MAINTENANCE MANUAL

800MHz SYNTHESIZED RANGR

TWO WAY FM RADIO

SERVICE SECTION

TABLE OF CONTENTS

GENERAL ELECTRIC*

U.S.A.

DESCRIPTION

This section contains the information required to service the radio. The section includes disassembly procedures, procedures for replacing transistors, Integrated Circuits (IC's) and chip components. The section also includes alignment procedures and troubleshooting information (see Table of Contents).

INITIAL ADJUSTMENT

After the radio has been installed (as described in the Installation Manual), the following adjustments should be made by a certified electronics technician.

TRANSMITTER ADJUSTMENT

The adjustment for the transmitter includes measuring the forward and reflected power, and setting the transmitter to rated power output. Then, measure the frequency and modulation and record these measurements for future reference. For the complete transmitter adjustment, refer to the Alignment Procedure (see Table of Contents).

RECEIVER ADJUSTMENT

No adjustment for the input circuit is required. For complete receiver adjustment, refer to the Receiver Alignment Procedure (see Table of Contents).

MAINTENANCE

PREVENTIVE MAINTENANCE

To ensure high operating efficiency and to prevent mechanical and electrical failures from interrupting system operations, routine checks should be made of all mechnical and electrical parts at regular intervals. This preventive maintenance should include the checks as listed in the table of Maintenance Checks.

MAINTENANCE CHECKS	INTERVAL	
	6 Months	As Required
CONNECTIONS - Ground connections and connections to the voltage source should be periodically checked for tightness. Loose or poor connections to the power source will cause excessive voltage drops and faulty operation. When ground connections are not made directly to the battery, the connection from the battery to vehicle chassis must be checked for low impedance. A high impedance may cause excessive voltage drops and alternator noise problems.	X	
ELECTRICAL SYSTEM - Check the voltage regulator and alternator or generator periodically to keep the electrical system within safe and economical operating limits. Overvoltage is indicated when the battery loses water rapidly. Usage of 1 or 2 ounces of water per cell per week is acceptable for batteries in continuous operation. A week battery will often cause excessive noise or faulty operation.		X
MECHANICAL INSPECTION - Since mobile units are subject to constant shock and vibration, check for loose plugs, nuts, screws and parts to make sure that nothing is working loose. Be sure that all screws are properly torqued.	X	
ANTENNA - The antenna, antenna base and all contacts should be kept clean and free from dirt or corrosion. If the antennas or its base should become coated or poorly grounded, loss of radiation and a weak signal will result.	X	
ALIGNMENT - The transmitter and receiver meter readings should be checked periodically, and the alignment "touched up" when necessary. Refer to applicable Alignment Procedure and troubleshooting sheet for typical voltage readings.		X
FREQUENCY CHECK - Check transmitter frequency and deviation, as required by FCC. Normally, these checks are made when the unit is first put into operation, after the first six months and once a year thereafter.		X

TABLE 1 MAINTENANCE CHECKS

DISASSEMBLY PROCEDURE

To gain access to the unit for servicing:

1. Remove the lock screw on the front of the radio using No. 30 TORX driver.
2. Pull the radio forward and lift radio out of mounting blacket.

To remove the printed wire boards:

1. Each of the boards may be removed after removing the radio cover, the cables and the retaining screws securing the board to the main frame.
2. The cables and the screws to be removed are listed in Table 2.

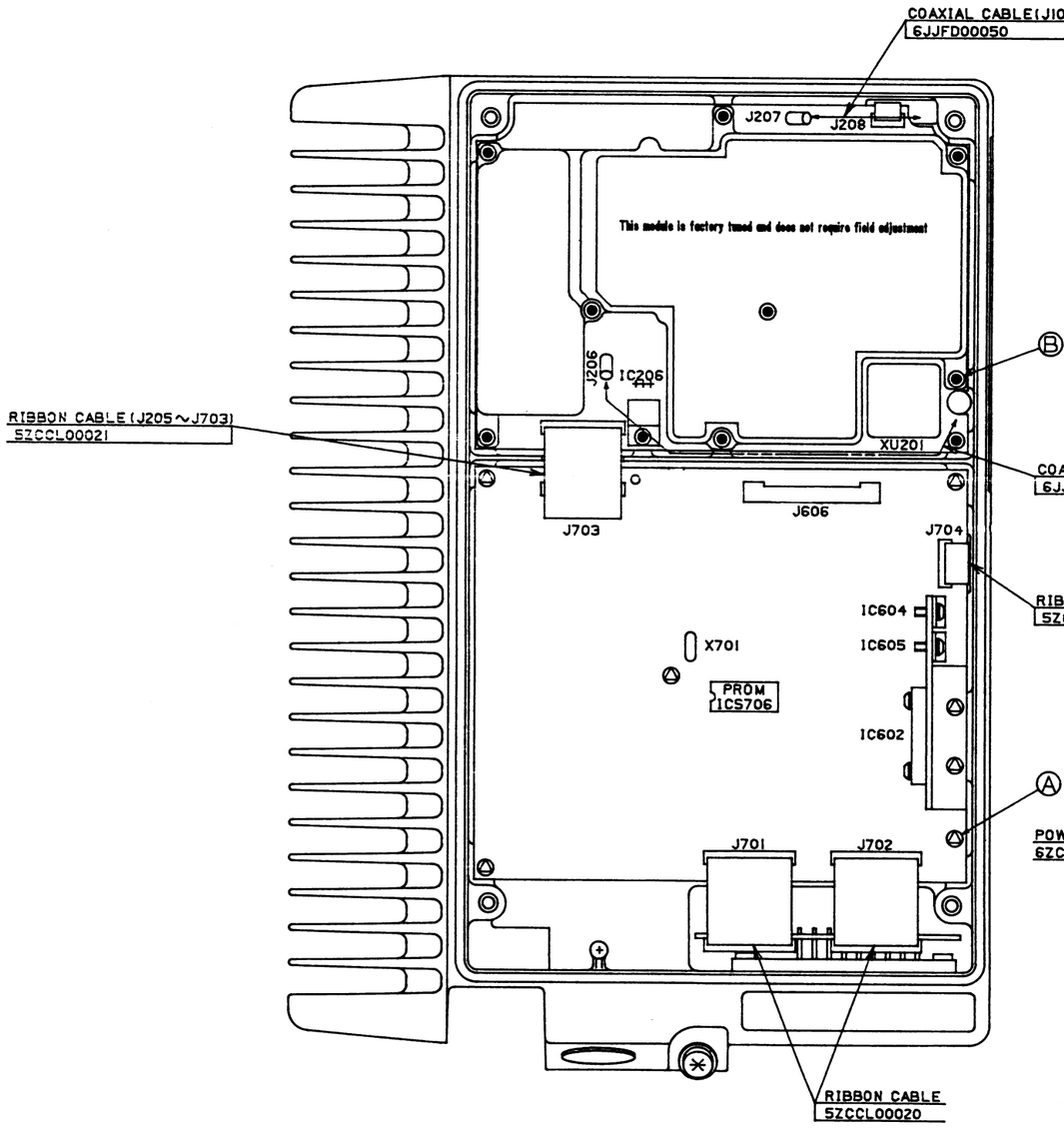


Figure 1.

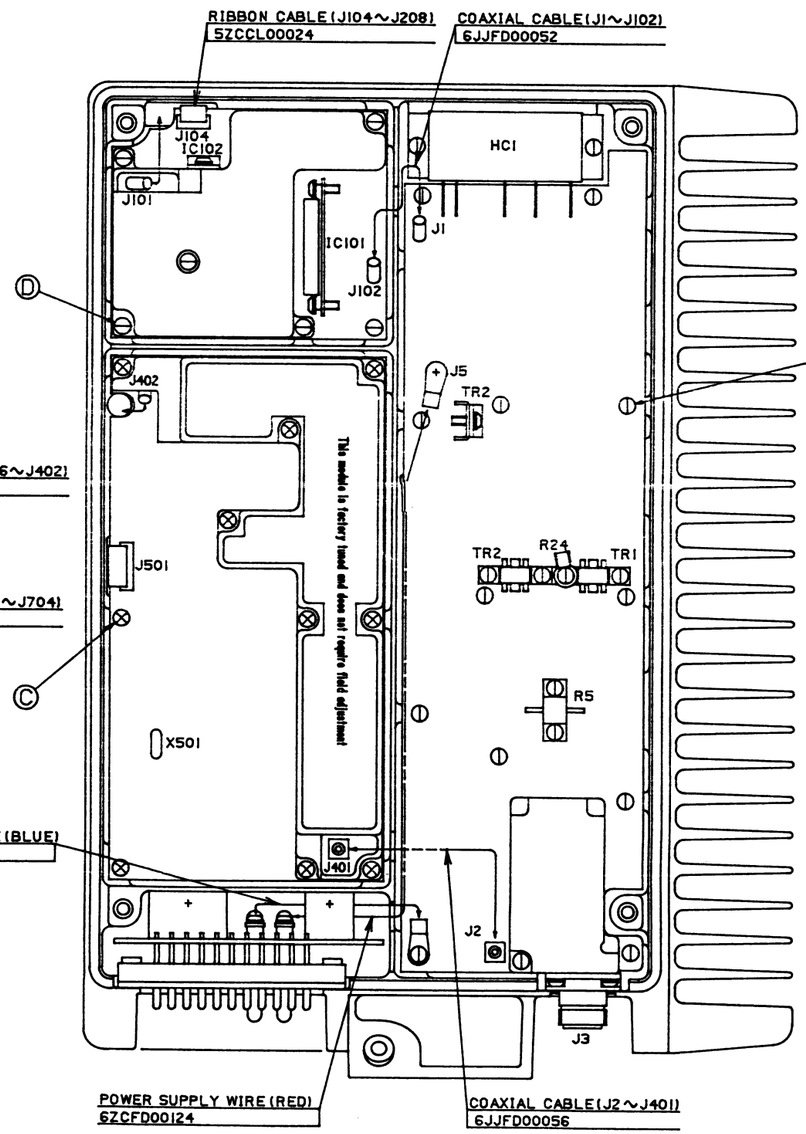


Figure 2.

