MAINTENANCE MANUAL

800 MHz SYNTHESIZED RANGR 16 PLUS™

TWO WAY FM RADIO

SERVICE SECTION

TABLE OF CONTENTS

GENERAL ELECTRIC

DESCRIPTION

This section contains the information required to service the radio. Included are disassembly procedures, and procedures for replacing transistors, Integrated Circuits (IC's) and chip components. This 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. Measure the frequency and modulation, and record these measurements for future reference. For the complete transmitter adjustment, refer to the Transmitter 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 facilitate troubleshooting of problems on the printed circuit board assemblies, the following service accessories are available:

DESCRIPTION	PART NUMBER
EXTENSION CABLE 22 CONDUCTOR	B19/6JJFD00057
EXTENSION CABLE 10 CONDUCTOR	B19/6JJFD00058
EXTENSION CABLE 10 CONDUCTOR	B19/6JJFD00059
EXTENSION CABLE 4 CONDUCTOR	B19/6JJFD00060
EXTENSION CABLE 6 CONDUCTOR	B19/6JJFD00061
COAXIAL CABLE	B19/6JJFD00062
COAXIAL CABLE	B19/6JJFD00063
TUNING TOOL	B19/MPTC00003

To ensure high operating efficiency and to prevent mechanical and electrical failures from interrupting system operations, routine checks should be made of all mechanical and electrical parts at regular intervals. This preventive maintenance should include the checks as listed in Table 1, 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 drop 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 resistance. A high resistance may cause excessive voltage drop 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 weak 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 antenna or its base should become coated or poorly grounded, loss of radiation and a weak signal will result.	X	
ALIGNMENT - The transmitter and receiver voltage 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 the 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

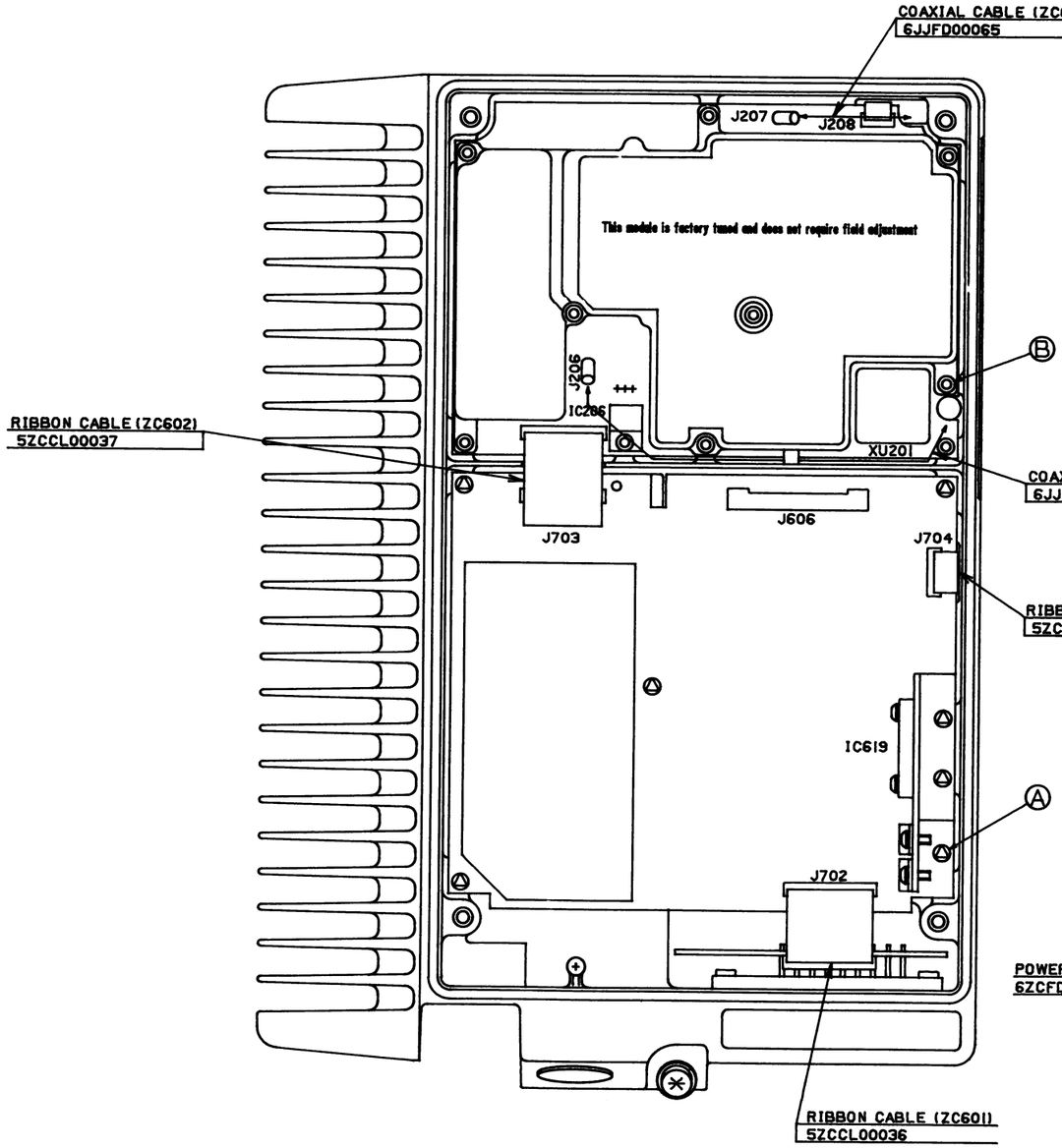
DISASSEMBLY PROCEDURE

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 remove from the mounting bracket.

