TECHNICAL MANUAL

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

FOR

CRYSTAL IMPEDANCE METERS TS-683/TSM, TS-683A/TSM, AND TS-683B/TSM

(NSN 6625-00-247-7347)

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1976

WARNING

Hazardous voltages are used in the operation of this equipment. Use extreme caution not to contact high voltage, 115V or 230V, input connections when operating this equipment. When working inside the equipment, always disconnect primary power and ground the high-voltage capacitors. Failure to comply may result in serious injury or DEATH to personnel.

*TECHNICAL MANUAL
No. 11-6625-456-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *2 August 1976*

Operator's, Organizational,
Direct Support, and General
Support Maintenance Manual

CRYSTAL IMPEDANCE METERS

TS-683 / TSM, TS-683A / TSM, AND TS-683B / TSM

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REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028-2 (Test) located in the back of the manual. Simply tear out the self addressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Form 2028-2 (Test) in the back of your manual, use the standard DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, New Jersey 07703.

In either case a reply will be furnished direct to you.

* This manual supersedes TM 11-2652, 30 November 1953, including all changes.

LIST OF ILLUSTRATIONS

LIST OF TABLES

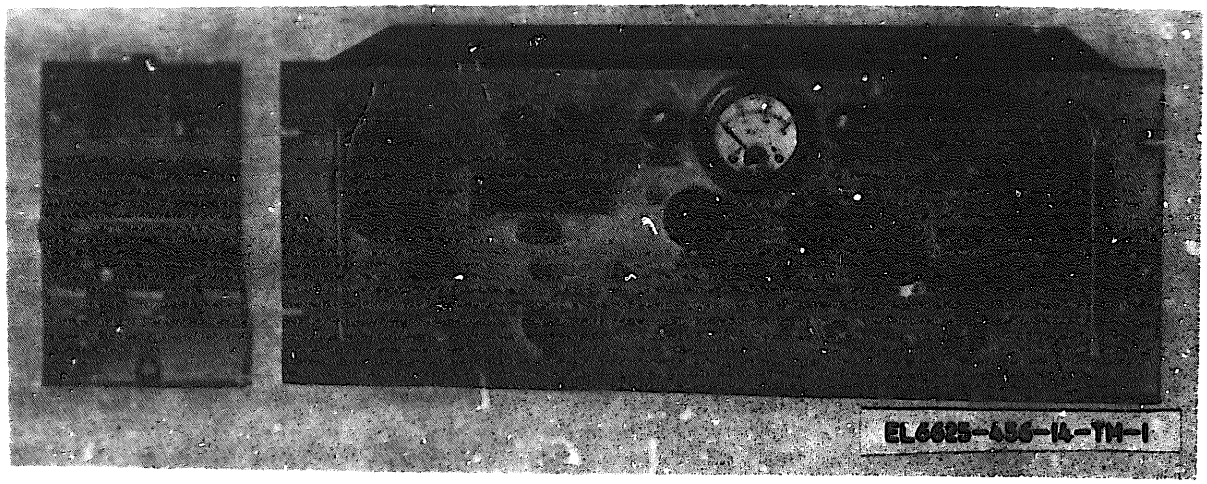


Figure 1-1. Crystal Impedance Meter TS-683/TSM.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual describes Crystal Impedance Meters TS-683/TSM, TS-683A/TSM, and TS-683B/TSM, and covers their installation, operation, and operator, organizational, and general support maintenance. There is no direct support maintenance authorized for this equipment. Official nomenclature utilizing (*) is used to indicate all models of the equipment. Therefore, the crystal impedance meters will hereinafter be referred to as CI meter or TS-683(*)/TSM, except where model differences dictate.

1-2. Indexes of Publications

a. Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

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

1-3. Forms and Records

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

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

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

1-4. Administrative Storage

For procedures, forms, and records, and inspections required during administrative storage of this equipment, refer to TM 740-90-1.

1-5. Destruction of Army Material

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

Section II. DESCRIPTION AND DATA

1-6. Purpose and Use

The TS-683(*)/TSM is used to measure the electrical parameters of quartz crystals of the type used for communications purposes. The equiment is designed specifically to test quartz crystal units for conformance with MIL-C-3098F. Provision is made to measure directly the effective series-resonant and antiresonant resistances of a piezoelectric quartz crystal in its holder. The series capacitance C can be computed from the static capacitance C° of the crystal unit, the load capacitance C' of the circuit, and the series-resonant and antiresonant frequencies. The inductance L can be computed from C and the nominal frequency of the crystal unit. The performance index, PI, is determined from these electrical parameters of the crystal unit. The greater the PI, the greater the activity of the crystal, and the more satisfactory it is for communications purposes.

1-7. Description

a. TS-638(*)/TSM. The TS-638(*)/TSM is a portable unit designed to measure the equivalent circuit parameters of a piezoelectric crystal in the frequency range of 10.0 to 140.0 MHz. The unit consists of a power supply with a VR tube regulated voltage source, and two similar tuned-plate, tuned-grid variable frequency oscillators. One oscillator is used in coordination with crystals in the frequency range of 10 to 60 MHz: the other oscillator is tuned to cover the 55- to 140-MHz frequency range. A double-pole, double-throw switch selects the oscillator to cover the frequency range of the crystal unit to be tested. Each oscillator is subdivided into two bands. Selection of the desired band is controlled by a two-position switch. All circuits except the VOLTAGE CHANGE-OVER switch are operated by front panel controls. Selection of voltage input is made with the switch at the rear of the chassis. The impedance meter is inclosed in a metal case designed for standard rack and panel mounting. The panel dimensions are 19 inches long by 7 inches high. The overall depth, including handles and cable connectors, is 10½ inches. The impedance meter dust cover, which constitutes the top and rear sides of the metal case, may be removed by unscrewing the nine binding-head screws on the sides and back of the unit. On the TS-683/TSM, fuse holder E2 is mounted on the rear of the chassis. On the TS-683A/TSM and TS-683B/TSM, fuse holder E2 and an additional spare fuse holder E23 are mounted on the front panel. An external meter jack (J4), mounted on the rear of the chassis, also is furnished on the TS-683A/TSM and TS-683B/TSM. The external meter is used during the test of crystals with drive voltage requirements so low that the result could not be accurately obtained on the panel meter.

b. Minor Components. Twelve plastic-encased calibrating resistors, with pin connectors to match the spacing of the crystal sockets and having values of 10, 22, 30, 40, 51, 60, 68, 82, 91, 100, 120, and 150 ohms, are supplied with the CI meter. The resistors are substituted for the crystal unit during the course of series-resonant and antiresonant resistance measurements. A variable calibrating resistor, Adapter VR-2, is supplied as a convenient calibrating resistor for use below the 50 MHz range. This adapter contains a 100-ohm composistion rheostat. Two pin connectors, which match the spacing of the crystal socket, and a ground pin permit the adapter to be plugged into the crystal socket. An antiresonant adapter (AR-1) is provided for insertion into either crystal socket on the meter panel. This adapter contains a similar socket to receive a crystal. When plugged into the adapter, a crystal is connected to the meter panel socket through an integral 32 pF (picofarad) load capacitor. Crystal Socket Adapter UG-683/U (provided with the TS-683A/TSM and TS-683B/TSM only) is a receptacle for the HC-10/U type crystal holder. This adapter may also be inserted into either crystal socket on the meter panel, or into the crystal socket on an antiresonant adapter AR-1. Crystal Socket Adapter MX-1020/TSM (provided with the TS-683B/TSM only) is a receptacle for the HC-18/U and HC-26/U crystal holders. A small box is provided to hold the 12 calibrating resistors, the variable calibrating resistor, the antiresonant adapter, and the crystal socket adapter. A 5-foot rf output cable assembly is supplied with the CI meter.

c. Additional Equipment Required. Digital Readout Electronic Counter AN/USM-207 is normally used with the impedance meter to read oscillator frequencies.

1-8. Differences Between Models

The models of TS-683(*)/TSM are similar in purpose, operation, and appearance. The differences between the models that affect the operator and organizational repairman are found in table 1-1.

1-9. Tabulated data

The characteristics of the TS-683(*)/TSM are as follows:

Power requirements .	115 V or 230 Vac, 50-1000 Hz, 30W.
Frequency range .	Four bands: 10 to 20 MHz, 18 to 60 MHz, 55 to 75 MHz. 65 to 140 MHz.
Resistance calibration	Twelve calibrating resistors with values of 10, 22, 30, 40, 51, 60, 68, 82, 91, 100, 120, and 150 ohms and a 100-ohm variable calibrating resistor are used.
Number of tubes	4 .
Weight :	46 lbs.

1-10. Items Comprising an Operable Equipment

The items comprising an operable TS-683(*)/TSM are found in table 1-2.

Table 1-1. Differences Between Models

Component	*TS-683/TSM*	*TS-663A/TSM and TS-663B/TSM*
Telephone jack J4.	Not furnished.	Located on rear chassis.
Crystal Socket Adapter UG-603/U.	Not furnished.	Located in spare parts box.
Spare fuseholder E23.	Not furnished.	Located on front panel.
Fuseholder E2.	'Located on rear chassis.	Located on front panel.
Meter shunt control R16.	1,000 ohms.	2,500 ohms.
Power cord W1.	Cord CX-112/U assembly.	Used with Connector Plug U-120/U.
Rf output jack J1.	Socket SO-239.	Receptacle UG-568/U.
Rf output plug.	Plug PL-259.	Plug UG-573/U.

Table 1-2.

Table 1-2. Items Comprising an Operable TS-683(*)/TSM

NSN	QTY	NOMENCLATURE	Fig. No.
6625-00-247-7847	1	Crystal Impedance Meter TS-683(*)/TSM.	1-1
	1	RF Output Cable Assembly.	
	1	Crystal Socket Adapter UG-683/U (TS-683A/TSM and TS-683B/TSM only).	1-1
	1	Antiresonant Adapter AR-1.	1-1
	1	Variable Calibrating Resistor VR-2.	1-1
	12	Calibrating Resistors (Values from 10 to 150 ohms).	1-1

CHAPTER 2

SERVICE UPON RECEIPT AND INSTALLATION

Section I. SERVICE UPON RECEIPT OF MATERIEL

CAUTION

The CI meter is easily damaged. Use care in its uncrating, unpacking, and handling.

2-1. Unpacking

a. Follow the steps below for unpacking export shipments of the CI meter:

(1) Place the packing case on a table or workbench.

(2) Cut and fold back the metal straps.

(3) Remove the nails with a nailpuller. Remove the top and sides of the packing case. Do not attempt to pry off the sides and top; such action may damage the equipment.

(4) Carefully cut and remove the waterproof liner.

(5) Lift out large and small corrugated cartons.

(6) Open large corrugated carton and lift out inner carton with moisture-vaporproof barrier.

(7) Carefully cut and remove barrier, and open the inner corrugated carton.

(8) Lift out the CI meter and discard bags of desiccant.

b. The CI meter may be received in domestic packing cases. The instructions given in *a* above apply to domestic shipments. If wrapping paper has been used in lieu of cartons, remove it carefully and check the contents as described in paragraph 2-2.

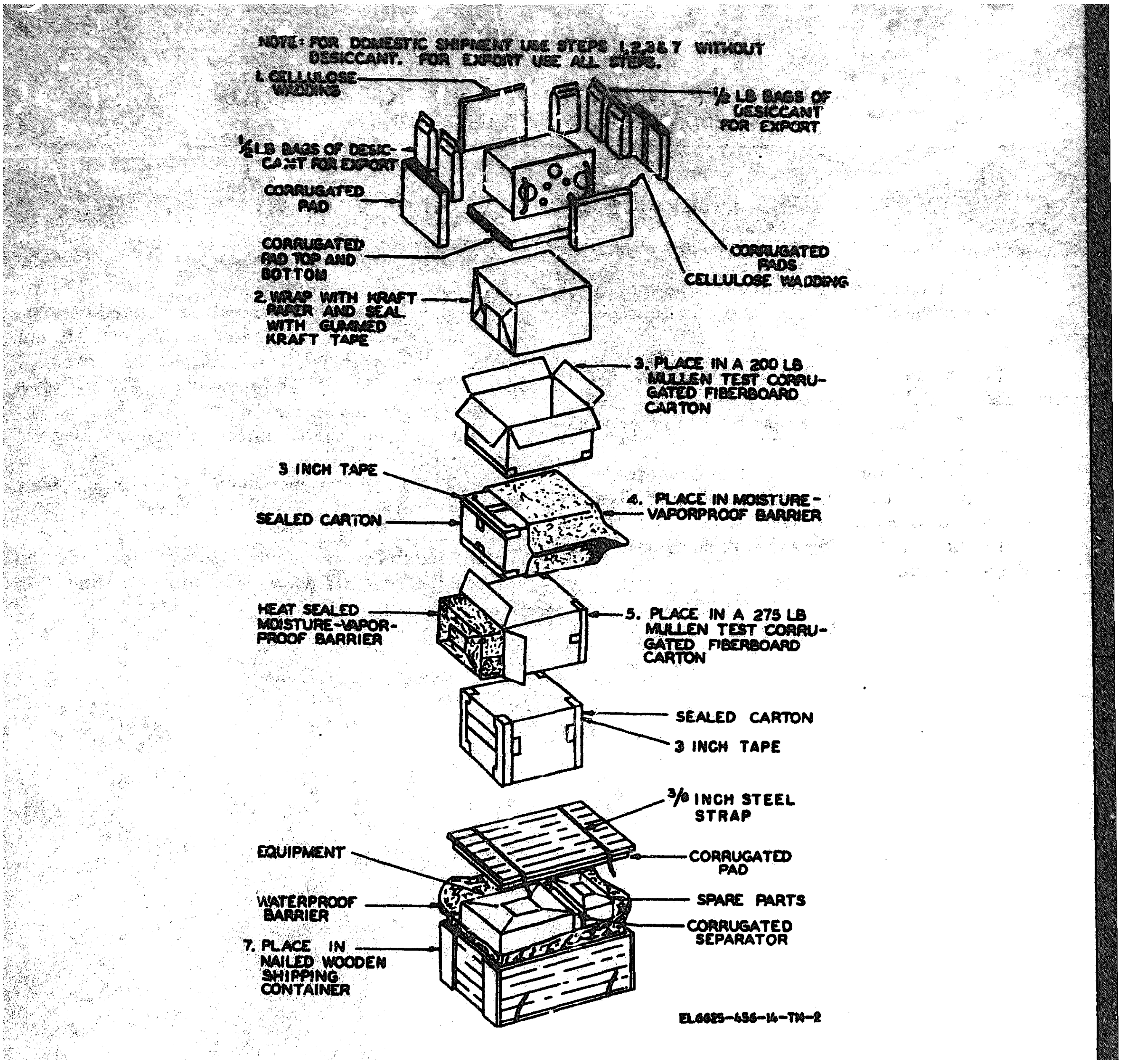


Figure 2-1. Crystal Impedance Meter TS-683(*)/TSM, packing diagram.

2-2. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6, as in paragraph 1-3.

b. Check the equipment against the packing slip. If a packing slip is not available, check equipment against the data given in table 1-2. Report all discrepancies in accordance with paragraph 1-3. The equipment should be placed in service even though a minor assembly or part that does not affect proper functioning is missing.

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

2-3. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraphs 2-1 and 2-2 for unpacking and checking.

b. Check the tags for information on changes in the wiring of the equipment. If any changes have been made, note them in this manual, preferable on the appropriate schematic.

Section II. INSTALLATION

2-4. Interconnection.

The only test connection required is between CI meter output jack J1 and the frequency measuring device. The 5-foot rf output cable assembly, supplied with the CI meter, is used for this connection. Ac power is supplied through cable W1, which is attached to the real panel.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INSTRUMENTS

3-1. General

Haphazard operation or improper setting of the controls may damage the equipment. It is, therefore, essential that the operator know the function of every control. The actual operation is discussed in paragraphs 3-3 through 3-11.

CAUTION

The VOLTAGE CHANGE-OVER switch (S2) (fig. 6-2) located on the rear panel must be set correctly and locked in the operating voltage position. SCREEN VOLTAGE control R17 should be set fully counterclockwise before switch S1 is set to ON.

3-2. Operator/Crew Controls

Table 3-1 lists the controls and indicators used by the operator, together with their functions. Items used by maintenance personnel are covered in instructions for the appropriate maintenance category. The front panel controls are illustrated in figure 3-1

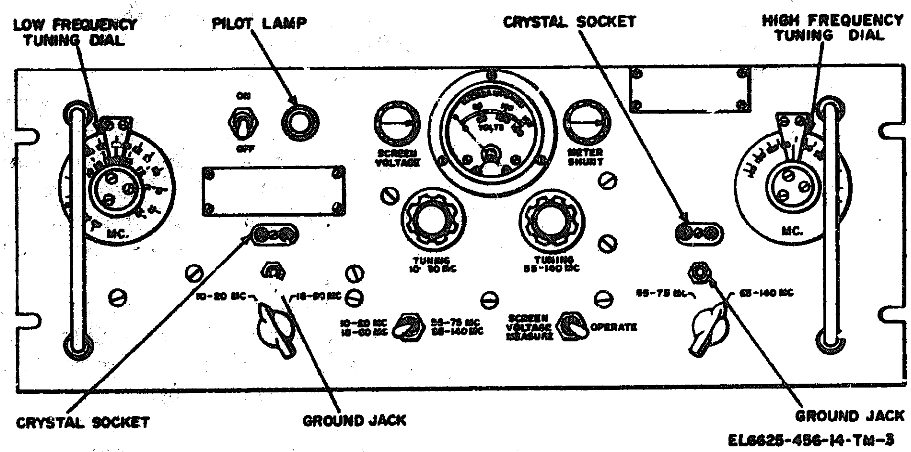


Figure 3-1. Crystal Impedance Meter TS-683/TSM, front panel view.