Board name	Cables to be removed	Screws to be removed
System control board	Four ribbon cables	Seven scerws A (Figure 1)
Synthesizer board	Two coaxial cables and two ribbon cables	Ten screws B (Figure 1)
PA board	Two power supply wires (red and blue), two coaxial cables, one ribbon cable	21 screws E Figure 2
Tx Exciter board	Two coaxial cables, one ribbon cable	Six screws D (Figure 2)
Rx board	Two coaxial cables and one ribbon cable	Ten screws C (Figure 2)

TABLE 2 - DISASSEMBLY PROCEDURE

To replace the printed wire boards.

1. Perform above procedures in reverse order.

PA TRANSISTOR REPLACEMENT

WARNING

The 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 replace the PA RF transistors:

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. Lift out the transistor. Remove any old solder from the printed circuit board with a vacuum desoldering tool. 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.

3. Trim the new transistor leads (if required) to the lead length of the removed transistor. The letter M on the top of the transistor also indicates the collector.

4. Apply a coat of silicon grease to the transistor mounting surface. Place the transistor in the mounting hole. Align the leads as shown on the Outline Diagram. Then replace the transistor mounting screws using moderate torque.

5. 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.

CAUTION

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.

REMOVING IC's

Removing IC's (and most other soldered-in components) can be easily accomplished by using a vacuum desoldering tool. To remove an IC, heat each lead separately on the solder side and remove the old solder with the desoldering tool.

CAUTION

The CMOS Integrated Circuit devices used in this equipment can be destroyed by static discharges. Before handling one of these devices, the serviceman should discharge himself by touching the case of a bench test instrument that has a 3-prong power cord connected to an outlet with a known good earth ground. When soldering or desoldering a CMOS device, the soldering iron should also have a 3-prong power cord connected to an outlet with a known good earth ground. A battery operated soldering iron may be used in place of the regular soldering iron.

REPLACING CHIP COMPONENTS

Replacement of chip components should always be done with a temperature - controlled soldering iron using a controlled temperature of 700°F (371°C). However, do not touch black metal film of the resistors or the ceramic body of capacitors with the soldering iron.

NOTE

The metalized end terminations of the parts may be touched with the soldering iron without causing damage.

REMOVING CHIP COMPONENTS

1. Using two soldering iron heat each end of the chip at the same time until solder flows, and then remove and discard the chip.

2. Remove excess solder with a vacuum solder extractor.

3. Carefully remove the epoxy adhesive and excess flux to prevent damage to the printed board.

REPLACING CHIP COMPONENTS

1. Using as little solder as possible, "tin" one end of the component and one of the pads on the printed wiring board.

2. Place the "tinned" end of the component on the "tinned" pad on the board and simultaneously touch the component and the pad with a well "tinned" soldering iron while pressing the component down on the board.

3. Place the "tinned" soldering iron on the other end of the component and the pad simultaneously. Apply solder to the top of the end of the component until the solder starts to flow. Use as little solder as possible while getting a good joint.

4. After the component has cooled, remove all flux from the component and printed wiring board are with alcohol.

TEST AND TROUBLESHOOTING PROCEDURES

Maintenance of the radio is facilitated by using the Self Test and Diagnostics routines and servicing techniques unique to this radio. Typical voltage readings are provided on the Schematic Diagram for reference when troubleshooting.

CAUTION

Before bench testing the radio, be sure of the output voltage characteristics of your bench power supply.

To protect the transmitter power output transistors from possible instant destruction, the following input voltages must not be exceeded:

Transmitter unkeyed:	16.5 Volts
Transmitter keyed (50 ohms resistive load):	16.3 Volts
Transmitter keyed (no load or non-resistive load):	14 Volts

These voltages are specified at the normal vehicle battery terminals of the radio and take the voltage drop of standard cables into account. The voltage limits shown for a non-optimum load is for "worst case" conditions. For antenna mismatches likely to be encountered in practice, the actual limit will approach the 16.3 Volt figure.

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 must not exceed the limits shown, even for transient peaks of short duration.

Many commonly used bench power supplies cannot meet these requirements for load 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 automative storage battery.

MICROCOMPUTER

When servicing the microcomputer/ synthesizer circuitry it is sometime desirable to force the microcomputer into specific operating modes. Followings are tips that allow you to initiate these modes.

- To force the microcomputer to continually try to reload the synthesizer ground the lock detect line to the microcomputer at IC701-8. This mode will enable you to check the serial data, clock, channel change pulse and enable signals to the synthesizer.

- To stop the microcomputer from running, disable the watchdog timer by shorting the collector and emitter of TR701 and ground the single step line at IC-702-5.

MICROPHONICS

Synthesized radios tend to be sensitive to shock and vibration, creating microphonics. The construction of the RANGR radio with its die cast aluminum frame, cast shield, and multiple board mounting screws, provides a high degree of immunity. Note, when removing either printed circuit board or the shields, the location and position of all mounting hardware including rubber padding and bracket (if included).

When servicing the radio be sure that no solder build-up has occured on the chassis or shield.

To assure a high degree of resistance to microphonics be sure to replace exactly, all hardware remove. Be sure that all mounting screws are properly torqued and shields are in place. Refer to the Mechanical Layout Diagram.

NOTE

Loose or rubbing parts, especially in the VCO area are particularly sensitive and can cause microphonics. Again, be certain all hardware is properly installed and torqued.

MICROCOMPUTER DIAGNOSTICS

The microcomputer, in addition to operational programming, contains software for self diagnostic routines to aid in troubleshooting the radio. Since the radio can not function with a defective microcomputer, the self diagnostic routines include internal tests as well as input/output tests to verify proper operation.

The internal tests include a ROM test which verifies that the proper program is stored in the microcomputer and a RAM test which checks for proper data transfer to and from all memory locations.

The input/output tests include a test which grounds one pin at a time on Port 1 and the data bus, and a test which mirrors the inputs PTT, FB5, CG DISABLE, ADVANCE CHANGE, and FB4 - FB1 onto the data bus.

These tests assure proper operation of the ports and data bus, in addition to checking the input/output

instructions of the microcomputer. When troubleshooting the radio, if problems are suspected on the system board, the diagnostic routines should be performed first before going on to the test procedures and lignement instructions.

TEST EQUIPMENT REQUIRED

- o 13.8 VDC supply, 500 mA (unless being tested in radio)
- o DC Voltmeter (Data Tech 30L or equivalent)
- o Oscilloscope (Tektronix 404 or equivalent)

TEST PROCEDURE

1. Connect oscilloscope to J801-18 (SPKR 1) and ground.
2. Enter the self diagnostic mode as follows:

   Cautions: When using the radio with the S550, S5950 or S990 control head, the ADVANCE CHANGE line should be disconnected from the control head by removing connector P3. Instead of keying the microphone ground J606-10.

   - o Key microphone while on hook. (Ground J801-11).
   - o Apply A+ through a 10K resistor to J801-32.
   - o Turn radio on. (Apply 13.8 VDC to J801-19).

ROM AND RAM TESTS

Once power is supplied to the board, the microcomputer will jump to the self diagnostic test and immediately begin execution of the ROM and RAM tests. Upon completion of the ROM and RAM test (less than a second) the display, data bus, or alert tone will indicate when the tests have been successfully completed. Test status is indicated as follows:

	D3	D2	D1	D0	ALERT TONE
ROM TEST FAILED	0	0	0	0	NONE
ROM TEST PASSED RAM TEST FAILED	0	0	0	1	NONE
ROM TEST PASSED RAM TEST PASSED	0	0	1	0	1 kHz

If the data bus is inaccessable then the alert tone can be used to indicate whether the tests passed. If the tests are successfully completed there will be a 1 kHz tone on SPKR 1 and it will be heard on the speaker if the board is in a radio. If no alert tone is present, then either the ROM or RAM test has failed.

If these tests have failed, the microcomputer function is defective. Before replacing the microcomputer, exhaust all other possibilities. Check associated circuits for shunted or open printed wire runs and components.

INPUT/OUTPUT TESTS

If the ROM and RAM tests are completed satisfactorily, release the PTT switch and remove A+ from J801-32. Note that the data bus will still indicate 02 (Hex), however, the 1 kHz tone should no longer be displayed on the scope or heard on the speaker.

The I/O test grounds one pin at a time on Port 1 and the data bus and is stepped through the test sequence by

operating the PTT switch (momentarily grounding J801-11). Port 1 and the data bus can be monitored using a voltmeter. Port 1 consists of pins 27-34 on microcomputer IC702. The data bus includes pins 12-19 on IC702. Refer to schematic diagram for data bus and port identification for IC702. For example:

P17 = port 1 bit 7.