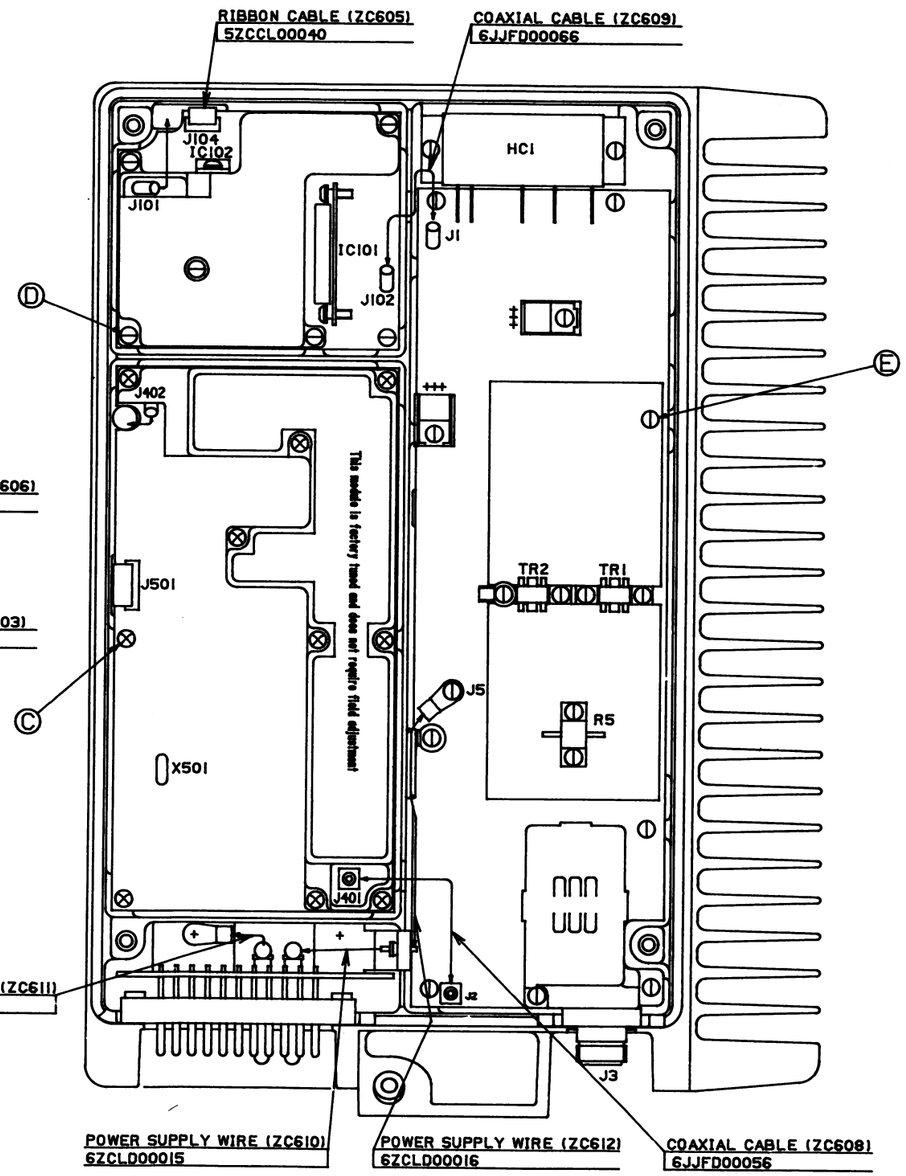
To remove the printed wire boards:

1. Remove the radio cover.
2. Remove the cables and screws for the desired board as listed in Table 2.



Disassembly–Top View

Figure 1



Disassembly–Bottom View

Figure 2

Board name	Cables to be removed	Screws to be removed
System Control board	Three ribbon cables	Seven screws 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 and 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 Preceding procedures in reverse order.

CAUTION

After securing the radio, it is important that the screws holding the covers be fully secured. This ensures that the RF shielding gaskets make good contact and that the radio performance specifications are not compromised.

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 when replacing transistors of this type.

To replace the PA RF transistors:

1. Unsolder one lead at a time using a 50-watt soldering iron. Use a scribe or knife to hold the lead away from the printed circuit board until the solder cools. Removed the mounting screws.

2. Lift out the transistor. Remove any old solder from the printed circuit board with a vacuum desoldering tool. Use care to prevent damage to the printed circuit board runs because part of the matching network is included in the emitter and collector runs.

3. Trim the new transistor leads (if required) to the lead length of the removed transistor.

4. Apply a thin coat of silicone 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 (9.4 kg•cm).

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. Do not use excessive heat that may cause the printed wire board runs to separate 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 set at 700°F (371°C). However, do not touch the 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 irons, heat both ends of the chip at the same time until solder flows. 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 of the board. Simultaneously touch the component and the pad with a well "tinned" soldering iron, pressing the component down on the board.

3. Place the "tinned" soldering iron on the other end of the component and 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 to get a good joint.

4. After the component has cooled, remove all flux from the component and printed wiring board area using 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 loaded):	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 sometimes desirable to force the microcomputer into specific operating modes. Following are tips that allow you to initiate these modes.

- Ground the lock-detect line to the microcomputer at IC618-2, to force it to continually try to reload the synthesizer. 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, ground IC611-10 to activate the reset circuit.

MICROPHONICS

Synthesized radios tend to be sensitive to shock and vibration, creating microphonics. The construction of the RANGR 16 PLUS™ radio with its die-cast aluminum frame, cast shield, and multiple board mounting screws, provides a high degree of immunity. When removing either printed circuit boards or shield, note the location of all mounting hardware.

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

To assure a high degree of resistance to microphonics, be sure to replace all hardware exactly as removed.

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 all operational modes, contains software to perform diagnostics. Certain self-diagnostics are run at power-up (external RAM and ROM tests) while others are invoked through the Control Unit at reset.

When reset occurs, a check sum is calculated on the program memory (IC-605). If an error occurs, an E1 is flashed on the SYSTEM display. Once the check sum test passes, a read/write test is performed to all RAM (IC-606) locations. If any location fails, an E2 is flashed on the SYSTEM display of the Control Unit. Once an error is displayed, the radio remains in the error-display state and no further operation is allowed.

A test mode is provided for adjusting and checking radio settings. The test mode is activated via the Control Unit. When using the S550 16 PLUS control head, power down the unit and connect J203-11 to J203-19. When the unit is turned on again, it will enter the test mode.

In test mode, the GROUP display shows the RF test channel and the SYSTEM display shows the test number. The test channel is determined by the information in the personality PROM selected at programming.

There are nine tests which may be selected via the SYSTEM switch:

01 Mic Test -- used to set receive audio output level and microphone deviation.

02 Channel Guard Test -- used to Set Channel Guard tone deviation.

03 Channel Guard plus MIC Test -- used to verify Channel Guard plus voice audio deviation.

04 Alert Tone Test -- used to test alert tone operation and verify receive Voice Guard audio operation.

05 Digital Data Test -- used to set digital data deviation and verify receive Voice Guard ® audio operation.

06 Voice Guard Transmit Data Test -- transmits Voice Guard data (must be driven from an external source)

07 Voice Guard Transmit Audio Test -- Transmits audio from the Voice Guard TX DATA HI line (must be driven from an external source)

08 Modem Data Loop-back Test -- checks modem receive and transmit paths.

09 Software Revision Test -- displays current software revision number in the GROUP display.

When operated in the test mode, some of the Control Unit controls function differently.

OFF/VOLUME Turns off/on DC power to the RANGR 16 PLUS™ and adjusts receive audio level (same as standard operation).

Squelch When SCN is pressed and held, the SYSTEM control adjusts the squelch level. Rotating the SYSTEM control counterclockwise on squelches the radio. Releasing SCN will store the squelch setting. The same procedure is used in conventional mode or when monitoring a trunked call.

