TM 11-5895-1097-40

TECHNICAL MANUAL

GENERAL SUPORT

MAINTENANCE MANUAL

TEST SET, CRYSTAL MODULE,

TS-3630/GRA-114

(NSN 5895-01-057-6265)

HEADQUARTERS, DEPARTMENT OF THE ARMY

13, AUGUST, 1984

TECHNICAL MANUAL

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WASHINGTON, DC, 13 August 1984

GENERAL SUPPORT MAINTENANCE MANUAL TEST SET, CRYSTAL MODULE TS-3630/G RA-114 (NSN 5895-01-057-6265)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications- Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MP, Fort Monmouth, NJ 07703.

In either case, a reply will be sent to you.

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WARNING

120 volts ac is used in the operation of this equipment. When testing, servicing, or repairing this equipment, disconnect ac line voltage. If ac is required, be extremely careful.

DEATH ON CONTACT

May result if personnel fail to observe safety precautions.

SHOCK HAZARD EXISTS

When working inside the equipment, after the ac line voltage has been disconnected, always ground every part before touching it. For Artificial Respiration, refer to FM 21-11.

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LIST OF ILLUSTRATIONS

CHAPTER 1
INTRODUCTION

Section I. General

1-1. Scope

a. This manual describes general support maintenance for test Set, Crystal Module TS3630/GRA114. It includes instructions for troubleshooting, repairing, and testing the equipment. It also lists all the tools, test equipment and materials needed for maintenance.

b. The test set and its major electronic components are functionally described in chapter 2 of this manual. Operating instructions and organizational maintenance are covered in TM 11-5895-1097-12.

1-2. Consolidated Index of Army Publications and Blank Forms

Refer to the latest issue of DA Pam 310-1 to determine whether there are new editions, changes or additional publications pertaining to the equipment.

1-3. Maintenance Forms, Records, and Reports

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738750 as contained in Maintenance Management Update.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 (Report of Discrepancy (ROD) as prescribed in AR 735112/DLAR 4140.55/NAVMA TINST 4355.73A/AFR 400-54/MCO 4430.3F.

c. Discrepancy in Shipment Report (DISREP) (SF361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 5538/NAVSUPINST 4610.33C/AFR 7518/MCO P4610.19D/DLAR 4500.15.

1-4. Destruction of Army Electronic Materiel

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

1-5. Administrative Storage

Refer to TM 740-90-1, Administrative Storage, for instructions on preparation of equipment for storage.

1-6. Reporting Equipment Improvement Recommendations (EIR)

If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communications Electronics Command and Fort Monmouth, ATTN: DRSELMEMP, Fort Monmouth, New Jersey 07703. We'll send you a reply.

Section II. DESCRIPTION AND DATA

1-7. Description

a. General. Refer to TM 11-5895-1097-12 for general description.

b. Functional. Refer to chapter 2 of this manual for functional block and circuit description.

1-8. Tabulated Data

Refer to TM 11-5895-1097-12 for tabulated data.

CHAPTER 2
FUNCTIONING OF EQUIPMENT

2-1. General

The TS3630/GRA114 is a solid state receiver used to test crystal modules on overtone frequencies corresponding to those in Radio Link, Sound Ranging AN/GRA114. The test set provides a GO/NO GO indicator of crystal activity by means of lamps. ABNC con nector provides an output to a frequency counter for accurate readings. In addition, the test provides a regulated dc power source for testing the AN/GRA114 receiver circuit cards.

2-2. Block Diagram Description

(fig. 2-1)

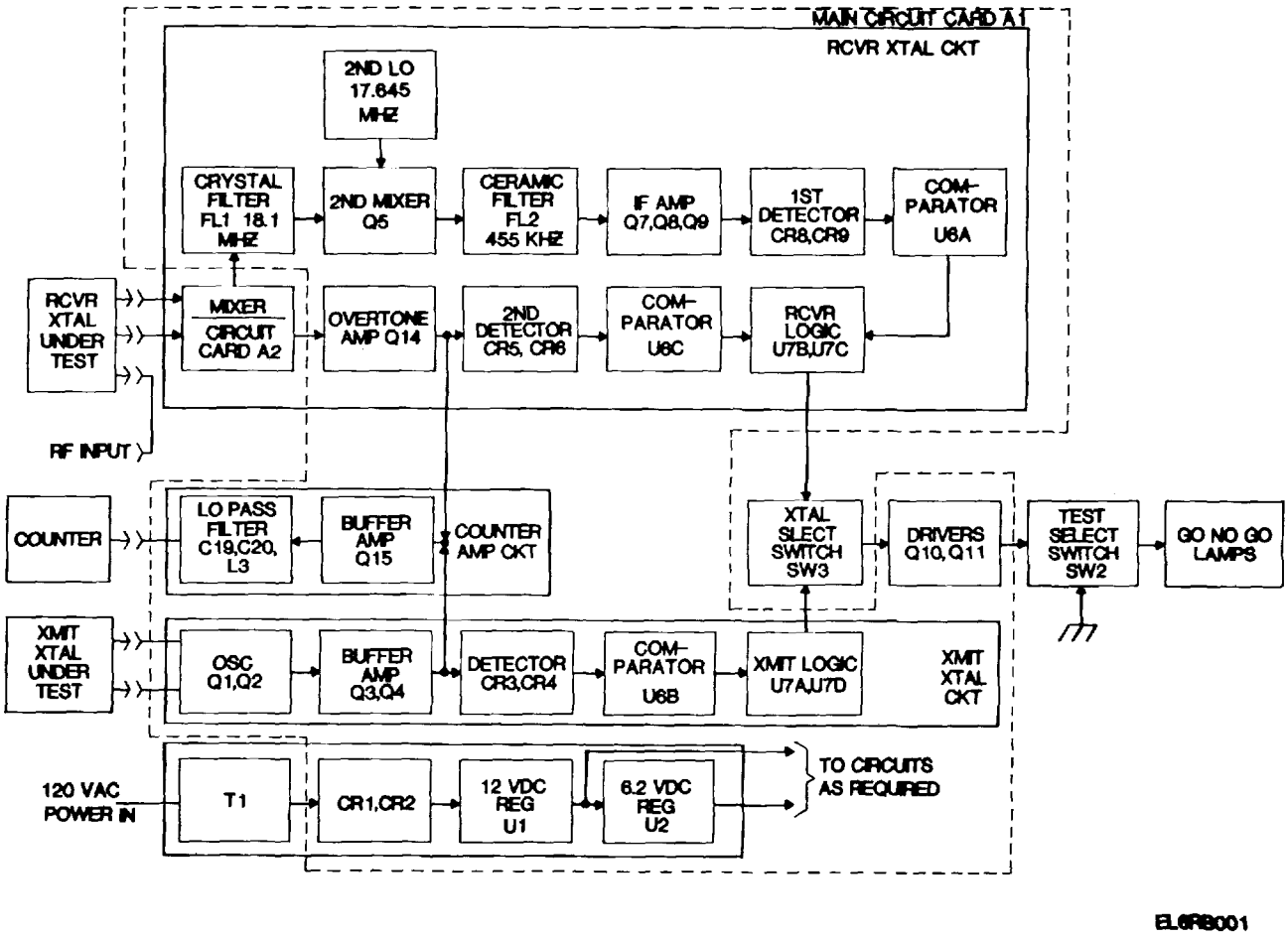


Figure 2-1. TS-3630/GRA-114 Functional Block Diagram

a. Rcvr Xtal Circuit. The input signal, from the RF INPUT receptacle, is applied to the RCVR XTAL MODULE under test. The module output is heterodyned by the first mixer (circuit card A2), producing the first intermediate frequency (if.) signal. This signal is then coupled by the crystal filter FL1 to the second mixer Q5. This signal, in conjunction with the signal from the second local oscillator Q6, is heterodyned, producing the second if. signal. The second if. signal is then coupled,

by the ceramic filter FL2, to the if. amplifier Q7, Q8, and Q9 which provides overall gain. The amplified if. signal is then dectected and compared against a set value, determining the operability of the RCVR XTAL MODULE under test. If the rcvr xtal under test is good, the rcvr comparator portion of U6 will drive the rcvr logic NOR gates of U7. This output will drive the GO lamp driver QI I and light the GO lamp. If the rcvr xtal under test is no good, the output of the logic gates will be inverted. This output will drive the NO GO lamp driver QIO, and light the NO GO lamp.

b. Xmit Xtal Circuit. The XMIT XTAL MODULE under test forms the crystal portion of a local oscillator QI and Q2. This signal is then amplified by Q3 and Q4. The amplified signal is then detected and compared against a set value, determing the operability of the XMIT XTAL MODULE under test. If the xmit xtal under test is good, the xmit comparator portion of U6 will drive the xmit logic NOR gates of U7. This output will drive the GO lamp driver Q 11, and light the GO lamp. If the xmit xtal under test is no good, the output of the logic gates will be inverted. This output will drive the NO GO lamp Q10, and light the NO GO lamp.

c. Counter Buffer Amplifier Circuit. The input to the counter circuit is the xtal overtone frequency before detection of either the rcvr or xmit circuits, whichever is being used. This signal is amplified, buffered, filtered and fed to a BNC connector (COUNTER OUTPUT) on the front panel.

d. Power Supply Circuit. The power supply circuit consists of a transformer mounted on the front panel, full wave rectifiers CRI and CR2, a 12 Vdc regulator, and a 6.2 Vdc regulator on the main circuit card A1.

2-3. Circuit Description (fig. FO-2, FO-3)

a. Rcvr Xtal Circuit. The rcvr xtal circuit consists of a first mixer, crystal filter, second mixer, second local oscillator, ceramic filter, if. amplifier, overtone amplifier, two detectors, two comparators and two logic gates.

(1) First mixer. Components U4, T1, T2, C21 through C26, R22, R23 and L5 comprise the first mixer. The first mixer is of a balanced design to minimize signals in the output. Its purpose is to combine the incoming RF and LO signals, from the rcvr xtal module, into a single if. of 18.1 MHz. The first mixer converts the RF and first local oscillator energy to the 18.1 MHz if. by vector addition of the two signals. This difference frequency is picked off by the selectivity of TI resonating with C22 and C25.

(2) Crystal filter. The 18.1 signal from the first mixer stage is coupled through FLI, the 18.1 MHz crystal filter, and applied to the input of the second mixer. C32, C43, C35, R27 and L9 form a network to match the crystal filter impedance to the second mixer input.

(3) Second local oscillator. The second local oscillator Q6 is a crystal controlled oscillator running at the fundamental frequency of the crystal Y1, which is 17.645 MHz. The crystal Y1 operates as a series collector base feedback path. C40 and C41 provide phase shift to ensure oscillation. The oscillator signal at the base of Q7 is coupled by C39 to the second mixer input. (Q5)

(4) Second Mixer. The second mixer, Q5, receives the 18.1 MHz if. signals from FL1 and the 17.645 MHz local oscillator signals from Q6. Q5 heterodynes the two signals ? and produces an output at the second if. of 455 KHz.

(5) Ceramic filter. The second if. signal from the second mixer stage is coupled through FL2, the 455 KHz filter, and applied to the input of the if. amplifier.

(6) If. amplifier. The if. amplifier chain, Q7, Q8, and Q9 provide approximately 40 dB gain for the 455 KHz signal.

(7) First detector. The amplified if. signal is detected by a detector circuit using components CR8, CR9, and C48. The output level of the detector is compared by the comparator circuit U6A.

(8) Rcvr circuit amplifier. Q12 and Q13 are general purpose high frequency amplifiers. They amplify the signal from the local oscillator of the RCVR XTAL MODULE under test. This amplified signal, sampled through the secondary of transformer T3, is fed to the overtone buffer amplifier where is is again amplified by Q 14 and detected by the second detector CR5, CR6, and C31.

(9) Comparator. U6 is a quad single supply comparator, used for level detection. The signal levels detected from the if. amplifier and the overtone buffer amplifier are compared against set voltage levels. The outputs of both comparators U6A and U6C are fed to the logic NOR gates U7C.

(10) Rcvr logic U7C and U7B. Both of the comparator outputs are input to U7 which verifies the presence of the correct signals and performs inversions where they are required. If both signals are correct, NOR gate U7C would bias the GO driver Q1 1 to light the GO lamp. If either one or both of the signals is correct, U7B, by inversion of U7C output, would bias the NO GO driver to light the NO GO lamp.

b. Xmit Xtal Circuit. The xmit xtal circuit consists of an oscillator buffer amplifier, detector, comparator and two logic gates.

(1) Oscillator. The oscillator, a modified Butler circuit, is made up of Q1, Q2 and the XMIT XTAL MODULE under test. The output of Q2 is the second harmonic of the crystal inserted into the test socket.

(2) Buffer amplifier. Q3 and Q4 amplify the oscillator signal to a detectable level.

