4, 10	2, 9		2, 9	1, 10
[A.C.]	2, 11	4, 12, 1			2, 11	1, 12

[RANGE]
S2

SWITCH POSITION	CONTACTS MADE			
	SECTION 1 FRONT	SECTION 1 REAR	SECTION 2 FRONT	SECTION 2 REAR
[2.5V-RX1]	9, 11	18, 2	15, 16	12, 1
[5V-RX10]	9, 13	18, 4	15, 16	12, 3, 4
[10V-RX100]	9, 15	18, 6	15, 16	12, 5
[25V-RX1000]	9, 17	18, 8	15, 16	12, 7
[50V-RX10K]	9, 1	18, 10	15, 16	12, 9
[100V-RX100K]	9, 3	18, 12	15, 16	12, 11
[250V-RX1M]	9, 5	18, 14	15, 16	12, 13
[500V-D.C.ONLY]			15, 16	12, 15
[1000V-D.C.ONLY]				12, 17

7. RESISTOR R1 IS NOT USED ON MULTIMETER TS-505C/U AND TS-505D/U, AND ON SOME ELECTRONIC MULTIMETERS TS-505B/U.
8. ON THE TS-505D/U THERE ARE NO CONNECTIONS FROM THE [COMMON] TEST LEAD TO CHASSIS GROUND. THE [COMMON] LEAD, CONNECTED TO PIN 7 OF TRANSFORMER T1, IS THE GROUND REFERENCE. A [GROUND] BINDING POST IS AVAILABLE FOR CONNECTING THE CASE TO EARTH GROUND.

TM6625-239-35-20

Figure 21. Electronic Multimeters TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U, schematic diagram.

APPENDIX I

REFERENCES

Following is a list of applicable references available to the field and depot maintenance personnel of TS-505(*)/U:

DA Pamphlet 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TA 11-17	Signal Field Maintenance Shops.
TA 11-100(11-17)	Allowances of Signal Corps Expendable Supplies for Signal Field Maintenance Shops.
TM 11-2535A	Meter Test Equipments AN/GSM-1B and AN/GSM-1C.
TM 11-2535B	Meter Test Set TS-682A-GSM-1.
TM 11-5102	Resistor, Decade ZM-16/U, ZM-16A/U.
TM 11-5527	Multimeters TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-5540	Electric Light Assembly MX-1292/PAQ.
TM 11-6625-203-12	Operation and Organizational Maintenance: Multimeter AN/URM-105, Including Multimeter ME-77/U.
TM 11-6625-203-35	Field and Depot Maintenance: Multimeter AN-URM-105 Including Multimeter ME-77/U.
TM 11-6625-239-12	Operator's and Organizational Maintenance Manual: Electronic Multimeters TS-505A/U and TS-505B/U and Multimeters TS-505C/U and TS-505D/U.
TM 11-6625-239-35P	Field and Depot Maintenance Repair Parts and Special Tool Lists: Electronic Multimeters TS-505/U, TS-505A/U, TS-505B/U, TS-505C/U, and TS-505D/U.
TM 11-6625-274-35	Field and Depot Maintenance Manual Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-316-12	Operational and Organizational Maintenance Manual, Test Sets, Electron Tube TV-2/U, TV-2A/U, and TV-2B/U.

By Order of Secretary of the Army:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General.

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USASA (2)
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LOGCOMD (2)
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USATC AD (2)
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USATC FA (2)
USATC Inf (2)
Svc Colleges (2)
Br Svc Sch (2)
GENDEP (2) except
  Atlanta GENDEP (None)
Sig Sec, GENDEP (5)
Sig Dep (12)
Ft Monmouth (63)
USA Corps (1)
USASCS (250)

Dugway PG (2)
Pine Bluff Arsenal (2)
Granite City Engr Dep (2)
USAERDL (2)
Madigan Gen Hosp (2)
Brooke Gen Hosp (2)
APG (2)
Anniston Ord Dep (2)
Blue Grass Ord Dep (2)
Erie Ord Dep (2)
Letterkenny Ord Dep (2)
Navajo Ord Dep (2)
Seneca Ord Dep (2)
Pueblo Ord Dep (2)
Raritan Arsenal (2)
Redstone Arsenal (2)
QMRECOMD (2)
USMA (2)
CMLCMATCOM (2)
AFIP (3)
WRAMC (3)
AFSSC (1)
USAEPG (2)
EMC (1)
USACA (2)
USASEA (1)
USASSAMRO (1)
Army Pictorial Cen (2)
USA Caribbean Sig Agcy (1)
USA Sig Msl Spt Agency (12)
USASSA (20)
USAOMC (3)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)

AMS (1)
Sig Fld Maint Shops (2)
JBUSMC (2)
Units org under fol TOE:
  (2 cy ea UNOINDC)
  11–5
  11–6
  11–7
  11–8
  11–15
  11–16
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  11–85
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  11–87
  11–97
  11–98
  11–117
  11–155
  11–157
  11–158
  11–500 (Tms AA–AE) (4)
    (Tms RA–RT)
  11–555
  11–557
  11–558
  11–587
  11–592
  11–597
  11–608
  29–56

NG: State AG (3); Units—Same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used see AR 320–50.