MOBILE RADIO

DESCRIPTION AND MAINTENANCE
459.025—459.650 MHz, 25 WATT MASTR® EXECUTIVE II
RCC AND IMTS SYNTHESIZED TRANSMITTER

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DESCRIPTION

The MASTR® Executive II Synthesized transmitters are crystal-controlled, frequency modulated transmitters designed for up to thirty-two channel operation in the 459.025-459.650 MHz frequency band. This solid-state, high reliability transmitter utilizes integrated circuits and discrete components to provide 25 Watts of transmitted RF power. The transmitter consists of:

- The Synthesizer; with channel frequency, modulator, amplifier and multiplier stages.
- The System Board; with audio processor and audio adaptor.
- The Power Amplifier; with amplifier, driver, PA final, power control and low-pass filter assembly.

Figure 1 is a block diagram of the MASTR Executive II Synthesized transmitter showing the synthesizer, audio circuits and PA board.

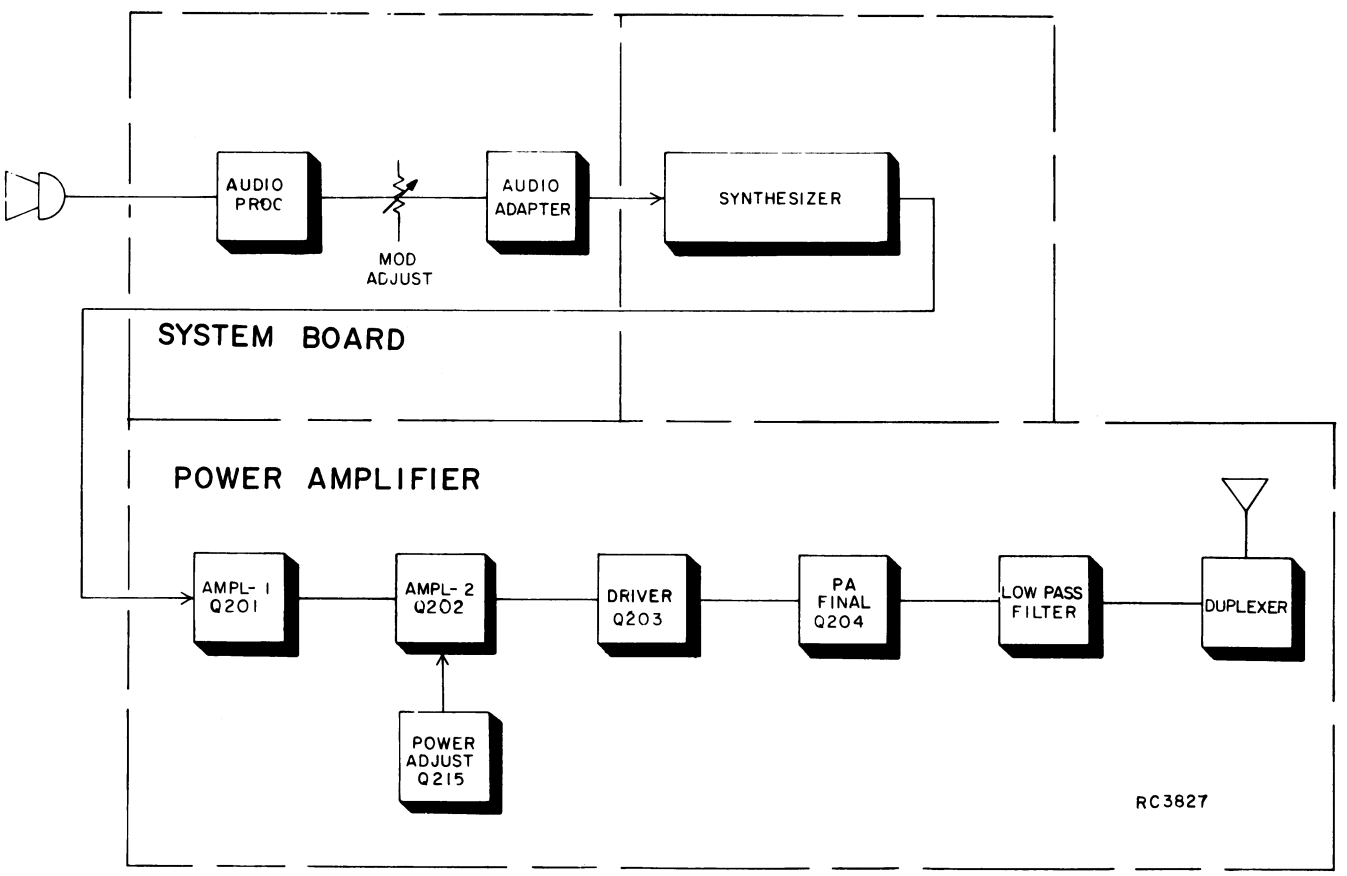


Figure 1 - Synthesized Transmitter Block Diagram

GENERAL ELECTRIC

The synthesizer contains the channel frequency phase-lock-loop circuits, modulated ICOM and multipliers to provide 200 milliwatts of modulated RF power to the power amplifier.

The power amplifier assembly includes four transistor stages (two amplifiers, a driver and power amplifier) to provide 25 Watts of output power, a low-pass filter and a power adjust circuit to adjust the output power to the desired level.