(3) Detector. The amplified signal is detected by a detector circuit using components CR3, CR4, and C17. The output level of the detector is compared by the comparator U6B.

(4) Comparator U6B. The signal level detected from the buffer amplifier is compared against set voltage levels. The output of the comparator is fed to logic NOR gate U7D.

(5) Xmit logic U7A and U7D. The comparator output is fed to U7 which verifies the correct signal and performs inversions where they are required. If the signal is correct, NOR gate U7D would bias the GO driver Q 11 to light the GO lamp. If the signal is incorrect, U7A, by inversion of U7D output, would bias the NO GO driver Q10 to light the NO GO lamp.

c. Counter Buffer Amplifier Circuit. The counter buffer amplifier consists of a high frequency amplifier (Q15) and a low pass filter. Q15's base input is the overtone frequency of either the rcvr or xmit circuits, whichever is being used. The input is amplified and matched by the use of pulse transformer T5. The signal is capacitively coupled to a low pass filter consisting of C19, C20, and L3 which prevents any harmonics from appearing at the COUNTER OUTPUT connector.

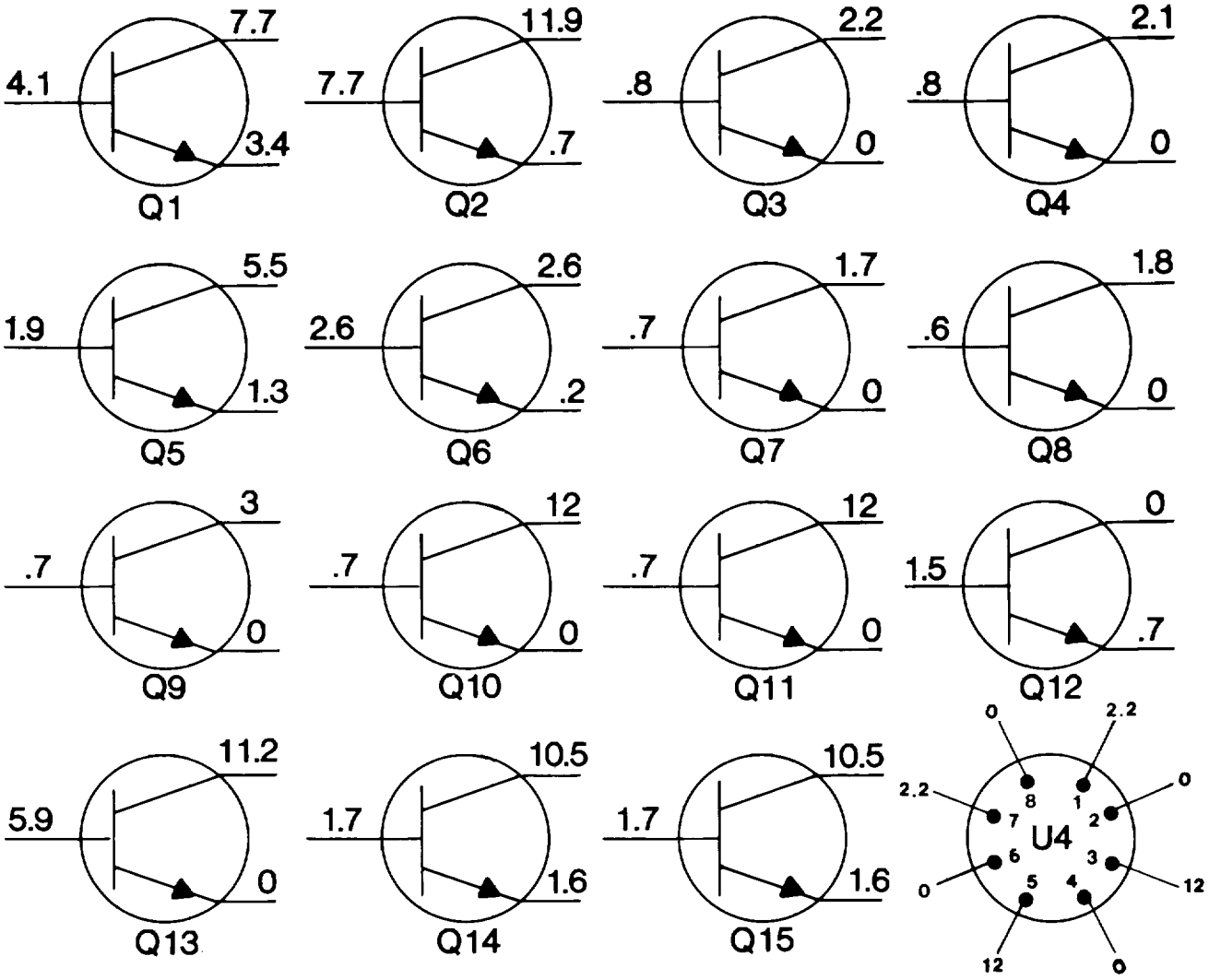
d. Power Supply Circuit. Dc power is provided by a full wave center tapped rectifier circuit consisting of a center tapped transformer TI, mounted on the front panel, which provides 28 Vac to the rest of the power supply components mounted on the main circuit card. These consist of CRI and CR2 which rectify the ac input to + 26 + 2 Vdc and feed it to the 12 volt regulator U1.

(1) The 12 volt regulator UI supplies + 12 ± 0.5 Vdc to the 6.2 volt regulator U2, and the + 12V jack on the front panel, the RF amplifier of the RCVR XTAL MODULE, the first mixer, the overtone amplifier, the xmit xtal circuit, the counter buffer circuit, the indicators, and the lamp drivers.

(2) The 6.2 volt regulator U2 supplies + 6.2 ± 0.1 Vdc to the local oscillator of the RCVR XTAL MODULE, second mixer, second local oscillator, if. amplifier, comparator U6, logic U7, and the + 6V jack on the front panel.

e. Xtal Select Switch SW3. The xtal select switch SW3 is a DPDT switch which connects either the xmit xtal circuit or the rcvr xtal circuit to the lamp drivers Q10 and Q11.

f. Test Select Switch SW2. The test select switch is a DPDT switch with a spring loaded center off position. It connects the GO/NO GO indicators momentarily to the lamp drivers Q10 and Q11, or momentarily to ground to test the functioning of the indicators.



NOTES:

1. Vcc = 12VDC
2. V REG=6.2 VTVM WITH RESPECT TO GROUND
3. ALL MEASUREMENTS ARE MADE WITH CRYSTALS INSTALLED
4. U4 PINS 1 and 7 VOLTAGES MAY VARY DEPENDING ON VOLTAGES OF DEVICE ± 3%

EL6RB002

Figure 3-1. TS-3630/GRA-114 Transistor Voltages.

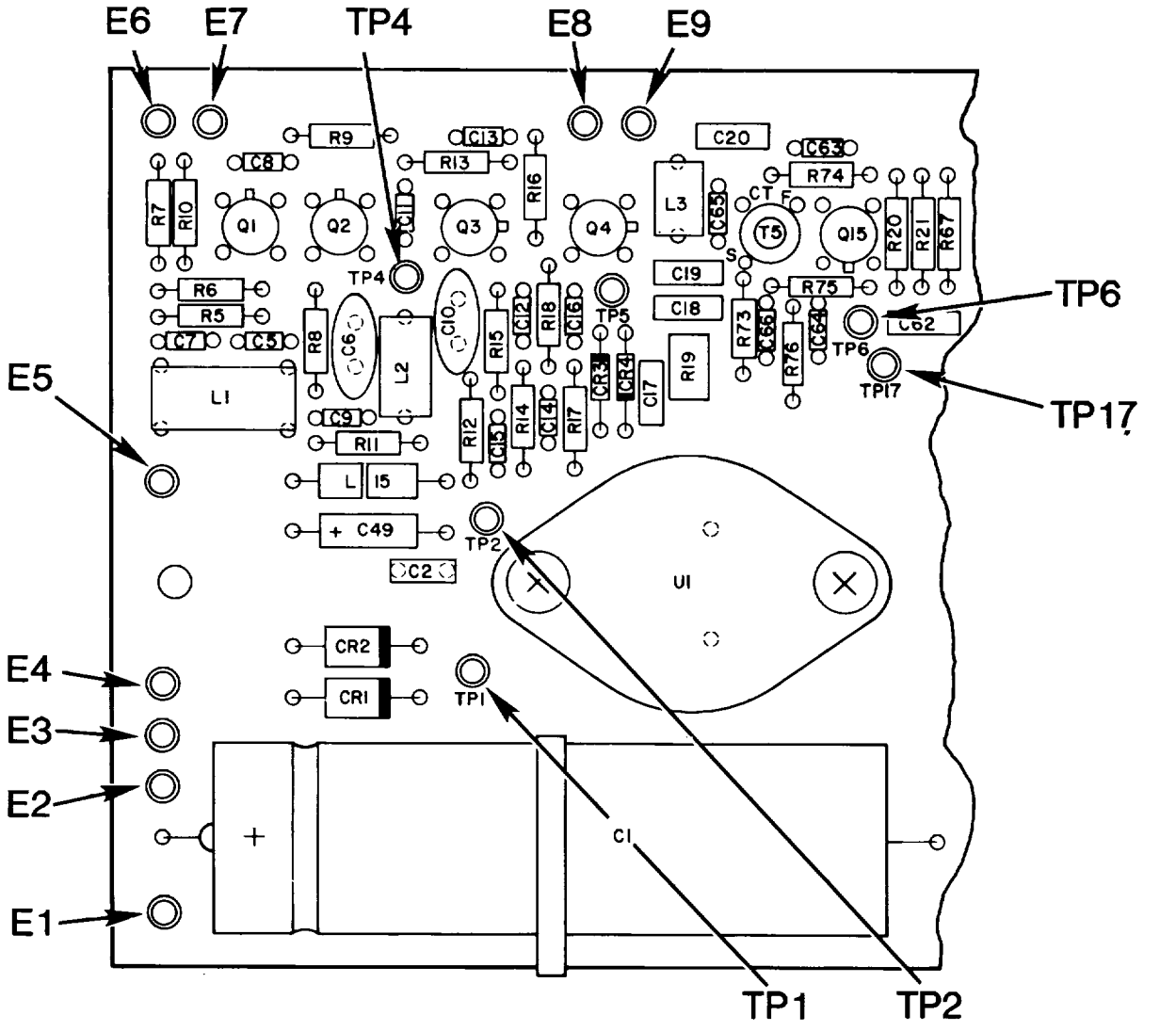


Figure 3-2. (1) Main Circuit Card A 1 (Sheet 1 of 3).

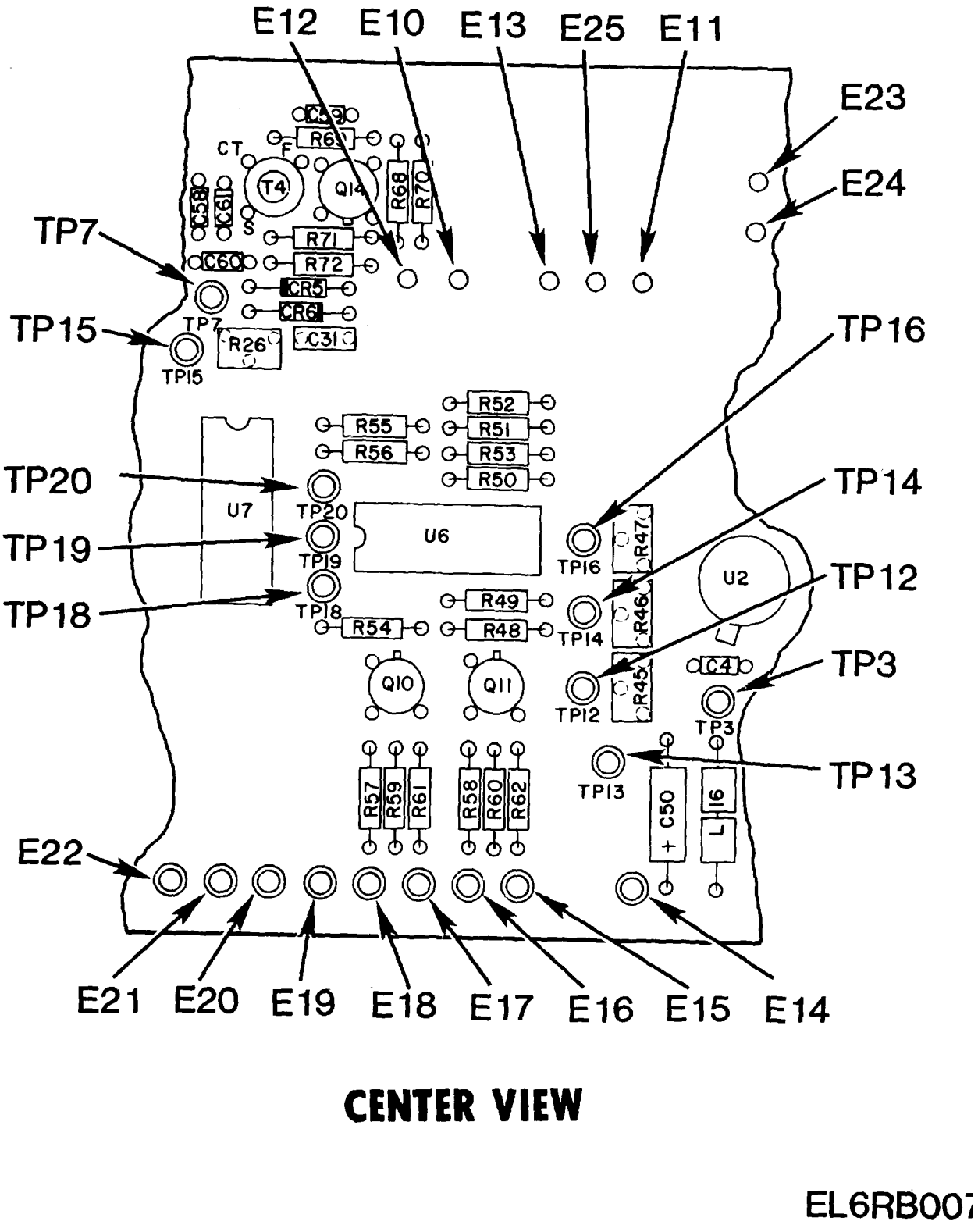


Figure 3-2. (2) Main Circuit Card A 1 (Sheet 2 of 3).