Table 3-1. Operator Controls and Indicators

Control, indicator, connector	*Function*
115V/230V VOLTAGE CHANGE-OVER switch S2 (at rear of chassis).	Connects power transformer primary windings for 115V or 230V operation.
ON/OFF switch S1	Switches power on and off when CI meter is connected to power source.
Pilot lamp E1	When lit, indicates current flowing through primary windings of transformer
10-20 MC 18-60 MC/55-75 MC 65-140 MC range switch S5.	Connects either low or high frequency oscillator into operating circuit.
10-20 MC/18-60 MC rotary band switch S3.	Selects band of low frequency oscillator.
55-75 MC/65-140 MC rotary band switch S4.	Selects band of high frequency oscillator.
SCREEN VOLTAGE MEASURE/OPERATE switch S6.	In OPERATE position, connects meter M1 to read grid current; in SCREEN VOLTAGE MEASURE position to read screen voltage.
SCREEN VOLTAGE control R17.	Varies screen voltage of oscillator tubes and adjusts drive level.
Grid current meter M1	Dc microammeter used to measure a convenient proportion of total rectified grid current. It is also used as a dc voltmeter (with external multiplying resistor) to measure screen voltage.

Table 3-1. Operator Controls and Indicators—Continued

Control, indicator, or connector	Function
METER SHUNT control R16.	Varies value of shunt resistor across grid current meter.
TUNING 10-40 MC control (low frequency readout dial).	Tunes low frequency oscillator to desired frequency. Used in conjunction with S3 and S5.
TUNING 35-140 MC control (high frequency readout dial).	Tunes high frequency oscillator to desired frequency used in conjunction with S4 and S5.
Crystal sockets X5 and X6.	Two-pin sockets, .486" center to center, to accept pins of .050" diameter. Used to add crystal to low or high frequency oscillator circuit, respectively.
Ground jacks J2 and J3.	Provide convenient ground connections below crystal sockets.
Rf output jack J1 (at rear of chassis).	A coaxial cable receptacle from which a small portion of the rf output of the impedance meter may be connected (via rf cable assembly W5) to frequency measuring equipment.
Fuseholder F1 (TS-683/TSM rear; TS-683A/B/TSM front).	Holds 1-ampere fuse.
External meter jack J4 (rear of TS-683A/B/TSM only).	Permits the use of an external meter with a lower voltage range for tests where the voltage measured is too low to be read accurately on the panel meter.

Section II. OPERATION UNDER USUAL CONDITIONS

3-3. Starting Procedure

Perform the operations given in *a* and *b* below before using the CI meter.

CAUTION

Do not connect power cord to ac outlet until VOLTAGE CHANGE-OVER switch S2 is locked in the proper position.

a. Preliminary. Set front panel controls as follows:

(1) Set the METER SHUNT control fully clockwise.

(2) Set the SCREEN VOLTAGE control fully counterclockwise.

(3) Determine whether the power source is 115V or 230V, and set VOLTAGE CHANGE-OVER switch S2 (at rear of chassis) to the proper value. The proper setting for either source voltage is marked clearly on the chassis.

(4) Connect the power cord to the ac outlet.

b. Starting. Adjust the drive level for crystal units of the same type, and single specified frequency by performing the procedures given in (1) through (9) below. Readjust the drive level approximately once an hour and whenever there is reason to believe that the line voltage has fluctuated.

(1) Set the power switch to ON and allow a 15-minute warmup period.

(2) Set range switch S5 to the frequency range that includes the frequency of the crystal unit to be tested; set band switch S3 or S4, whichever is applicable, to the proper frequency range.

(3) Plug the crystal unit into the appropriate crystal socket (X5 for the low frequency range or X6 for the high frequency range).

(4) Turn the SCREEN VOLTAGE control slightly in a clockwise direction. Do not advance the control too far because the grid current meter may deflect violently off scale when the crystal resonant frequency is reached.

(5) Adjust the low frequency or high frequency TUNING control, whichever is applicable, for a maximum grid current meter reading; adjust the SCREEN VOLTAGE adjust control for a reading between 50 and 75 uA (microamperes).

(6) Remove the crystal from the crystal socket.

(7) From the specification covering the crystal unit to be tested, determine the value of calibration resistance for the applicable crystal type and frequency. If the calibration resistance is specified, select the calibrating resistor by following the procedure given in (*a*) below. If no calibration resistance is specified, follow the procedure given in (*b*) below.

(*a*) From the box of calibrating resistors, select a resistor within 2 percent of the specified value. If the resistor is not available in the box of calibrating resistors, mount a nonwirewound resistor of the required value on the base of a crystal holder (type HC-6/U).

(*b*) If no calibration resistance is specified, select two resistors from the box of calibrating resistors, one giving a slightly higher grid current meter reading when substituted for the crystal unit and the other giving a slightly lower reading. Use the resistor that gives the reading closer to that of the crystal unit.

(8) From the specification determine the voltage drop for the calibration resistor. If no voltage drop is specified, determine the drive level

and compute the voltage drop, using the following formula:

$$E = \sqrt{PR}$$

where:

E = voltage drop in volts
P = specified drive level in watts (convert milliwatts to watts by dividing by 1,000)
R = calibration resistance in ohms

Example:

P = 4 milliwatts = 0.004 watts
R = 40 ohms
$E = \sqrt{PR}$
$E = \sqrt{(0.004)(40)} = \sqrt{0.16}$
E = 0.4 volt

(9) Measure the voltage drop across the calibration resistor; use Multimeter TS-352B/U as described in (*a*) below; Electronic Voltmeter ME-30A/U as described in (*b*) below; or a fabricated cyrstal diode differential voltmeter as described in (*c*) below.

(*a*) If a large number of crystal units is to b tested, prepare a resistor holder as shown in figure 3-2. Insert the male end of the holder into the crystal socket and plug the resistor into the female end of the holder. As an alternate method, if only a small number of crystal units is to be tested, wrap two or three turns of No. 16 copper wire around each pin on the resistor; keep the free ends of the wire as short as possible and insert the wires into the crystal socket. Use the ac probe of Multimeter TS-352B/U to measure the voltage between each tab on the resistor holder and ground or between each exposed resistor pin and ground. Subtract the smaller reading from the larger to obtain the voltage drop across the resistor.

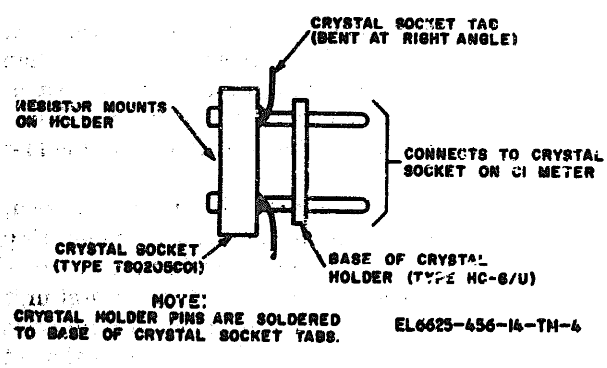


Figure 3-2. Resistor holders.

(*b*) Using Electronic Voltmeter ME-30A/U, insert the voltmeter probe into the crystal socket and plug the resistor into the voltmeter probe. Read the voltage directly from the voltmeter scale.

(*c*) Construct a crystal diode differential voltmeter as shown in figure 3-3. Measure the voltage drop across the calibration resistor ((*a*) above) and calibrate the microammeter in volts for each frequency at which it is to be used. This meter, if properly calibrated, is a rapid and fairly accurate means of measuring the voltage drop across the calibration resistor. Plug the differential voltmeter into the crystal socket on the impedance meter; plug the resistor into the socket on the voltmeter. Read the voltage from the calibrated microammeter scale.

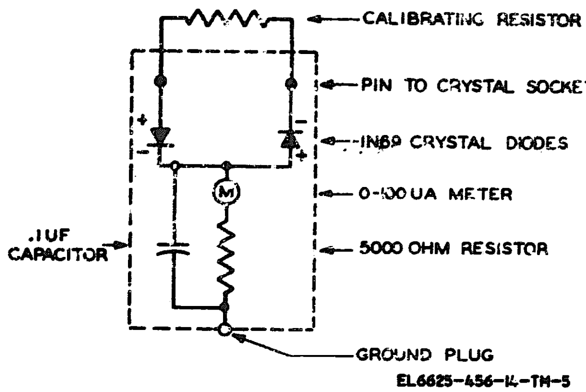


Figure 3-3. Differential voltmeter, simplified schematic diagram.

(10) If the measured voltage (9) above is the same as the specified or computed voltage (8) above, the drive level is properly adjusted. If the measured voltage is not the same as the specified or computed voltage, proceed as follows:

(a) To decrease the measured voltage, turn the SCREEN VOLTAGE adjust control counterclockwise: to increase the measured voltage, turn the SCREEN VOLTAGE adjust control clockwise.

(b) Repeat the voltage measurement (9) above.

(c) Check the measured voltage against the specified or computed voltage. If necessary, repeat steps (a) and (*b*) above until the measured voltage equals the specified or computed voltage.

NOTE

Do not change the setting of the SCREEN VOLTAGE adjust control after the drive level has been set. If the SCREEN VOLTAGE adjust control is disturbed, readjust the drive level.

3-4. Measurement of Equivalent Resistance of Series-Resonant Crystal Units

The equivalent resistance of a crystal unit may be determined by using fixed resistors or a variable resistor, Adapter VR-2 (the variable resistor may be used only at frequencies below 50 MHz (*c* below)). Determine the equivalent resistance using two fixed resistors (*a* below) or, for a slightly more accurate measurement, four fixed resistors (*b* below).

a. Measurement Using Two Fixed Resistors.

(1) Adjust the drive level (para 3-3*b*).

NOTE

Readjust the drive level each time the crystal type or frequency is changed.

(2) Plug the crystal unit into the proper crystal socket.

(3) Adjust the appropriate TUNING control for a maximum grid current meter reading. If necessary, adjust the METER SHUNT control for a midscale reading.

NOTE

Do not disturb the setting of the SCREEN VOLTAGE control; the setting must remain fixed for the remainder of this test.

(4) Connect if cable assembly W5 between if output jack J1 (rear) and Electronic Counter AN/USM-207 and measure the crystal frequency.

(5) Replace the crystal unit with a calibrating resistor that gives a grid current reading as close as possible to that of the crystal unit, preferably on the low side. Adjust the appropriate TUNING control (fig. 3-1) of the impedance meter until the electronic counter indicates the same frequency noted in step (4) above.

(6) Replace the resistor with the crystal unit and note any difference in frequency.

(7) Substitute the calibrating resistor for the crystal unit. If the grid current reading is greater than that of the crystal unit, select another calibrating resistor that gives a grid current reading as close as possible, on the low side, to that of the crystal unit. Adjust the TUNING control on the impedance meter for the frequency noted in step (4) above.

(8) Repeat steps (6) and (7) above until the frequency indicated on the electronic counter is the same for both the crystal unit and the calibrating resistor.

(9) With the crystal unit in the crystal socket, adjust the METER SHUNT control for a midscale meter reading; observe and note the reading. Designate this value I_{xtal}.

(10) Substitute a calibrating resistor in the crystal socket that will give a grid current reading just below that of the crystal unit (step (7) above; observe and note the reading. Designate this value I_1.

(11) Substitute a calibrating resistor that gives a grid current reading just above that of the crystal unit; observe and note this reading. Designate this value I_h.

(12) Calculate the equivalent resistance of the crystal unit by means of the following formula:

$$R = R_1 + \frac{(I_h - I_{xtal})(R_h - R_1)}{I_h - I_1}$$

where:

R = equivalent resistance of crystal unit
R_1 = resistance value of lower calibrating resistor
R_h = resistance value of higher calibrating resistor
I_{xtal} = grid current meter reading for crystal unit (in microamperes)
I_1 = grid current meter reading for R_1 (in microamperes)
I_h = grid current meter reading for R_h (in microamperes)

Example:

R_1 = 10 ohms
R_h = 22 ohms
I_{xtal} = 100 uA
I_1 = 73uA
I_h = 128 uA

$$R = R \frac{(I_h - I_{xtal})(R_h - R_1)}{I_h - I_1}$$

$$R = 10 + \frac{(128 - 100)(22 - 10)}{(128 - 73)}$$

$$R = 10 + \frac{(28)(12)}{55} = 10 + \frac{336}{55}$$

R = 16.11 ohms

(13) With the crystal unit inserted in the crystal socket, measure the operating frequency of the crystal unit on the electronic counter.

b. Measurement Using Four Fixed Resistors.

(1) Adjust the drive level (para *3-3b).*

NOTE

Readjust the drive level each time the crystal type or frequency is changed.

(2) Perform the procedures given in *a (2)* through (8) above.

(3) With the crystal unit in the crystal socket, adjust the METER SHUNT control for a midscale meter reading: observe and note this reading.

(4) Select four resistors from the box of calibrating resistors: two that give higher grid current meter readings when substituted for the crystal unit, and two that give lower grid current meter readings

(5) Insert the resistors, one at a time, into the crystal socket; observe and note the grid current meter reading for each resistor.

(6) Plot the grid current meter readings against the resistance values on linear graph paper.

(7) Locate the graph the grid current meter reading obtained with the crystal unit in the crystal socket ((3) above). Read the equivalent resistance for this value of grid current from the graph.

(8) With the crystal unit inserted in the crystal socket, measure the operating frequency of the crystal unit on the electronic counter.

c. Measurement Using Variable Resistor:

NOTE

The variable resistor may be used only for measurement of equivalent resistance of crystal unit9 below 50 MHz.

(1) Adjust the drive level (para *3-3b*).

(2) Plug the crystal unit into the crystal socket.

(3) Adjust the frequency tuning control for a maximum grid current meter reading. If necessary, adjust the METER SHUNT control for a midscale reading. Note the grid current meter reading.

(4) Connect if cable assembly W5 between if output jack J1 (rear) and Electronic Counter AN/USM-207. Obtain an approximate measurement of the crystal frequency on the electronic counter.

(5) Replace the crystal unit with the variable resistor; adjust the variable resistor control knob to obtain the same meter reading as that obtained in (3) above. Adjust the frequency tuning dial of the impedance meter for the same frequency noted in step (4) above.

(6) Replace the variable resistor with the crystal unit and note any difference in frequency. Note the grid current meter reading.

(7) Substitute the variable resistor for the crystal unit; adjust the variable resistor control knob to obtain the same meter reading as that obtained in (6) above. Adjust the frequency tuning dial on the impedance meter for the same frequency reading as in step (4) above.

(8) Repeat the procedures given in (6) and (7) above until the frequencies indicated on the electronic counter and the grid current meter reading are the same for both the crystal unit and the variable resistor.

(9) Measure the resistance across the terminals of the variable resistor. The measured resistance is the equivalent resistance of the crystal unit under test.

(10) With the crystal unit inserted in the crystal socket, measure the operating frequency of the crystal unit on the electronic counter.

3-5. Measurement of Equivalent Resistance of Antiresonant Crystal Units

The procedure for measuring the equivalent resistance of antiresonant crystal units is the same as for series-resonant crystal units (para 3-4), except that adapter AR-1 must be used with the crystal unit. Insert adapter AR-1 into the appropriate crystal socket, and then plug the crystal unit into the adapter. When substituting resistors for the crystal unit, do not use the adapter.

3-6. Using Impedance Meter as Go-No-Go Gage, Series-resonant Operation

The go-no-go method described in this paragraph is inherently inaccurate. This method is to be used only as a production test for rapidly processing a quantity of crystal units. Results should be checked against accurate measurements obtained by the method given in paragraph 3-4 to determine whether the go-no-go method is suitable for the intended use. All crystal units in any group tested by this method must be of the same type and specified frequency.

NOTE

The following procedure must be repeated each time the crystal type or frequency is changed.

a. Adjust the drive level in one of the following ways:

(1) If the drive level and the calibration resistance are specified for the applicable crystal type and frequency, adjust the drive level by performing the procedure given in paragraph 3-3*b*.

(2) If the drive level is specified but the calibration resistance is not specified, proceed as follows:

(*a*) Determine the tentative equivalent resistance of a number of crystal units from the group to be tested; follow the procedure given in paragraph 3-4.

(*b*) Compute the average of the resistance values (step *(a)*) by adding the equivalent resistance values measured and dividing by the number of values used.

(c) Select a calibrating resistor as close as possible to the average value.

(*d*) With the selected resistor, set the drive level by performing the procedure given in paragraph 3-3*b* (1) through (6), (8), (9), and (10).

(3) If the drive level is not specified, set the drive level as low as possible. Proceed as follows:

(*a*) Perform the procedures given in paragraph 3-3*b* (1) and (2).

(*b*) Set the METER SHUNT control fully clockwise.

(*c*) Set the SCREEN VOLTAGE adjust control for an approximate midscale grid current meter reading.

b. Insert a crystal unit from the group to be tested into the crystal socket.

c. Adjust the frequency tuning control for a maximum grid current meter reading. If necessary, adjust the METER SHUNT control for a midscale reading.