1. Momentarily press and release the PTT switch (J801-11) Port 1 and data bus lines all will go high.

2. Momentarily press and release the PTT switch (J801-11). IC702-34 and IC702-19 will go low. All other outputs should be high.

3. Momentarily press and release the PTT switch (J801-11). IC702-33 and IC702-18 will go low. All other outputs should be high.

4. Momentarily press and release the PTT switch (J801-11). IC702-17 will go low. All other outputs should be high. Note that IC702-32 will remain high. This is because this output switches the radio into the transmit mode when grounded. Thus the output is bypassed so that the radio will never go into the transmit mode during self test.

5. Momentarily press and release the PTT switch (J801-11). IC702-31 and IC702-16 will go low. All other outputs should be high.

6. Momentarily press and release the PTT switch (J801-11). IC702-30 and IC702-15 will go low. All other outputs should be high.

7. Momentarily press and release the PTT switch (J801-11). IC702-29 and IC702-14 will go low. All other outputs should be high.

8. Momentarily press and release the PTT switch (J801-11). IC702-28 and IC702-13 will go low. All other outputs should be high.

9. Momentarily press and release the PTT switch (J801-11). IC702-27 and IC702-12 will go low. All other outputs should be high.

10. Momentarily press and release the PTT switch (J801-11). Port 1 outputs will all be set high.

NOTE

At this point the program advances to mirror the outputs PTT, FB5, CG DISBL, ADVANCE CHANGE, and FB4-FB1 onto the data bus IC702-12 through IC702-19, respectively.

11. Momentarily apply ground to the following points while observing status of the associated data bus as indicated below. When ground is applied, the data bus should go low and then go high when ground is removed.

Momentarily Ground	Data Bus	Momentarily Ground	Data Bus
J801-30	IC702-18	J801-13	IC702-14
J801-10	IC702-17	J801-2	IC702-13
J801-32	IC702-16	J801-1	IC702-12
J801-4	IC702-15	J801-11	IC702-19

12. Exit the diagnostic routines by momentarily removing power from the radio.

TEST FREQUENCIES

If the EEPROM is not custom programmed to the customer specified

personality, then a standard test program is provided. The EEPROM is programmed on several channels including tone and digital Channel Guard and carrier control timer. The test program is given in the table 3 below.

Tx frequency Rx frequency	Channel Guard	Carrier Control Timer
(MHz) 815.9625 860.9625	(Hz) 71.9	(MIN) 1.00
824.9875 869.9875	023	
806.0125 851.0125		1.00
860.9875 860.9625	71.9	
869.9875 869.9625		
815.9875 860.9875		
824.9625 869.9625		
806.0375 851.0375		
861.3250 860.9750		
869.9750 869.9500		
851.3500 851.3500		

TABLE 3 PROGRAM TEST FREQUENCIES

PA TROUBLESHOOTING PROCEDURE

DC VOLTAGE CHECK

First, Check for meter readings for power supply voltage and various stabilized DC voltages, JACK, J606.
The typical readings for the test positions and test points are given in the chart below.

TEST POSITION	METERING POINT	FUNCTION MEASURED	SCALE	TYPICAL READING
B	J606-3	9V-RX	0-15V	9V
B	J606-4	5V 0-15V5V		
H	J606-8	EX9V	0-15V	9V
I	J606-9	+8V	0-15V	8V
J	J606-11	9V	0-15V	9V
K	J606-12	A+	0-15V	13.6V

TABLE 4 READINGS AT J606

PA QUICK CHECK

When troubleshooting the transmitter check for typical readings for the DC voltages across R130 and R131, the Synthesizer Output, J207, and the Exciter output, J102.

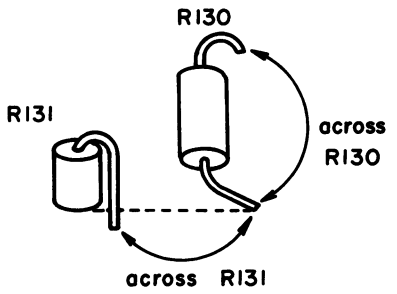
SYMPTOM	PROCEDURE	ANALYSIS
Little or No RF Output	Key transmitter and monitor DC voltages across R130 for 0.3 VDC or R131 for 1.0 VDC. Each voltage should increase. 	If voltage does not increase, check TR101 to TR104, HC101 and associated components.
	Disconnect the coaxial cable ZC608 from the synthesizer board and measure TX INJECTION, J207. Should be +5 to +15 dBm.	If TX INJECTION is low, check TR220, TR221 and associated circuitry.
	Disconnect the coaxial cable from the Exciter board and measure EXCITER OUTPUT, J102. Should be 0.4 watts or more.	If EXCITER OUTPUT is low, check TR101 to TR104, HC101 and associated components.

TABLE 5 PA QUICK CHECK

TYPICAL PERFORMANCE INFORMATION

SIGNAL LEVELS

SIGNAL	INDICATION	VOLTAGE LEVEL
CAS	High Level	9.0 VDC
	Low Level	0.15 VDC
RUS	High Level (Rx Un-sq)	9.0 VDC
	Low Level (Rx Squelched)	0.15 VDC
	Low Level (Rx Mute/PTT pulled low, Rx unsquelched)	0.6 VDC
Sq Dis, Input	Logic Low (Sq. Dis)	0 VDC
	Logic High(Sq)	2.4 VDC
	Rx Un-Sq	0.14 VDC
CCT PA ENBL	Logic Low	0.35 VDC
	Logic High	5.5 VDC
Tx ENBL	Logic Low	2.0 VDC
	Logic High	9.0 VDC
PTT, Input	Logic Low	0 VDC
	Logic High	13 VDC

TABLE 6 SIGNAL LEVELS

RADIO CONNECTOR IDENTIFICATION

Front Connector	J801
System Metering	J606
RX RF	J401
RX INJ	J206
TX INJ	J207
EX Output	J102

TABLE 7 RADIO CONNECTOR IDENTIFICATIONS

TRANSMITTER ALIGNMENT

TEST PROCEDURES

These Test Procedures are designed to assist you in servicing a transmitter that is operating -- but not properly. Once a defect is pin-pointed, refer to the Transmitter Troubleshooting Procedure. Before starting, be sure that transmitter is tuned and aligned properly.

CAUTION

Before bench testing the radio, be sure of the output voltage characteristics of your bench power supply.

To protect the transmitter power output transistors from possible instant destruction, the following input voltages must not be exceeded:

Transmitter unkeyed:	16.5 Volts
Transmitter keyed (50 ohms resistive load):	16.3 Volts
Transmitter keyed (no load or non-resistive load):	14.0 Volts

These voltages are specified at the normal vehicle battery terminals of the radio and take the voltage drop of standard cables into account. The voltage limits shown for a non-optimum load is for "worst case" conditions. For antenna mismatches likely to be encountered in practice, the actual limit will approach the 16.3 Volt figure.

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 must not exceed the limits shown, even for transient peaks of short duration.

Many commonly used bench power supplies cannot meet these requirements for load 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.

MODULATION LEVEL ADJUSTMENT

The MOD ADJUST controls are adjusted to the proper setting before shipment and normally do not required 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, instantaneously limits the slope of the audio wave to the modulator, thereby preventing over-modulation while preserving intelligibility.

TEST EQUIPMENT

1. An audio oscillator (GE Model 4EX6A10)
2. Deviation Monitor
3. An output meter or a VTVM
4. GE Test Set Model 4EX3A11 with Test Set Adapter Cable 19C851.532G1

PROCEDURE OF SYNTHESIZER TRANSMIT DEVIATION

NOTE

The transmit deviation has been properly set by the factory and should require no readjustment. Should it become necessary to adjust the deviation please refer to the Maintenance Manual LBI-31653 and the section TX AUDIO PROCESSOR in SYSTEM CONTROL BOARD and MODULATION LEVEL CONTROL in FREQUENCY SYNTHESIZER BOARD. These will familiarize you with the modulation deviation and make the Alignment Procedure more understandable.

1. Select a center frequency channel. Disable Channel Guard, if present.

2. Rotate RV201 and RV603 fully counterclock wise.

3. Apply a 1 kHz tone at 1 Vrms through a 10μF capacitor to MIC HI at J701-16 (+ lead of capacitor).

   Connect the deviation monitor to the antenna connector J3 via a 30 dB coupler, whose output is terminated in a 50 ohm load. Key the radio.

   Set VCO DEVIATION ADJUST, RV202 for $\pm$3.75 kHz deviation.

4. Remove P605. Set RV603 fully clockwise. Apply a 400 Hz tone to J605-2 and with the radio keyed, vary its amplitude until the Deviation Monitor reads 2 kHz. Note the level.

5. Change the signal generator frequency to 10 Hz at the same level and set REF MOD ADJUST, RV201 for a deviation of 2 kHz. Unkey the radio.

6. Disconnect the signal generator and replace P605 in position 1-2.

7. Select a frequency with Channel Guard (preferably close to 838 MHz).

   Key the radio and set CG DEVIATION ADJUST, RV603 for a deviation reading of $\pm$0.75 kHz.