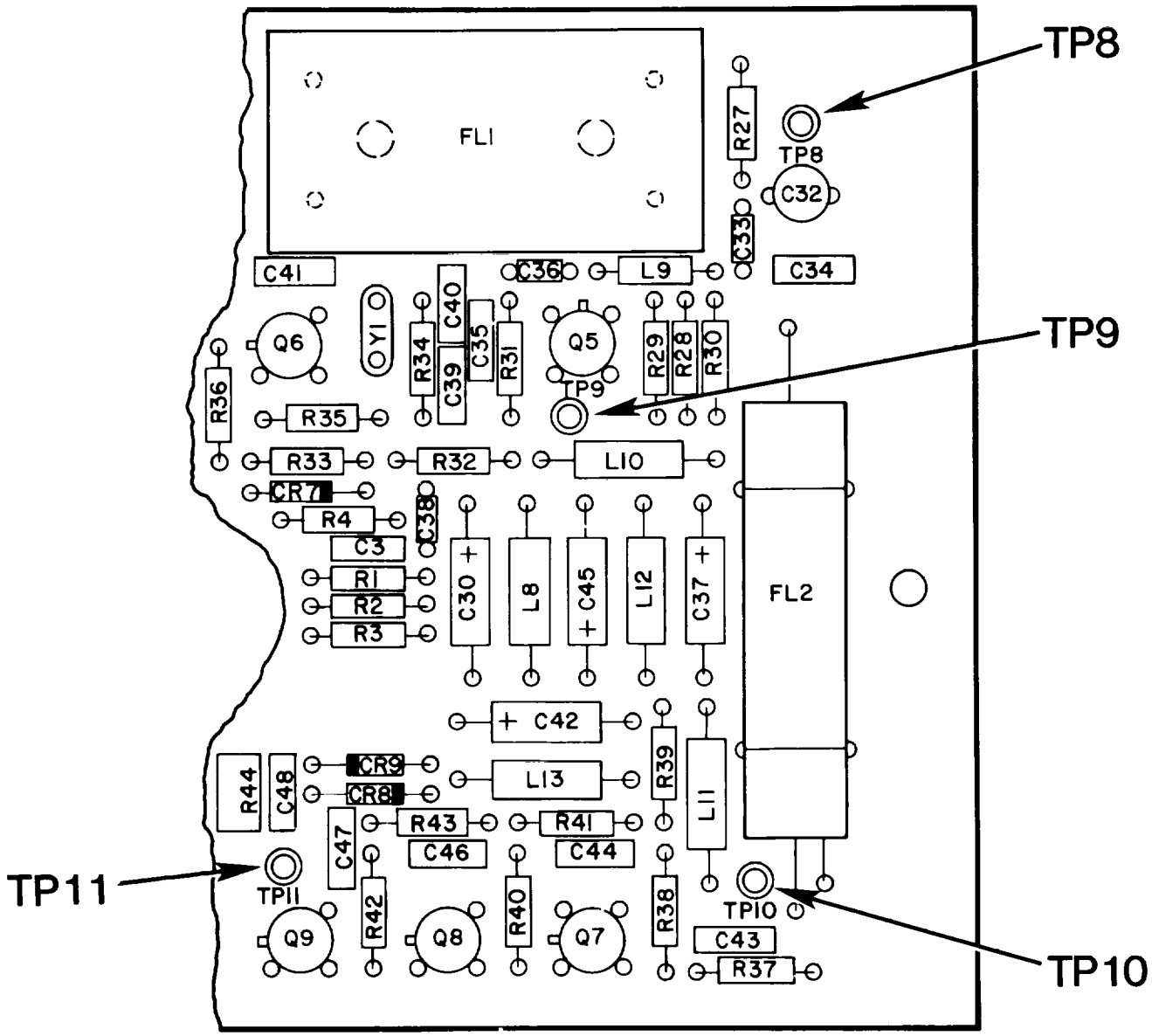


Figure 3-2. (3) Main Circuit Card A1 (Sheet 3 of 3).

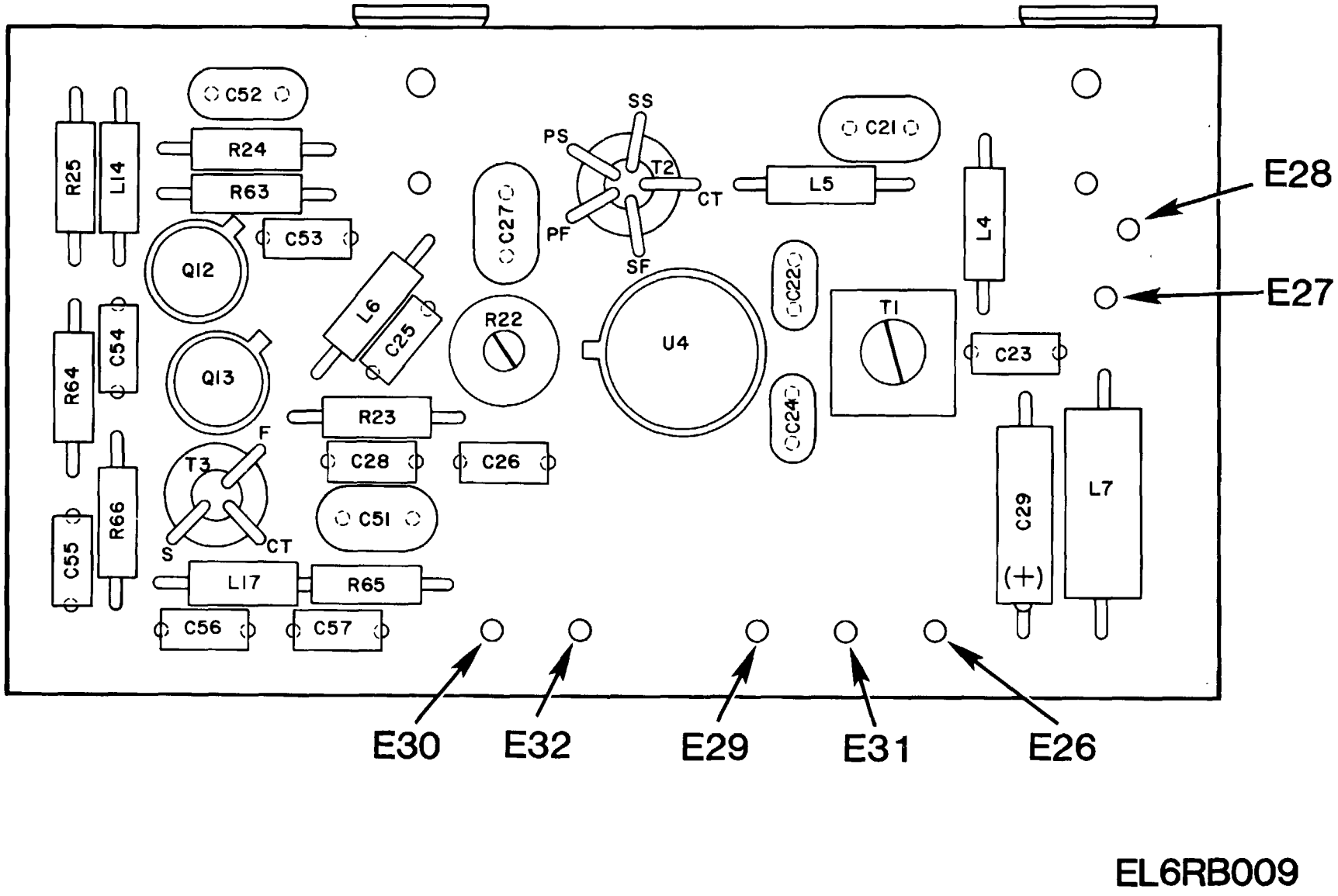


Figure 3-3. Mixer Circuit Card A2.

3-4. Waveform Measurements
There are no waveforms measurements authorized to be made on the TS-3630/GRA-1 14.

3-5. Continuity Measurements.
Routine continuity checks between various points of circuitry can be made using Multimeter AN/USM-223, or equivalent, and the schematic and wiring diagrams (fig FO-2, FO-3).

3-6. Bench Tests.
Follow the procedures in table 3-1 to determine the proper operation of the test set. Set up equipment as required in figures 3-4 and 3-5.

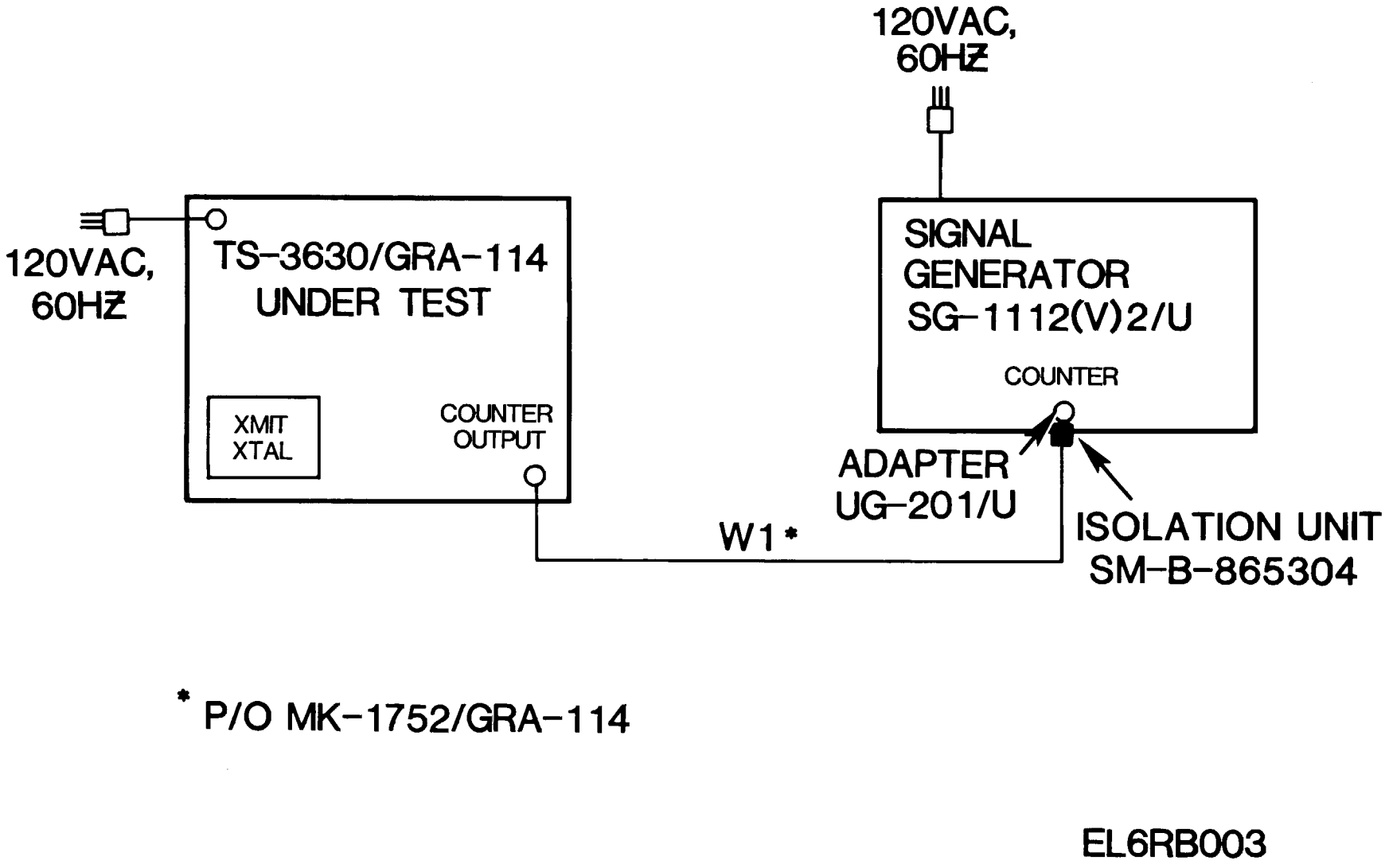


Figure 3-4. TS-3630/GRA-114 Bench Test Sign-up.