NOTE

Do not disturb the setting of the SCREEN VOLTAGE adjust conrol; this setting must remain fixed for the remainder of this test.

d. Connect rf cable assembly W5 from rf output jack J1 to Electronic Counter AN/USM-207 and measure the crystal frequency.

e. Replace the crystal unit with a calibrating resistor that has a value equal to the maximum equivalent resistance specified for the crystal type and frequency.

f. Adjust the frequency tuning control of the impedance meter so that the signal is the same as that measured in step (*d*) above.

g. Adjust the METER SHUNT control to obtain a midscale meter reading. This adjustment must remain fixed throughout the remainder of this test.

h. Note the grid current value; this value is the passing activity level.

i. Remove the resistor from the crystal socket.

j. Proceed to test crystal units by plugging one unit at a time into the crystal socket and noting the grid current value. If the grid current meter reading for a crystal unit is equal to or greater than the value noted in *h* above, the unit meets the equivalent resistance requirement; if the meter reading is less, the unit fails the requirement.

3-7. Using Impedance Meter as a Go-No-Go Gage, Antiresonant Operation

The procedure for using the impedance meter as a go-no-go gage to test antiresonant crystal units is the same as for series-resonant crystal units (para 3-6), except that adapter AR-1 must be used with the crystal unit. Insert adapter AR-1 into the appropriate crystal socket and then plug the crystal unit into the adapter. When substituting resistors for the crystal unit, do not use the adapter.

3-8. Preparation for Reduced Level of Drive Test

The reduced level of drive test is specified only for series-resonant crystal units. If the test is desired for antiresonant crystal units, the procedure will be the same as for series-resonant crystal units, except that adapter AR-1 must be used with the crystal unit.

a. Perform the procedures given in paragraph 3-3*b* (1) through (8).

b. Insert the selected resistor into the crystal socket.

c. Adjust the SCREEN VOLTAGE adjust control, alternately removing and inserting the resistor, until a difference of 2.5μA (one-half of one meter division) is obtained between the grid current meter readings with and without the resistor. On the TS-683A/TSM or TS-683B/TSM, connect a more sensitive microammeter (50μA) to jack J4 for more accurate grid current measurements, and use this meter for the above measurements.

d. Replace the resistor with the crystal unit; adjust the frequency tuning dial for a maximum grid current meter reading.

e. Substitute the resistor for the crystal unit and repeat the procedure given in *c* above.

f. The impedance meter is now ready for performing the reduced level of drive test on crystal units of the same type and specified frequency. For this procedure, refer to the specification covering the crystal unit to be tested.

3-9. Crystal Parameters, General

a. Piezoelectric Effect. When an electrical stress is applied to a cut quartz crystal in the direction of one of the major axes, a mechanical stress is produced at right angles to this axis. Conversely, a mechanical stress along a major axis will cause electrical changes to appear on the faces of the crystal perpendicular to the stress axis. The polarity of the electrical stress and the direction of the corresponding mechanical force are interrelated: a reversal in one causes a reversal in the other. This relationship between electrical stress and mechanical force is termed the piezoelectric effect and provides a means of relating mechanical vibrations to electrical circuits.

b. Resonance. An alternating voltage applied across a quartz crystal will cause the crystal to vibrate; if the frequency of the applied alternating voltage approximates a frequency at which mechanical resonance can exist in the crystal, the amplitude of the vibrations will be very large. Any crystal has several such resonant frequencies that depend on the crystal dimensions, the type of oscillation involved. and the orientation of the plate cut from the natural crystal.

c. Properties of Piezoelectric Resonator. A good piezoelectric resonator possesses the following properties: a low-temperature co-efficient of resonant frequency, a high piezoelectric activity (performance index), and a frequency spectrum containing only one resonant frequency in the vicinity of the desired oscillation. Temperature can alter the frequency of mechanical resonance through its effects on the density, the linear dimensions, and the moduli of elasticity of the crystal. Since some of the elastic constants are positive, and others are negative, the temperature coefficient of frequency may be either positive, negative, or zero, according to the mode of oscillation, the orientation of the crystal plate, and the shape of the plate. The electrical circuit associated with a vibrating crystal is shown in figure 3-4. The capacity, C_0, represents the electrostatic capacity between the crystal electrodes when the crystal is in place but not vibrating; the series combination of L, C, and R represents the equivalent mass compliance, and frictional loss of the vibrating crystal, respectively.

3-10. Crystal Parameters, Measurement

a. Static Capacitance, C_0. The value of the static capacitance of the crystal unit, C_0, may be measured by any conventional capacitance measuring unit. If this measurement is made by using a Q-meter or an rf bridge, be careful to select a frequency of operation somewhat lower than the crystal unit frequency. Figure 3-4 shows a diagram of the parameters of a piezoelectric crystal.

b. Series-Resonant and Antiresonant Resistances. The measurements of the effective resistance in ohms at series resonance is outlined in the operational procedure (para 3-4); measurement of the effective resistance in ohms at antiresonance is outlined in the operational procedure (para 3-5).

c. Series Capacitance, C. Use the following equation to calculate the capacitance, C, of the series arm of the crystal unit:

$$C \text{ (in farads)} = \frac{2(C_0 + C_1)\,\Delta F}{F}$$

where:

ΔF = the difference between the antiresonant frequency and the series-resonant frequency (F_a - F_s) in Hz.

F = the nominal frequency of the crystal unit in Hz.

C_0 = the static capacitance of the crystal unit in farads.

C_1 = the load capacitance in farads.

d. Inductance, L. Use the following equation to calculate the inductance, L, in the series arm of the crystal:

$$L \text{ (in henries)} = \frac{1}{(2\pi f)^2 C}$$

where:

f = the nominal frequency of the crystal unit in Hz.

C = series capacitance, C, of the crystal unit in farads.

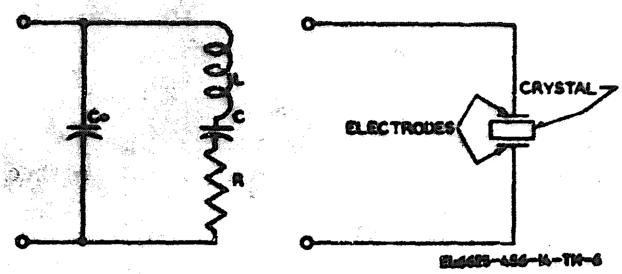


Figure 3-4. *Equivalent electrical circuit of piezoelectric crystal.*

e. Voltage Across Crystal Unit. This voltage may be measured as in paragraph 3-3*b* (9). Series resonance and antiresonance present two different cases as follows:

(1) *Series-resonant voltage.*

$$E = E_d = RI$$

where:

E = voltage across the crystal unit in volts.

E_d = difference between the two vacuum-tube voltmeter readings.

R = effective series-resonant resistance in ohms (para 3-4).

I = rf crystal current in amperes.

(2) *Antiresonant voltage.*

$$E = \frac{E_d}{2\pi F C_1 R_e} = \frac{I}{2\pi F C_1}$$

where:

E_d = difference between the two voltmeter readings.

F = nominal frequency of the crystal unit in Hz.

C_1 = load capacitance in farads.

R_e = effective antiresonant resistance in ohms (para 3-5).

2π = 6.28 (a constant).

f. Performance Index (PI). The PI of the crystal unit also may be calculated from the equation:

$$PI = \frac{X_e^2}{R_e} = \frac{1}{(2\pi F C_1)^2 R_e} = \frac{1}{(wC_1)^2 R_e}$$

where:

$$X_e = \frac{1}{2\pi F C_1}$$

$$w = 2\pi F$$

3-11. Stopping Procedure

a. Set the power switch to OFF.

b. Remove test crystals and adapters from sockets.

c. Disconnect line cord from the power outlet.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

3-12. Operation in Arctic Climates

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

a. Keep the equipment warm and dry. If the equipment is not kept in a heated enclosure, construct an insulated box for its protection.

b. Make certain the equipment has been warmed up sufficiently before use. This may take 15 to 30 minutes, depending on the temperature of the surrounding air.

c. When equipment which has been exposed to the cold is brought into a warm room, it will sweat until it reaches room termperature. When the equipment has reached room termperature, dry it thoroughly.

3-13. Operation in Tropical Climates

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

3-14. Operation in Desert Climates

The main problem with electronic equipment in desert areas is the large amount of sand and dust that lodges in the moving parts and mechanical assemblies. Cleaning and servicing intervala shall be shortened according to local conditions.

CHAPTER 4

OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. OPERATOR AND ORGANIZATIONAL TOOLS AND EQUIPMENT

4-1. Common Tools and Equipment

Tools and test equipment used by the operator and organizational repairman for the CI meter are listed in table I of appendix C.

4-2. Special Tools and Equipment

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

Section II. LUBRICATION

4-3. General

The following precautions should be observed when the TS-683 (*)/TSM is lubricated. Note that lubrication is performed during manufacture, and with normal care, is not required during the life of the equipment. If equipment is overhauled completely, lubricate it in accordance with information given below.

a. Do not use excessive amounts of oil or grease, and do not allow connections to become greasy.

b. Be sure that lubricants and points to be lubricated are clean and free from sand, grit, or dirt. These abrasives are the chief cause of bearing wear and their presence often necessitates bearing replacements. Use a solvent to clean all parts, except for electrical contacts. Before lubricating, clean all surfaces with a lint-free cloth dampened with a solvent. Keep solvent off surrounding parts. Lubrication points are illustrated in figure 4-1.

d. Gasoline will not be used as a cleaning fluid for any purpose. When the unit is overhauled or repairs are made, clean the parts, except for electrical contacts, with a solvent.

e. Use carbon tetrachloride as a cleaning fluid only in the following cases: on electrical equipment where inflammable solvent cannot be used because of fire hazard, and for cleaning electrical contacts including relay contacts, plugs, commutators, etc.

f. Tables 4-1 and 4-2 contain additional lubrication information.

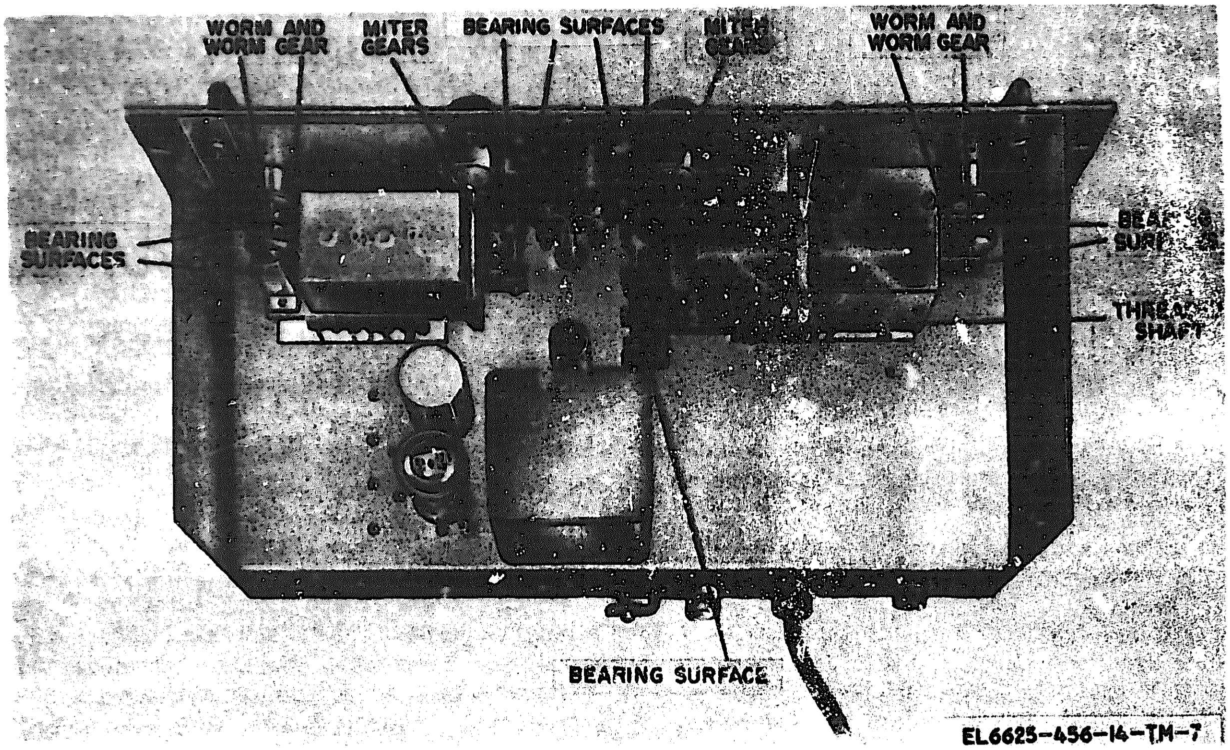


Figure 4-1. Crystal Impedance Meter TS-683(*)/TSM, lubrication points.

4-4. Lubrication Under Unusual Conditions

a. Arctic Regions. Lubricants that are satisfactory at moderate temperatures stiffen and solidify at subzero temperatures; as a result, moving parts bind or become inoperative. When preparing equipment for low-temperature operation, thoroughly remove lubricants used for moderate temperatures. Even small amounts of such lubricants, if allowed to remain, may impair the operation of moving parts. Be sure to use the lubricant specified for low-temperature operation.

b. Tropical Regions. High temperatures and moisture due to rain or condensation may cause lubricants which are normally satisfactory to flow from moving parts and other surfaces. These bearing surfaces will wear excessively, and hinges, fasteners, and other parts will be damaged or destroyed by rust and corrosion. Inspect the equipment daily and lubricate it as required to insure efficient operation; use lubricants that are suitable for high temperatures.

c. Desert Regions. Dust and sand infiltrating the equipment cause grit in the lubricants that will seriously impair the action of the moving parts of the set. Hot, dry temperatures cause the lubricants to flow from the moving parts, and conditions similar to those described in *b* above will result. Use lubricants that are suitable for high temperatures. Inspect and clean the equipment daily.

Table 4-1. Parts Lubricated by Manufacturer

Parts lubricated	*Lubricant*
Teeth of all gears, both oscillator units.	Grease, instrument
Bearings of both tuning knob and indicating dial shafts.	Oil, engine
Two end bearings of low frequency (LIA and LIB) tuning indicator shaft.	Oil, engine
Threaded portion of low frequency tuning shaft.	Oil, engine

Table 4-2. Parts Not Requiring Subsequent Lubrication

Part lubricated	*Reason subsequent lubrication is not required*
Low frequency tuning inductor L1A and L1B end collector rings.	Under ordinary service conditions factory lubrication should last for life of unit.
Low frequency tuning inductor L1A and L1B contact wheels and shaft.	Under ordinary service conditions factory lubrication should last for life of unit.
High frequency tuning inductor L2A and L2B sliding contacts.	Under ordinary service conditions factory lubrication should last for life of unit.

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-5. General.

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

4-6. Scope of Operator and Organizational Maintenance

a. General.

(1) Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to maintain the equipment in serviceable conditon. Operator preventive maintenance is performed daily and weekly; specific procedures are found in table 4-3.

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

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

b. PMCS Periods. Preventive maintenance checks and services for the CI meter are required on a daily, weekly, monthly, and quarterly basis. These checks must be performed during the specified intervals. In addition, the daily checks and services must be performed under the special conditions listed below:

(1) Initial installation.

(2) Return from higher category maintenance.

(3) Once each week, if the equipment is maintained in a standby condition.

Table 4-3. Operator/Crew Preventive Maintenance Checks and Services

D—Daily
Time required: 0.8

W—Weekly
Time required: 0.4

Interval and Sequence No. D	W	ITEM TO BE INSPECTED PROCEDURE	Work Time (M/H)
1		COMPLETENESS See that the equipment and components are complete. Refer to table 1-2.	0.1
2		EXTERIOR SURFACES Clean the exterior surfaces, including the panel and meter glass. Check meter glass for cracks. Refer to para 4-9 for cleaning procedures.	0.1
3		CONNECTORS Check the tightness of all connectors.	0.1
4		CONTROLS AND INDICATORS While making the operating checks (sequence Nos. 5 through 20) observe that the mechanical action of each knob. dial, and switch, is smooth and free of binding and excessive looseness. Also check the meter for sticking or bent pointer.	
5		VOLTAGE CHANGE-OVER SWITCH S2 Place in proper position for power supply voltage.	0.1
6		LINE CORD Plug into ac outlet. Check for fit and security.	
7		SCREEN VOLTAGE CONTROL R17 Set fully counterclockwise.	
8		METER SHUNT CONTROL R16 Set fully clockwise.	
9		RF OUTPUT CABLE ASSEMBLY Connect from jack J1 at rear of chassis to frequency measuring equipment.	0.1
10		ON/OFF SWITCH S1 Set to ON.	
11		RANGE SWITCH S5 Set to low frequency range.	