   NOTE: If Channel Guard or Voice Guard is not used on any frequency, the VCO DEVIATION ADJUST RV202 may be set for a deviation of $\pm$4.5 kHz instead of $\pm$0.375 kHz.

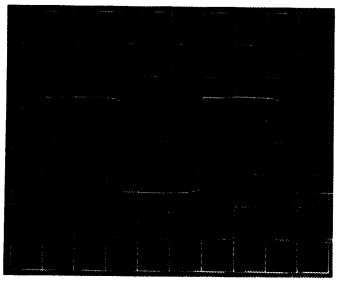
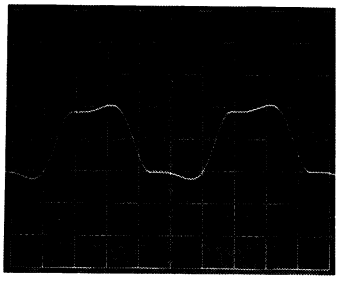
AUDIO CHECKS

TEST EQUIPMENT REQUIRED

- o Audio Oscillator
- o AC Voltmeter
- o Oscilloscope
- o Deviation Monitor

AUDIO AC VOLTAGE

1. Connect audio oscillator output across J701-16 (or J801-9) and J701-3 (or J801-5).

	IC607-1	IC607-7
SCOPE HORIZONTAL SETTING	200 µSEC/DIV	200 µSEC/DIV
VERTICAL	2 VOLTS/DIV	2 VOLTS/DIV
SET AUDIO OSCILLATOR at 1000 Hz WITH OUTPUT OF 1.0 VRMS. MODULATION ADJUSTED FOR 4.5 kHz DEVIATION. NOTE: AN RMS OR PEAK READING VOLTMETER WILL READ 1/2 TO 1/3 OF PEAK-TO-PEAK READINGS.		

AUDIO SENSITIVITY

1. Connect audio oscillator output across J701-16 (or J801-9) and J701-3 (or J801-5). Adjust output for 1000 Hz at 1.0 VRMS.

2. Reduce generator output until deviation falls to 3.0 kHz for radios without Channel Guard or to 2.25 kHz for radios with Channel Guard. Voltage should be less than 120 millivolts.

SYNTHESIZER AND TRANSMITTER ALIGNMENT

TEST EQUIPMENT REQUIRED

1. Wattmeter, 50 ohm (capable of measuring 150 Watts & 1 Watt)
2. DC Voltmeter, 20,000 ohms per volt
3. Digital Voltmeter
4. Power supply, 13.8 VDC regulated
5. GE Test Set, 4EX3A11 with Test Set Adapter Cable 19C85153261

PRELIMINARY CHECKS AND ADJUSTMENTS

NOTE

Refer to Figure 3 for location of tuning and adjustment controls.

1. Apply DC power to radio.

2. Connect plug of GE Test Set to Metering jack J606. Set polarity to "+" and voltage range to the 1 volt position (Test 1).

NOTE

Before alignment or making any adjustments to the transmitter, be sure that power supply voltage (A+) and various stabilized DC voltages are proper. Refer to Table 4.

ALIGNMENT PROCEDURE

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
				SYNTHESIZER
				NOTE The synthesizer is factory aligned and should not require further adjustment. Should it become necessary to adjust the synthesizer please refer to the Maintenance Manual LBI-31653 and the sections from "Frequency Segment Control" to the "Frequency Synthesizer" section. These will familiarize you with the operation of the VCO's and make the Alignment Procedure more understandable. NOTE The label on the cover of the Synthesizer must be removed, or holes made in it to gain access to the adjustable components, through the existing holes in the shield. These hole locations are shown in Figure 3. NOTE In order to adequately align/check two segments of the Tx VCO, it is recommended that the test PROM Listed at TABLE 3 is used.
1.	TP201 (Control Voltage Monitor)	CV202	7.0 VDC	Select Channel 5 (869.9875 MHz). With a 50 ohm load on the antenna connector J3, key the radio. Adjust CV202 until the lock detector indicator, CD710, goes out. Monitor TP201 with a digital voltmeter and adjust CV202 for a reading of 7.0±0.1VDC. Check that CD710 remaine out. Unkey the radio.
2.	TP201 (Control Voltage Monitor)	CV201	6.0VDC	Select Channel 1. (Receive frequency 860.9625 MHz). Adjust CV201 until lock detector indicator, CD710, goes out. Monitor TP201 with a digital voltmeter and adjust CV201 for a reading of 6.0±0.1VDC. Check that CD710 remaine out.

3.	TP201 (Control Voltage Monitor)			Select Channles, 7, 10 and 11 in turn. On each channel, key the radio anD note that the voltage at TP201 lies in the range 4.5 to 7.5VDC.
4.	TP201			Select Channels 2 and 11 and note that the voltage at TP201 lies in the range 4.5 to 7.5VDC.
5.	J207 J206		0-+6 dBm	Monitor TX injection at J207 and Rx injection at J206. Tx injection 0 to +6 dBm Rx injection 0 to +6 dBm
REFERENCE OSCILLATOR FREQUENCY				
6.	J207	FREQ TRIM Control on VC-TXCO	Channel Operating Frequency	NOTE This step assumes the frequency is measured when the transmitter is first keyed. If delayed, the rapidly rising ambient temperature must be taken into consideration. The oscillator frequency should be set at 25°C ambient temperature. In the range of 10°C to 40°C, if the frequency deviates more than ±1ppm, it may be reset according to Figure 4 Temperature/Frequency Correction Curue. Press the PTT switch while monitoring the Tx injection frequency at J207. Adjust FREQ TRIM Control on VC-TXCO for the assigned channel frequency ±0.2 ppm Note: The receiver injection frequency will automatically be correct.
EXCITER				
				NOTE The Exciter requires no adjustment. When it should become necessary to check the Exciter, proceed as follows.

				NOTE The exciter can be isolated from the rest of the radio for checking purposes, if desired. To isolate and set up for alignment, remove coaxial cables ZC608 and ZC610. Connect a (0-1 watt) wattmeter to J101. Apply a 0 to +6 dBm on-frequency signal to J102.
7.			CV1	Check output power on the wattmeter. It should be greater than 400 milliwatts. NOTE Disconnect wattmeter from J101. Reinstall Z608 and Z610 if removed. Connect wattmeter set for 150 watts to antenna jack J3. Balance to make both outputs 806MHz and 870MHz above 18W at 10.88V.
8.			CV2 CV3	Tune for maximum power on indicated wattmeter at 806MHz
9.			RV1	Monitor the transmitter output power on each channel. Select the channel with the lowest output power and set RV1 for 35 watts output.
10.			RV2	Set RV2 for half of rated transmitter output power while the collector of transistor TR5 is grounded.

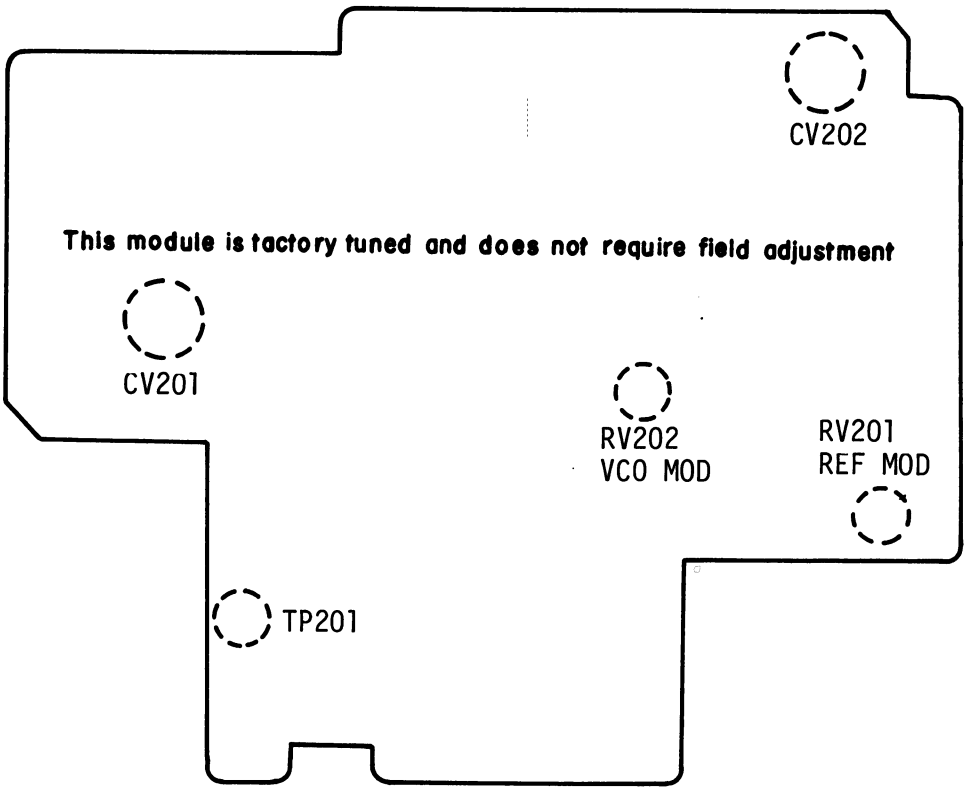


Figure 3. Hole locations for synthesizer tuning and transmitter deviation adjustment