MAINTENANCE

DISASSEMBLY

- To service the transmitter remove the two retaining screws from the front cap assembly and pull radio out of case assembly.
- To remove PA Board:
  1. Remove PA top cover and unplug the exciter/PA cable W216 from J201; unsolder the PA/low pass filter cable W214 from W205 and the shield from ground. NOTE: The PA heat sink assembly pivots 90° to permit access to the PA board.
  2. Unsolder the two power feed through capacitors (C297, C298) and remove the retaining screw from power adjust transistor Q215 to the chassis. Be careful not to damage the mica insulation placed between the transistor and the chassis.
  3. Remove the PA transistor (Q202) hold-down nut and spring washer on the rear of the PA assembly.
  4. Remove the two screws securing each of the two flange transistors to the PA board.
  5. Remove the four PA board mounting screws, and lift the board out.

PA TRANSISTOR REPLACEMENT

WARNING

The stud mounted RF Power Transistors used in the transmitter contain Beryllium Oxide, a TOXIC substance. If the ceramic or other encapsulation is opened, crushed, broken or abraded, the dust may be hazardous if inhaled. Use care in replacing transistors of this type.

- To remove PA RF transistor Q202:
  1. Unsolder one lead at a time with a 50 Watt soldering iron. Use a scribe or X-acto® knife to hold the lead away from the printed circuit board until the solder cools.
  2. Turn the PA board over.
  3. Hold the body of the transistor to prevent it from turning. Remove the transistor hold-down nut and spring washer through the hole in the heat sink with an 11/32 inch nut-driver for Q202. Lift out the transistor, and remove the old solder from the printed circuit board with a desoldering tool such as a SOLDA PULLT®. Special care should be taken to prevent damage to the printed circuit board runs because part of the matching network is included in the base and collector runs.
- To remove RF PA transistors Q203 and Q204 (Flange type):
  1. Unsolder one lead at a time with a 50 Watt soldering iron. Use a scribe or X-acto® knife to hold the lead away from the printed circuit board until the solder cools. Special care should be taken to prevent damage to the printed circuit board runs because part of the matching network is included in the base and collector runs.
- To replace RF PA transistors:
  1. Trim the new transistor leads (if required) to the lead length of the removed transistor. Cut the collector lead of Q202 at a 45° angle for future identification (see Figure 2). The letter "C" on the top of each transistor also indicates the collector. Refer to Figure 4 for lead identification of Q203 and Q204.

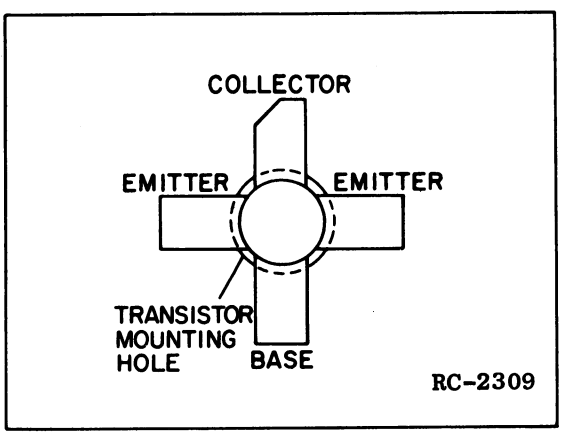


Figure 2 - Lead Identification

  2. Apply a coat of silicon grease around the transistor mounting surface, and place the transistor in the mounting hole. Align the leads as shown on the Outline Diagram. Then hold the body of the transistor and replace the hold-down nut and spring-washer (Q202) or the two retaining screws (Q203 and Q204) using moderate torque, 8 inch-pounds for Q202 or 6 inch-pounds for

Q203 and Q204. A torque wrench must be used for this adjustment since transistor damage can result if too little or too much torque is used.

3. Make sure that the transistor leads are formed as shown in Figure 3 (Q202) so that the leads can be soldered to the printed circuit pattern, starting from the inner edge of the mounting hole.

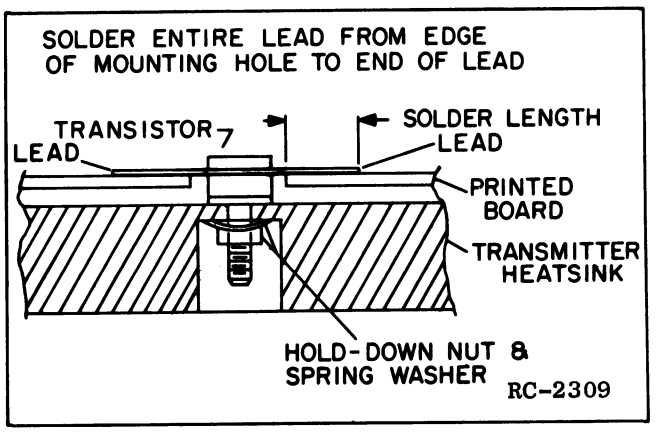


Figure 3 - Lead Forming

4. Solder the leads to the printed circuit pattern. Start at the inner edge of mounting hole and solder the remaining length of transistor lead to the board. Use care not to use excessive heat that causes the printed wire board runs to lift up from the board. Check for shorts and solder bridges before applying power.

NOTE

Failure to solder the transistor leads as directed may result in the generation of RF loops that could damage the transistor or may cause low power output.

TROUBLESHOOTING

The Troubleshooting Procedure permits rapid fault location in the synthesizer and power amplifier. See Table of Contents.