GROUP Transmit channels are changed using the GROUP switch. Recommended GROUP settings and frequencies are presented in Table 3. These frequencies are normally programmed in the radio when it leaves the factory.

The test routines are used during adjustment of the RANGR 16 PLUS™. When troubleshooting the RANGR 16 PLUS™, it is recommended that the transmitter and receiver alignment procedures be followed to locate the problem.

GROUP Setting	TX FREQ. (MHz)	RX FREQ. (MHz)	CHANNEL GUARD	CCT
1	815.9625	860.9625	71.9	
2	824.9875	869.9875	023	
3	806.0125	851.0125		1 min
4	860.9875	860.9625	71.9	
5	869.9875	869.9625		
6	815.9875	860.9875		1 min
7	824.9625	869.9625		
8	806.0375	851.0325		
9	861.3250	860.9750		
10	869.9750	869.9500		
11	851.3500	851.3500		
12	823.0000	851.0000		1 min

Table 3 - Group Settings and Frequencies

PA TROUBLESHOOTING PROCEDURE

DC VOLTAGE CHECK

First, Check meter readings for power supply voltage and various stabilized DC voltages at TP606. The typical readings for the test points are given in Table 4.

METERING POINT	FUNCTION MEASURED	TYPICAL READING
TP606-1	A-	-
TP606-2	N.C.	-
TP606-3	R 9 V	9 V
TP606-4	+5 V	5 V
TP606-5	N.C.	-
TP606-6	Tx A+	13.6 V
TP606-7	N.C.	-
TP606-8	EX 9 V	9 V
TP606-9	+8 V	8 V
TP606-10	N.C.	-
TP606-11	+9 V	9 V
TP606-12	+5 VA	5 V

Table 4 - Readings at TP606

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) as listed in Table 5.

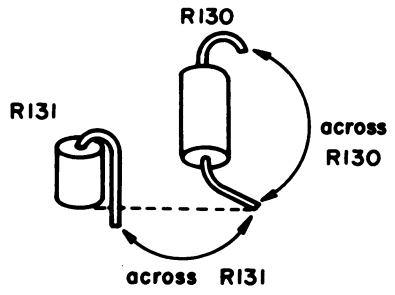
SYMPTOM	PROCEDURE	ANALYSIS
Little or No RF Output	Key transmitter and monitor DC voltages across R130 for 0.3 VDC or R131 for 1.0 VDC. Each voltage should increase. 	If voltage does not increase, check TR101 to TR104, HC101 and associated components.
	Disconnect the coaxial cable ZC607 from the synthesizer 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

RADIO CONNECTOR IDENTIFICATION

The RANGR 16 PLUS™ interface connectors are identified in Table 6.

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

Table 6 - Radio Connector Identification

TEST PROCEDURES

These Test Procedures are designed to assist you in servicing a transmitter that is not operating properly. Once a defect is pinpointed, 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 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, instantaneously limits the slope of the audio wave to the modulator, thereby preventing over-modulation while preserving intelligibility.

TEST EQUIPMENT REQUIRED

- 13.8 VDC, 15 A supply (unless tested in vehicle)
- Audio Oscillator (GE Model 4EX6A10)
- 50-ohm RF load at rated transmitter output power
- Deviation Meter
- 30 dB directional coupler
- Output Meter or VTVM

TRANSMIT DEVIATION ADJUSTMENT

NOTE

The transmit deviation has been set at the factory and should not require adjustment. Should readjustment become necessary, refer to the Maintenance Manual LBI-31828 circuit descriptions for the System and Synthesizer boards. These descriptions will make the alignment procedure more understandable.

1. Connect the Control unit to the RANGR 16 PLUS™.
2. Connect J203-11 to J203-2 (enable test mode) on the Control unit.
3. Connect DC power to RANGR 16 PLUS™ through the Control unit.
4. Set GROUP control to 01 (815.9625 MHz RF test frequency).
5. Set SYSTEM control to test 01.
6. Rotate Synthesizer board control RV201 fully counterclockwise.
7. Set audio signal generator for a 1 kHz tone at 1 Vrms, and couple through a 100 µF capacitor (+ lead of capacitor) to MIC HI at J702-10.
8. Connect the deviation meter to antenna connector J3 through a 30 dB coupler terminated in a 50-ohm load.
9. Key the radio, and set VCO DEVIATION ADJUST control RV202 on the Synthesizer board for 3.75 kHz deviation.
10. Remove P602 on the System Control board and apply a 400 Hz sine wave to J602-TX MOD.
11. Key the radio and vary the amplitude of the audio signal until the deviation is 2 kHz. Unkey the radio and record the amplitude of the audio signal.
12. Change the signal generator frequency to 10 Hz and adjust the audio output to the same level obtained in the preceding step.
13. Key the radio and adjust the REF MOD ADJUST control RV201 for a deviation of 2 kHz.

14. Unkey the radio, and disconnect the signal generator.

15. Replace P602 in the TX MOD position.

16. Set the SYSTEM control to 02.

17. Key the radio, and adjust the CG DEVIATION ADJUST control RV601 for a deviation of 0.75 kHz.

18. Unkey the radio and set the SYSTEM control for 03 (Channel Guard plus voice audio test).

19. Verify deviation does not exceed 4.5 kHz.

20. Unkey the radio, and set the SYSTEM control to 05 (Digital Data test).

21. Key the radio, and adjust DATA DEVIATION ADJUST control RV602 for 3.2 kHz deviation.

MODEM DATA LOOP-BACK TEST

This test verifies continuity from TX DATA (IC614-1) through IC615, IC617, IC615, IC612, P601, IC613, and IC611 returning to the modem as RX DATA (modem receive data).

TEST EQUIPMENT REQUIRED

- 13.8 VDC regulated power supply

TEST PROCEDURE

1. Place P601 in the TEST position.

2. Connect the control unit to the RANGR 16 PLUS™.

3. Connect J203-11 to J203-2 (enable test mode) on the Control Unit.

4. Connect DC power to RANGR 16 PLUS™.

5. Set the SYSTEM display to 08 (Modem Data Loop-Back Test).

6. Momentarily key the transmitter. The BSY indicator will illuminate during the active part of the data test. When the test finishes, one of the following results will appear in the GROUP display.

   E0 -- Test completed without failure

   E1 -- First pass failed. Receive and transmit data not the same.

   E2 -- Second pass failed. Unable to disable receive data (check TR602).