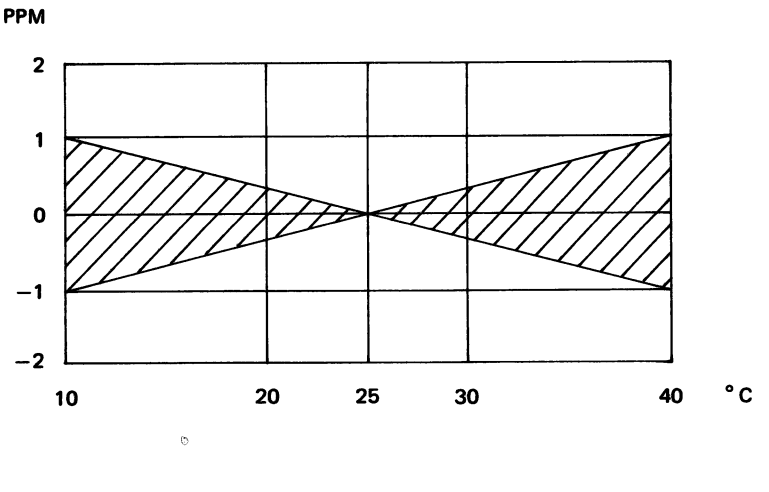


Figure 4. CORRECTION FACTOR IN RFQ.SETTING FOR 2 PPM OSCILLATOR

RECEIVER ALIGNMENT

Alignments for Front-End and Local Injection circuits are not required because a dielectric band-pass filter is employed in the RANGR wideband synthesized radio receiver.

TEST EQUIPMENT REQUIRED

- o GE TEST Set 4EX3A11, 4EX8K12, or 20,000 ohms-per-volt multimeter.
- o AC Voltmeter
- o RF Signal Generator
- o Frequency Counter (851 to 870 MHz)
- o 4-ohm 15 watt resistor
- o Audio Isolation Transformer (1:1) 19A116736P1 or equivalent

> NOTE
>
> Before aligning the receiver or making any adjustments to the radio be sure that the output of 9 Volt Regulator is 9.0 ±0.2 VDC

ADJUSTMENT PROCEDURES

RECEIVER FREQUENCY ADJUSTMENT

No receiver frequency adjustment is required.

2nd RECEIVER OSCILLATOR

Using a frequency counter monitor 2nd Local Terminal. Set L506 for a frequency of 82.655MHz ±200Hz.

IF/FM DETECTOR ALIGNMENT

Apply a 1000 microvolt, on-frequency test signal modulated by 1,000 Hz with ±3.0 kHz deviation to antenna jack J3.

Connect a 4 ohm, 15 watt resistor in place of the speaker Connect the isolation transformer input across the resistor. Connect the isolation transformer output to the Distortion Analyzer (See Figure 5).

Adjust the VOLUME control for 5 Watts output 4.47 VRMS using the Distortion Analyzer as a voltmeter.

Set the output signal level of the RF signal generator so as to obtain 12dB SINAD at audio output.

Adjust coils L502 to L505 to obtain minimum 12dB SINAD.

Set the output signal level of the RF signal generator to 1000 microvolt.

Adjust the L508 until audio output level becomes maximum.

Adjust the RV602 until audio output level at TP1 becomes 300 m Vrms.

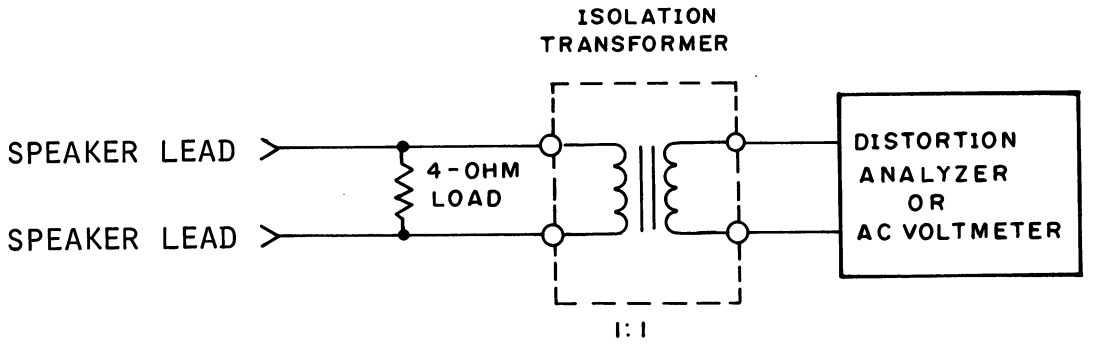


Figure 5. Audio Isolation Transformer

RV605 ADJUSTMENT PROCEDURE

RV605 is used to set squelch amplifier gain to correct for noise variations between various bands of RANGR. This control does not require adjustment unless the squelch hybrid HC601 is changed or the systems board is exchanged between radio's of different frequency bands.

1) Connect signal generator to the receiver antenna jack.

   Output: Set to desired receiver frequency.(output level - off)
   Modulation frequency: 1kHz
   Deviation: 3kHz

2) Set the squelch control to maximum squelch.(fully CCW)

3) Set RV605 fully clockwise.

4) Adjust signal generator for 12dB SINAD.

5) Note the signal generator level for 12dB SINAD and increase its level by 12dB.

6) Change the signal generator modulation frequency to 3kHz and increase the deviation to 6kHz.

7) Adjust RV605 CCW until the squelch just closes.

8) Reduce the generator deviation to 3kHz. The squelch should open. Slowly increase the deviation level until the squelch closes again. the level should be higher than 5.5kHz.

9) Remove the signal generator modulation and measure the signal strength required to open the squelch. The max squelch opening sensitivity should be greater than 20dB noise quieting but less than 1μV.

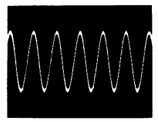
RECEIVER AUDIO AND SQUELCH CHECKS

SQUELCH CIRCUIT TEST WITH 6kHz SIGNAL

PRELIMINARY STEPS

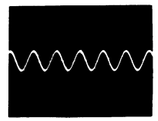
1. Quiet receiver with 1000 uV modulated signal applied to antenna jack J3.
2. Set the squelch volume on the control head to 8dB SINAD
3. Set modulation to 6 kHz.
4. Set deviation to 3 kHz
5. Use 10 megohm probe.

(A)



HOR .1 MSEC/DIV
VERT .1 V/DIV
0.36 ∿0.56 V P-P

(B)



HOR .1 MSEC/DIV
VERT .1 V/DIV
(0.15 V P-P)

(C)

HOR .1 MSEC/DIV
VERT 2 V/DIV
(7.5 ∿8.0 VDC)
BASE LINE 0 VDC

SQUELCH CIRCUIT CHECKS WITH NOISE

PRELIMINARY STEPS

1. No input signal applied.
2. Set the squelch volume on the control head to 8dB SINAD
3. Use 10 megohm probe.

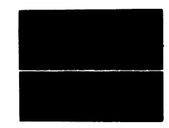
(A)

HOR .5 MSEC/DIV
VERT 1 V/DIV
(3.5 ∿4.0V P-P)

(B)

HOR .5 MSEC/DIV
VERT 1 V/DIV
(2 V P-P)

(C)



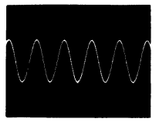
HOR .5 MSEC/DIV
VERT 2 V/DIV
(7.5 ∿8.0 VDC)

AUDIO CIRCUIT

PRELIMINARY STEPS

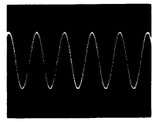
1. Apply 1000 uV on frequency signal with 1000 Hz modulation and 3 kHz deviation to antenna jack J3.
2. Output set to 10 Watts (6.3 VRMS) into 4-ohm load.
3. Use 1 megohm probe.

(D)



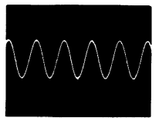
HOR .5 MSEC/DIV
VERT 50 MV/DIV
(160 MV P-P)

(E)



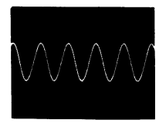
HOR .5 MSEC/DIV
VERT .2 V/DIV
(.84 V P-P)

(F)



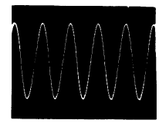
HOR .5 MSEC/DIV
VERT .1 V/DIV
(.28 V P-P)

(G)



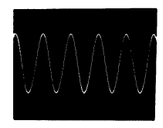
HOR .5 MSEC/DIV
VERT .1 V/DIV
(.28 V P-P)

(H)