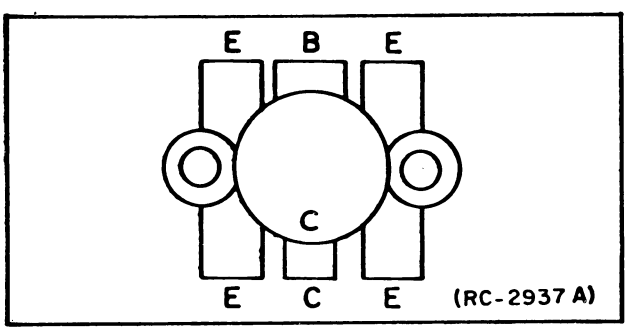


Figure 4 - Lead Identification for Q203 and Q204

ICOM FREQUENCY ADJUSTMENT

First, check the frequency to determine if any adjustment is required. The frequency should be set with a frequency meter or counter with an absolute accuracy that is 5 to 10 times better than the tolerance to be maintained, and with the entire radio as near as possible to an ambient temperature of 26.5°V (79.8°F).

MASTR II ICOMs should be reset only when the frequency shows deviation in excess of the following limits:

1. ±0.5 PPM, when the radio is at 26.5°C (79.8°F).
2. ±2 PPM at any other temperature within the range of -5°C to +55°C (+23°F to +131°F).
3. The specification limit (±2 PPM) or ±5 PPM at any temperature within the ranges of -40°C to -5°C (-40°F to +23°F) or +55°C to +70°C (+131°F to +158°F).

If the radio is at an ambient temperature of 26.5°C (79.8°F), set the oscillator for the correct operating frequency.

If the radio is not at an ambient temperature of 26.5°C, setting errors can be minimized as follows:

1. To hold the setting error to ±0.6 PPM (which is considered reasonable for 5 PPM ICOMS):
   a) Maintain the radio at 26.5°C (±5°C) and set the oscillator to desired frequency, or -
   b) Maintain the radio at 26.5°C (±10°C) and offset the oscillator, as a function of actual temperature, by the amount shown in Figure 5.

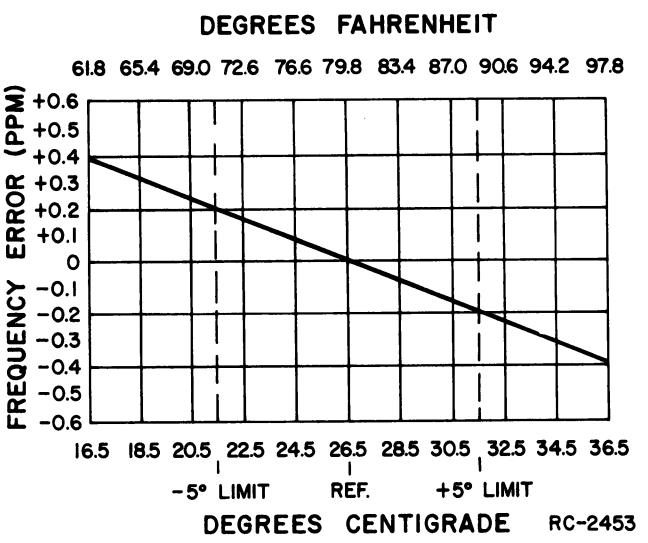


Figure 5 - ICOM Frequency Offset Chart

2. To hold setting error to ±0.35 PPM (which is considered reasonable for 2 PPM ICOMs): Maintain unit at 26.5°C (±5°C) and offset the oscillator, as a function of actual temperature, by the amount shown in Figure 5.

TRANSMITTER ALIGNMENT

EQUIPMENT

1. GE Test Set Model 4EX3A11 or Test Kit 4EX8A12.
2. A 50 ohm wattmeter connected to antenna jack J2.
3. A frequency counter.
4. A deviation monitor.

PRELIMINARY CHECKS

1. Connect the red plug on the GE Test Set to the System Board metering jack J902 and the black plug to A901-J2 on the Synthesizer mother board. Set the polarity to (+) and set the range to the Test 1 position (1 Volt position for 4EX8K12) for all adjustments.
2. Connect the receiver VCO output (P3 on the Synthesizer) to a 50 ohm load.
3. Connect a 500 MHz frequency counter through a 20 dB pad to J1 on the A904 Transmitter VCO board.

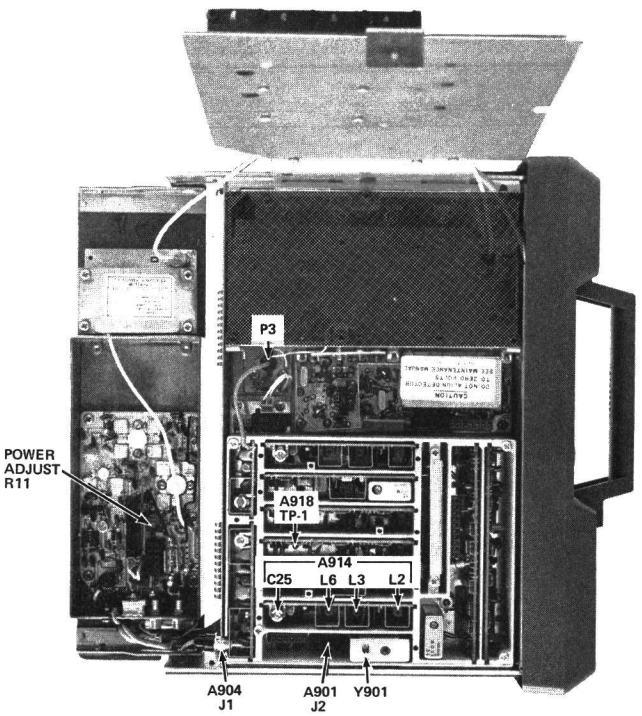


Figure 6 - Alignment Adjustment Location

ALIGNMENT PROCEDURE

1. Select Channel 1 at the control unit and adjust the following components on the transmitter Oscillator/Multiplier Board A914:

Test Meter Position	Adjust Component on A914
A	Peak L2
B	Peak L3
C	Peak L6
D	Peak C25

2. Connect a 10 Volt, 10 Megohm DC Voltmeter to TP1 on the A918 Phase Detector Board and adjust C5 on the A904 VCO to produce 6.0 Volts ±0.1 Volts as read on the meter at TP1.

3. Adjust the FM ICOM Y901 for a frequency of 459.025 (RCC) or 459.375 (IMTS) ±0.4 PPM (184 Hz) as read on the frequency counter.

4. Disconnect the 20 dB pad and frequency counter from J1. Connect the transmitter input cable into J1. The power into the PA should be 200 mW or greater.

NOTE

With the Test Set connected to the PA metering jack, the voltage reading at position "F" with the HIGH SENSITIVITY button pressed may be converted to driver current by reading the current as 15 Amperes full scale. The voltage reading at position "G" with the HIGH SENSITIVITY button pressed may be converted to PA collector current by reading the current as 15 Amperes full scale.

5. With the battery voltage at 13.6 Volts or the PA collector voltage at 13.0 Volts, set Power Adjust potentiometer R213 on the PA Board for the desired power output from 1 to 40 Watts.

   If the battery voltage is not at 13.6 Volts or the collector voltage at 13.0 Volts and full rated output is desired (40 Watts at 13.6 Volts), set R213 for the output power according to the actual battery voltage or collector voltage as shown in Figure 7, 8 or 9.