Table 4-3. Operator/Crew Preventive Maintenance Checks and Services—Continued

D—Daily
Time required: 0.3

W—Weekly
Time required: 0.4

Interval and sequence No. D	W	ITEM TO BE INSPECTED PROCEDURE	Work time (M/H)
12		ROTARY BAND SWITCH S3 Set to 10-20 MC.	
13		40—OHM CALIBRATING RESISTOR Plug into crystal socket X5. Meter indicates minimum of 30 uA.	0.1
14		ROTARY BAND SWITCH S3 Set to 18-60 MC. Meter indicates minimum of 30 uA.	
15		RANGE SWITCH S5 Set to high frequency range.	
16		ROTARY BAND SWITCH S4 Set to 55-75 MC.	
17		100—OHM CALIBRATING RESISTOR Plug into crystal socket X6. Meter indicates minimum of 30 uA.	0.1
18		ROTARY BAND SWITCH S4 Set to 65-140 MC. Meter indicates minimum of 30 uA.	
19		SCREEN VOLTAGE MEASURE/OPERATE SWITCH S6 Hold in SCREEN VOLTAGE MEASURE position. Vary SCREEN VOLTAGE control. Meter reads from 0-150 volts.	0.1
20		ON/OFF SWITCH S1 Set to OFF. Pilot lamp extinguishes.	
	1	CABLES Inspect cord and cable for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, striped, or worn excessively.	0.1
	2	HANDLES Inspect handles for looseness. Replace or tighten as necessary.	0.1
	3	METAL SURFACES Inspect exposed metal surfaces for rust and corrosion. Touch up paint as required.	0.2

Table 4-4. Organizational Preventive Maintenance Checks and Services

M—Monthly
Time required: 1.1

Q—Quarterly
Time required: 0.3

Interval and Sequence No. M	Q	ITEM TO BE INSPECTED PROCEDURE	Work Time (M/H)
1		LUBRICATION Check and renew lubricants as specified in paragraphs 4-3 and 4-4.	0.3
2		PLUCKOUT ITEMS Inspect seating of pluckout items. Make certain the tube clamps grip tube bases tightly.	0.2
3		JACKS Inspect jacks for snug fit and good contact.	0.1
4		TRANSFORMER TERMINALS Inspect the terminals on the power transformer. There should be no evidence of dirt or corrosion.	0.1
5		RESISTORS AND CAPACITORS Inspect the resistors and capacitors for cracks, blistering, or other defects.	0.2
6		INSULATORS Inspect insulators. bushings. and sleeves for cracks, chipping, and excessive wear.	0.1
7		INTERIOR Clean interior of chassis and cabinet.	0.1
	1	PUBLICATIONS See that all publications are complete. serviceable, and current.	0.1
	2	MODIFICATIONS Check DA Pam 310-7. and insure that all applicable MWO:s have been applied. ALL URGENT MWOl s must be applied immediately. ALL ROUTINE MWO's must be scheduled.	0.1
	3	SPARE PARTS Inspect all spare parts for general condition and method or storage. There should be no evidence of overstock, and all shortages must be noted on valid requisitions.	0.1

Section IV. ORGANIZATIONAL TROUBLESHOOTING

4-7. General

Organizational troubleshooting of this equipment is based on the operational checks (table 4-3, sequence Nos. 5 through 20). To troubleshoot the equipment, perform all functions of the TS-683(*)/TSM until an abnormal condition or resut is observed. Note the abnormal condition or result and refer to table 4-5, Organizational Troubleshooting. If the corrective measures indicated do not result in correction of the trouble, higher category maintenance repair is required.

4-8. Electron Tube Replacement

To safeguard against disposal of functional electron tubes, observe the following procedures:

CAUTION

Do not rock or rotate a tube when removing it from a socket; pull the tube straight out with a tube puller. Failure to comply may result in damage to tube or socket.

a. Discard tubes when a test by a tube tester or other instrument shows that they are defective.

b. Discard tubes when the tube defect is obvious, such as a broken envelope or lead.

c. Do not discard tubes merely because they have been used for a specified length or time. Satisfactory operation in a circuit is the final proof of tube quality. The tube in use may work better than a new one.

d. Do not discard tubes only because they fall on, or slightly above the minimum acceptable value when checked in a tube tester. Some new tubes fall near the low end of the acceptable range; yet these tubes may provide satisfactory performance throughout a long period of operational life at this near limit value.

Table 4-5. *Organizational Troubleshooting*

Malfunction	Probable cause	Corrective action
1. After completing sequence Nos. 5 through 10 of table 4-4, pilot light E1 does not light.	a Defective fuse.	a Replace fuse.
	b. Line cord or plug defective.	*b.* Check continuity of line cord and plug.
	c. Defective pilot light.	c. Replace pilot light.
	d. Voltage changeover switch set to wrong voltage, or defective.	*d.* Check setting of switch.
2. Improper meter readings while performing sequence Nos. 11 through 15 of table 4-4.	Defective oscillator tube V1.	Check and replace.
3. Improper meter readings while performing sequence Nos. 16 through 20 of table 4-4.	Defective oscillator tube V2.	Check and replace.
4. Low maximum screen voltage during sequence No. 19 of table 4-3.	Defective rectifier tube V3.	Check and replace.
5. High maximum screen voltage during sequence No. 19 of table 4-3.	Defective voltage regulator tube V4.	Check and replace.

Section V. CI METER MAINTENANCE

4-9. Cleaning

Inspect the exterior of the TS-683(*)/TSM. The surfaces should be clean, and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable but exposure of the fumes to an open flame or hot metal forms highly toxic phosgene gas.

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

c. Remove dust or dirt from plugs and jacks with a soft brush.

CAUTION

Do not press on the meter face when cleaning. Damage to the equipment may result.

d. Clean the front panel, meter, and controls; use a soft, clean cloth. If necessary, dampen the cloth with water or mild detergent for more effective cleaning.

4-10. Repainting and Refinishing

a. When the finish on the case has been scarred or badly damaged, rust and corrosion can be prevented by touching up bare surfaces.

CAUTION

Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits. Use No. 000 sandpaper to clean down to bare metal with a bright, clean finish.

b. When a touchup job is necessary, apply paint with a small brush. Two thin coats are usually a more effective protection than one heavy coat. Paint used will be authorized and consistent with existing regulations.

CHAPTER 5

FUNCTIONING OF EQUIPMENT

5-1. Block Diagram.
(fig. 5-1)

Crystal Impedance Meters TS-683/TSM, TS-683A/TSM, and TS-683B/TSM measure the equivalent circuit parameters of a piezoelectric crystal in the frequency range of 10.0 to 140.0 MHz. The impedance meters consist of two tuned-plate, tuned-grid, variable-frequency oscillator circuits and a conventional power supply. Each circuit covers one of the specified frequency ranges, with switch S5 permitting the use of either circuit. The crystal under test, or any one of 12 fixed calibrating resistors in the range from 10 to 50 ohms, is made part of a feedback network. The magnitude of the oscillations is indicated by the microampere scale on the grid current meter.

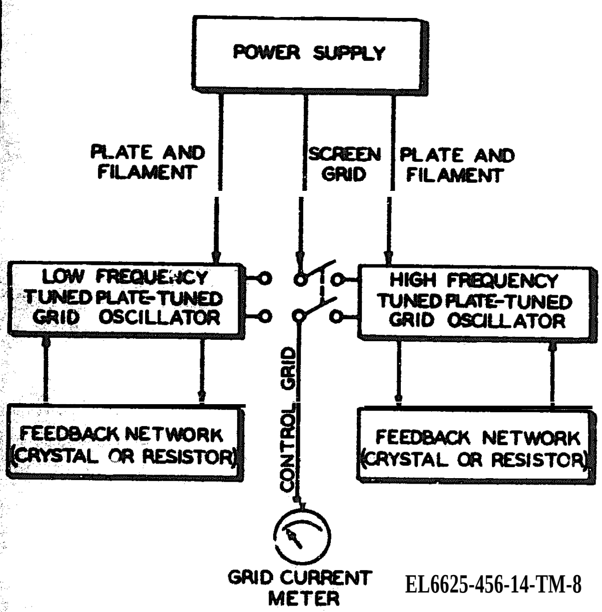


Figure 5-1. *Crystal Impedance* Meter TS-683(*)/TSM, block *diagram.*

a. Oscillator Circuit. The CI meter is essentially a tuned-grid oscillator circuit in which the crystal unit to be tested is placed in the feedback path. The crystal unit thus controls the oscillation frequency of the circuit and the amplitude of oscillation. The effective resistance of the crystal unit is measured by application of the following principle of substitution: In any system, if an element of the system is removed and a substitute element is inserted so that the original set of boundary conditions is satisfied and no new ones are added, the substitute element is equivalent operationally to the original element. Thus, if the boundary conditions (oscillation frequency and amplitude of oscillation) are measured at some point in the circuit, a network of resistance and reactance is substituted for the crystal unit without changing the boundary conditions; then, the network represents the crystal unit at that particular frequency and amplitude of oscillation. The crystal unit may be operated at either its series-resonant frequency or at antiresonant frequency. At series resonance, the equivalent electrical circuit (fig. 3-4) is purely resistive. At antiresonance, the equivalent electrical circuit of the crystal unit is inductive. Thus, if the crystal unit is operated at its antiresonant frequency, and if the correct value of load capacitance C_1 is connected in series with the crystal unit, the combination of the crystal unit and load capacitance appears as a pure resistance at the correct operating frequency. Therefore, in either case, a resistance may be substituted for the crystal unit or for the combination of crystal unit and load capacitance; this resistance can be adjusted to such a value that the oscillation frequency and amplitude are the same as they were before the substitution was made. This value of resistance is, therefore, the effective series-resonant resistance (R) or the effective antiresonant resistance (R_e). In actual use, the exact series-resonant or antiresonant frequency may be unknown: this information, however, is not necessary. The circuit of the crystal impedance meter connected to appropriate frequency measuring equipment is tuned first to the approximate frequency; then, by alternate adjustment of the value of the substitution resistance and of the circuit tuning, the correct frequency and value of resistance are obtained. Generally, adjustment must be made only two or three times before satisfaction of the boundary conditions is attained. These adjustments may be compared with the resistance and reactance adjustments performed when balancing an impedance bridge.

b. Power Supply. The power supply is a conventional type that converts 115 or 230 volts ac, 50 to 1,000 Hz, to the regulated voltage necessary for the plate and screen grid of the oscillator tubes. The power supply uses a rectifier tube in a full-wave circuit with an OA2 as a voltage regulator. A 1-ampere fuse (F1) opens the circuit if an overload or short occurs inside the impedance meter. Power ON/OFF switch S1 breaks one side of the ac line. VOLTAGE CHANGE-OVER switch S2 adapts the unit for operation on either 115 or 230 volts ac, 50 to 1,000 Hz, by connecting the two halves of the primary winding in parallel or in series.

5-2. **Oscillator Circuit.**

a. The oscillator circuits (fig. 5-2, 5-3, and 5-4) use rf pentode tybes type 5654 (V1 and V2) operating as class C amplifiers. The feedback path provided by either a crystal or a calibrating resistor converts the amplifier in use to a class C oscillator. The frequency bands (four) are selected with frequency range switch S5 and rotary band switches S3 and S4. Switch S5 connects the screen-grid potential to oscillator tube V1 or V2, and also connects the panel microammeter in the grid circuit of the same tube. The other switches, S3 and S4, set the bands covered by the two oscillators. When switch S3, associated with the lower frequency oscillator, is in the 10-20 MC position, capacitors C1 and C2 are connected in parallel with the grid and plate tuning inductors, coil L1A and coil L1B, respectively, to obtain the tuning band specified. When switch S3 is operated to the 18-60 MC position, capacitors C1 and C2 are removed from the circuit, leaving only the circuit-distributed capacitance across grid inductor L1A and the circuit-distributed capacitance plus capacitor C3 across plate inductor L1B. Similarly, when switch S4, associated with the higher frequency oscillator, is in the 55-75 MC position, capacitors C7 and C8 are connected in parallel with the grid and plate tuning inductors L2A and L2B, respectively, to obtain the tuning band specified. When switch S4 is operated to the 65-140 MC position, capacitors C7 and C8 are removed from the circuit. The two oscillator circuits are continuously variable throughout their bands by their tuning controls; TUNING 10-60 MC control drives the low-frequency tuning dial and varies the inductance of coils L1A and L1B, and TUNING 55-140 MC drives the high-frequency tuning dial and varies the inductance of coils L2A and L2B. Out&t jack J1 is connected to the plate tuning circuits of the two oscillators through coupling capacitors Cl5 and C16.

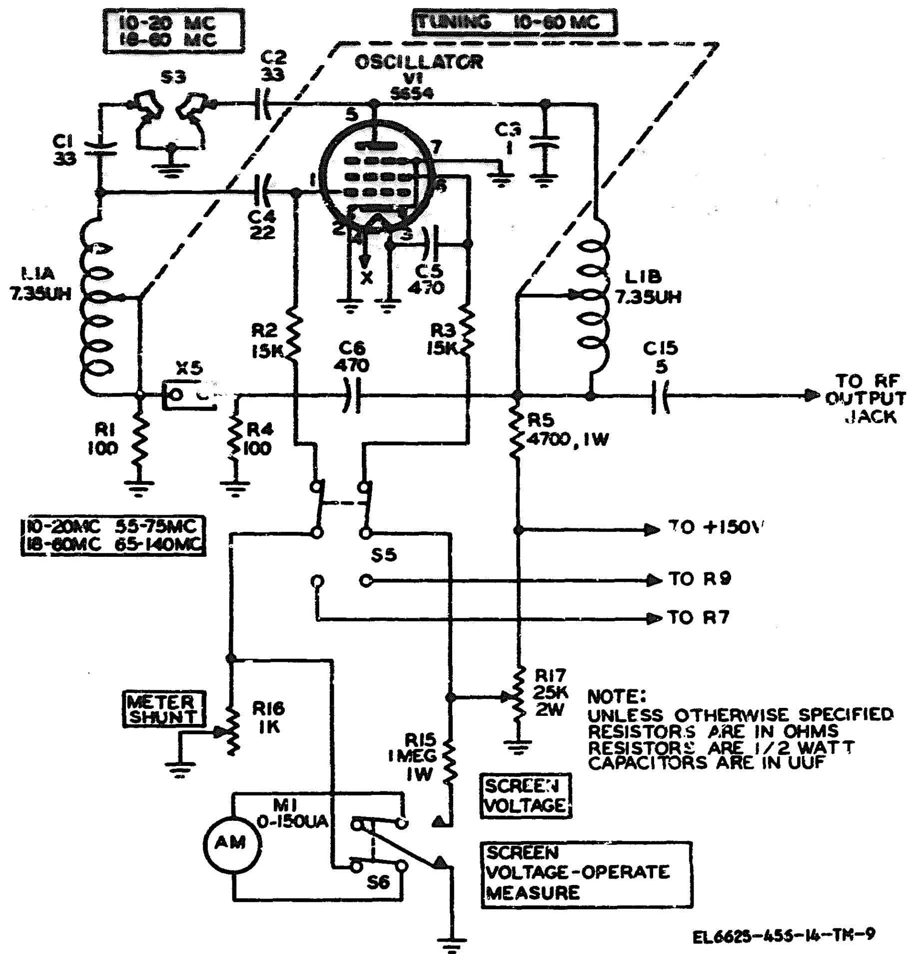


Figure 5-2. Low frequency oscillator circuit, TS-683/TSM, simplified schematie diagram.

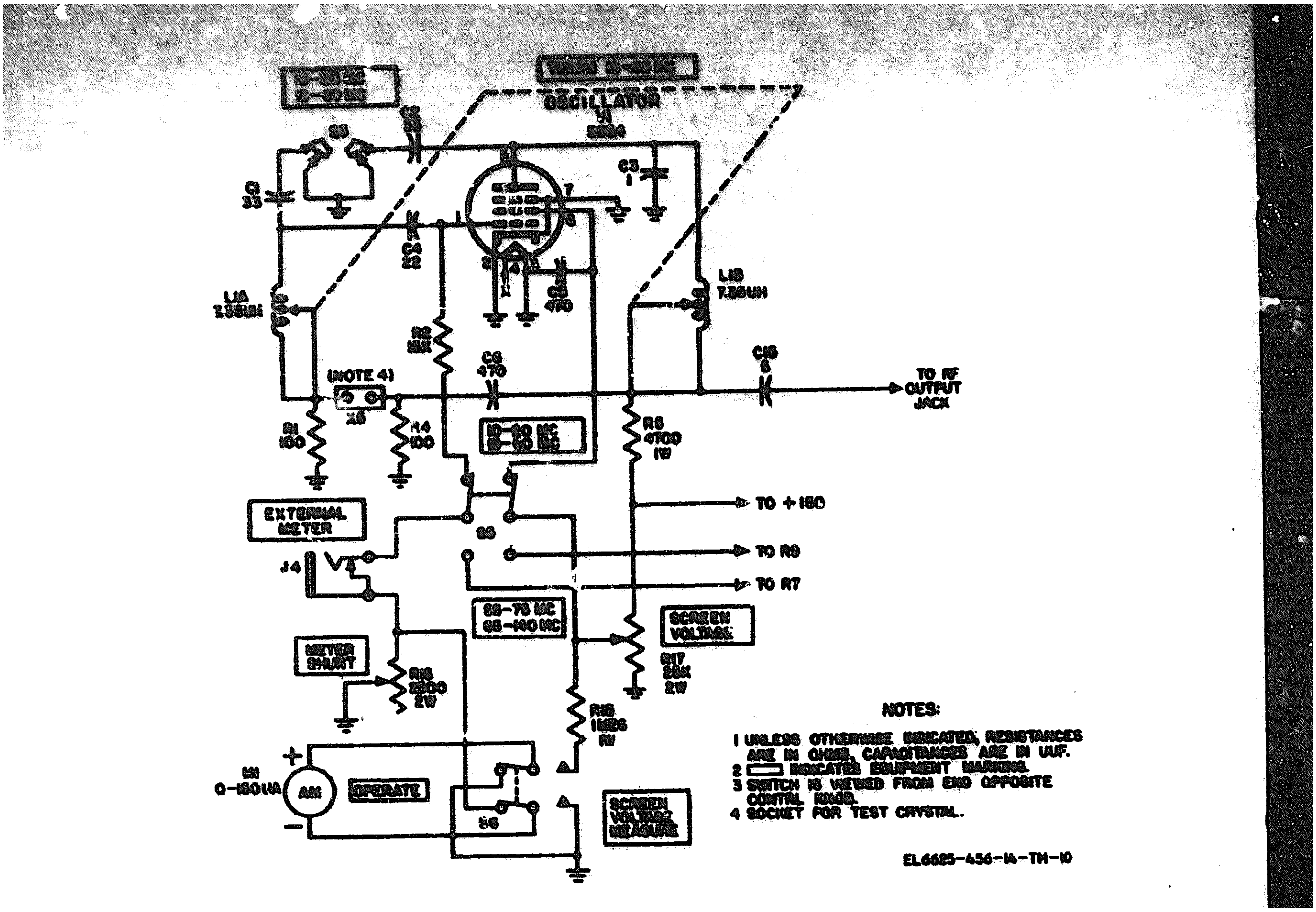


Figure 5-3. Low frequency oscillator, TS-683A/TSM and TS-683B/TSM, simplified schematic diagram.