7. Return P601 to the AF OUT position.

AUDIO CHECKS

TEST EQUIPMENT REQUIRED

- Audio Oscillator
- AC Voltmeter
- Oscilloscope
- Deviation Meter

AUDIO AC VOLTAGE

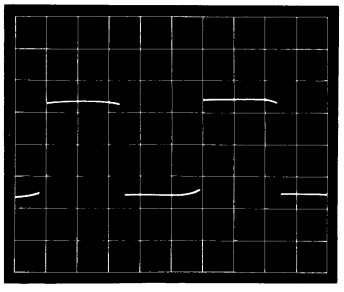
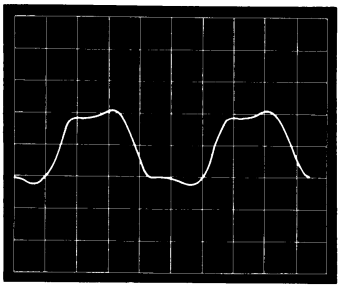
1. Connect audio oscillator across J702-10 (MIC HI) and J702-12 (GROUND).

NOTE

An rms or peak-reading voltmeter will read 1/2 to 1/3 of peak-to-peak values.

2. Set audio oscillator for 1000 Hz sine wave at 1 Vrms.

3. Connect the oscilloscope probe to IC613-7 and IC612-1 and observe the indicated wave forms.

		IC613-7	IC612-1
SCOPE SETTING	HORIZONTAL	200µ SEC/DIV	200µ SEC/DIV
	VERTICAL	0.5 VOLTS/DIV	2 VOLTS/DIV
			

4. Key the radio and observe a deviation of 3.75 kHz.

AUDIO SENSITIVITY

1. Connect the audio oscillator output across J702-10 (MIC HI) and J702-12 (GROUND).

2. Set the audio oscillator for a 1000 Hz sine wave at 1 Vrms.

3. Key the radio, and reduce the audio oscillator level until the deviation falls to 3.0 kHz.

4. Unkey the radio and measure the audio oscillator output voltage. The voltage level should be less than 110 mV.

SYNTHESIZER AND TRANSMITTER ALIGNMENT

TEST EQUIPMENT REQUIRED

- Wattmeter (50-ohm) with 1 and 150 watt ranges
- DC Voltmeter, 20 k ohms/volt sensitivity
- 50-ohm RF load at rated transmitter output power
- Digital Voltmeter
- 13.8 VDC regulated power supply

PRELIMINARY CHECKS AND ADJUSTMENTS

NOTE

Refer to Figure 3 for tuning and adjustment control locations.

1. Apply DC power to the radio.

2. Allow power supply voltage (A+) and DC supply voltages to stabilize. Voltage readings should agree with Table 4.

3. Connect a 50-ohm load to the radio.

ALIGNMENT PROCEDURE

The synthesizer is factory aligned and should not require adjustment. Should readjustment become necessary, refer to the Maintenance Manual LBI-31828 circuit descriptions for the Synthesizer board. These descriptions will make the alignment procedure more understandable.

Before beginning the alignment, holes must be made in the label to gain access to the adjustable components. The hole locations are shown in Figure 3. In order to align the two segments of the transmit VCO, it is recommended that the test frequencies listed in Table 3 be used during the test mode.

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
1.	TP201	CV202	7.0 VDC	SYNTHESIZER ALIGNMENT a. Select GROUP 05 (869.9875 MHz) b. Key the radio and adjust CV202 until the Lock-Detect indicator (CD610) goes out. c. Monitor TP201 with a DVM and adjust CV202 for a reading of 7.0 ± 0.1 VDC. d. Check that CD610 remains out, and unkey the radio.
2.	TP201 (Control Voltage Monitor)	CV201	6.0 VDC	a. Select GROUP 01 (receive frequency 860.9625 MHz) b. Adjust CV201 until the Lock-Detect indicator (CD610) goes out. c. Monitor TP201 with a DVM and adjust CV201 for a reading of 6.0 ± 0.1 VDC. Check that CD610 remains out.
3.	TP201 (Control Voltage Monitor)		4.5-7.5 VDC	a. Select GROUP 03, 07, 10, and 11 in turn, keying the radio on each GROUP. b. On each GROUP setting, the voltage at TP201 should be in the range of 4.5 to 7.5 VDC.
4.	TP201		4.5-7.5 VDC	a. Select GROUP 02 and 11 and verify the voltage at TP201 is in the range of 4.5 to 7.5 VDC.
5.	J207 (TX injection) & J206 (RX injection)		0 to 6 dBm	a. Monitor J207 and verify signal level of 0 to 6 dBm into 50 ohms. b. Monitor J206 and verify signal level of 0 to 6 dBm into 50 ohms.
6.				REFERENCE OSCILLATOR FREQUENCY NOTE Measure the frequency when the radio 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.

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
	J207	FREQ TRIM Control on VC-TCXO	Channel operating frequency	a. Key the radio and monitor the TX injection frequency at J207. Adjust the FREQ TRIM control on VC-TCXO for the assigned channel frequency ±0.2 ppm. The receive injection frequency will also be adjusted automatically.
7.				EXCITER NOTE The exciter requires no adjustment. Check the exciter with the following procedure. NOTE The exciter may be isolated from the rest of the radio. To isolate and set up for alignment, remove coaxial cables ZC607 and ZC609, and connect a wattmeter (0-1 watt) to J102. a. Apply a 6 dBm signal to J101 at a frequency of 1/6 the output frequency. The wattmeter should indicate an output greater than 400 mW.
8.			RV1	a. Key the radio, and monitor transmitter output on each channel. b. Select the channel with the highest output power and set RV1 for rated output power.

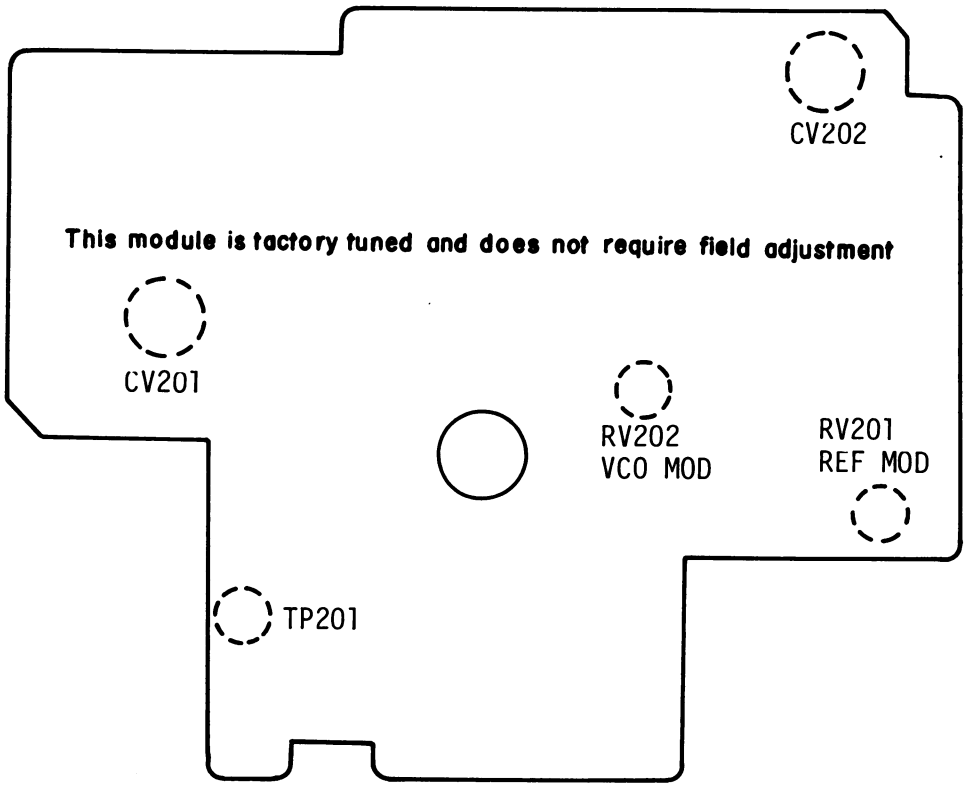
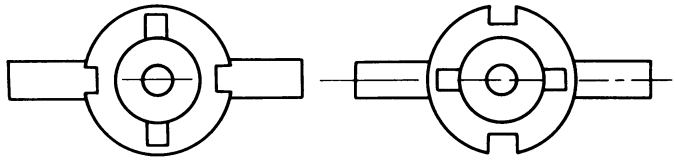