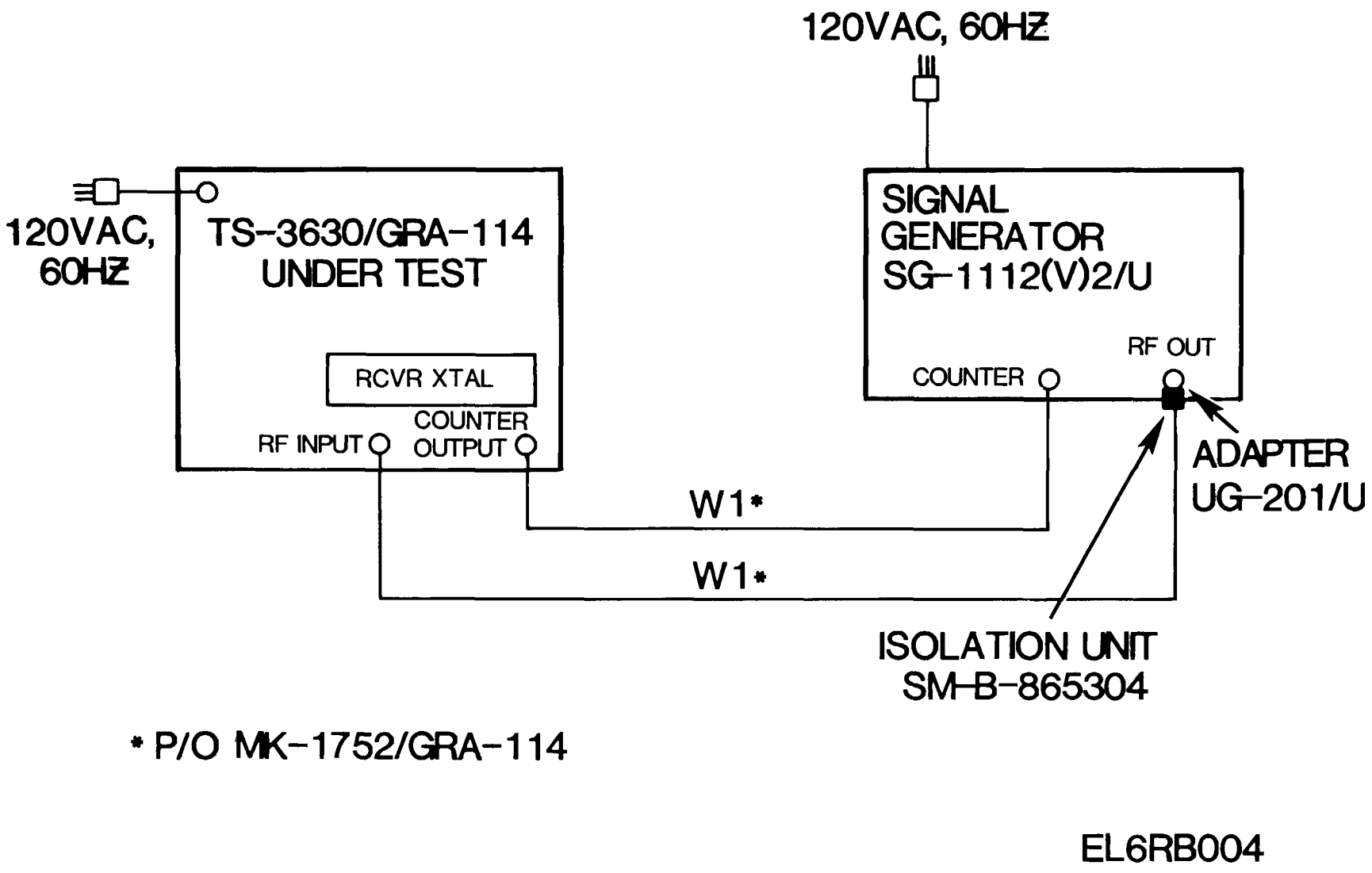


Figure 3-5. TS-3630/GRA-114 Bench Test Set-up.

Table 3-1. Bench Test Procedures

Step	Procedure	Result/Indication
1	Set all controls to their OFF position and connect test set to a known good 120 Vac source.	None.
2	Set POWER ON/OFF switch to ON and observe power indicator	POWER indicator shall light.
3	Set test select switch to LAMP TEST and observe GO/NO GO in dicators.	GO/NO GO indicators shall light
4	Using Multimeter AN/USM-223, measure voltage between +6V and GND binding posts.	Shall be +6.2V ±0.05
5	Using Multimeter AN/USM-223, measure voltage between + 12V and GND binding posts. +0.2.	Shall be + 12V
6	a. Insert test xmit xtal into XMTR XTAL MODULE, test socket.	a. None.
	b. Set xtal select switch to XMTR XTAL MODULE, test select switch to XTAL TEST and observe GO indicator.	b GO indicator shall light.
	c. Set up equipment as shown in figure 3-4, set test select switch and observe reading on counter	c. Overtone frequency of the xmit xtal as marked, within the limits shown in table 3-2.
	d. Remove test xmit xtal from test socket.	d. None.
	a. Insert test rcvr xtal into RCVR XTAL MODULE test socket.	a. None.
	b. Set xtal select switch to RCVR XTAL MODULE.	b. None.
	c. Set up equipment as shown in figure 3-5. Set signal generator to produce a 15 uV continuous wave signal at the marked module frequency.	c. None.
	d. Set test select switch to XTAL TEST and observe GO indicator.	d GO indicator shall light.
	e. Observe frequency counter reading e of Signal Generator SG- 112-(V)2/U	e. Overtone frequency of rcvr xtal as marked within the limits shown in table 3-3.

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Table 3-2. Transmitter Crystal Module Limits

Module Marking	Part No.	Act. Freq.	Limits
82.77 MHz	SM-D-706982-2	63.70MHz	63.69873 - 63.70127
82.95	SM-D706982-1	82.95	82.94834 - 82.95166
138.10	SM-D706478-11	59.425	59.42381 - 59.42619
138.20	SMD706478-10	59.475	59.47281 - 59.47619
138.30	SM-D706487-36	50.525	59.52381 - 59.52619
138.40	SM-D706478-35	59.575	59.57381 - 59.57619
138.50	SM-D706478-34	59.625	59.62381 - 59.62619
138.60	SM-D-706478-33	59.675	59.67381 - 59.67619
138.70	SM-D-706478-32	59.725	59.72381 - 59.72619
138.80	SM-D-706478-31	59.775	59.77381 - 59.77620
138.90	SM-D-706478-30	59.825	59.82380 - 59.82620
139.00	SM-D-706478-29	59.875	59.87380 - 59.87620
140.60	SM-D-706478-9	60.674	60.67379 - 60.67621
140.70	SM-D-706478-8	60.725	60.72379 - 60.72621
140.80	SM-D-706478-28	60.775	60.77379 - 60.77622
140.90	SM-D-706478-27	60.825	60.82378 - 60.82622
141.00	SM-D-706478-26	60.875	60.87378 - 60.87622
141.10	SM-D-706478-25	60.925	60.92378 - 60.92622
141.20	SM-D-706478-24	60.975	60.97378 - 60.97622
141.30	SM-D-706478-23	61.025	61.02378 - 61.02622
141.40	SM-D-706478-22	61.075	61.07378 - 61.07622
141.50	SM-D-706478-21	61.125	61.12378 - 61.12622
141.60	SM-D-706478-20	61.175	61.17378 - 61.17622
143.10	SM-D-706478-7	61.925	61.92376 - 61.92624
143.20	SM-D-706478-6	61.975	61.97376 - 61.97624
143.30	SM-D-706478-19	62.025	62.02376 - 62.02624
143.40	SM-D-706478-18	62.075	62.07376 - 62.07624
143.50	SM-D-706478-17	62.125	62.12376 - 62.12624
143.60	SM-D-706478-16	62.175	62.17376 - 62.17624
143.70	SM-D-706478-15	62.225	62.22376 - 62.22624
143.80	SM-D-706478-14	62.275	62.27376 - 62.27625
143.90	SM-D-706478-13	62.325	62.32375 - 62.32625
144.00	SM-D-706478-12	62.375	62.37375 - 62.37625
149.50	SM-D-706981-3	65.125	65.12370 - 65.12630
150.20	SM-D-706981-2	65.475	65.47371 - 65.47629
150.80	SM-D-706981-1	65.775	65.77369 - 65.77632

Table 3-3. Receiver Crystal Module Limits

Module Marking	Part No.	Act. Freq.	Limits
82.77 MHz	SM-D706884-02	64.67 MHz	64.66871 - 64.67129
82.95	SM-D706884-01	64.85	64.84870 - 64.85130
138.10	SM-D706522-34	120.00	119.99760-120.00240
138.20	SM-D706522-33	120.10	120.09760-120.10240
138.30	SM-D706522-32	120.20	120.19760-120.20240
138.40	SM-D706522-31	120.30	120.29760-120.30241
138.50	SM-D706522-30	120.40	120.39760-120.40241
138.60	SM-D-706522-29	120.50	120.49759-120.50241
138.70	SM-D-706522-28	120.60	120.59759-120.60241
138.80	SM-D-706522-27	120.70	120.69759-120.70241
138.90	SM-D-706522-26	120.80	120.79759-120.80241
139.00	SM-D-706522-25	120.90	120.89759-120.90241
140.60	SM-D-706522-24	122.50	122.49755-122.50245
140.70	SM-D-706522-23	122.60	122.59755-122.60245
140.80	SM-D-706522-22	122.70	122.69755-122.70245
140.90	SM-D-706522-21	122.80	122.79755-122.80245
141.00	SM-D-706522-20	122.90	122.89755-122.90245
141.10	SM-D-706522-19	123.00	122.99754-123.00246
141.20	SM-D-706522-18	123.10	123.09754-123.10246
141.30	SM-D-706522-17	123.20	123.19754-123.20246
141.40	SM-D-706522-16	123.30	123.29754-123.30246
141.50	SM-D-706522-15	123.40	123.39754-123.40246
141.60	SM-D-706522-14	123.50	123.49753-123.50247
143.10	SM-D-706522-13	125.00	124.99750-125,00250
143.20	SM-D-706522-12	125.10	125.09750-125.10250
143.30	SM-D-706522-11	125.20	125.19750-125.20250
143.40	SM-D-706522-10	125.30	125.29750-125.30250

Table 3-3. Receiver Crystal Module Limits - Cont.

Module Marking	Part No.	Act. Freq.	Limits
143.50	SM-D-706522-9	125.40	125.39750 -125.40250
143.60	SM-D-706522-8	125.50	125.49749 -125.50251
143.70	SM-D-706522-7	125.60	125.59749 -125 0251
143.80	SM-D-706522-6	125.70	125.69749 -125.70251
143.90	SM-D-706522-5	125.80	125.79749 -125.80251

Table 3-3. Receiver Crystal Module Limits - Cont.

Module Marking	Part No.	Act. Freq.	Limits
144.00	SM-D-7065224	125.90	125.89749 -125.90251
149.50	SM-D-706522-3	131.40	131.39738-31.402621
150.20	SM-D-706522-2	132.10	132.09736- 132.10264
150.80	SM-D706522-1	132.70	132.69735- 132.70265

Section II. TOOL AND EQUIPMENT

3-7. Tool and Equipment Required

The following list of tools and equipment are required to perform general support maintenance on the TS3630/GRA1 14.

a. Tools.

(1) Tool Kit, Electronic Equipment TK-100/G (NSN 5180-00-605-0079).

(2) Tool Kit, Electronic Equipment TK-105/G (NSN 5180-00-610-8177).

b. Equipment.

(1) Maintenance Kit MK-1752/GRA-114 (NSN 5895-01-057-6263.

(2) AN/USM-223 (NSN 6625-00-999-7465).