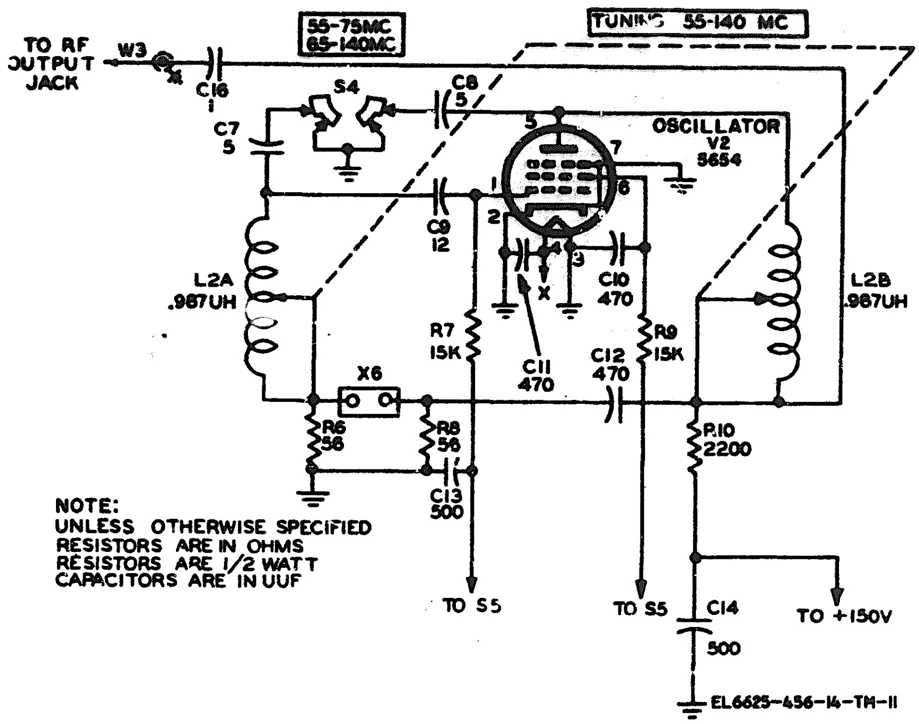


Figure 5-4. High frequency oscillator circuit, *TS-683/TSM, simplified schematic diagram.*

NOTE

The functioning of the low and high frequency oscillator circuits is identical, except for the frequency bands covered; therefore, only the functioning of the lower frequency unit (fig. 5-3) will be discussed in detail. For this discussion, it is assumed that frequency range switch S5 has been set to the low position.

b. **When the control grid (pin 1) is driven positive during a cycle of oscillation, a rectified current flows through 15,000-ohm grid leak resistor R2 and the grid current meter (the sensitivity of which is adjusted by METER SHUNT potentiometer R16) to ground. Capacitor C4 blocks the rectified control grid current from flowing through the grid tank circuit, which consists of rf variable coil L1A paralleled by the circuit-distributed capacitance for the higher frequency band and with the added capacitance of C1 when S3 is 3 is in the lower frequency band position. In the plate circuit of the tube, dc plate current flows through voltage-dropping resistor R5 and variable tuning inductor L1B to the plate. Coil L1B with its associated capacitance, tracks in frequency with grid coil L1A. The screen-grid positive dc voltage obtained from potentiometer R17 (SCREEN VOLTAGE), connected across voltage regulator tube V4, controls the amplitude of oscillation. Capacitor C5 bypasses rf from screen grid to ground. The cathode (pin 2) and the suppressor (pin 7) are** connected to ground to reduce the likelihood of output-input circuit **feedback** through the tube.

c. The higher frequency **oscillator (fig. 5-4), covering** the bands 65-75 **MC and** 65-140 **MC, differs** from the lower frequency **oscillator** as follows: a two-section, spiral-type, variable inductance tuner is used. Because of the frequency bands cove**red, the** inductance of tuner coils L2A and L2B **is con**siderabley less than the lower frequency coils. **Smaller loading capacitors C7 and C8 are shunted across the tuning inductances by switch S4 when operation in the 55-75 MC band is desired. A plate circuit compensating capacitor corresponding to C3 is not required. Grid blocking capacitor C9 is smaller, as are crystal load resistors R6 and R8 and plate voltage-dropping resistor R10. The theory of operation is the same as for the lower frequency** oscillator.

d. **When an adequate feedback path is provided and the screen-grid potential is increased to a satisfactory value, the circuit oscillates. The feedback path is through crystal socket X5 or X6. This socket also is used when the calibrating resistors are substituted for the crystal being measured. The 470-pF capacitor, C6, provides a low-**

impedance path for the rf voltage developed across resistor R5 by the rf current generated in the tuned plate tank circuit of tube V1. Capacitor C6 also provides the necessary phase relation for the rf feedback voltage to the grid circuit. The feedback voltage is injected into the grid circuit across voltage dividing resistor R1. Adapter AR-1 is provided with the impedance meter. This plugs into crystal socket X5 or X6. It contains a 32.0-pF capacitor in series with a crystal socket and is used for antiresonant resistance measurements, which are made in the same manner as series-resonant resistance measurements. The resistance determined by using the adapter is the approximate antiresonant resistance of the crystal unit operating into a 32.0-pF load capacitance. A resistance substitution method is used when making both series-resonant and antiresonant resistance measurements. Calibrating resistors (fixed values) in the range between 10 and 150 ohms are plugged into the crystal sockets on the panel. The calibrated resistor selected should give most nearly the same frequency and amplitude of oscillation as the oscillating crystal unit. Amplitude of oscillation is indicated on the grid current meter. The approximate crystal resistance is that of the selected calibrating resistor. The crystal sockets will accommodate any two-pin crystal holder having 0.050-inch pins with 0.486-inch center-to center spacing.

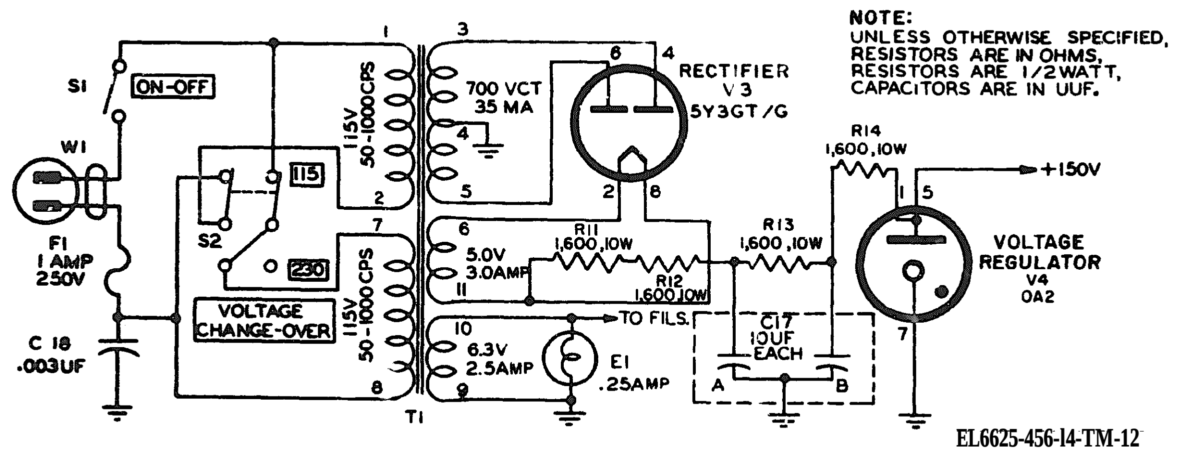
5-3 Power Supply

(fig. 5-5)

a. Transformer T1 has a primary rating of 115 or 230 volts ac, single-phase, with output windings on the secondary of 700 volts at 35 mA (milliampere) center-tapped for the plates of V3, 5.0 volts at 3.0 amperes for the filament of V3, and 6.3 volts at 2.5 amperes for the filaments of V1, V2, and pilot lamp E1. The rectified voltage is taken off one side of the filament of rectifier tube V3.

b. The rectified output of V3 is filtered free of ripple by resistors R11, R12, and R13 and capacitors C17A and C17B. The filter is connected to voltage-dropping resistor R14, which, in turn, is connected to voltage-regulating tube V4. Tube V4, operating in conjunction with resistor R14, maintains the voltage across its terminals constant at approximately 150 volts, despite normal changes in line voltage and current drain of the connected circuits. If the voltage across this gaseous regulator rises, the tube will draw more current; this action causes a greater voltagge drop across R14 and keeps the voltage at the plate (pin 5) of V4 constant. If the line voltage drops becuase of outside causes, leas current will be drawn by tube V4, the voltage across R14 will be smaller, and the voltage at the plate (pin 5) of tube V4 will be constant.

c. The screen grid of the oscillator tube in use is supplied with dc (direct-current) voltage controlled by potentiometer R17 (SCREEN VOLTAGE) connected across voltage regulator tube V4. This screen grid voltage controls the amplitude of oscillations. Pilot lamp El is operated from the 6.3-volt winding of the secondary of transformer T1. The 0.003 WF (microfarad) capacitor, C18, bypasses rf current from the input ac power line to ground. The 500-pF capacitor, C14, prevents rf currents of the plate circuit from flowing in the power supply circuit.



EL6625-456-14-TM-12

Figure 5-5. TS683(*)/TSM power supply. simplified schematic diagram.

CHAPTER 6

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

NOTE

No direct support maintenance is authorized.

6-1. Voltage and Resistance Measurements

It shall be assumed that general support maintenance personnel are capable of making most voltage and resistance measurements without detailed, step-by-step instructions. The basic guidelines below shall be followed:

WARNING

Certain points on the chassis of the CI meter operate at dangerous potentials. Be extremely careful when handling or testing any part of the equipment while it is connected to the power source.

a. When measuring voltages, use tape or sleeving to insulate the test prod, except for the extreme tip.

b. Make resistance and voltage measurements as directed in tables 6-1 and 6-2, or in the appropriate schematic diagram.

c. In all tests, the possibility of intermittent trouble should not be overlooked. This type of trouble may be made to appear by tapping or jarring the equipment.

6-2. Dc Resistance of Transformers and Coils

The dc resistance data table 6-1 is provided as an aid to troubleshooting. When using the data, observe the following:

a. Before making resistance measurements of the windings, determine that faulty operation is very likely due to a faulty transformer.

b. Do not use the resistance measurements as the sole basis for discarding a transformer or coil as defective. Bear in mind that, due to rather broad winding tolerances during manufacture, resistances may vary from one transformer or coil to another; the table values are typical average values.

c The normal resistance values of replacement transformers and coils may differ greatly from the values given in the table; however, most replacements will approximate the given values.

6-3. Tools and Test Equipment

A list of the required tools and test equipment for troubleshooting and maintenance of the CI meter will be found in appendix C.

Table 6-1. *Resistance to Ground Measurement*

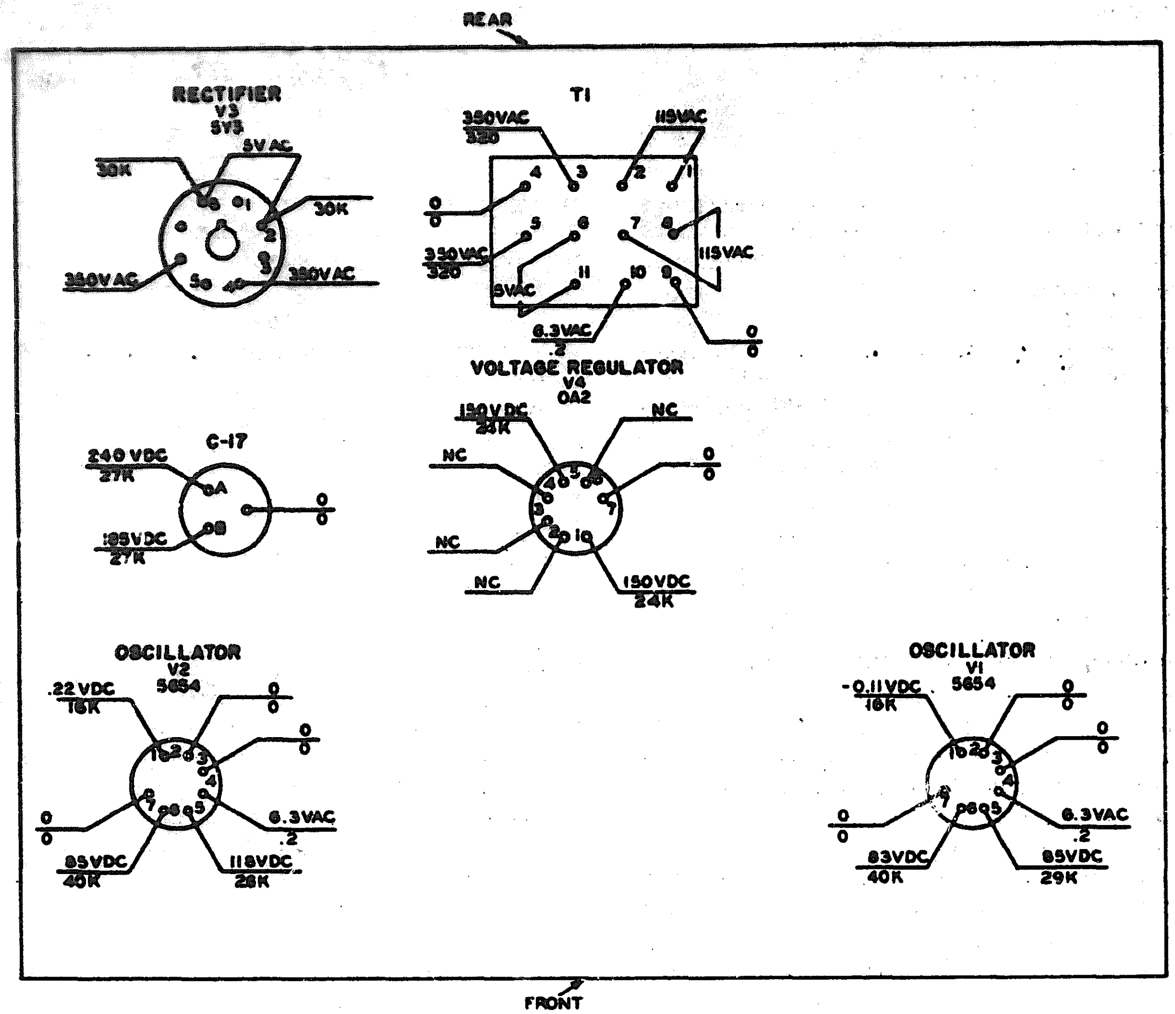
NOTE

Measure the dc resistance of the primary circuit of the power transformer from prong to prong on the ac plug. With switch S1 closed, the resistance should be about 10 ohms with switch S2 in the 115V position, and 40 ohms in the 230V position.

Component part	Terminal	Resistance to ground (ohms)
V3	4	320
V3	6	320
T1	10	0.2
V1	1	16K (S5 at low frequency range; R16 fully clockwise).
V1	5	29K
V1	6	40K (S5 at low frequency range; R17 fully clockwise).
V2	1	16K (S5 at high frequency range; R16 fully clockwise).
V2	5	26K
V2	6	40K (S5 at high frequency range; R17 fullyclockwise).

Table 6-2. *Voltage to Ground Measurements*

Component part	Terminal	DC Voltage to ground
V3	2	340V
C17A	+ (pos)	240V
C17B	+ (pos)	185V
V4	1 or 5	150V (tube lighted)
V1	1	−0.11V (S5 at low frequency range; R17 fully counterclockwise).
V1	5	85V
V1	6	83V (S5 at low frequency range; R17 fully clockwise)
V2	1	−0.22V (S6 at high frequency range; R17 fully counterclockwise).
V2	5	118V
V2	6	85V (S5 at high frequency range; R17 fully clockwise).



NOTES:

1. INPUT 115VAC
2. READINGS TAKEN TO GROUND UNLESS INDICATED.
3. 20 000 OHMS-PER-VOLT MULTIMETER USED FOR READINGS.
4. UNIT NON-OSCILLATING DURING MEASUREMENTS.
5. SCREEN VOLTAGE CONTROL FULL COUNTERCLOCKWISE
6. S5 IN 10-20MC, 18-60MC POSITION FOR V1; IN 55-75MC, 65-140MC POSITION FOR V2 READINGS.
7. POWER ON FOR VOLTAGE READINGS, OFF FOR RESISTANCE MEASUREMENTS.
8. RESISTANCES ARE IN OHMS.

EL6625-456-14-TM-13

Figure 6-1. Component terminal voltage and resistance diagram.