Figure 3 - Hole locations for synthesizer tuning and transmitter deviation adjustment

- POWER AMPLIFIER -

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
9.		RV1 CV1 CV2	38 W	NOTE Set the radio in the condition where power supply voltage and ambient temperature are 13.6V and 25°C or near respectively.

<table>
<tr><th>STEP</th><th>METERING POINT</th><th>TUNING CONTROL</th><th>METER READING</th><th>PROCEDURE</th></tr>
<tr><td></td><td></td><td></td><td></td><td>a. Reset RF POWER ADJUSTER RV1 installed on the PA board for full counterclockwise rotation.
b. Check the transmitter power output at the high end of the band. If it is around 38 watts (37 to 38 watts), then CV1 and CV2 adjustment are not necessary.
c. If not, adjust CV1 and CV2 to provide 38 watts after each capacitance of CV1 and CV2 is reset for maximum value as shown in the figure below.
 
Capacitance max. Capacitance min.
Top view of CV1 & CV2
NOTE
Adjust CV1 and CV2 in equal difference of power output. When the power output is 35 watts after CV1 and CV2 reset, for example, increase it to 38 watts in the following manner.
1 Increase 1.5 watts by adjusting CV1.
2 Increase 1.5 watts by adjusting CV2.
NOTE
Avoid to set the power output in excess of 38 watts in order to meet with the specification BATTERY DRAIN, especialy in the low end of the band.</td></tr>
<tr><td>10.</td><td></td><td>RV1</td><td>35 W</td><td>Set the power output to 35 watts (rated power output) by adjusting RV1.</td></tr>
</table>

TRANSMIT AUDIO CHECKS

1. Connect the control unit to the RANGR 16 PLUS™.

2. Connect J203-11 to J203-2 (enable test mode) on the Control unit.

3. Connect DC power to RANGR 16 PLUS™.

4. Set SYSTEM control to test 01.

5. Apply a 1000 Hz, 1 Vrms sine wave to MIC HI at J702-10.

6. Monitor the points listed in Table 7 using an oscilloscope equipped with a 10 Meg ohm probe. Observe the typical levels indicated in the table.

FIGURE 4 REFERENCE	MONITOR POINT	TYPICAL PEAK-TO-PEAK READINGS
A	IC613-7	1.3 V square wave with slow rise and fall times
B	IC617-26	Similar to that on IC613-7, but slower rise and fall times.
C	IC612-1 (TX MOD)	4.5 V wave form similar to that on IC617-26

Table 7 - Typical 1000 Hz Levels

7. Set SYSTEM control to 02.

8. Monitor the points listed in Table 8 using an oscilloscope equipped with a 10 Meg ohm probe. Observe the typical levels indicated in the table.

FIGURE 4 REFERENCE	MONITOR POINT	TYPICAL PEAK-TO-PEAK READINGS
D	IC615-10	4.5 V staircase at 75 Hz
E	IC617-6	0.4 V approximate sine wave at 75 Hz
C	IC612-1 (TX MOD)	0.8 V, 75 Hz sine wave

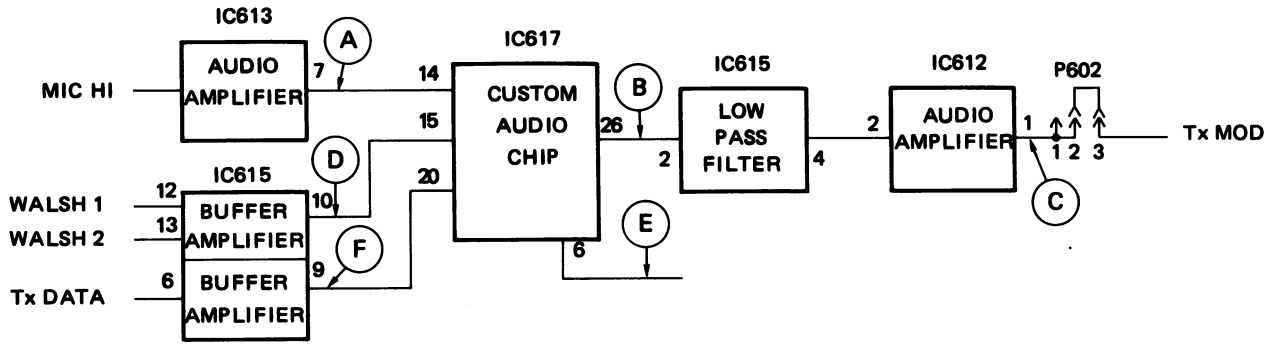
Table 8 - Typical Channel Guard Levels

9. Set SYSTEM control to 05.

10. Monitor the points listed in Table 9 using an oscilloscope equipped with a 10 Meg ohm probe. Observe the typical levels indicated in the table.