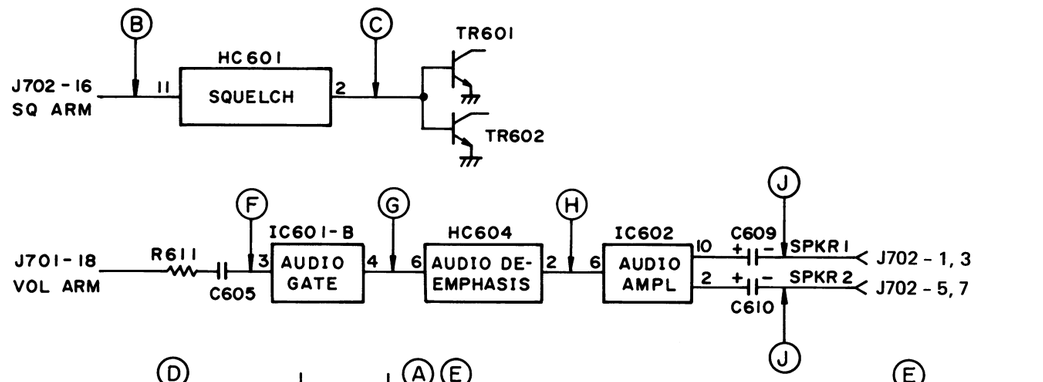


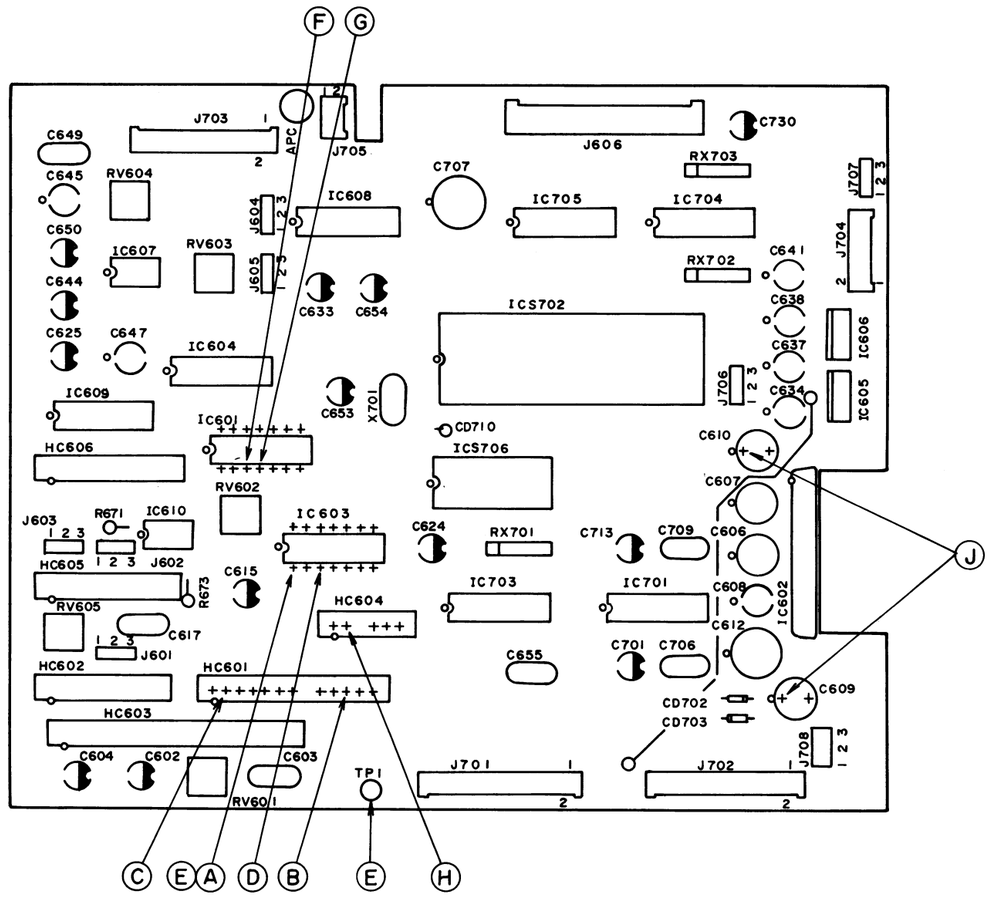
HOR .5 MSEC/DIV
VERT 50 MV/DIV
(280 MV P-P)

(J)



HOR .5 MSEC/DIV
VERT 2 V/DIV
(8.8 V P-P)





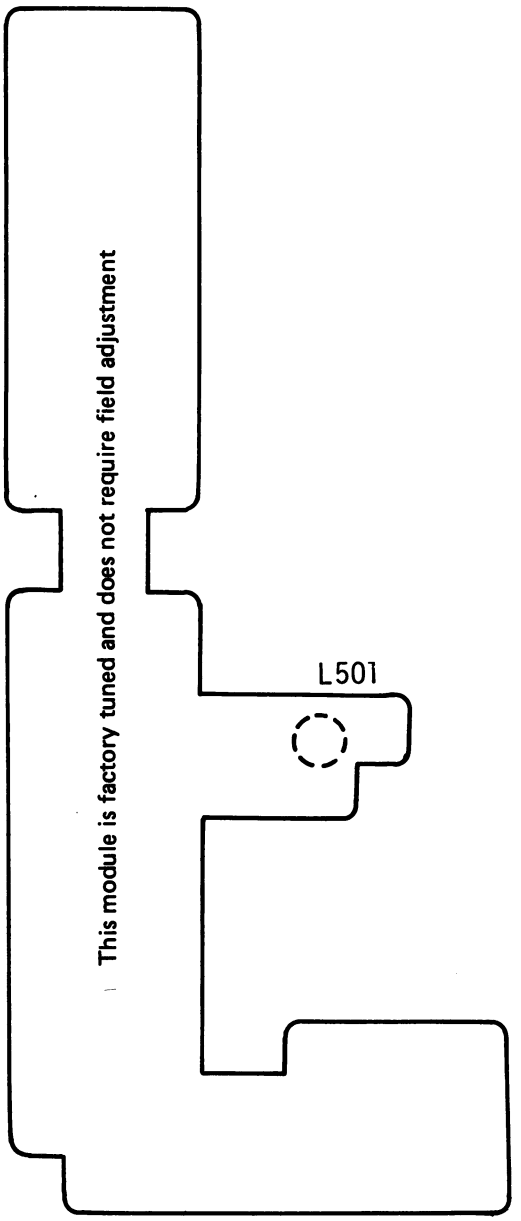


Figure 6. Hole location for receiver adjustment

TEST PROCEDURE

These Test Procedures are designed to help you to service a receiver that is operating--but not properly. The problems encountered could be low power, poor sensitivity, distortion, limiter not operating properly, and low gain. By following the sequence of test steps starting with Step 1, the defect can be quickly localized. Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

TEST EQUIPMENT REQUIRED

- o Distortion Analyzer
- o Signal Generator
- o 6 dB attenuation pad
- o Audio Isolation Transformer
- o 4 ohm resistor (15 watt minimum)

PRELIMINARY ADJUSTMENT

NOTE

These procedures are written around the Heathkit Distortion Analyzer. If a Distortion Analyzer other than the Heath IM-12 is used, measure the sensitivity and modulation acceptance bandwidth in accordance with manufacturer's instructions.

1. Unsquelch the receiver.

STEP 1
AUDIO POWER OUTPUT
AND DISTORTION

TEST PROCEDURE

Measure Audio Power Output as follows:

A. Apply a 1000 microvolt, on-frequency test signal modulated by 1,000 Hz with +3.0 kHz deviation to antenna jack J3.

B. With 10 Watt Speaker

Disconnect a speaker. Connect a 4.0 ohm, 15 Watt load resistor in its place.

Connect the isolation transformer input across the resistor. Connect the isolation transformer output to the Distortion Analyzer (See Figure 4).

C. Adjust the VOLUME control for 10 Watts output 6.32 VRMS using the Distortion Analyzer as a voltmeter.

D. Make distortion measurements according to manufacturer's instructions. Reading should be less than 3%. If the receiver sensitivity is to be measured, leave all controls and equipment as they are.

SERVICE CHECK

If the distortion is more than 3%, or maximum audio output is less than 10 Watts, make the following checks:

E. Battery and regulator voltage---low voltage will cause distortion. (Refer to Receiver Schematic Diagram for voltages.)

F. Audio Gain (Refer to Receiver Troubleshooting Procedure).

G. FM Detector alignment (Refer to Receiver Alignment).

STEP 2
USABLE SENSITIVITY
(12 DB SINAD)

TEST PROCEDURE

If STEP 1 checks out properly, measure the receiver sensitivity as follows:

A. Apply a 1000 microvolt, on-frequency signal modulated by 1000 Hz with 3.0 kHz deviation to J3.

B. Place the RANGE switch on the Distortion Analyzer in the 200 to 2000 Hz distortion range position (1000 Hz filter in the circuit). Tune the filter for minimum reading or null on the lowest possible scale (100%, 30%, etc.)

C. Place the RANGE switch to the SET LEVEL position (filter out of the circuit) and adjust the input LEVEL control for a +2 dB reading on a mid range (30%).

D. Set signal generator output to 0.3 uV. Switch the RANGE control from SET LEVEL to the distortion range. Readjust Distortion Analyzer SET LEVEL as required until a 12 dB difference (+2 dB to -10 dB) is obtained between the SET LEVEL and distortion range positions (filter out and filter in).

E. The 12 dB difference (Signal plus Noise and Distortion to noise plus distortion ratio) is the "usable" sensitivity level. The sensitivity should be less than rated 12 dB SINAD specifications with an audio output of at least 5 Watts (4.47 Volts RMS across the 4.0 ohm receiver load using the Distortion Analyzer as a Voltmeter).

F. Leave all controls as they are and all equipment connected if the Modulation Acceptance Bandwidth test is to be performed.

SERVICE CHECK

If the sensitivity level is more than rated 12 dB SINAD, check the alignment of the IF stages as directed in the Alignment Procedure.