(3) Repair Kit MK-772/U (NSN 5999-00-757-7042).

(4) Signal Generator SG-1 112(V)2/U (NSN 6625-00- 500-6525).

(5) Voltmeter, RF AN/URM-145 (NSN-6625-00-973- 3986).

3-8. Repair Parts.

Repair parts are listed and illustrated in the repair parts and special tools list (RPSTL) TM 115895109740P, covering general support maintenance for this equipment. TM 115895109720P will also be used where applicable.

Section III. TROUBLESHOOTING

3-9. General Troubleshooting Information

a. Troubleshooting at the general support maintenance category includes the techniques outlined for organizational maintenance and additional techniques required to isolate a defective assembly and part. Paragraph 3-10 describes the systematic procedure to be followed which will enable maintenance personnel to isolate the cause of the trouble and correct the fault.

b. The first step is to trace the fault to a particular module or assembly. This is called localization. Bench tests can be made by following the procedures in paragraph 3-6.

c. The final step is to trace the fault to the defective part on an asssembly. This is called isolation.

d. Localization and isolation of a fault are determined by visual inspection, voltage measurements, and use of the troubleshooting charts. Visual inspection will locate many faults without testing the circuits. All visual signs should be observed and an attempt made to localize the fault.

NOTE

In all tests the possibility of intermittent troubles should be investigated. Jarring or tapping the equipment may expose this type of problem.

3-10. Troubleshooting Procedures.

a. General. The malfunction listed in tables 3-4 and 3-5 are presumed to exist after all lower level troubleshooting procedures and corrective measures have been performed. The tables provide general support maintenance personnel with the information required to check and corrrelate all information from organizational maintenance with the test equipment and tools available Perform the procedures contained in the troubleshooting tables in the order given. Do not proceed to the next action when the corrective measures have already been taken to eliminate the trouble.

(1) Defective material, such as piece parts, modules. or minor components, shall be recorded and identified by National stock number (NSN), inspected and verified as defective. All replaced equipment will be repaired, or disposed of in accordance with AR 7551 and current established procedures for general support.

(2) When replacing a part, make sure that the part is the same as the one being replaced. Refer to section IV maintenance of test set, for instructions on assembly.

(3) When trouble has been localized to a stage, either through performance of the tests given in your troubleshooting charts, or other means, isolate the defective part by measuring voltage at the test points and other points related to the stage suspected of being faulty.

WARNING

When troubleshooting this equipment, be extremely careful. 120 volds AC is present in the power supply circuit. DEATH ON CONTACT or serious injury may result if safety precautions are not followed. Do not make internal connections alone. Always have another person to help in the case of an accident. Always disconnect the ac source, and ground the part with a shorting

stick before making resistance measurements.

CAUTION

This equipment is transistorized: observe all cautions to prevent transistor damage. Do not make continuity checks other than those spcecified in the tables. Damage to the transistors and microelectronic devices, which can impair the performance of the equipment, may result if improper battery voltages and polarities are applied.

b. Voltage Measurements. This equipment is transistorized. Observe all cautions to prevent transistor damage. Make voltage measurements in this equipment only as specified. When measuring voltages, use tape or sleeving to insulate the entire test prod, except for the extreme tip. A momentary short circuit can ruin the transistor. (For example, if the bias is shorted out, excessive current would ruin the transistor between emitter and the base.) Use resistor and capacitor color codes shown in figure FO-1 to find values of components, or refer to the component locations drawing.

c. Intermittent Troubles. In all tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble may develop by tapping or jarring the assembly. Check the wiring and connections to the assemblies and subassemblies.

d. Test Points. The printed circuit card is equipped with test points to facilitate connections of test instruments. The test points should be used whenever possible to avoid needless disassembly of the equipment. These test points are shown on the schematic diagram (fig. FO-2).

Table 3-4. Test Set Troubleshooting

Malfunction	Probable cause	Corrective action
1. POWER indicator fails to light when POWER switch is set to ON.	a. Defective POWER indicator assembly.	a. Connect test set to known good 120 Vac source. Set test select switch to LAMP TEST and observe that GO/NO GO indicator light. If correct, repair wiring/replace defective POWER indicator.
	b. Defective input power cord.	b. Disconnect test set from 120 Vac source. Using Multimeter AN/USM-223, check for continuity of ac input circuit (fig. FO-3). If incorrect, repair wiring/- replace defective component.
	c. Defective fuse assembly.	c. Same as b. above.
	d. Defective POWER switch Sl.	d. Same as b. above.
	e. Defective transformer TI.	e. Using Multimeter AN/USM-223, measure dc input of T1. (1) If correct, go to table 3-5, malfunction I. (2) If incorrect, replace TI.
2. One or both test indicators (GO/NO GO) fail to light with test select switch set to LAMP TEST.- Power indicator is lit.	Defective LAMP TEST circuit (indicator assembly or test select switch S2).	Disconnect test set from 120 Vac source. Using Multimeter AN/USM-223, check for continuity of LAMP TEST circuit (fig. 3-2 and FO-3). Repair defective wiring/replace defective component.
3. No test indicator (GO/NO GO) lights to show status of XTAL MODULE under test.	a. Defective XTAL TEST indicators assembly or test select switch S2.	a. Set test select switch to LAMP TEST and observe that both indicators light. If incorrect, disconnect test set from 120 Vac source. Using Multimeter AN/USM-223, check for continuity of indicators and S2 (fig. 3-2 and FO-3). Repair defective wiring- /replace defective component.
	b. Defective xtal select switch 52.	b. Disconnect test set from 120 Vac source. Using Multimeter AN/USM-223, check for continuity of xtal select circuit (fig. 3-2 and FO-3). (1) If correct, continue troubleshooting. If incorrect, repair wiring/replace defective S3.
4. NO GO indicator always lights when XMIT MODULES are tested.	Defective XMIT XTAL MODULES, test socket (J7) or main circuit card A1.	Insert a known good XMIT XTAL into test socket. Test xtal and observe indicators. a. If GO indicator lights, XMIT XTAL MODULES tested before were defective. b. If NO GO indicator lights, disconnect test set from 120 Vac source. Using Multimeter AN/- USM-223, check for continuity between test soc-

Table 3-4. Test Set Troubleshooting - Cont.

Malfunction	Probable cause	Corrective action
		ket and Al circuit card. (fig. 3-2 and FO-3). (1) If correct, go to table 3-5, malfunction 2. (2) If incorrect, repair wiring.
5. NO GO indicator always lights when RCVR XTAL MODULES are tested	Defective RCVR XTAL MODULES, test socket (J4, J5, J6) RF INPUT (J8), or circuit cards Al, A2	a. Insert a known good RCVR XTAL MODULE into test socket. Test xtal and observe indicators. If GO indicator lights, RCVR XTAL MODULES tested before were defective. b. If NO GO indicator lights, remove xtal module and check for + 6.2 Vdc at panel left end connector and + 12 Vdc at center connector. (1) If correct, go to table 3-5, malfunction 3. (2) If incorrect, repair wiring/replace defective component.
6. Test set rcvr power jacks (+ 6, + 12, GND) do not power AN/GRA-114 RCVR circuit cards	Defective wiring	Disconnect test set from 120 Vac source. Using Multimeter AN/USM-223, check for continuity of output wiring (fig. 3-2 and FO-3). a. If correct, go to table 3-5, malfunction 4. b. If incorrect, repair wiring.

Table 3-5. Circuit Card Troubleshooting.

Malfunction	Probable cause	Corrective action
1. POWER indicator fails to light when POWER switch is set to ON	a. Defective diodes CRI, CR2, capacitor C1	a. Using Multimeter AN/USM-223, check for + 26 ±2 Vdc at TPI (fig. 3-2 and FO-3). If incorrect, disconnect test set from 120 Vac source. Using multimeter check CR I, CR2, Cl. Replace defective component. b. Using Multimeter AN/USM-223, check for + 12 _0.5 Vdc at TP2 (fig. 3-2 and FO-3). (1) If correct, repair circuit card wiring. (2) If incorrect, replace UI.
2. NO GO indicator always lights to show status of xmit xtal module	a. Xmit circuit out of alinement (1) Xmit circuit alinement	a. Insert a hi band xmit xtal module into J7. Set up equipment as shown in figure 3-4. (1) Connect RF voltmeter to TP4 and peak L1. Observe signal generator counter input. (a)LI peaks, counter indicates xtal overtone frequency. Continue troubleshooting. (b) Abnormal indication, go to step b below.
	(2) Comparator U6B alinement	(2) Using multimeter, check for + 1.8 Vdc at TP16. Adjust R47. (a) If correct, check for + 2 Vdc at TP17. Adjust R19. (b) If incorrect at TP16, check power supply U2. (c) If incorrect at TP17, go to step b below.
	b. Defective oscillator circuit	b. Using RF voltmeter, check for at least 200 mV at TP4. (1) If correct, continue troubleshooting. (2) If incorrect, check Q1, Q2 and associated components.
	c. Defective buffer amplifier circuit	c. Using RF voltmeter, check for at least 2 Vrms at TP5. (1) If correct, continue troubleshooting. (2) If incorrect, check Q3, Q4 and associated components.
	d. Defective comparator circuit	d Using multimeter, check for + 0.1 Vdc maximum at TP20. (1) If correct, continue troubleshooting. (2) If incorrect, replace U6.
	e. Defective logic gate	e. Using multimeter, check for at least + 5 Vdc at E22. (1) If correct, check R58, R60, R62, QI 1, and associated wiring. (2) If incorrect, replace U7.

Table 3-5. Circuit Card Troubleshooting.

Malfunction	Probable cause	Corrective action
3. NO GO indicator always lights to show status of rcvr xtal module	a. Rcvr circuit out of alinement (1) First mixer stage module local oscillator alinement	a. Set up equipment as shown in figure 3-5. Set signal generator RF output to 100 uV at 18.1 MHz. (1) Connect RF volmeter to TPI I and adjust TI and C32 for maximum voltage. (a) T1 and C32 peak. Continue troubleshooting. b. Abnormal indication go to step b below.
	(2) First mixer stage xtal module RF amplifier alinement	(2) Remove signal input from J5 and connect to J6 (RF plug). Adjust R22 for minimum signal. (a) R22 dips. Continue troubleshooting. (b) Abnormal indication go to step b below.
	(3) Comparator U6A alinement	(3) Reconnect signal input to J5. Using multimeter, check for + 1.4 Vdc at TP12. Adjust R45. (a) If correct, check for 1.5 Vdc at TP13. Adjust R44. (b) If incorrect at TP12, check power supply U2. (c) If incorrect at TP13, go to step b below.
	(4) Comparator U6C alinement	(4) Set RF output to 50 mV at 132.7 MHz. Using multimeter, check for 1.9 Vdc at TP14. Adjust R46. (a) If correct, check for 2 Vdc at TP15. Adjust R26. (b) If incorrect at TP14, check power supply U2. (c) If incorrect at TP15, go to step b below.
	b. Defective first mixer stage	b. Set up equipment as shown in figure 3-5. Using RF voltmeter check for at least 275 mV at TP8. (1) If correct, continue troubleshooting. (2) If incorrect, check A2 components and wiring, and FLI.
	c. Defective second local oscillator stage	c. Using RF voltmeter, check for at least 75 mV at TP9. (1) If correct, continue troubleshooting. (2) If incorrect, check Q6, YI, and associated components.
	d. Defective second mixer stage	d. Using RF voltmeter, check for at least 40 mV at TP10. (1) If correct, continue troubleshooting. (2) If incorrect, check pi network, Q5, FL2 and associated components.
	e. Defective if. amplifier stage	e. Using RF voltmeter, check for at least 2 Vrms at TP11. (1) If correct, continue troubleshooting. (2) If incorrect, check Q7, Q8, Q9 and associated components.
	f. Defective overtone detector	f. Using RF voltmeter, check for at least 4 Vrms at TP7. (1) If correct, continue troubleshooting. (2) If incorrect, check CR5, CR6 and associated components.
	g. Defective comparator U6A	g. Using multimeter, check for + 0.1 Vdc maximum at TP18. (1) If correct, continue troubleshooting. (2) In incorrect, replace U6.
	h. Defective comparator U6C	h. Using multimeter, check for + 0.1 Vdc maximum at TP19. (1) If correct, continue troubleshooting. (2) If incorrect, replace U6.
	i. Defective logic gate	i. Using multimeter, check for at least 5 Vdc at E19 and E22. (1) If correct, check R58, R60, R62, Q11 and associated wiring. (2) If incorrect, replace U7.
4. Test set rcvr power jacks (+ 6, + 12, GND) do not power AN/GRA-114 RCVR circuit cards	Defective U2 regulator circuit	Using multimeter, check RI, R2, R3, R4, C3, C4. a. If correct, replace U2. b. If incorrect, replace defective component.