FIGURE 4 REFERENCE	MONITOR POINT	TYPICAL PEAK-TO-PEAK READINGS
F	IC615-9	1.3 V pseudorandom data
B	IC617-26	1.2 V pseudorandom data
C	IC612-1 (TX MOD)	3.5 V pseudorandom data

Table 9 - Typical Data Levels



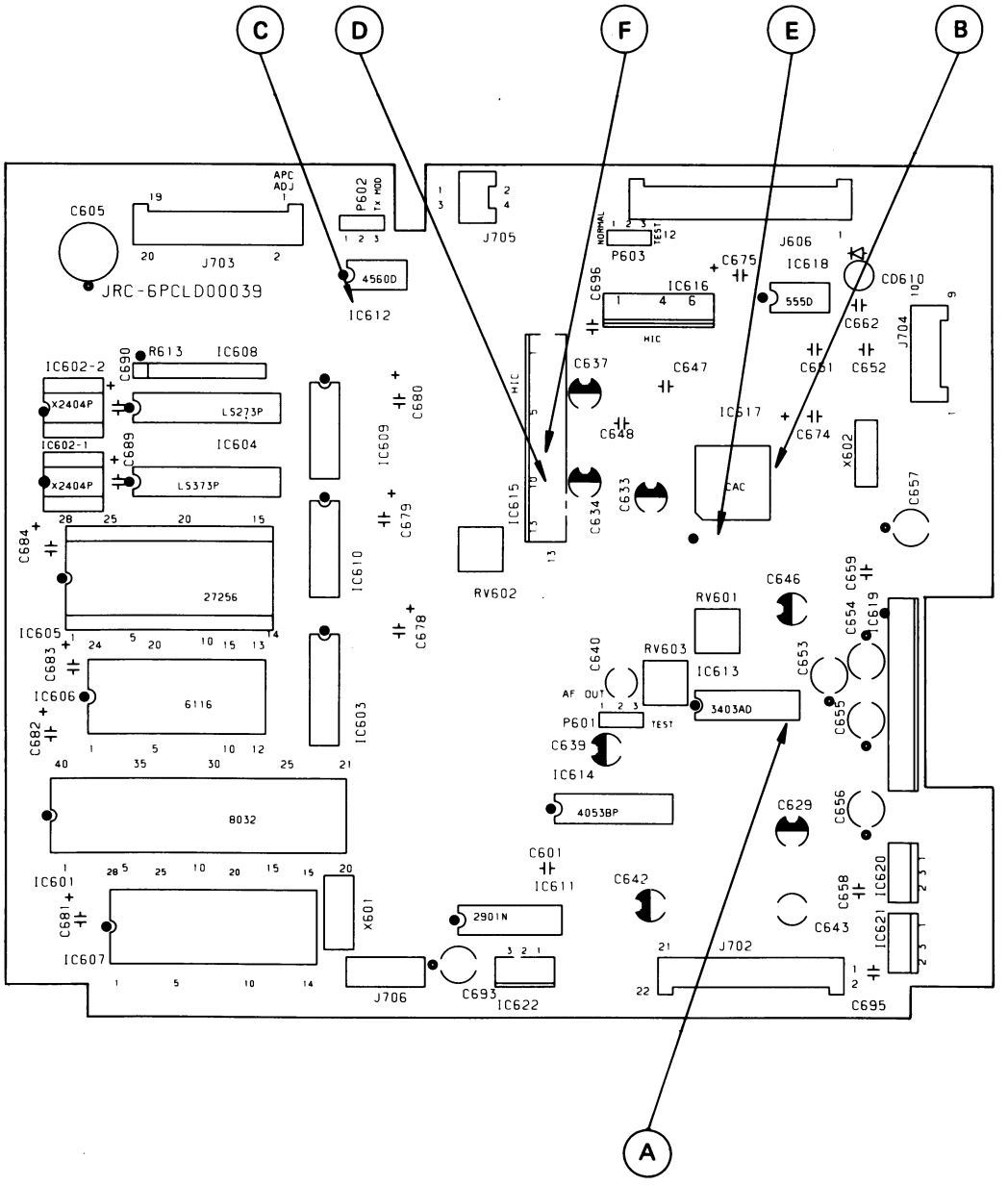


Figure 4 - TRANSMIT AUDIO CHECKS

RECEIVER ALIGNMENT

Alignment of front-end and Local Injection circuits is not required because a dielectric band-pass filter is employed in the RANGR 16 PLUS™ wideband synthesized radio receiver.

TEST EQUIPMENT REQUIRED

- 20,000 ohms-per-volt multimeter.
- AC Voltmeter
- RF Signal Generator
- Frequency Counter (806 to 870 MHz)
- 4-ohm, 15-watt resistor
- Audio Isolation Transformer (1:1) 19A116736P1 or equivalent
- Oscilloscope

> 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 82.655 MHz ±200 Hz.

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 4).

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 12 dB SINAD at audio output.

Adjust coils L501 (Figure 7) to L505 to obtain minimum 12 dB SINAD.

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

Adjust L508 for maximum audio output.

Adjust RV603 until audio output level at TP1 becomes 300 mV rms.

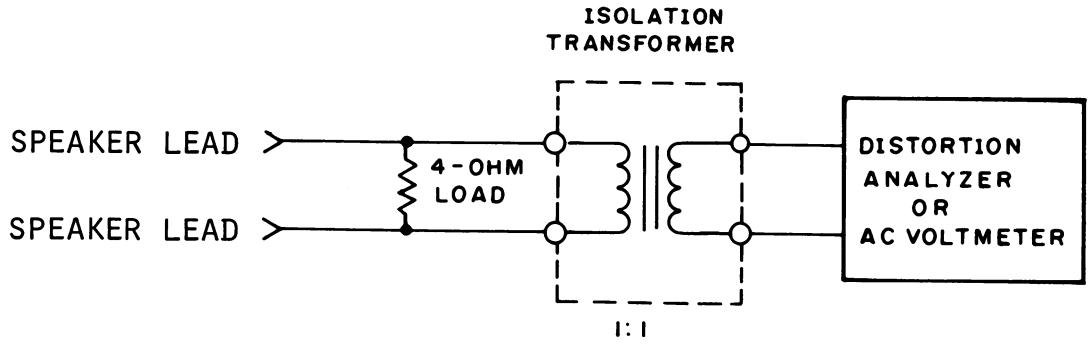


Figure 5 - Audio Isolation Transformer

RECEIVER AUDIO CHECKS

1. Connect the control unit to the RANGR 16 PLUS™.

2. Connect J203-11 to J203-2 (enable test mode) on the Control Unit.

3. Connect DC power to RANGR 16 PLUS™.

4. Set SYSTEM control to test 01.

5. Connect the 4-ohm load, isolation transformer, and distortion analyzer or AC voltmeter as shown in Figure 5.

6. Apply an on-frequency signal to the antenna connector J3 at 1 mV, modulated with a 1 kHz sine wave at 3 kHz deviation.

7. Adjust the OFF/VOLUME control for a 6.3 Vrms signal across the 4 ohm load.

8. Monitor the points listed in Table 10 using an oscilloscope equipped with a 10 Meg ohm probe. Observe the typical sine wave levels indicated in the table.