STEP 3
MODULATION ACCEPTANCE
BANDWITH(IF BANDWITH)

TEST PROCEDURE

If STEPS 1 and 2 check out properly, measure the bandwidth as follows:

A. Reduce audio output level to 10% of rated output.

B. Set the Signal Generator output for twice the microvolt reading obtained in the 12 dB SINAD measurement.

C. Set the Range control on the Distortion Analyzer in the SET LEVEL position (1000 Hz filter out of the circuit), and adjust the input LEVEL control for a +2 dB reading on the 30% range.

D. While increasing the deviation of the Signal Generator, switch the RANGE control from SET LEVEL to distortion range until a 12 dB difference is obtained between the SET LEVEL and distortion range readings (from +2 dB to -10 dB).

E. The deviation control reading for the 12 dB difference is the Modulation Acceptance Bandwidth of the

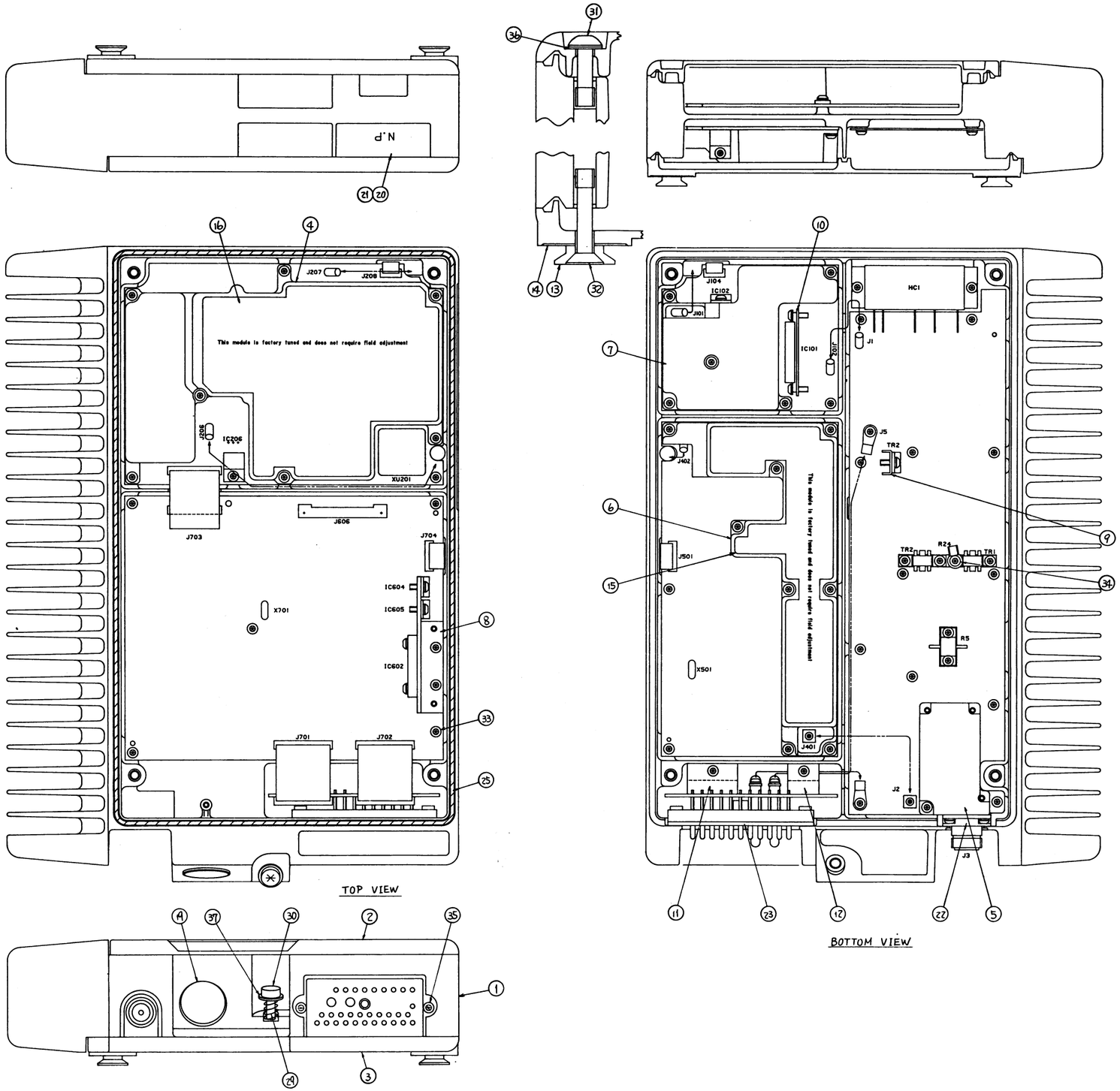
receiver. It should be more than +7.0 kHz.

SERVICE CHECK

If the Modulation Acceptance Bandwidth test does not indicate the proper width, check the synthesizer frequency and then refer to the alignment of IF stages.

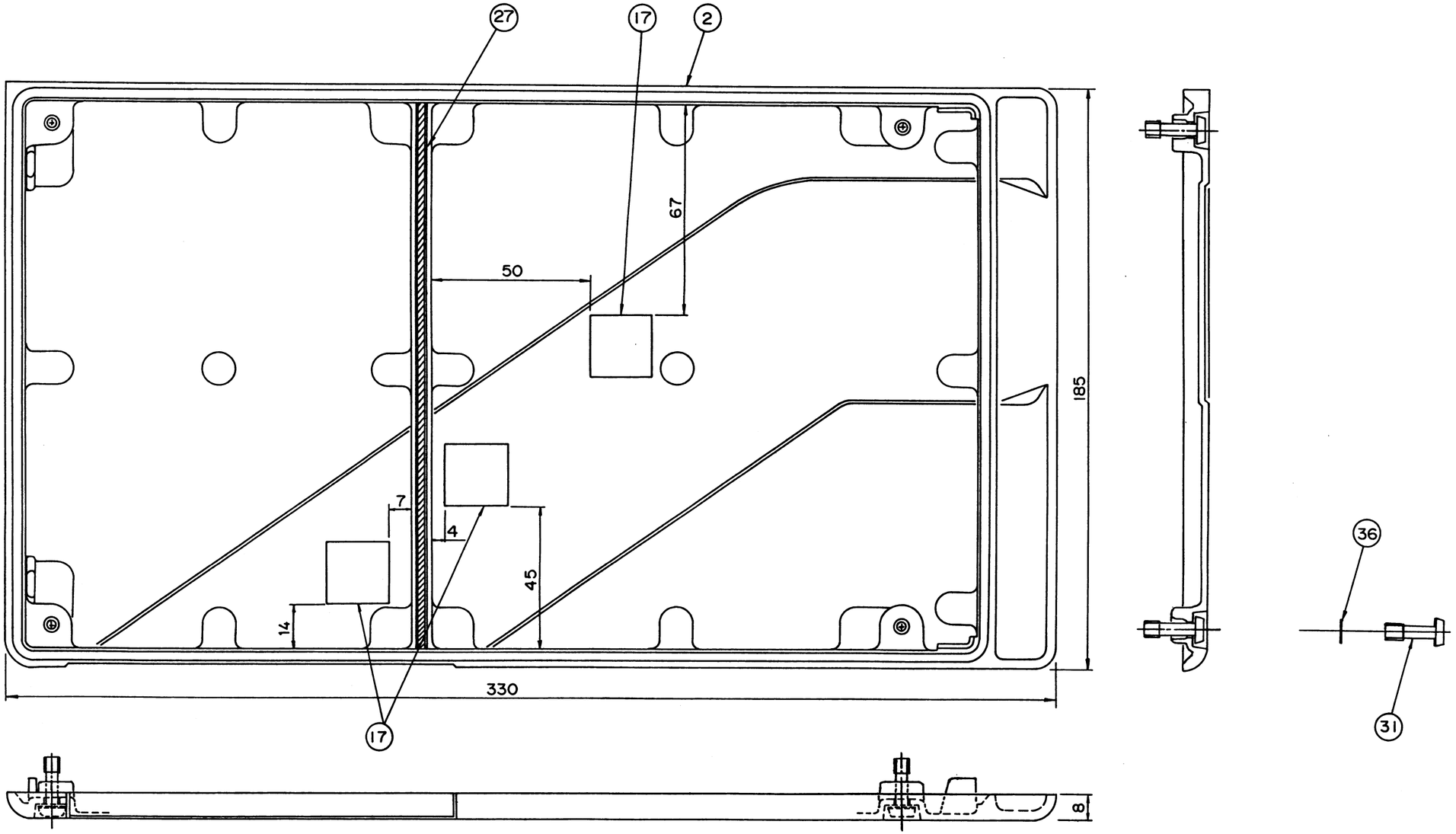
GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

GENERAL ELECTRIC*
U.S.A.