Section II. TROUBLESHOOTING

6-4. General

The first step in servicing a defective CI meter is to sectionalize the fault. Sectionalization means tracing the vault to one of the three major circuits responsible for the abnormal operation: either of the two oscillator circuits, or the regulated power supply circuit. The second step is to localize the fault. Localization means tracing the fault to a particular stage or network within one of the three major circuits. The third step is to isolate the fault. Isolation means tracing the fault to the 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 isolated by checking voltages and resistances.

6-5. Component Sectionalization, Localization, and Isolation.

Listed in *a*, *b*, and *c* below is a group of tests arranged to reduce unnecessary work and to aid in tracing trouble to a specific component.

a. Visual Inspection. The purpose of visual inspection is to locate any obvious trouble. Through inspection alone, the repairman frequently may discover the trouble or determine the circuit in which the trouble exists. This inspection is valuable in avoiding additional abnormalities in the CI meter and in forestalling future failures.

b. Troubleshooting Tables. The procedures listed in the tables will aid greatly in locating trouble.

c. Intermittents. In all these tests, the possibility of intermittent malfunctions should not be overlooked. If present, this type of trouble may be made to appear by tapping or jarring the equipment. It is possible that external connections may cause the trouble. Test wiring for loose connections, moving wires and components with an insulated tool. This may indicate the location of a fault.

6-6. Localizing Trouble in Filament and B+Circuits.

Trouble in Crystal Impedance Meter TS-683(*)/TSM often can be detected by checking the resistance of the filament and high-voltage circuits before applying power to the equipment, thereby preventing damage to the power supply. Disconnect the power cord from the ac power source. Remove the bottom cover plate. Place all tubes in their sockets. Set Multimeter TS-352B/U at a suitable resistance range and measure the resistance between the terminals (*a* below) and ground. If incorrect resistance reading are obtained, check the circuit wiring for anything that might cause a short circuit, such as a metallic chip or a piece of solder. If no short circuits are detected, check the circuit components, such as the filter capacitors and rectifier tube, for short or partial shorts. If the correct resistance measurements are obtained, connect the power cord to the ac power source. Set the multimeter controls for dc voltage measurements (300 volts or higher) and connect the multimeter test leads to measure the positive dc voltages between the terminals (*b* below) and ground. If a voltage reading is obtained but the reading is low, turn off the equipment and measure the ac line voltage. If the line voltage is correct, an unusually high load current is being drawn from the power supply; this load may be caused by defective circuit components. If no voltage indications are obtained, check fuse F1, power ON-OFF switch S1, VOLTAGE CHANGE-OVER switch S2, power transformer T1, and rectifier tube V3.

6-7. Additional Troubleshooting Information

a. Dc and Filament Voltages. Check the dc and filament voltages on the socket pins of V1 and /or V2. Be sure that controls are properly set and that switch S5 is in the range position corresponding to the oscillator tube socket in use. If voltages appear correct, refer to the schematic diagram (fig. FO-2) and check the crystal holder networks for wiring continuities or shorts to chassis.

b. Dc Resistance of Transformer T1. The dc resistance of transformer T1 should correspond to the following:

Terminal 1-2 (connection S2 open)	20 ohms
Terminal 7-8(connection to S2 open)	20 ohms
Terminal 3-4	320 ohms
Terminal 4-5	320 ohms

Table 6-3. Troubleshooting

NOTE

All components are shown on figures 6-2, 6-3, and 6-4.

Malfunction	*Probable cause*	*Corrective action*
1. Pilot lamp does not light.	*a.* Cord not plugged into ac source, or open.	*a.* Check at source and meter.
	b. Fuse F1 blown.	*b.* Check and replace.
	c. Pilot lamp E1 burned out.	c. Check and replace.
	d. ON-OFF switch S1 defective.	*d.* Check and replace.
	e. VOLTAGE CHANGE-OVER switch S2 defective.	e. Check and replace.
	f. Transformer T1 open.	*f.* Check and replace.
2. Pilot lamp lights dimly (on 115V source). Voltage regulator tube V4 does not light.	*a.* VOLTAGE CHANGE-OVER switch S2 set for 230V.	a. set correctly.
	b. Regulator tube defective.	*b.* Check and replace.
	c. Rectifier tube V3 defective.	*c.* Check and replace.
	d. R11, R12, R13, or R14 open.	*d.* Check and replace.

Table 6-2. Troubleshooting—Continued

Malfunction	Probable cause	Corrective action
	e. High-voltage winding of T1 open.	e. Check and replace.
	f. Capacitor C17A or C17B shorted.	f. Check and replace.
	g. Capacitor C14 shorted.	g. Check and replace.
3. No apparent reading or deflection of grid current meter (with calibrating resistor in socket.	a. Oscillator tube V1 or V2 not oscillating.	a. Check and replace. See if tuning dial is within tuning range.
	b. METER SHUNT set too low.	b. Turn METER SHUNT control clockwise.
	c. SCREEN VOLTAGE control set too low.	c. Turn SCREEN VOLTAGE control clockwise.
	d. SCREEN VOLTAGE control defective (open).	d. Check and replace.
	e. Wiring shorted or open.	e. Check continuity.
	f. Meter open, transformer open, or oscillator coil open.	f. Check resistances as shown in figure 6-1. Check voltages as shown in figure 6-1.
	g. Contact wheel on L1A and L1B not tracking.	g. Slide wheels along shafts until they arrive within one-fourth turn of opposite ends of L1A and L1B as traveling stop on tuning shaft reaches locknuts.
	h. Contacts not made in J4 jack (TS-683A/TSM & TS-683B/TSM only).	h. Clean and adjust contacts.
4. Oscillates without crystal or calibrating resistor in panel socket.	a. Wiring disturbed in feedback or oscillator circuits.	a. Restore to their original position any wires which were disturbed while troubleshooting or repairing.
	b. Tube shield removed.	b. Replace shield.
	c. Tuning shaft on low-frequency oscillator grounded.	c. Remove tuning shaft from ground.
5. Stop on low frequency tuning does not function.	Locknuts loose.	Adjust locknuts to meet requirements in step 3g above.

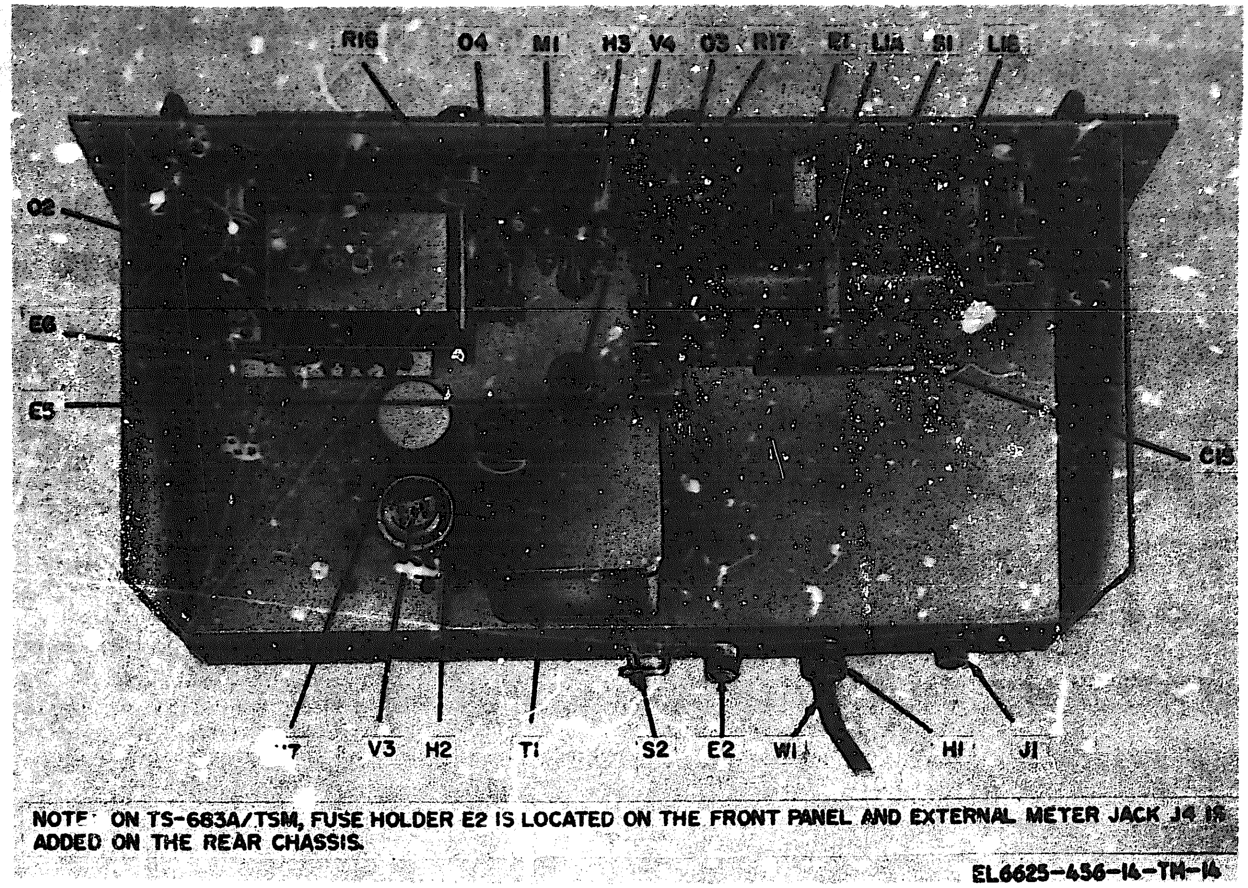


Figure 6-2. TS-683/TSM panel and chassis assembly, dust cover removed, top view.

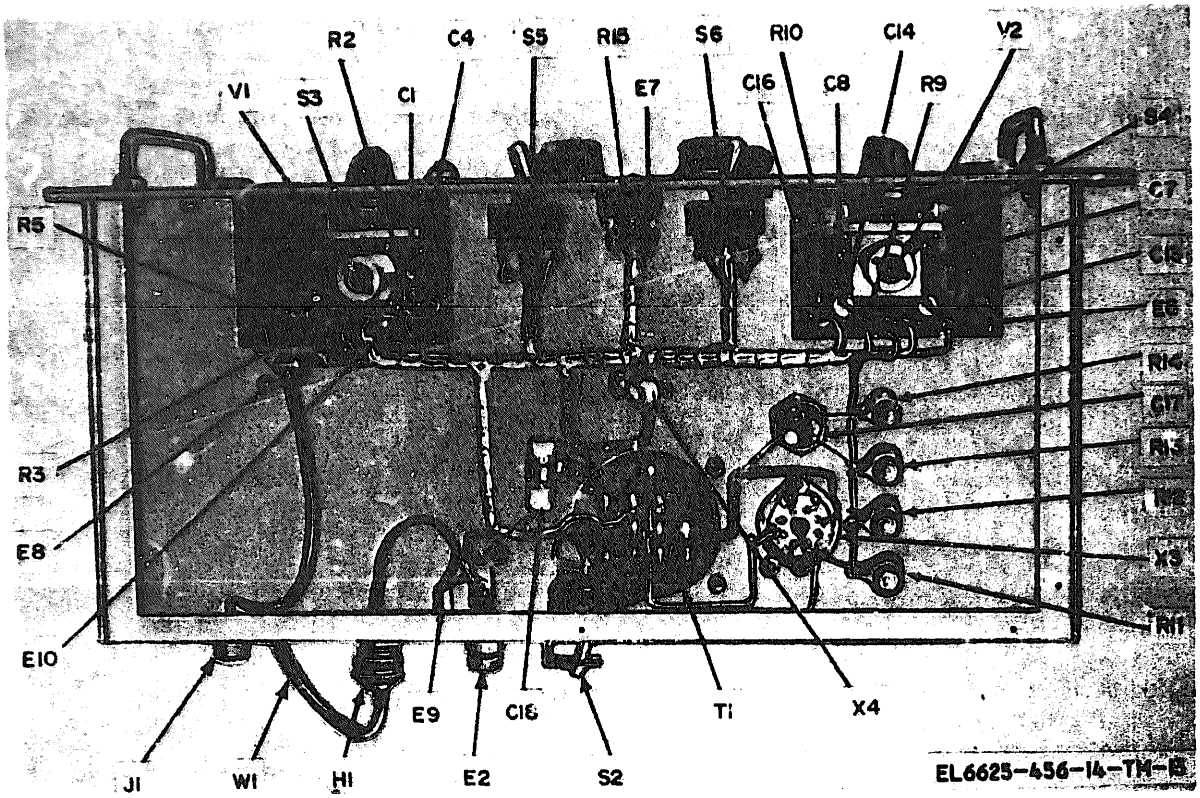


Figure 6-3. TS683/TSM panel and chassis assembly, cover plate removed, bottom view.

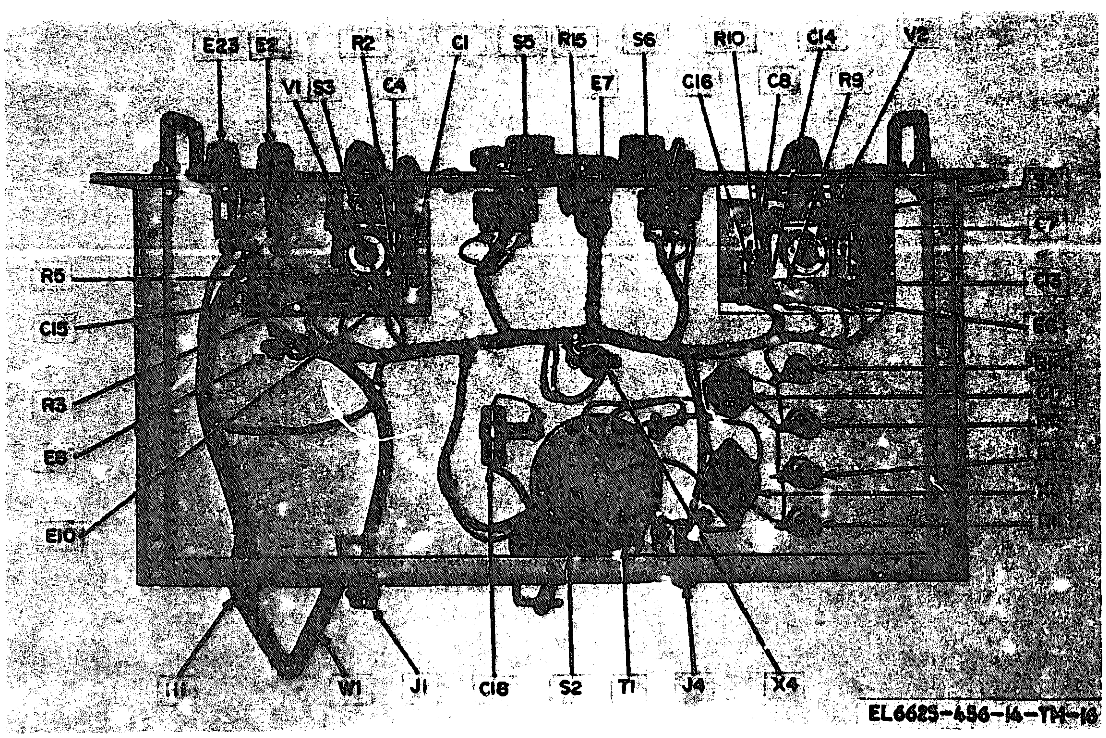


Figure 6-4. IS-683A/TSM and TS-663B/TSM panel and chassis assembly, cover plate removed, bottom view.

Section III. CI METER MAINTENANCE

6-8. General

Observe the following precautions when servicing the CI metrer:

a. When changing a component that is held by screws, always replace the lockwashers.

b. Careless replacement of parts greatly increases the likelihood of new faults. Note the following points:

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

(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 when soldering small resistors or ceramic capacitors. Overheating of the small parts may ruin the component or change its value.

(4) Do not allow drops of solder to fall into parts of the chassis, as they may cause short circuits.

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

(6) Replacement parts shall occupy exactly the same position in the circuit as the original part. A part that has the same electrical value but different physical size may cause trouble. Give particular attention to proper ground when replacing a part; use the same ground as in the original wiring. Failure to observe these precautions may result in decreased output or parasitic oscillations.

6-9. Replacement of Parts

a. General. When replacement of a component is necessary because of failure, follow the disassembly procedures given in *d* below. It is assumed that the dust cover and bottom cover plate have been removed during the troubleshooting procedure.

b. Resistors. The resistors are self-supporting. Unsoldering is the only procedure required for removal.

c. Fixed Capacitors. The small capacitors are self-supporting and may be removed by unsoldering. Dual electrolytic capacitor C17 is removed by unsoldering the leads and removing the capacitor mounting nut.

d. Disassemmbly.

(1) Loosen the setscrews on all knobs and remove the knobs from the front panel. Set each dial index over one of the end graduations and record its position. Loosen the setscrews in the dials and remove them from the front panel. Remove the three center screws in each dial plate and lift the dial plates off the front panel.

(2) To remove the *microammeter*, loosen the stud nuts, take off the wire lugs, and remove the panel screws holding the meter.

(3) To remove the low frequency range tuning assembly, (fig. 6-3 and 6-4), unsolder and tag the cabled wires to the coil unit terminal strip. Remove capacitor C15. Remove the dust cover from the tuning assembly. Unsolder the ground lead running from the tuning assembly to the rear of the front panel, or remove nameplate and remove screw and nut holding the solder terminal to the rear of the front panel. Unscrew the four screws holding the coil assembly to the front panel. Note that one of these screws is normally hidden by the dial plate. Remove the retaining nut that secures rotary band switch S3 to the front panel and lift the switch from the panel. The low frequency tuning assembly now is removable as a unit for replacement or repair.