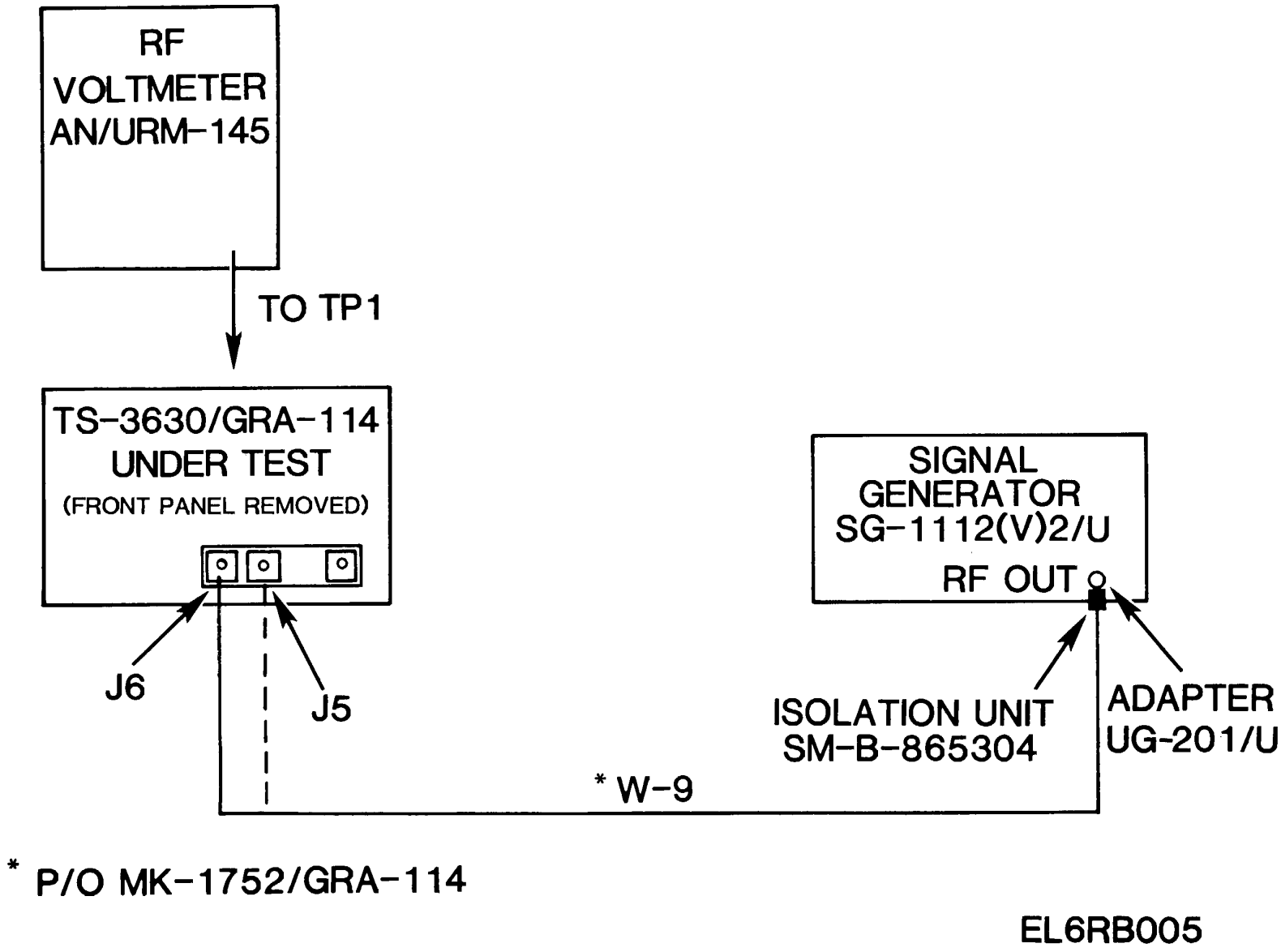

Figure 3-6. Circuit Card Rcvr Xtal Circuit Alinement Set Up.

Section IV. MAINTENANCE OF TEST SET

3-11. General

This section contains preliminary inspection, cleaning, disassembly and repairs, and repainting and refinishing instructions. After repairs or replacement have been made to components of the test set, it should be ready for return to service. To verify its condition, conduct the operational checks described in TM 115895109712 and the test procedures in section V.

3-12. Inspection

Preliminary maintenance on the test set consists of inspection upon receipt; and cleaning (para 3-13) if required.

a. Inspection. Inspection is the evaluation of a repairable item to determine the extent of repair, modification, or replacement necessary to make the item completely serviceable. Inspection includes, but is not limited to the following:

(1) A check of maintenance forms and records attached to the equipment.

(2) A check of DA Pam 310-1 for any modification work order (MWO) pertaining to the test set.

(3) A visual inspection of the test set for compliance with all MWO's.

(4) A listing of outstanding MWO's on DA Form 2404.

b. Visual Inspection.

(1) Exterior surface. Inspect exterior surfaces for obvious signs of damage. Check metal surfaces for signs of rust and corrosion.

(2) Controls and indicators. Inspect controls for smooth operation and alinement of position. Check to see that indicator assembly is intact and complete.

(3) Wiring. Inspect wiring for breaks, cuts, or worn insulation.

(4) Connectors. Inspect connectors for damage such as bent pins and dented or deformed casings.

(5) Include all results of the visual inspection on maintenance forms or work tag.

3-13. Cleaning

NOTE

Do not perform needless disassembly of equipment for the purpose of cleaning. Clean the equipment only to the extent required for serviceability.

a. Exterior Surfaces.

(1) Remove loose dirt or dust from outside surfaces of case and front panel using lint-free cloth and/or soft bristled brush.

WARNING

Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation and avoid prolonged breathing of vapors. DO NOT use near flames or extreme heat. Since cleaning compound dissolves natural oils, avoid prolonged contact with skin. If compound it taken internally, consult a physician immediately.

(2) Remove ground-in dirt or grease using a lint-free cloth dampened (not wet) with cleaning compound.

(3) Rinse cleaned areas with clean water and allow to dry.

b. Interior Surfaces.

WARNING

Compressed air is dangerous and can cause bodily harm. Compressed air shall not be used for cleaning purposes except when reduced to less than 29 pounds per square inch (psi); and then only with protective equipment to prevent chips or particles from entering the eyes or breaking the skin of the operator or other personnel.

CAUTION

Air jet can damage delicate components. Be careful NOT to place air jet too close to small coils or delicate components.

NOTE

When necessary to disturb the position of wiring and harness assemblies for cleaning purposes, always replace them to their original position after cleaning.

(1) Remove dust, dirt, and foreign matter from all surfaces, components, and wiring using air jet and soft bristled brush.

(2) Remove dust from connector holes and recesses using air jet and soft bristled brush.

CAUTION

Be careful when using lint-free cloth to wipe cleaning compound from resistors, as marking colors may be removed.

(3) Wipe interior surfaces using lint-free cloth dampened (not wet) with cleaning compound.

(4) Dry surfaces immediately with lint-free cloth.

(5) Wipe dust and dirt from casings, pins and cable clamps using lint-free cloth dampened (not wet) with cleaning compound.

(6) Dry surfaces immediately with lint-free cloth.

3-14. General Repair Procedures

The subassemblies and parts in the test set can be easily reached and replaced without the use of special tools. When replacing parts, observe the precautions listed below.

WARNING

120 volts AC is present at power supply connections inside equipment. Ensure test set is disconnected from power supply source before attempting repairs. DEATH ON CONTACT or serious injury may result if safety precuations are not observed.

CAUTION

Use a penciltype soldering iron with a 25watt maximum rating. Too much heat from the iron will damage the printed wiring of circuit cards. Use only enough heat to quickly remove or replace components. This equipment is also transistorized. If the iron must be used with ac, use an isolating transformer between the iron and the line. Do NOT use a soldering gun near the transistorized assemblies; damaging voltage may be induced in the circuit components.

NOTE

For additional soldering techniques refer to TB SIG 222.

3-15. Disassembly

WARNING

Ensure test set is disconnected from power source before attempting disassembly. DEATH ON CONTACT or serious injury may result if safety precautions are not observed.

CAUTION

Always read over and be sure you understand the instructions before attemping disassembly. Use the illustrations to locate parts and subassemblies of the unit to be disassembled. Careful removal of parts is important to avoid damage to the equipment.

To disassemble the test set, refer to figure 3-7 and proceed as follows:

a. Ensure POWER switch is in OFF position and ac power cord is disconnected from power source.

b. Remove four screws, lockwashers and washers (1) from panel assembly (2).

c. Carefully remove panel assembly (2) from case assembly (3).

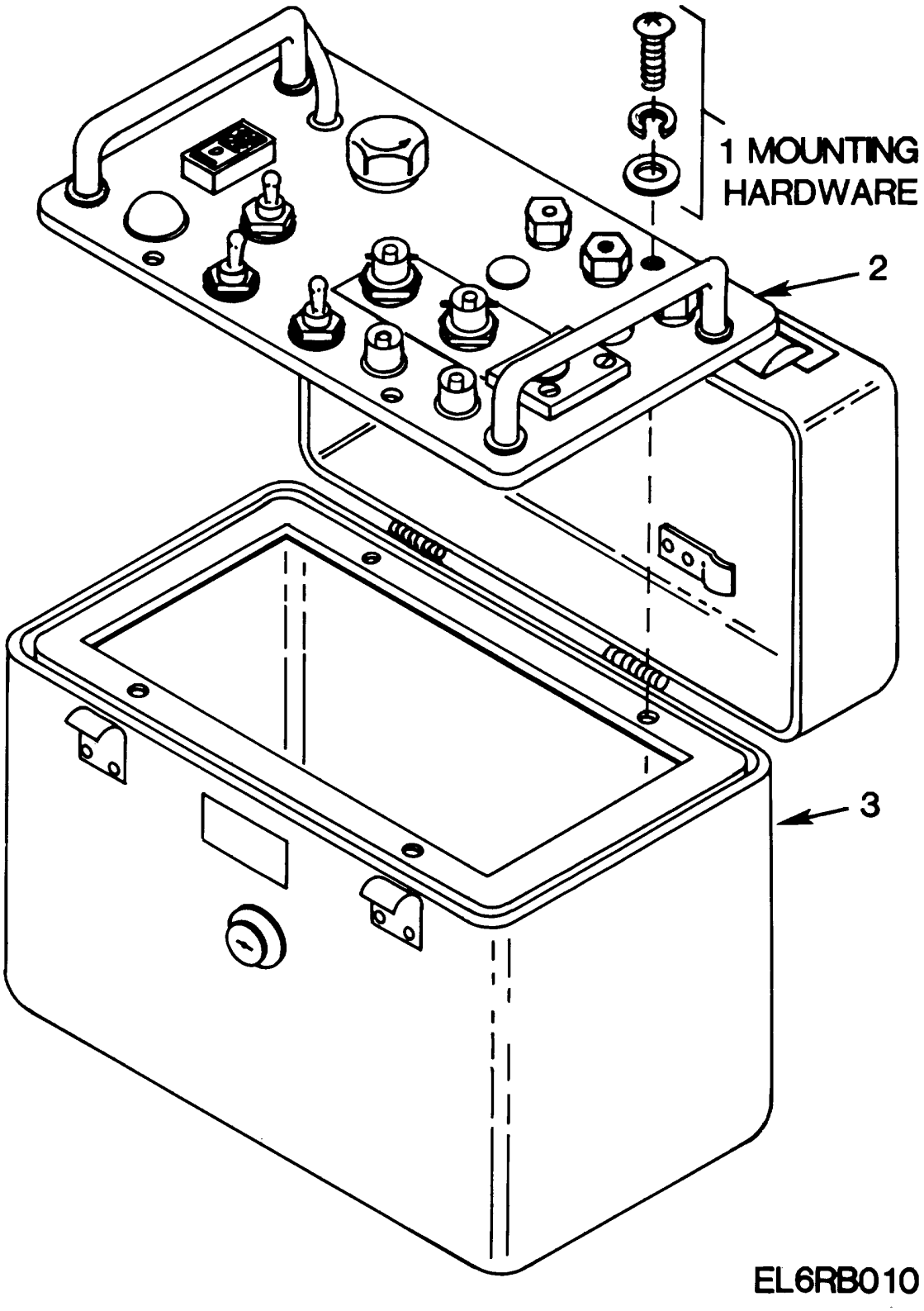

Figure 3-7. Test Set Disassembly.