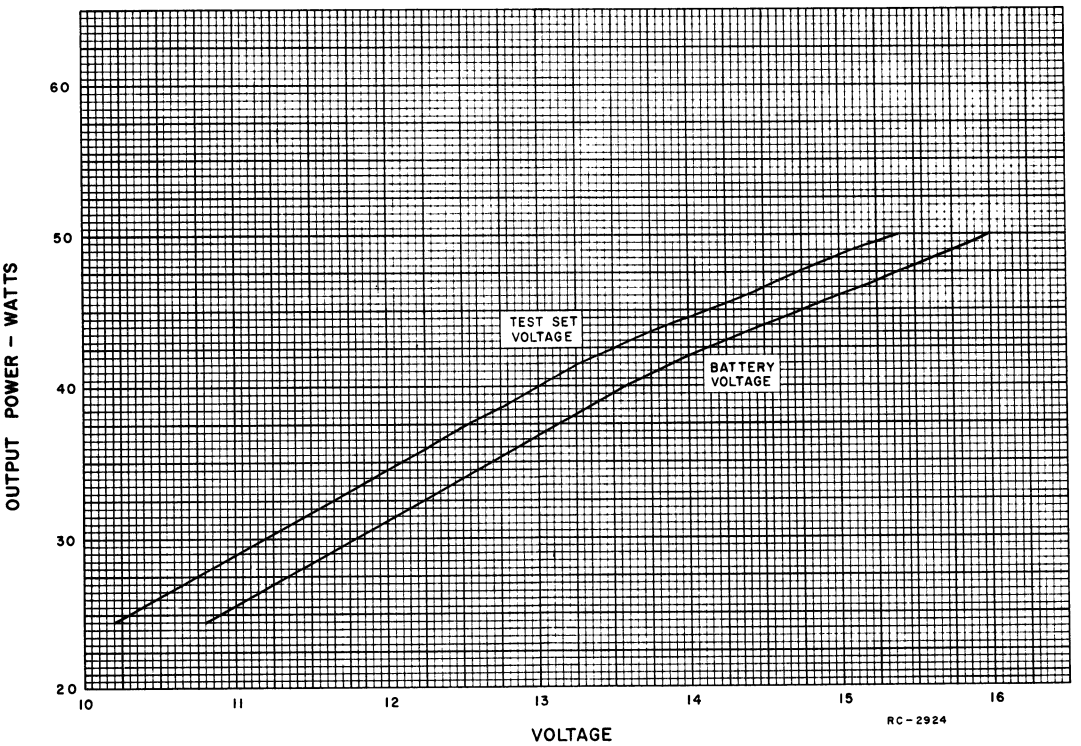


Figure 7 - 406-450 MHz Power Output Setting Chart

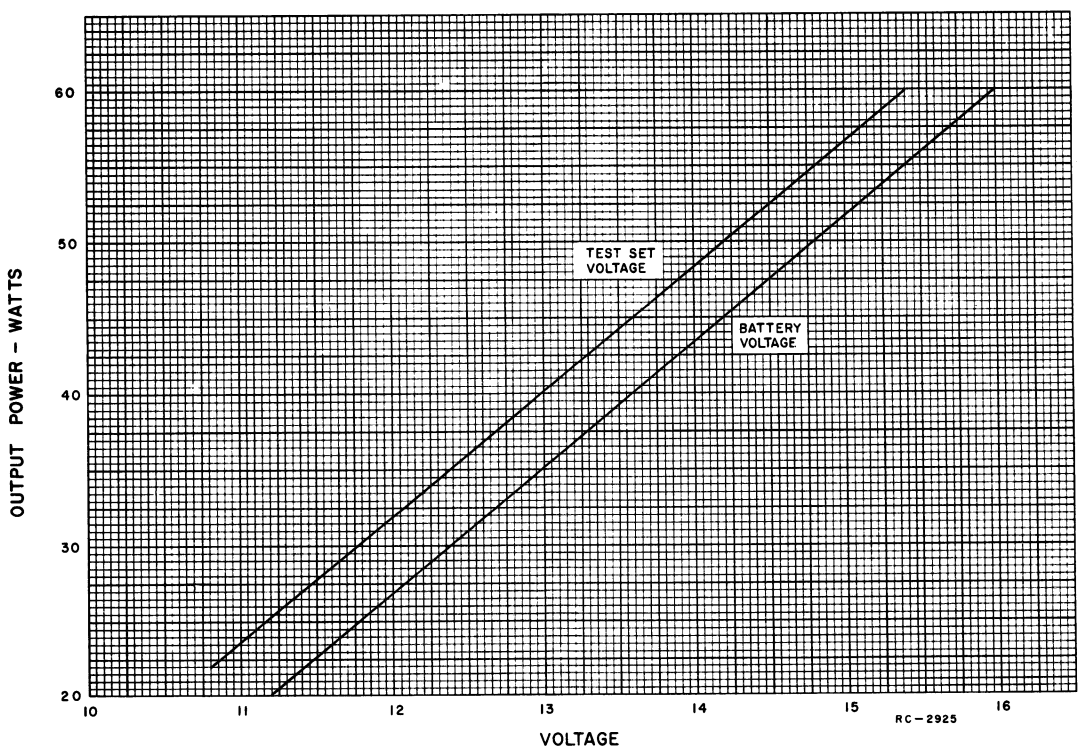


Figure 8 - 450-470 MHz Power Output Setting Chart

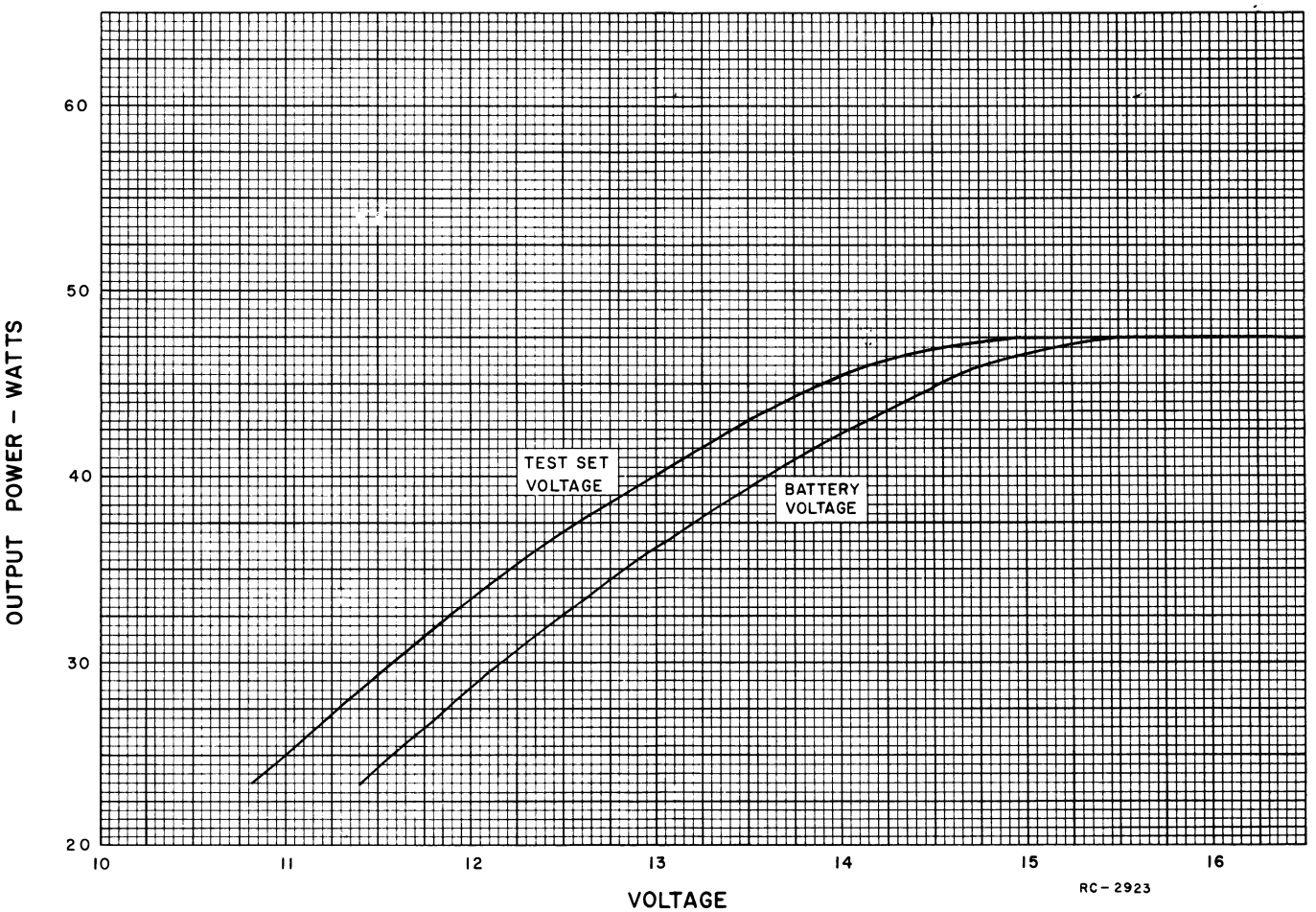


Figure 9 - 470-512 MHz Power Output Setting Chart

MODULATION ADJUSTMENT

The MOD ADJUST (R907 on the System Board) was adjusted to the proper setting before shipment and should not normally require readjustment. This setting permits approximately 75% modulation for the average voice level. The audio peaks which would cause overmodulation are clipped by the modulation limiter. The limiter, in conjunction with the de-emphasis network, instaneously limits the slope of the audio wave to the modulator, thereby preventing overmodulation while preserving intelligibility.

TEST EQUIPMENT

1. An audio oscillator (GE Model 4EX6A10).
2. A frequency modulation monitor.
3. An output meter or a VTVM.
4. GE Test Set Model 4EX3A11 or 4EX8K12.

PROCEDURE

1. Connect the audio oscillator and the meter across audio input terminals J10 (Green-Hi) and J11 (Black-Lo) on GE Test Set, or across J901-8 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and J901-9 (Mike Low) on the System Board.
2. Adjust the audio oscillator for 1 Volt RMS at 1000 Hz.
3. Set MOD ADJUST R907 for a 4.5 kHz swing using the deviation polarity that provides the highest reading on the frequency modulation monitor.

TEST PROCEDURES

These Test Procedures are designed to assist in servicing a transmitter that is not operating properly. Problems encountered could be low power output, defective audio sensitivity, improper voice deviation or modulator adjust control set too high. Once a defect is pin-pointed, refer to the Troubleshooting Procedure. Before starting the test procedure, be certain that the transmitter is aligned to the proper operating frequency.

CAUTION

Before bench testing the MASTR Excutive II radio, be sure of the voltage characteristics of your bench power supply.