FIGURE 6 REFERENCE	MONITOR POINT	TYPICAL PEAK-TO-PEAK READINGS FOR SINUSOIDAL WAVEFORM
A	IC613-14	2.75 V
B	IC617-27	1.4 V
C	IC616-6	1.4 V
D	IC616-2	1.0 V
E	J702-1, 3	10 V
F	J702-2, 4	10 V

Table 10 - Typical 1 kHz Levels

9. Change modulation to a 100 Hz sine wave at 0.75 kHz deviation.

10. Monitor the points listed in Table 11 using an oscilloscope equipped with a 10 Meg ohm probe. Observe the typical levels indicated in the table.

FIGURE 6 REFERENCE	MONITOR POINT	TYPICAL PEAK-TO-PEAK READINGS
G	IC617-6	0.6 V sine wave
H	IC617-11	5.0 V square wave

Table 11 - Typical 100 Hz Levels

11. Remove the signal from J3 and fully squelch the radio (no signal).

12. Monitor the points listed in Table 12 using an oscilloscope equipped with a 10 Meg ohm probe. Observe the typical levels indicated in the table.

FIGURE 6 REFERENCE	MONITOR POINT	TYPICAL READINGS
A	IC613-14	3.5 Vp-p (noise)
J	IC617-4	5.0 Vp-p (noise)
K	IC617-56	3.5 VDC
L	IC617-51	3 volt negative-going pules, 10 ms wide at a 10 Hz rate, from a 4.2 VDC level
M	IC617-43	5 volt negative-going pulses, 10 ms wide at a 10 Hz rate, from a 5 VDC level

Table 12 - Typical Levels For No Signal Input

NOTE

The Custom Audio Chip (IC617) is a staticsensitive CMOS device in a 60-pin flat pack.

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.

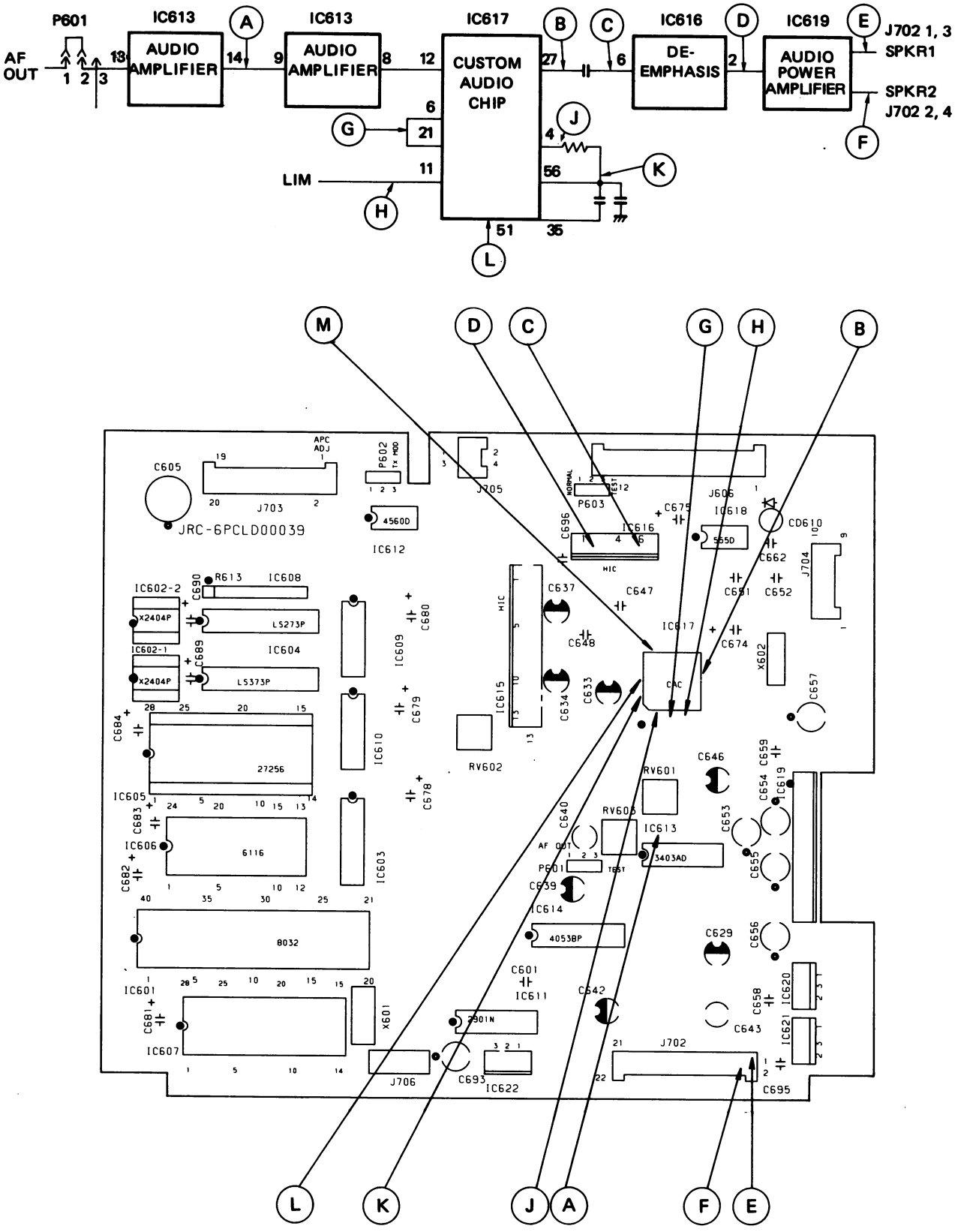


Figure 6 - RECEIVER AUDIO CHECK POINTS

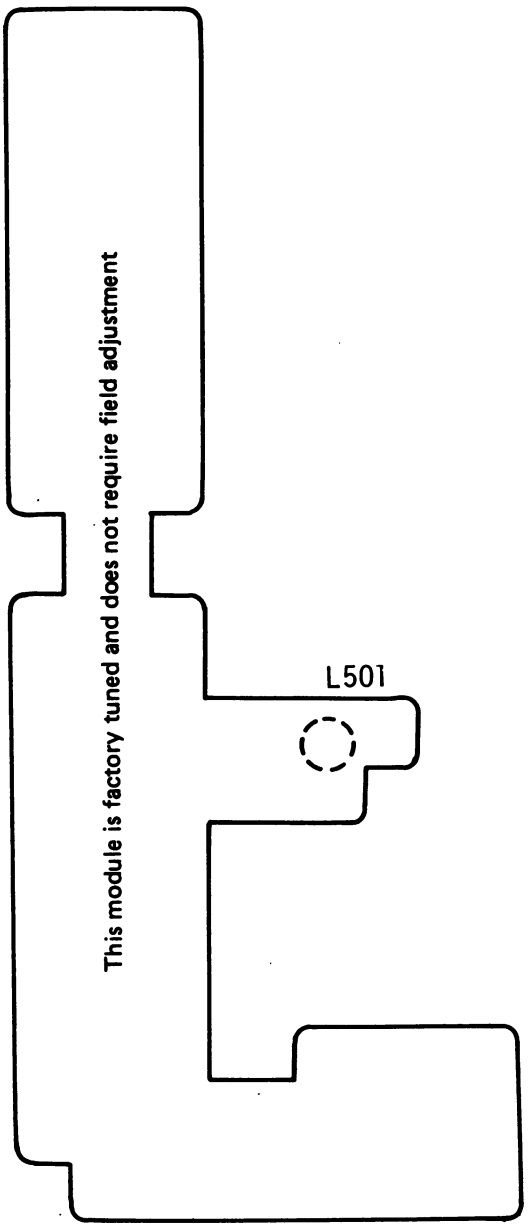


Figure 7 - Hole location for receiver adjustment

TEST PROCEDURE

These Test Procedures are designed to help you to service a receiver that is not operating 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 pinpointed, 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