(4) To remove the high frequency range tuning assembly, unsolder and tag the cabled wires to the coil unit terminal strip. Remove the three screws that hold the coil assembly to the panel. Note that one screw is normally hidden by the dial plate. Unscrew the nut that secures rotary band switch S4 to the front panel and remove the switch from the panel.

(5) To remove ON-OFF switch S1, range switch S5, and SCREEN VOLTAGE MEASURE-OPERATE switch S6 from the front panel, remove the respective retaining nut from each switch in the same manner as for switch S3. Unsolder and tag the leads to the SCREEN VOLTAGE and METER SHUNT controls.

(6) Remove the nuts which hold the handles and the four screws which hold the panel to the chassis. The chassis assembly now is removable for repair, if required.

(7) The crystal impedance meter now has been disassembled to the point where the remaining components can be removed as desired without difficulty.

e. Reassembly Procedure. To reassemble the equipment, reverse the above procedures. Handle the two tuning assemblies carefully to avoid disarranging critical wiring.

6-10. Alignment

No alignment procedure is necessary for Crystal Impedance Meter TS-683(*)/TSM unless either or both of the tuning assemblies require replacement. Refer to paragraph 6-9 for replacement procedures for either tuning assembly.

a. Equipment Used for Alignment and Adjustment. The alignment of Crystal Impedance Meter TS-683(*)/TSM is established on the higher frequency band of each oscillator unit. Digital Readout Electronic Counter AN/USM-207 should be used to make all frequency measurements necessary during alignment.

b. Alignment of CI Meter. Alignment of this equipment consists of establishing the correct tuning dial setting for a given frequency developed by each oscillator. The dial calibrations are intended only to be used as rough guides to the frequencies of the oscillators.

(1) *Alignment of low frequency tuning dial.* Connect rf output cable W5 to output jack J1 on the impedance meter and to the input of the electronic counter. Turn on both units and allow them to warm up for 15 minutes. Position switch S5 on the impedance meter to the low-frequency range, and rotary band switch S3 to the 18-60 MC position. Insert a 40-ohm calibrating resistor in crystal socket X5. Adjust the screen voltage to 60 volts by means of the SCREEN VOLTAGE control, with switch S6 held in the SCREEN VOLTAGE MEASURE position. Slowly vary the tuning control of the impedance meter until the electronic counter indicates 60 MHz. The dial reading should be 60 MHz to within the width of the indicator line. If this requirement is met, check the dial settings at 34 MHz (with SCREEN VOLTAGE control at 30 volts) and at 18 MHz (with SCREEN VOLTAGE control at 25 volts). Tolerance should be within ±3 percent. If the dial on the impedance meter is noticeably off at 60 MHz, loosen the three center screws slightly and rotate the dial plate until it reads correctly. Tighten the screws when the dial plate is properly positioned. Check the settings at 34 MHz and 18 MHz. If the dial cannot be made to log at the three frequencies, the contact wheels on coil L1A and L1B may not be tracking correctly. Refer to the troubleshooting table, table 6-4, for instructions necessary to correct this condition; then, repeat the alignment procedure.

(2) *Alignment of high frequency tuning dial.* Position switch S5 to the high frequency range, and rotary band switch S4 to the 65-140 MC position. Insert a 100-ohm calibrating resistor in crystal socket X6. Adjust the screen voltage to 130 volts by means of the SCREEN VOLTAGE control. Slowly vary the tuning control of the impedance meter until the electronic counter indicates 110 MHz. The dial reading should be 110 MHz to within the width of the indicator line. If this condition is met, check the dial settings at 90 MHz (with SCREEN VOLTAGE control at 130 volts) and at 65 MHz (with SCREEN VOLTAGE control at 35 volts). The tolerance should be within ±3 percent. If the dial is noticeably off at 110 MHz, rotate the dial plate as described in (1) above. Check the settings at the three test frequencies after the dial plate is positioned. If the dial cannot be made to log at the three frequencies, the sliding contacts on coils L2A and L2B may not be tracking correctly. If necessary, shift the contacts by lifting them gently with a small screw driver until satisfactory tracking is obtained. Always replace the metal cover on the coil unit when the alignment check is made.

Section IV. GENERAL SUPPORT TESTING PROCEDURES

6-11. General

a. Testing procedures are prepared for use by electronics field maintenance shops and electronic service organizations to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment must meet before it is returned to the using organization. These procedures may also be used as a guide for testing equipment that has been repaired at direct support maintenance if the proper tools and test equipment are available.

b. Comply with the instructions preceding each chart before proceeding to the chart. Perform each step in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Control settings* columns; then, perform each specific procedure and verify it against its performance standard.

6-12. Modification Work Orders

The performance standards listed in the tests (tables 6-4 through 6-7) are based on the assumption that all modifications have been performed. A listing of current modification work orders will be found in DA Pam 310-7.

6-13. Physical Test and Inspections

a. Test Equipment and Materials. No test equipment or materials are required.

b. Test Connections and Conditions.

(1) No connections are necessary.

(2) Remove dust cover.

c. Procedure. Follow procedures in table 6-4.

Table 6-4. Physical tests and Inspections

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	None	Controls may be in any position.	*a.* Inspect case and chassis for damage, missing parts, and condition of paint. NOTE Touchup painting is recommended instead of refinishing whenever practical; screw heads, binding posts, receptacles, and other plated parts will not be painted or polished with abrasives.	*a.* No damage evident or parts missing. External surfaces intended to be painted will not show bare metal. Panel lettering will be legible.
			b. Inspect all controls and mechanical assemblies for loose or missing screws, bolts, and nuts.	*b* screws, bolts, and nuts will be tight. None missing.
			c. Inspect all connectors, sockets, receptacles, holder, and meter for looseness, damage, or missing parts.	*c.* No loose parts or damage. No missing parts.
2	None	Controls may be in any position.	*a.* Rotate all panel controls throughout their limits of travel.	*a.* Controls will rotate freely without binding or excessive looseness.
			b. Inspect dial stops for damage or bending, and for proper operation.	*b.* Stops will operate properly without evidence of damage.

6-14. Oscillation Amplitude Test

a. Test Equipment and Materials. No test equipment or materials are required.

b. Test Connections and conditions. No Connections are necessary.

c. Procedure. Follow the procedures in table 6-5.

Table 6-5. Oscillation Amplitude Test

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1		METER SHUNT control fully clockwise. SCREEN VOLTAGE control fully counterclockwise. No crystals or calibrating resistors in crystal sockets.	*a.* Turn on TS-683(*)/TSM and allow 30-minute warmup.	*a* None
			b. Check meter reading for residual grid current.	*b. Less* than 15 mA.
2		METER SHUNT control fully clockwise. SCREEN VOLTAGE control fully clockwise.	*a.* Insert following calibrating resistors in appropriate crystal socket.	*a* None
			b. Set frequency for each calibrating resistor as directed in *c* below.	*b.* None
			c. Set as follows: *Band* / *Frequency (Mhz)* / *Calibrating Resistor (ohms)* 1 / 10-20 / 100 2 / 18-60 / 100 3 / 55-65 / 100 3 / 65-75 / 80 4 / 60-100 / 100 4 / 100-140 / 40	c. Meter reading shall be at least 30 mA over the residual grid current (step lb above).

6-15. Auxiliary Components Test

a. Test Equipment and Materials.

(1) Resistance Bridge ZM-4B/U.

(2) Multimeter TS-352B/U.

(3) RCL Bridge ZM-61/U.

b. Test Connections Conditions. Connect the equipment as shown in figure 6-5.

c. Procedure. Follow the procedures shown in table 6-6.

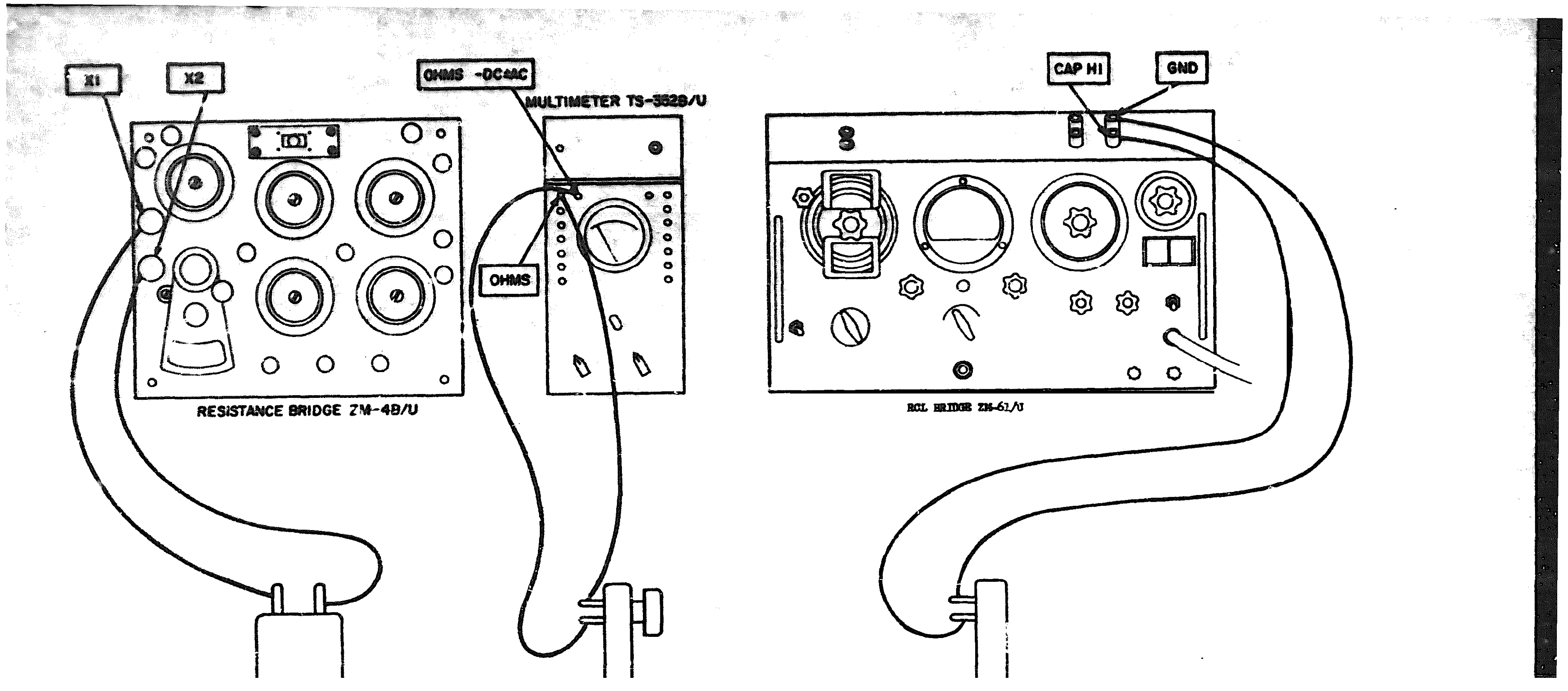


Figure 6-5. Auxiliary component test **connections.**

Table 6-6. **Auxiliary Components Test**

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	**ZM-4B/U:** **GA: RVM.** **RES-VAR-MUR: RES.** **MULTIPLY BY: 1/100** **MULTIPLY BY: 1/10** **(For resistors of 100 ohms and over.)**	**None.**	a. Turn on ZM-4B/U and allow 30-minute **warmup.** **b. Check resistance** of calibrating resistors listed: 10 ohm 22 ohm, 30 ohms, 51 ohms, 68 ohms, 82 ohms, 91 ohms, 100 ohms, 120 ohms, 150 ohms	**a. None** b. All values shall be as listed ±5%.
2	**Same as step 1**		Check resistance of calibrating resistors listed: 40 ohms, **60 ohms**	**All values shall be as listed ±2%.**
3	TS-352B/U: FUNCTION: OHMS **Range** switch: Rxl.		**Check resistance** of variable calibrating resistor adapter VR-2.	**Resistance shall be 100 ohms ±10%.** Resistance shall vary smoothly from zero to 100 ohms.
4	ZM-61/U: Power: ON.		a Allow ZM-61/U to warmup for 15 minutes. b. Connect a pair of 0.050 inch diameter leads (preferably an HC-13/U crystal base with long pins) to tets binding posts of bridge. c. Balance bridge. d. Place short (or shorted crystal socket) across pin8 of AR-l. e. Place AR-l on the 0.050 inch leads protruding from bridge, making sure that internal capacitor of AR-1 is connected to HI post. f. Measure capacitance of AR-l. If not within tolerance, proceed to steps g through i below. g. Remove back of AR-1 and fabricate a temporary back with a hole just over the capacitor. h. Install temporary back on AR-1 and adjust capacitor with an insulated screwdriver until measured capacitance across socket is within tolerance. i. Reinstall original back on AR-l.	32 ±0.2 pF.

6-16. Frequency Checks

a Test Equipment and Materials.

(1) Digital Readout Electronic Counter **AN/USM-207**

(2) Variable Transformer CN-16A/U.

b. Test Connections and conditions. connect the equipment as shown in figure G-6.

c. Procedure. Follow the procedure in table 6-7.

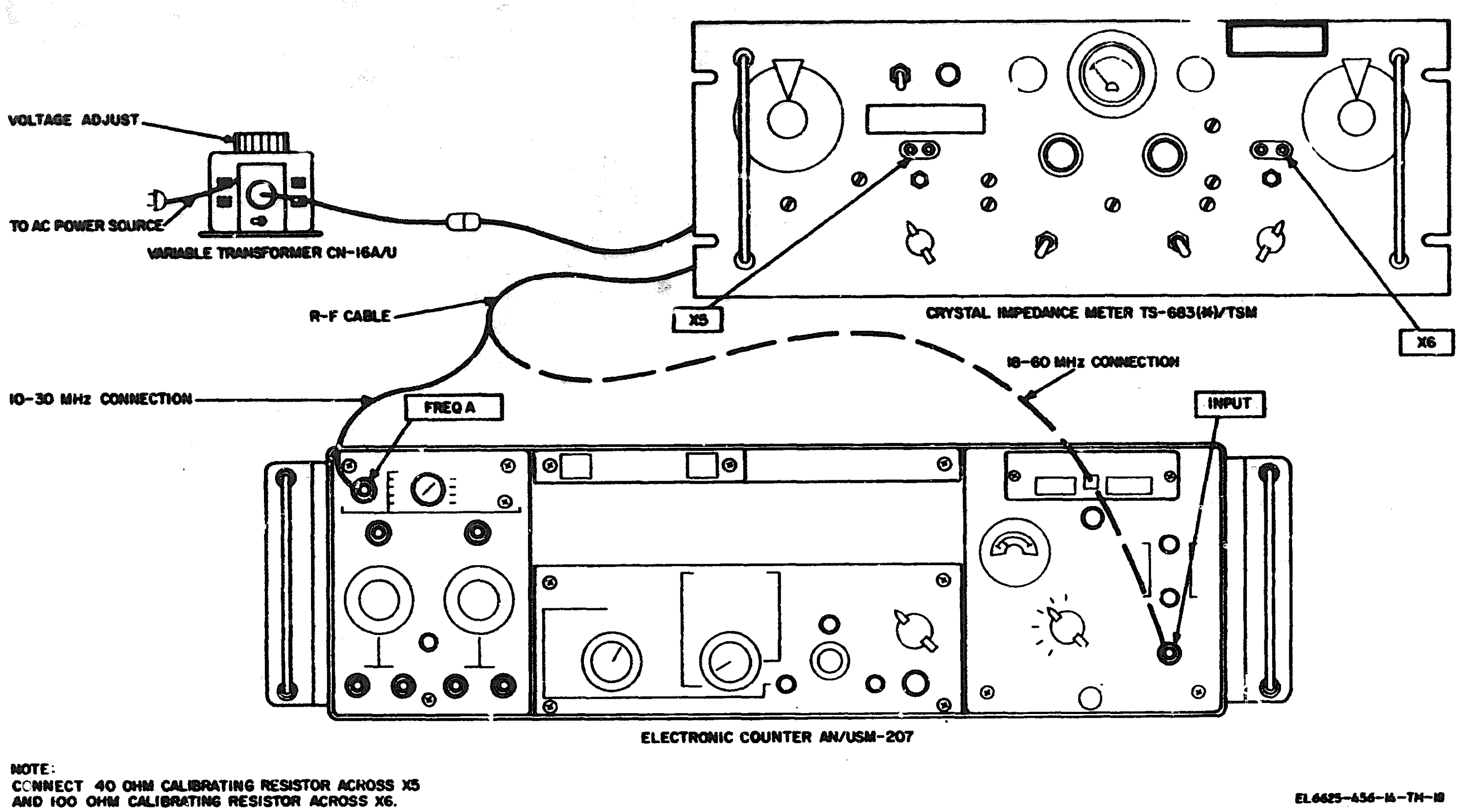
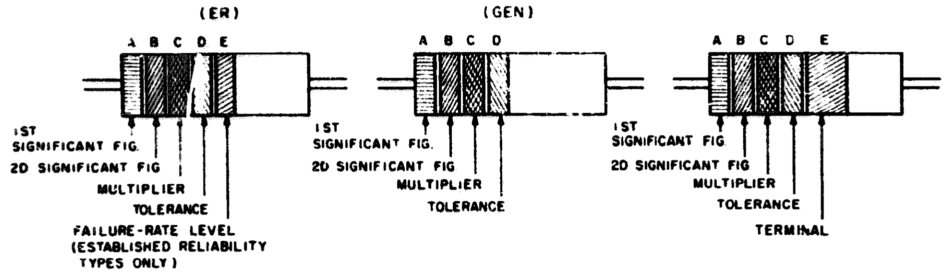


Figure 6-6. Frequency check test connections.