To protect the transmitter power output transistor from possible destruction, the following input voltages to the radio must not be exceeded:

Transmitter unkeyed: 20 Volts

Transmitter keyed: 18 Volts
(50 ohm resistive load)

These voltages are specified at the normal vehicle battery terminals of the radio and take the voltage drop of standard cables into account.

Routine transmitter tests should be performed at EIA Standard Test Voltages (13.6 VDC for loads of 6 to 16 Amperes; 13.4 VDC for loads of 16 to 36 Amperes). Input voltages should not exceed, the limits shown, even for transient peaks of short duration.

Many commonly used bench power supplies cannot meet these requirements for regulation and transient voltage suppression. Bench supplies which employ "brute force" regulation and filtering (such as Lapp Model 73) may be usable when operated in parallel with a 12 Volt automotive storage battery.

TEST EQUIPMENT REQUIRED

1. Wattmeter similar to:
   Bird #43
   Jones #711N
2. VTVM similar to:
   Triplett #850
   Heath #IM-21
3. Audio Generator similar:
   GE Model 4EX6A10
4. Deviation Meter (with a .75 kHz scale) similar to:
   Measurements #720
5. Multimeter similar to:
   GE TEST SET MODEL 4EX3A11,
   MODEL 4EX8K12 or
   20,000 ohms-per-Volt voltmeter

POWER MEASUREMENT

1. Connect the transmitter output from the antenna jack to the wattmeter through a 50 ohm coaxial cable. Make sure the wattmeter is terminated in a 50 ohm load.
2. Key the transmitter and check the wattmeter for the desired power output.
3. Check the setting of the Power Adjust Control (213).
4. Refer to the Transmitter Troubleshooting Procedure.

VOICE DEVIATION, SYMMETRY & AUDIO SENSITIVITY

1. Connect the test equipment to the transmitter as shown in Figure 8.
2. Set the audio generator output to 1.0 Volt RMS and the frequency to 1 kHz.
3. Key the transmitter and adjust deviation meter to carrier frequency.
4. Deviation reading should be ±4.5 kHz.
5. If necessary, adjust MOD ADJUST control R907 for the proper deviation on plus (+) or minus (-) deviation, whichever is greater.