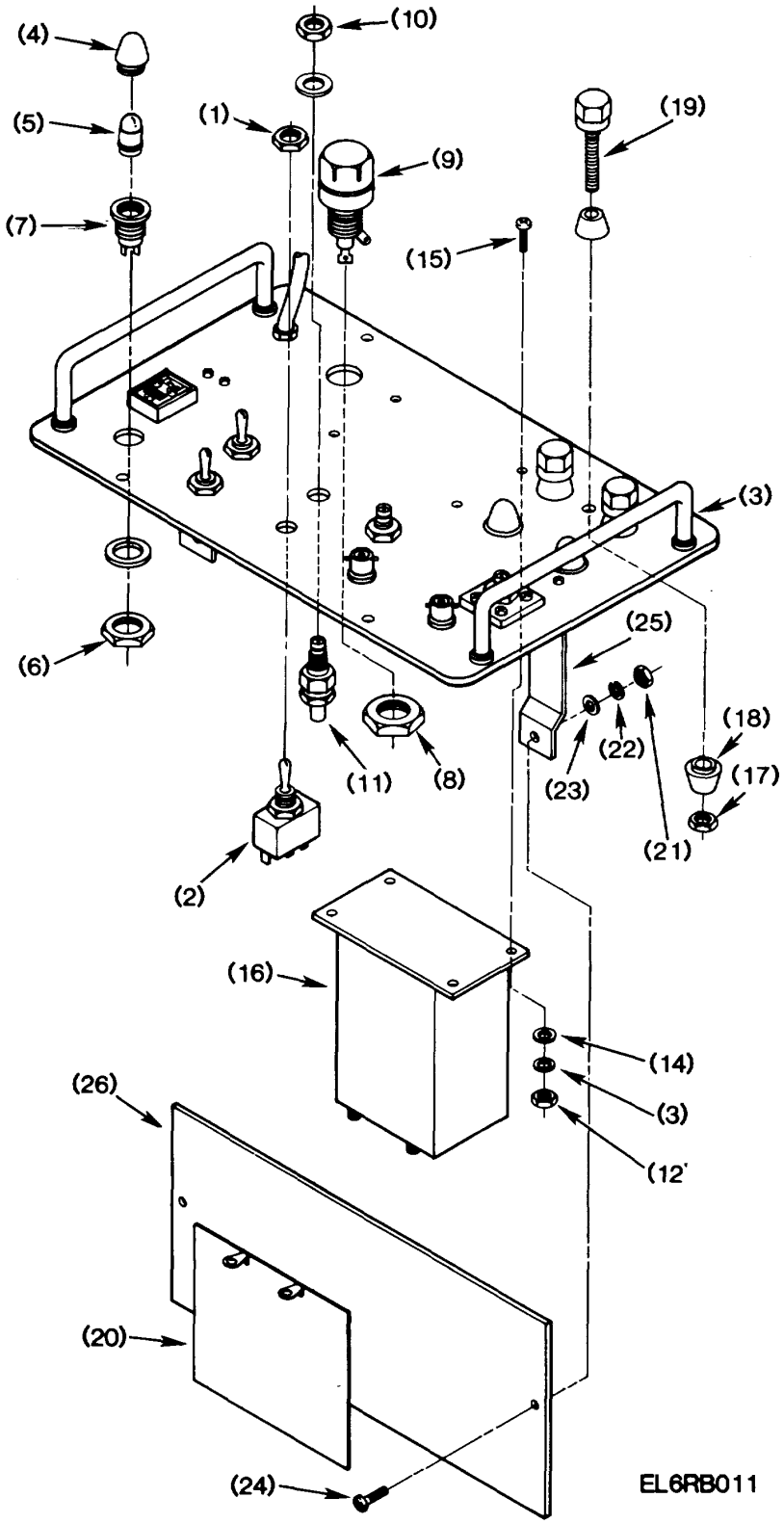

Figure 3-8. Exploded View of Test Set TS-3630/GRA-114.

3-16. Parts Replacement

a. Toggle Switch SI, S2, S3 Replacement. Refer to figure 3-8 and replace the defective switch as follows:

(1) Disassemble test set (para 3-15).
(2) Tag and unsolder all leads.
(3) Remove nut (1), then remove defective switch (2) from panel (3).
(4) Install new switch (2) into panel.
(5) Install nut (1) and tighten.
(6) Solder all leads to new switch.
(7) Reassemble test set (para 3-19).

b. Indicator Assembly Replacement. Refer to figure 3-8 and replace the defective indicator assembly as follows.

(1) Disassemble test set (para 3-15).
(2) Tag and unsolder all leads.
(3) Remove lens cap (4) and bulb (5).
(4) Remove nut (6) and defective indicator assembly (7).
(5) Install new indicator assembly (7) into panel (3).
(6) Install nut (6) and tighten.
(7) Solder all leads to new indicator assembly.
(8) Install bulb (5),and lens cap (4).
(9) Reassemble test set (para 3-19).

c. Fuse Assembly Replacement. Refer to figure 3-8 and replace the defective fuse assembly as follows.

(1) Disassemble test set (para 3-15).
(2) Tag and unsolder all leads.
(3) Remove nut (8), and lift fuse assembly (9) from panel (3).
(4) Install new fuse assembly (9) into panel. (3).
(5) Install nut (8) and tighten.
(6) Solder all leads to new fuse assembly.
(7) Reassemble test set (para 3-19).

d. Connector J4, JS, J6 Replacement. Refer to figure 3-8 and replace the defective connector as follows.

(1) Disassemble test set (para 3-15).
(2) Unsolder leads.
(3) Remove nut (10), and lift defective connector (11) from panel (3).
(4) Install new connector (11) into panel. (3).
(5) Install nut (10) and tighten.
(6) Solder all leads to new connector.
(7) Reassemble test set (para 3-19).

e. Transformer TI Replacement. Refer to figure 3-8 and replace the defective transformer as follows.

(1) Disassemble test set (para 3-15).
(2) Tag and unsolder all leads.
(3) Remove four nuts (12), lockwashers (13), flat washers (14), screws (15) and defective transformer (16).
(4) Aline new transformer (16) on panel (3).
(5) Install four screws (15), flat washers (14), lockwashers (13), nuts (12), and tighten.
(6) Solder all leads to new transformer.
(7) Reassemble test set (para 3-19).

f. + 6, + 12, GND Binding Post Replacement. Refer to figure 3-8 and replace the defective binding post as follows.

(1) Disassemble test set (para 3-15).
(2) Unsolder lead.
(3) Remove nut (17), insulator (18), and defective binding post (19).
(4) Install new binding post (19) into panel. (3).
(5) Install insulator (18), nut (17), and tighten.
(6) Solder lead to binding post.
(7) Reassemble test set (para 3-19).

g. Mixer Circuit Card Replacement. Refer to figure 3-8 and replace the defective circuit card as follows.

(1) Disassemble test set (para 3-15).
(2) Remove two nuts (10) from connectors J5, J6 (11) and allow nuts to fall down leads.
(3) Unsolder leads J5, J6, main circuit card, and remove circuit card (20).
(4) Retrieve two nuts (10) from leads.
(5) Install two nuts (1) over leads.
(6) Install circuit card (20) by engaging leads to connectors J5 and J6 (11), aline with main circuit card tiepoints and solder all connections.
(7) Install two nuts (10) on connectors J5 and J6 (11), and tighten.
(8) Reassemble test set (para 3-19).

h. Main Circuit Card Replacement. Refer to figure 3-8 and replace the circuit card as follows.

(1) Disassemble test set (para 3-15).
(2) Tag and unsolder all leads to circuit card.
(3) Remove two nuts (21), lockwashers (22), flat washers (23), and screws (24) securing circuit card to holding bracket (25).
(4) Unsolder tiepoints to mixer card (20), and remove main printed circuit card (26).
(5) Install circuit card (26), aline with holding brackets (25).
(6) Install two screws (24), flat washers (23), lockshers (22), nuts (21), and tighten.
(7) Solder tiepoints to mixer circuit card (20).

3-17. Circuit Card Repairs

a. Remove defective part by cutting leads as close as possible between part and circuit card mounting holes.

b. Remove any epoxy coating around lead connections on the cards printed wiring side.

c. Heat printed wiring at mounting holes with iron until solder melts.

d. Remove excess solder and remaining pieces of leads.

e. Bend the leads of replacement part to fit mounting holes.

f. Insert leads through mounting holes from parts side of circuit card.

g. Press part firmly against card.

h. On circuit card wiring side, cut leads leaving 1/8 inch protruding.

i. Bend and press the leads against the printed wi ring.

j. Quickly solder leads to printed wiring conductor

k. Apply protective coating to all repaired exposed areas.

3-18. Repainting and Refinishing

a. Refinishing processes should restore equipment to original appearance and as-in-new-standards. Minor damage to finishes, such as small scratches, require touchup painting of the affected area only. Major surface damage requires complete repainting.

b. Test Set TS-3630/GRA-114 is painted in accordance with military specification MIL-F-14072, Finish No. 513. IW. Use this material if the entire case is stripped and refinished. For nicks, scratches, or small areas which have peeling, use any matching paint or finish listed in SB 11-573.

NOTE

Touchup or new finish should be applied as prescribed in TB 43-0118.

3-19. Reassembly. To reassemble the test set, refer to figure 3-7 and proceed as follows:

WARNING

Ensure test set is disconnected from power source before attempting reassembly. DEATH ON CONTACT or serious injury may result if safety precautions are not observed.

CAUTION

Always read over and be sure you understand the instructions before attempting reassembly. Use the illustrations to locate parts and subassemblies of the unit to be reassembled.

a. Ensure POWER switch is in OFF position and ac power cord is disconnected from power source.

b. Carefully install panel assembly (2) into case assembly (3).

c. Install four screws (1) into panel assembly.

Section V. TESTING PROCEDURES

3-20. General

a. The following testing procedures are necessary to verify the performance standards for Test Set, Crystal Module TS3630/GRA114 for general support level maintenance as authorized by the maintenance allocation chart. If a part, subassembly, component, etc., does not meet the performance standard, the fault should be isolated and corrected using the troubleshooting, disassembly and repair sections of chapter 3 of this manual. The SMR recoverability code of the affected part should be determined by consulting TM 115895109720P and TM 115895109740P.

b. Insure all applicable MWO's have been done. Refer to DA Pam 310-1 for a listing of current MWO's.

c. Use the test equipment and materials listed for each test. Perform the test connections and conditions listed before proceeding to the actual test.

d. Perform each test step in sequence. Starting at step 1, perform all the actions listed in the "Control Settings" columns for test equipment and equipment to be tested, ensuring the controls are set accurately. Then perform all the actions listed in the test procedure column and verify the correct indication listed in the performance standard column.

3-21. Physical Tests and Inspection

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

b. Test Connections and Conditions.

(1) Remove any connections to test set.

(2) Disassemble test set and probe amplifier (para 3-15).

c. Procedure. Refer to table 3-6 for correct procedures.

Table 3-6. TS 3630/GRA-114 Physical Test and Inspection

Step no.	Control settings		Test procedure	Performance standard
	Test equipment	Unit under test		
	N/A	Controls may be set in any position	a. Inspect all exterior surfaces for stains, fungus and corrosion.	a. Surfaces shall be free of stains, fungus and corrosion.
			b. Inspect case for dents, cracks and general structural damage.	b. Case shall be free of Structural damage.
			c. Inspect painted surfaces for scratches and cracked or peeling paint.	c. All painted surfaces shall be free of scratches which penetrate the paint, and cracked or peeling paint.
			d. Inspect screws, nuts and bolts for looseness	d. All screws, bolts and nuts shall be tight; none shall be missing.
			e. Inspect front panel switches for looseness, missing knobs and normal switch action.	e. Switch knobs shall be tight and mechanical action normal.
			f. Inspect front panel indicators for burned-out or missing bulbs.	f. Indicator bulb shall be installed and in working order.
			g. Inspect fuse and fuseholder for proper size, burned out, or missing fuse	g. Fuse shall be correct size (A), installed and in working order.
			h. Inspect electrical components and printed circuit cards for signs of heat damage	h. Electrical components and printed circuit cards shall be free of heat damage.

Table 3-6. TS-3630/GRA-114 Physical Tests and Inspection - Cont.

		i Inspect electrical components and printed circuit cards for signs of physical damage. j. Inspect wiring for breaks and damaged or frayed insulation. damage.	i. Electrical components and printed circuit cards shall be free of physical damage. j. All wiring shall be free of

3-22. TS-36301GRA-114 Performance Test

a. Test Equipment and Materials.

(1) Signal Generator SG-II1112(V)2/U (NSN 6625-00-500-6525).

(2) Maintenance Kit MK-1752/GRA-114 (NSN 5895-01-057-6263).

b. Test Connections. Interconnect equipment as shown in figures 3-4 and 3-5.

c. Procedure. Perform procedures outlined in bench test procedures table 3-1.