Table 6-7. **Frequency Checks**

Step No.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*AN/USM-207:* (Below 30 MHz) POWER: TRACK. GATE TIME: 10^{6} . FUNCTION: FREQ. SENSITIVITY: 50V (above 30 MHz). POWER: TRACK. GATE TIME: 10^{6} . FUNCTION: FREQ. SENSITIVITY: PLUG-IN. DIRECT/HETRODYNE: DIRECT.		*a.* Turn on TS-683(*)/TSM and allow 30-minute warmup. *b.* Set TS-683(*)/TSM frequency to listed settings, insert listed calibrating resistor in crystal socket X5, and set screen voltage to listed values. Check frequency reading on AN/USM-207. *Band (MHz)* / *Freq (MHz)* / *Resist. (Ohms)* / *Screen (Volts)* 18-60 / 60 / 40 / 60 34 / 40 / 30 18 / 40 / 25 10-20 / 10 / 40 / 25 65-140 / 110 / 100 / 130 90 / 100 / 130 65 / 100 / 35 55-75 / 55 / 40 / 25	*a.* None *b.* Frequency accuracy should be ± 3% at each setting.



COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

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

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

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

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

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

BAND D — THE RESISTANCE TOLERANCE.

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

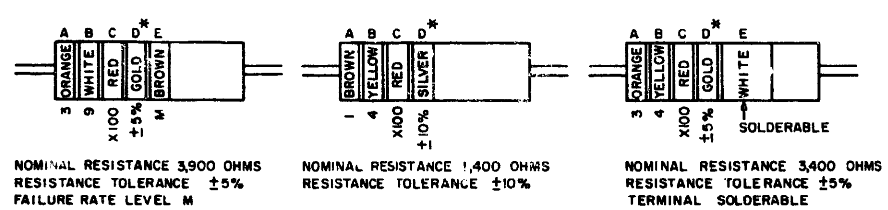
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

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

2R7 = 2.7 OHMS 10R0 = 10.0 OHMS

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

EXAMPLES OF COLOR CODING



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

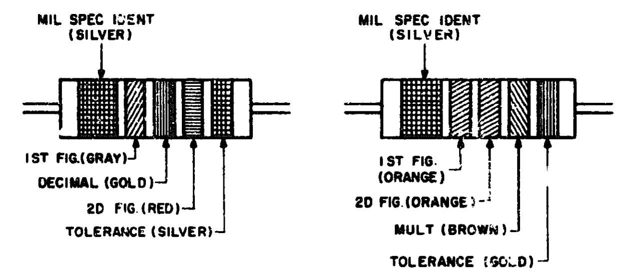
NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

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

COMPOSITION-TYPE RESISTORS FILM-TYPE RESISTORS

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

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2UH ± 10% (B) 330UH ± 5%

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

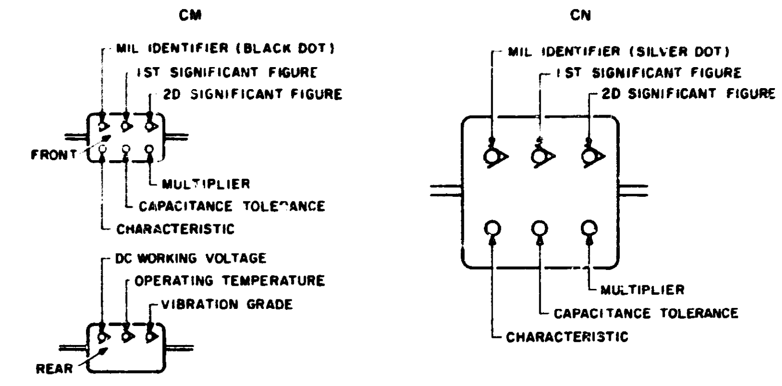
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

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

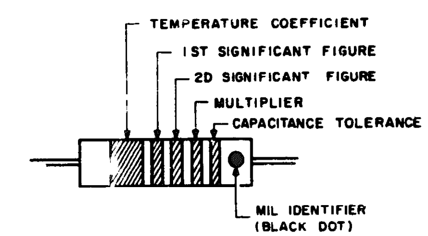
MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

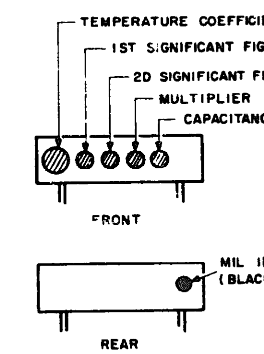
B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

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

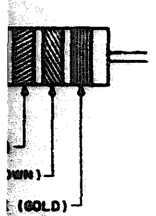


MICA-DIELECTRIC PAPER-DIELECTRIC GLA





AXIAL LEAD RADIAL LEA



(GOLD)

H ± 5%

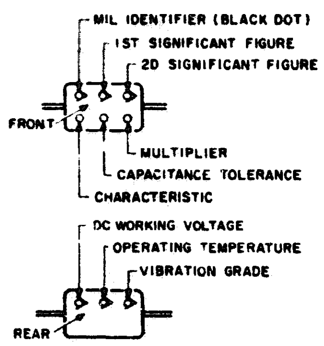
AY A, AN EXAMPLE OF
THE COLOR BANDS FOR

D R.F. CHOKES.

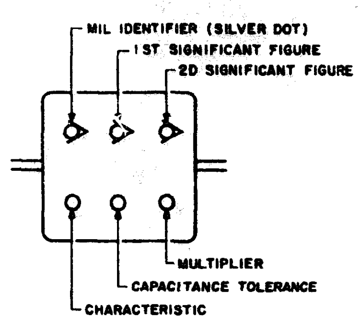
COLOR FIGURES
ALUE OF THE

DARD INDUCTORS.

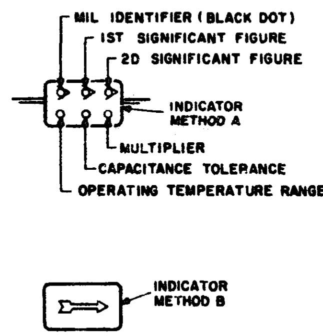
CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.



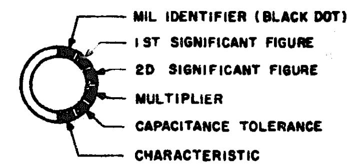
MICA-DIELECTRIC



PAPER-DIELECTRIC



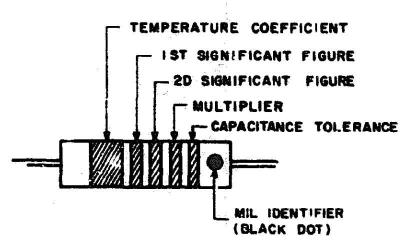
GLASS-DIELECTRIC, GLASS CASE



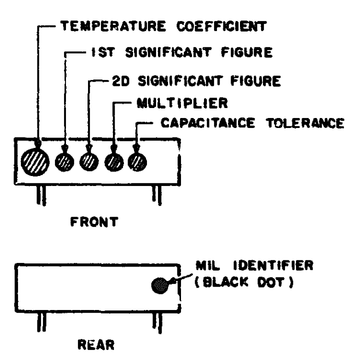
MICA, BUTTON TYPE

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

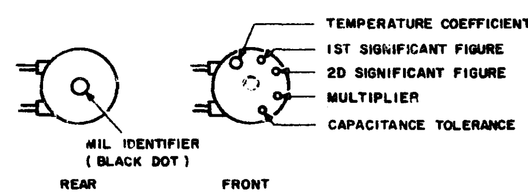
COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY CB	0	0	1			±20%	±20%		A			-55° TO +70°C	10-55 HZ
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%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



AXIAL LEAD



RADIAL LEAD



DISK-TYPE

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC.

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

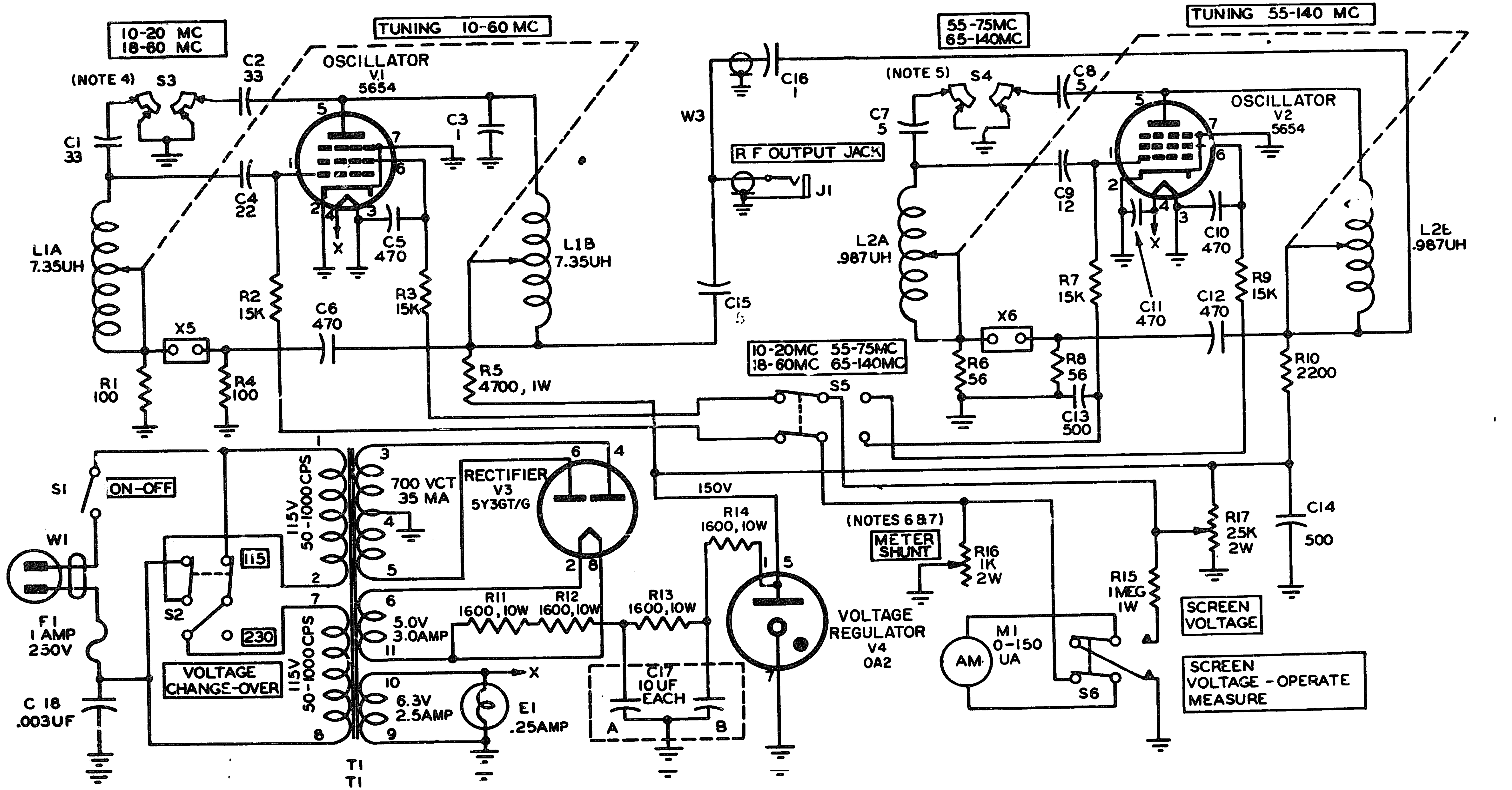
1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.
2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS MIL-C-5, MIL-C-25D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.
3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE

* OPTIONAL CODING WHERE METALLIC PIGMENTS ARE UNDESIRABLE.

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

ESC-FM 913 73

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



NOTES:

1. UNLESS OTHERWISE NOTED:
   RESISTORS ARE IN OHMS
   RESISTORS ARE 1/2 WATT
   CAPACITORS ARE IN UUF
2. ▭ INDICATES EQUIPMENT MARKINGS
3. SWITCHES ARE VIEWED FROM END OPPOSITE CONTROL KNOB.
4. SWITCH S3 IN "10-20MC" POSITION
5. SWITCH S4 IN "55-75MC" POSITION
6. ON TS-683A & B/TSM, METER SHUNT R16 IS 2,500 OHMS
7. ON TS-683A & B/TSM, EXTERNAL METER JACK J4 IS CONNECTED BETWEEN METER SHUNT R16 AND TERMINAL OF SWITCH S5.

EL6625-456-14-TM-19

Figure FO-2. Schematic diagram, Crystal Impedance Meter TS-683(*)/TSM.

APPENDIX A

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Index of Modification Work Orders.
TM 11-2019	Test Sets I-49, I-49A, and I-49B and Resistance Bridges ZM-4A/U and ZM-4B/U.
TM 11-2635A	Q Meters TS-617/U, TS-617A/U, and TS-617B/U.
TM 11-6625-366-15	Operator's Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352B/U.
TM 11-6625-700-10	Operator's Manual: Digital Readout Electronic Counter AN-USM-207.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command)

APPENDIX C

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for the TS-683(*)/TSM. It authorizes categories of maintenance for specific maintenance functions of repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

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

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

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

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

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

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

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

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

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module/component/assembly, end item or system. This function does not include the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

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

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

C-3. Column Entries

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

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

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function varies at different maintenance categories, appropriate "Worktime" figures will be shown for each category. The number of man-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C—Operator/Crew
O—Organizational
F—Direct Support
H—General Support
D—Depot

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

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

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

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

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

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

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

SECTION II. MAINTENANCE ALLOCATION CHART FOR CRYSTAL IMPEDANCE METERS TS-683(*)/TSM

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT
			C	O	F	H	D	
00	CRYSTAL IMPEDANCE METERS TS-683/TSM TS-683A/TSM AND TS-683B/TSM	Service		0.1				7
		Inspect		0.5				7
		Replace		0.2				7
		Test				1.5		1 thru 5
		Repair				1.0		6
		Overhaul					1.5	6
		Rebuild					2.0	6
		Inspect[1]				[illegible]		
		Align				0.5		1
		Replace				0.5		6

(1) Visually inspect.

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TABLE 6-6. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR

CRYSTAL IMPEDANCE METERS TS-683(*)/TSM

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	H,D	COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-207	6625-00-911-6368	
2	H,D	CAPACITANCE-INDUCTANCE-RESISTANCE BRIDGE ZM-61/U	6625-00-144-3070	
3	H,D	MULTIMETER TS-352B/U	6625-00-553-0142	
4	H,D	RESISTANCE BRIDGE ZM-4B/U	6625-00-500-0937	
5	H,D	VARIABLE TRANSFORMER CN-16/U	5950-00-235-2086	
6	H,D	TOOL KIT, ELECTRONIC EQUIPMENT TK-100/G	5180-00-605-0079	
7	0	TOOLS AND TEST EQUIPMENT AVAILABLE TO THE REPAIRMAN-USER BECAUSE OF HIS ASSIGNED MISSION.		

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INDEX

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS

SOMETHING WRONG WITH THIS MANUAL?

THEN. . .JOT DOWN THE DOPE ABOUT IT ON THIS FORM, TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

FROM: (YOUR UNIT'S COMPLETE ADDRESS)
Commander
Stateside Army Depot
ATTN: AMSTA-US
Stateside, N.J. 07703

DATE 10 July 1975

PUBLICATION NUMBER	DATE	TITLE
TM 11-5840-340-12	23 Jan 74	Radar Set AN/[illegible]-76

BE EXACT. . .PIN-POINT WHERE IT IS / IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PAGE NO.	PARAGRAPH	FIGURE NO.	TABLE NO.	
2-25	2-28			Recommend that the installation antenna alignment procedure be changed throughout to specify a 2° [illegible] antenna lag rather than 1°. REASON: Experience has shown that with only a 1° lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2° without degradation of operation
3-10	3-3		3-1	Item 5, Function column. Change "2 db" to "3db." REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.
5-6	5-8			Add new step f.1 to read, "Replace cover plate removed in step e.1, above." REASON: To replace the cover plate.
		F03		Zone C 3. On J1-2, change "+24 VDC to "+5 VDC." REASON: This is the output line of the 5 VDC power supply. + 24 VDC is the input voltage.

SAMPLE

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER: SSG I. M. DeSpiritof 999-1776

SIGN HERE: SSG I.M. DeSpiritof

DA FORM 1 AUG 74 **2028-2** *(TEST)*

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR MANUAL "FIND," MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

TEAR ALONG DOTTED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL MANUALS

SOMETHING WRONG WITH THIS MANUAL?

FROM: (YOUR UNIT'S COMPLETE ADDRESS)

DATE

PUBLICATION NUMBER	DATE	TITLE

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General, United States Army
Chief of Staff

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SAAD (30)
TOAD (14)
SHAD (3)
SigFLDMS (1)
USAERDAA (1)
USAERDAW (1)
Units org under fol TOE: (1)
11-16
11-97
11-98
11-117
11-500(AA-AC)
29-134
29-136

NG: None

USAR: None

For explanation of abbreviations used see, AR 310-50

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1.0 mm (e= .81 mm)

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