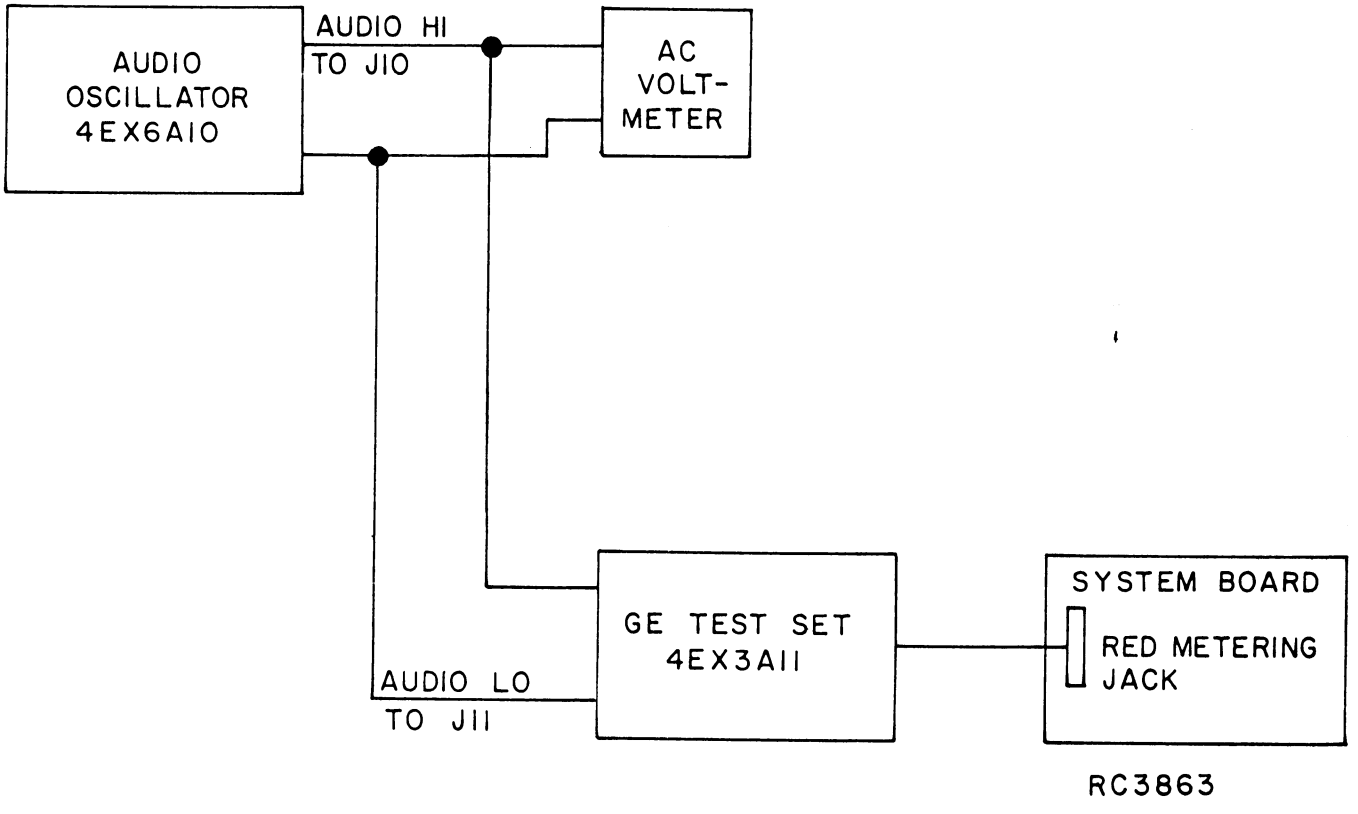
NOTE

The transmitter is adjusted at the factory for 4.5 kHz deviation. The factory adjustment will prevent the transmitter from deviating more than 5.0 kHz under worst conditions of frequency, voltage and temperature.

6. If the deviation reading of (+) or (-) differs by more than 0.5 kHz, check the Audio Processor, Audio Adapter and the FM ICOM.
7. Check audio sensitivity by reducing the generator output until deviation falls to 3.0 kHz. Voltage should be less than 120 millivolts. If not, refer to the Troubleshooting Procedure.

AUDIO AC VOLTAGES

Connect test equipment as shown:



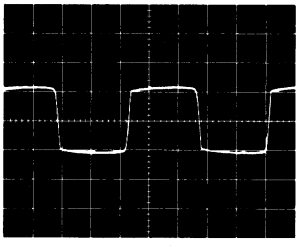
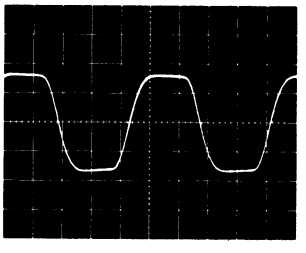
		JUNCTION OF AR101 R109 AND C103	J502 ON AUDIO ADAPTER BOARD
SCORE SETTING	HORIZONTAL	200 U SEC/DIV	200 U SEC/DIV
	VERTICAL	2 VOLTS/DIV	2 VOLTS/DIV
SET AUDIO OSCILLATOR AT 1000 Hz WITH OUTPUT OF 1.0 V RMS. R104 ADJUSTED FOR 4.5 kHz DEVIATION. NOTE: AN RMS OR PEAK READING VOLT METER WILL READ 1/2 to 1/3 OF PEAK-TO-PEAK READINGS.			

Figure 10 - Audio AC Voltage Measurements

GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

GENERAL ELECTRIC* U.S.A.

THESE PROCEDURES ASSUME A+ (13.8 VDC) IS APPLIED TO THE RADIO AND FOR TRANSMITTER TROUBLESHOOTING A WATTMETER IS CONNECTED TO THE ANTENNA JACK. THE TRANSMITTER MUST BE KEYED WHEN MAKING VOLTAGE MEASUREMENTS. RECHECK RADIO OPERATION AFTER MAKING EACH REPAIR TO ASSURE THAT THE RADIO IS OPERATING PROPERLY.