APPENDIX A
REFERENCES

AR 755-1	Disposal of Supplies and Equipment.
DA Pam 310-1	Consolidated Index of Army Publications and Blank Forms.
DA Pam 738-750	The Army Maintenance Management System (TAMMS).
SB 11-573	Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies, and Equipment Used by the Army.
TB 43-0118	Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TM 11-5895-1095-12	Operator and Organizational Maintenance Manual: Radio Data Link, Sound Ranging AN/GRA-114 (NSN 5895-01-057-6262) and Maintenance Kit, Radio Data Link MK-1752/-GRA-114 (5895-01-057-6263).
TM 11-5895-1097-12	Operator's and Organizational Maintenance Manual: Test Set Crystal Module TS-3630/GRA-114 (NSN 5895-01-057-6265N
TM 11-5895-1097-20P	Organizational Maintenance Repair Parts and Special Tool! List, Test Set, Crystal Module TS-3630/GRA-114. (NSN 5895-01-057-6265).
TM 11-5895-1097-40P	General Support Maintenance Repair Parts and Special Tool: List, Test Set, Crystal Module TS-3630/GRA-114 (NSN 5895-01-057-6265).
TM 740-90-1	Administration Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

By Order of the Secretary of the Army:

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

Official:

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

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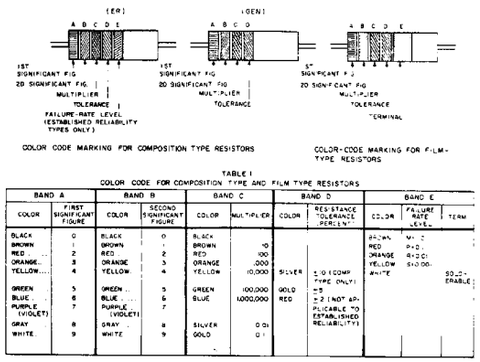


COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS

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, PERCENT*
BLACK	0	BLACK	0	BLACK	1			BROWN	1.0
BROWN	1	BROWN	1	BROWN	10			RED	0.1
RED	2	RED	2	RED	100			ORANGE	0.01
ORANGE	3	ORANGE	3	ORANGE	1,000			YELLOW	0.001
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	±10 (COMP TYPE ONLY)	WHITE	SOLDERABLE
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 (1000 HOURS). ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY TWICE THE WIDTH OF OTHER BANDS AND INDICATES TYPE OF TERMINAL.

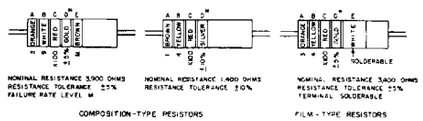
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS (THESE ARE NOT COLOR CODED)

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%

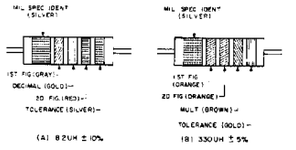
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±2%
TERMINAL SOLDERABLE

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.



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

TABLE II

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.

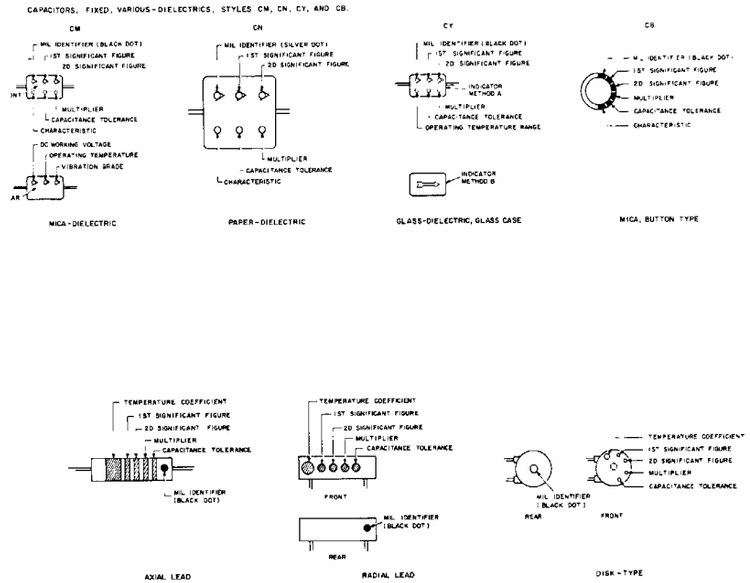


TABLE III — FOR USE WITH STYLES CM, CN, CY AND CB.

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

TABLE IV — TEMPERATURE COMPENSATING, STYLE CC.

COLOR	TEMPERATURE COEFFICIENT*	1ST SIG FIG	2D SIG FIG	MULTIPLIER	CAPACITANCE TOLERANCE: CAPACITANCES 9.9 PF OR LESS	CAPACITANCES 10 PF OR LESS	MIL ID
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	-30	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			

* 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-250, 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.

EL6RB016

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

FO-1 COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS AND INDUCTORS

Figure FO-1. Color Code Marking for MIL-STD Resistors, Inductors, and Capacitors.

Figure FO-1. Color Code Marking for MIL-STD Resistors, Inductors, and Capacitors.

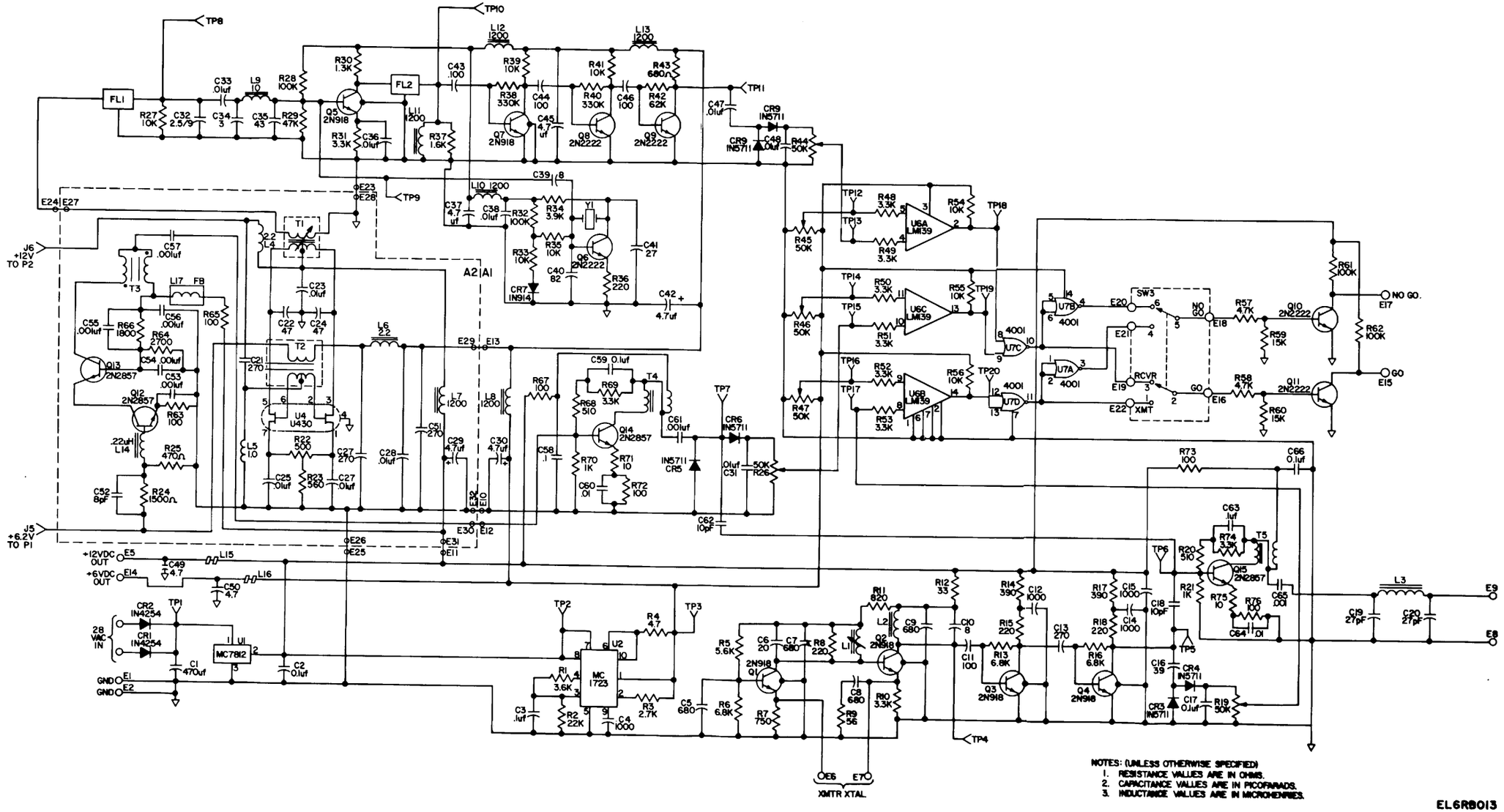


Figure FO-2. Schematic Diagram of TS-3630/GRA-114.

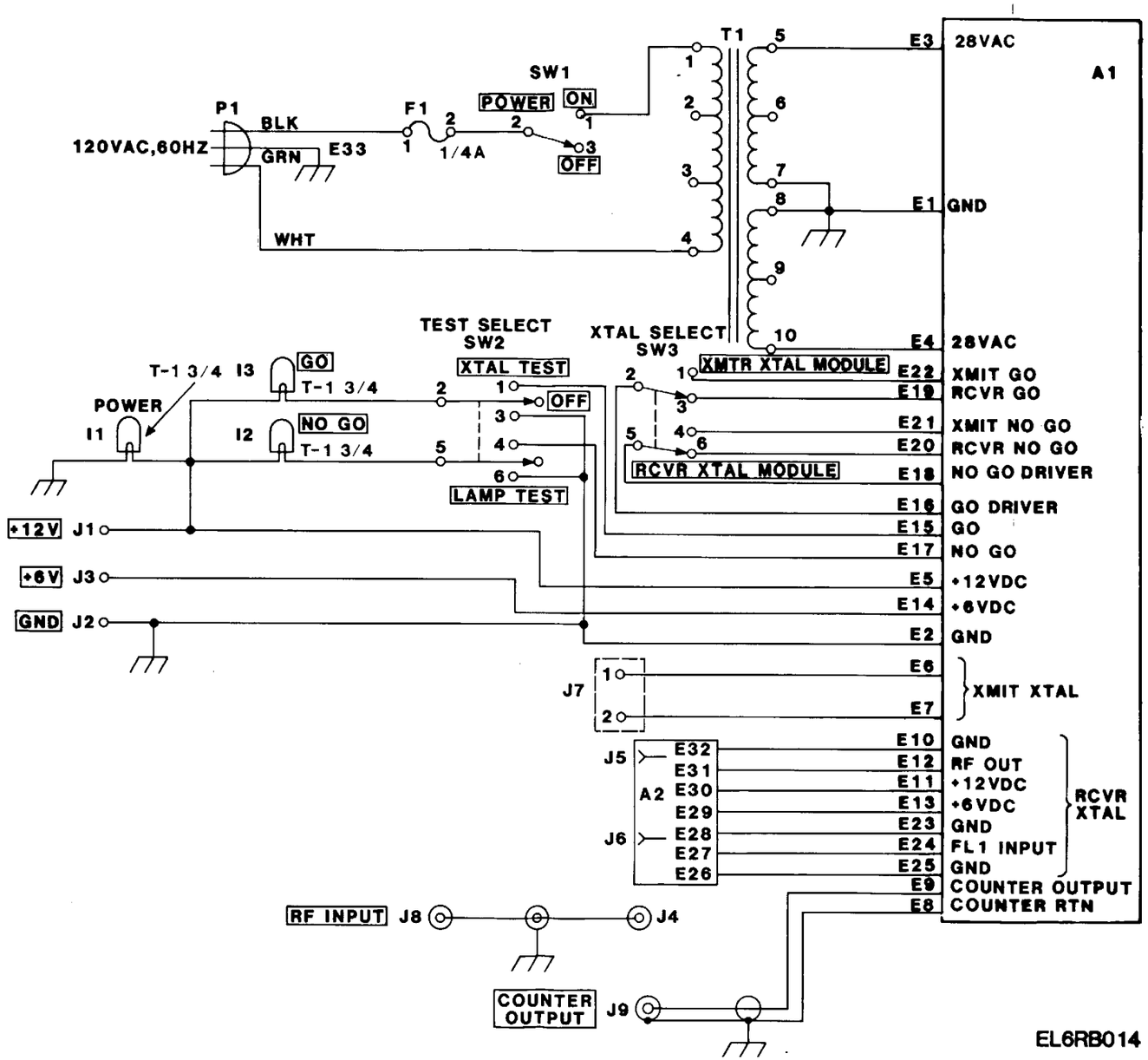


Figure FO-3. Wiring Diagram of TS-3630/GRA-114.

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