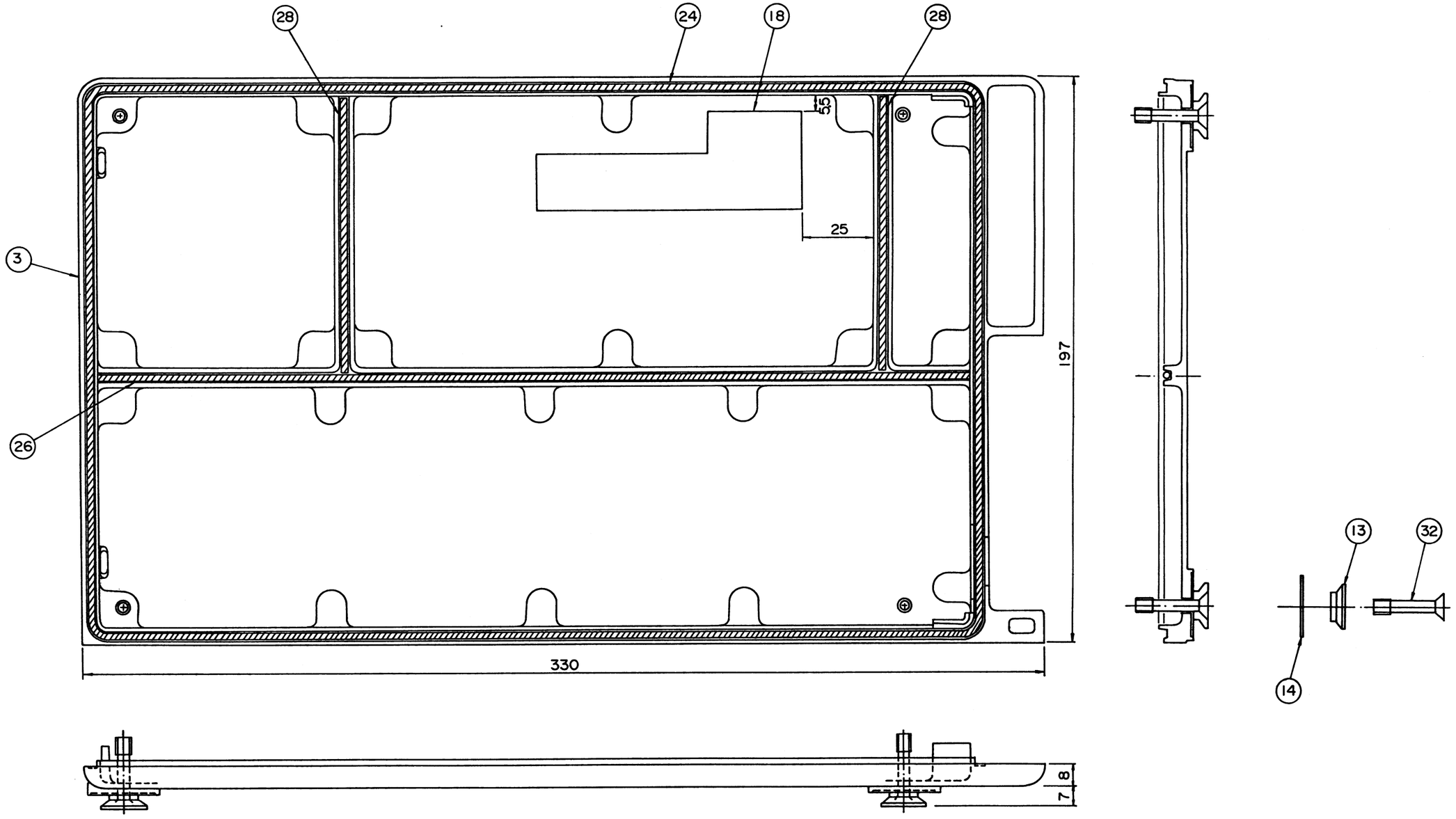


NO.	NOMENCLATOR	CODE
1	FRAME	MTC002415B
2	COVER, TOP	MTC002416B
3	COVER, BOTTOM	MTC002417A
4	CASE, SHIELD	MTC002425A
5	CASE, SHIELD	MTC002426A
6	CASE, SHIELD	MTC002428A
7	CASE, SHIELD	MTC002430A
8	PLATE, HEAT SINK	MTB145936
9	PLATE, HEAT SINK	MTB147952
10	PLATE, GROUNDING	MTB147822
11	PLATE, GROUNDING	MTB147949A
12	PLATE, GROUNDING	MTB147950A
13	FOOT	MTL032906B
14	SPACER	MTT021134A
15	SEAL	MTT021171A
16	SEAL	MTT021172A
17	PAD, PRESSURE	MTT021158
18	PAD, PRESSURE	MTT021217
19	COVER	MTV002836
20	PLATE, SERIAL NO.	MPNN18120A
21	OVER LAY	MPNN18378
22	GASKET, ANTENNA CONNECTOR	MPPK01109A
23	GASKET, INTERFACE CONNECTOR	MPPK01149
24	GASKET, SHIELD	MPPK01159
25	GASKET, SHIELD	MPPK01160
26	GASKET, SHIELD	MPPK01161
27	GASKET, SHIELD	MPPK01162
28	GASKET, SHIELD	MPPK01163
29	SPRING	MPSR02159A
30	SCREW	MPTG02014A
31	SCREW	MPTG02015
32	SCREW	MPTG02016
33	SCREW, PAN HEAD M3x8	BRTG03290
34	SCREW, PAN HEAD M3x12	BRTG03291
35	SCREW, FLAT HEAD M3x10	BRTG03293
36	WASHER, THRUST	BRTG01781
37	WASHER	BRTG03300

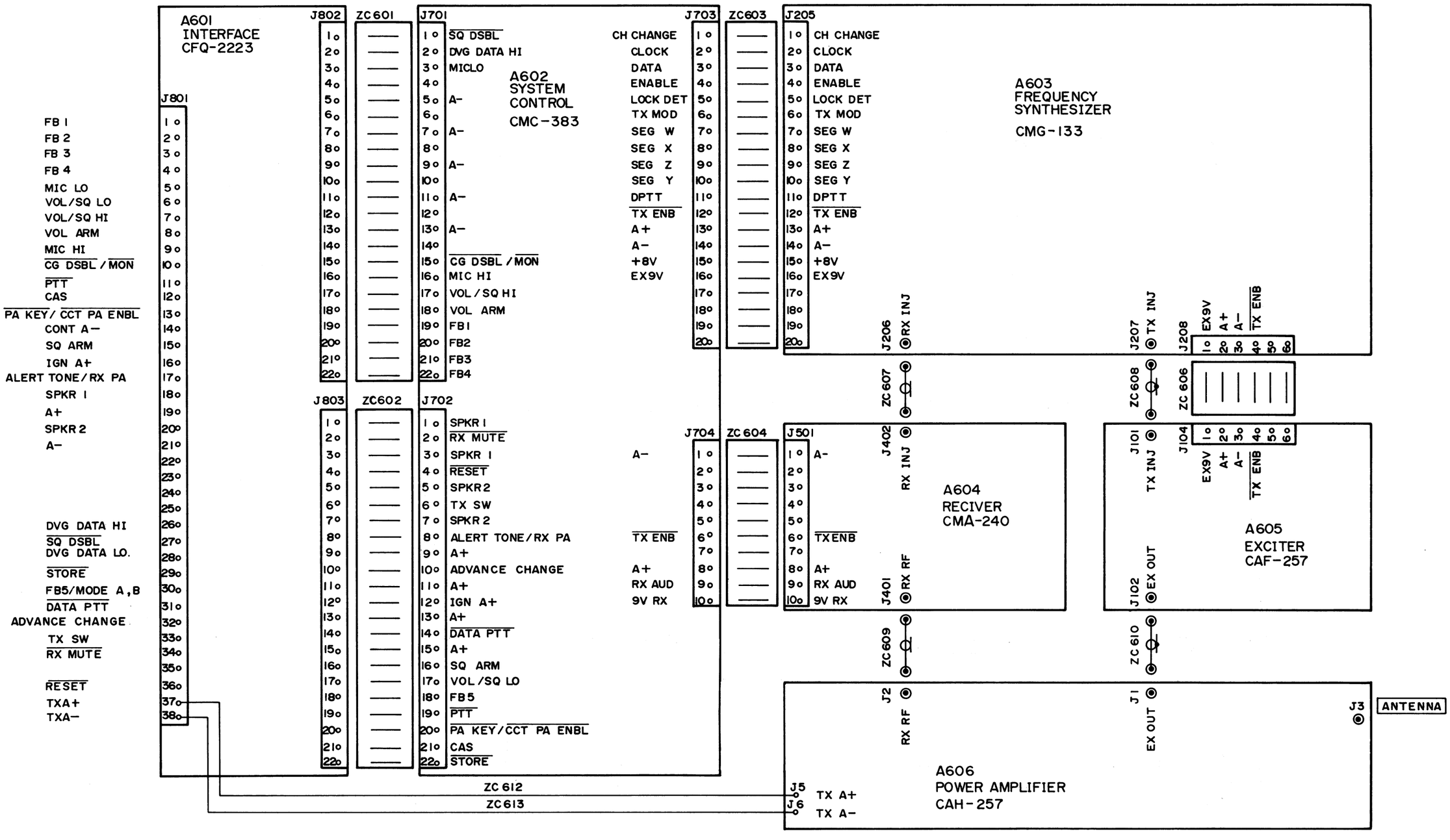
MECHANICAL LAYOUT DIAGRAM (1/3)



MECHANICAL LAYOUT DIAGRAM (2/3)
TOP COVER ASSEMBLY



MECHANICAL LAYOUT DIAGRAM (3/3)
BOTTOM COVER ASSEMBLY



SCHEMATIC DIAGRAM

INTERCONNECTION

DDOO-JHM-851S35