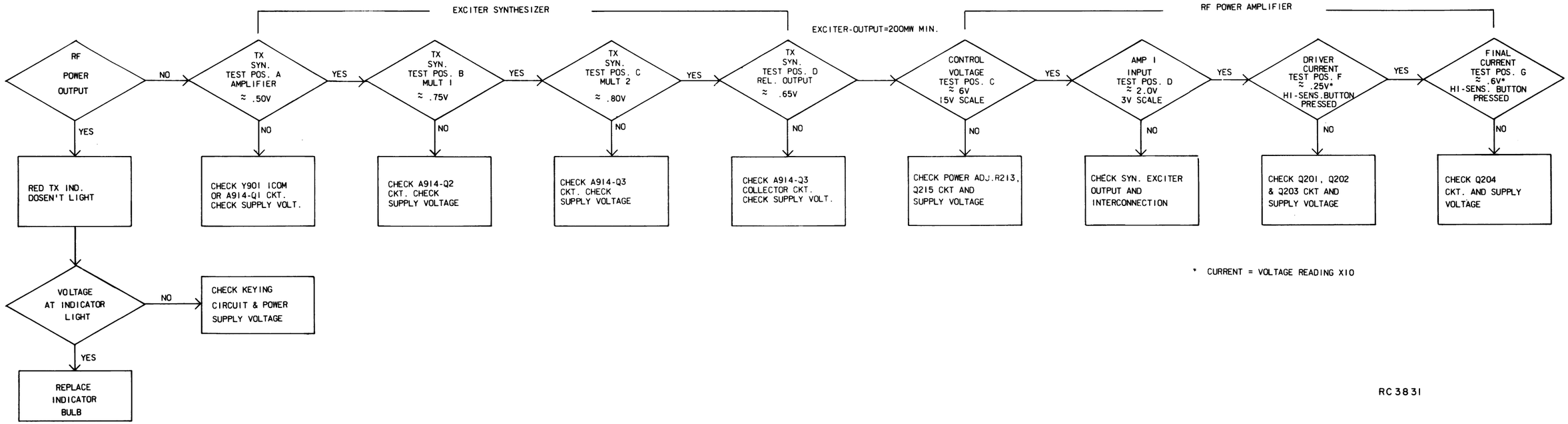


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FIGURE 11 - TROUBLESHOOTING FLOW CHART (SHEET 1)

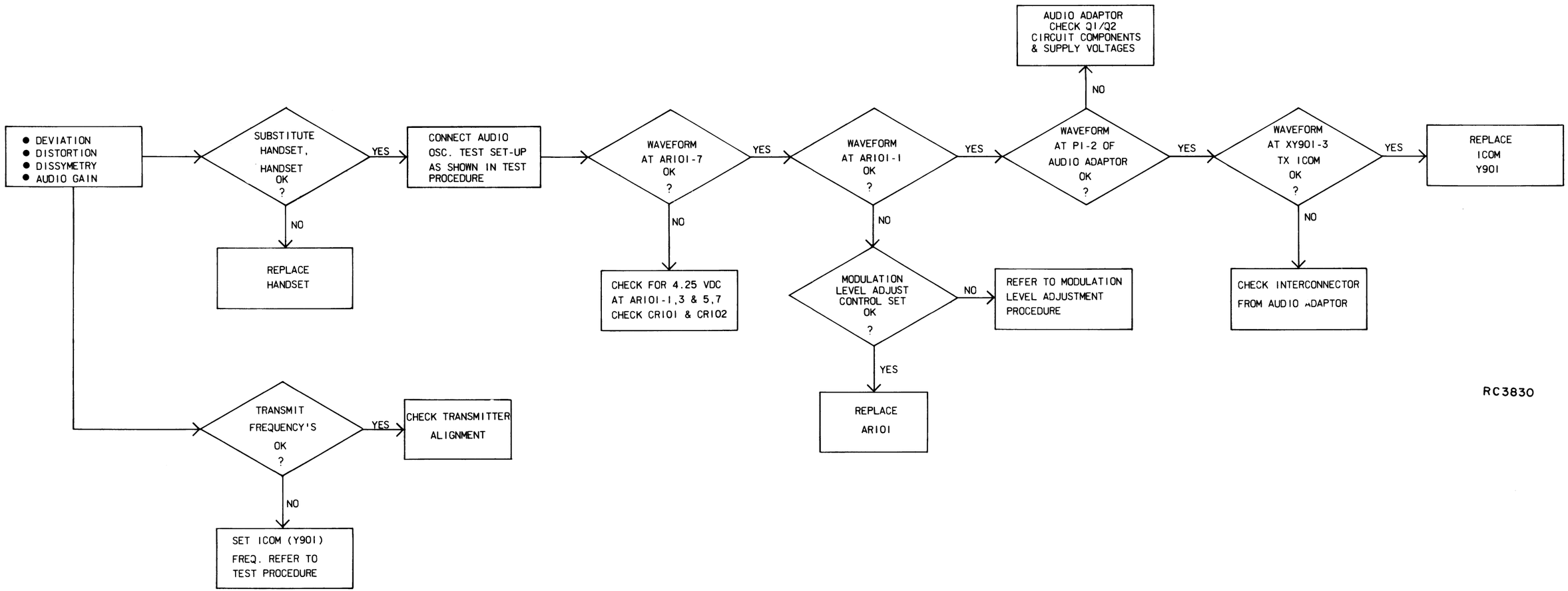

FIGURE 11 - TROUBLESHOOTING FLOW CHART (SHEET 2)