- Distortion Analyzer
- Signal Generator
- 6 dB attenuation pad
- Audio Isolation Transformer
- 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 the 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 the speaker. Connect a 4-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 5).

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 the manufacturer's instructions. Reading should be less the 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. Low battery and regulator voltage will cause distortion. (Refer to Receiver Schematic Diagram for voltages.)

F. 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 μV. 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
BANDWIDTH (IF BANDWIDTH)

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 to 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. If should be more than $\pm$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.

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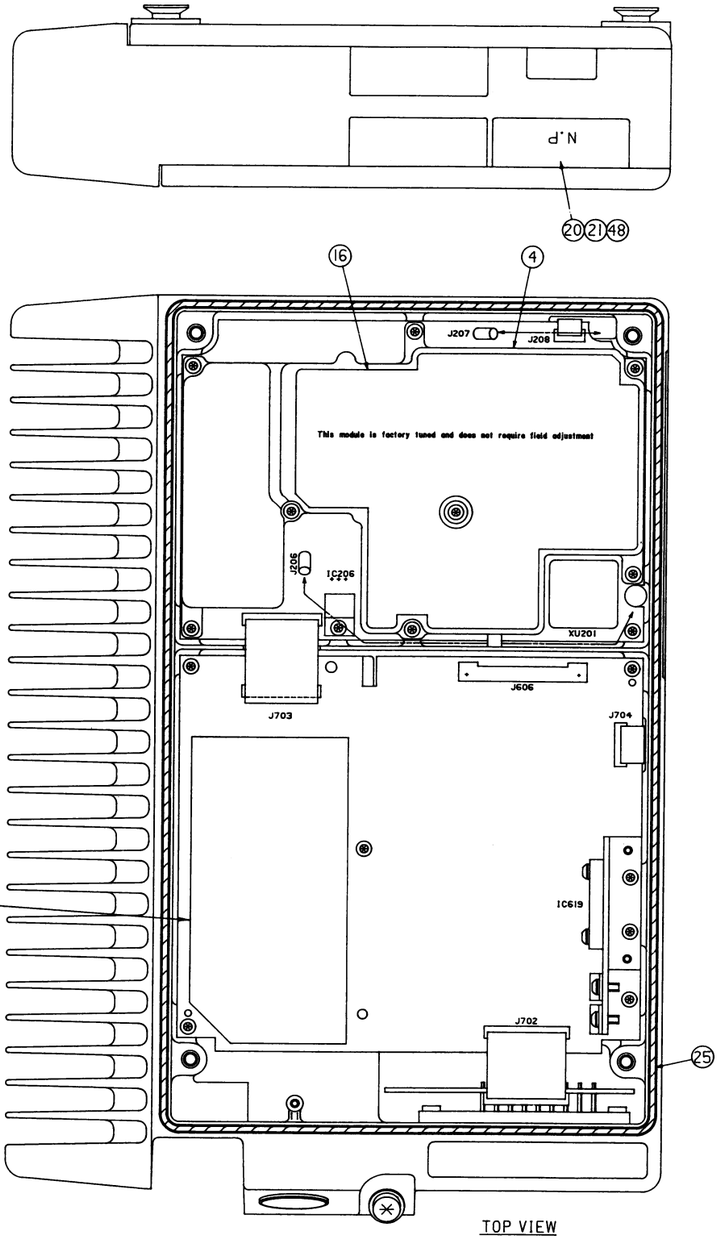
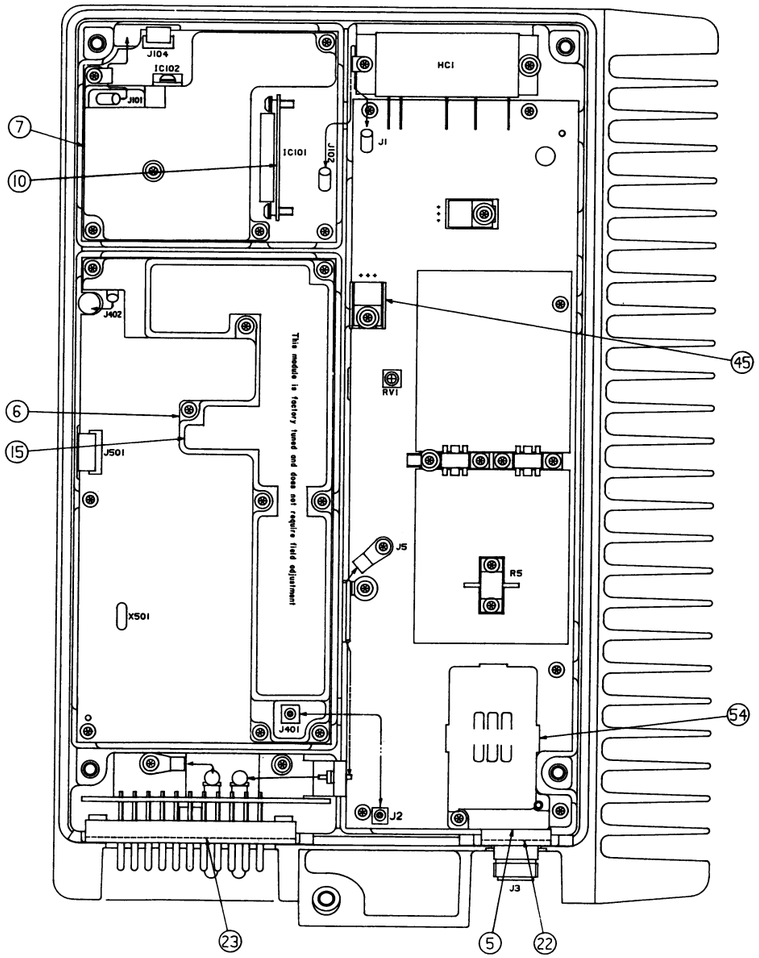
U.S.A.

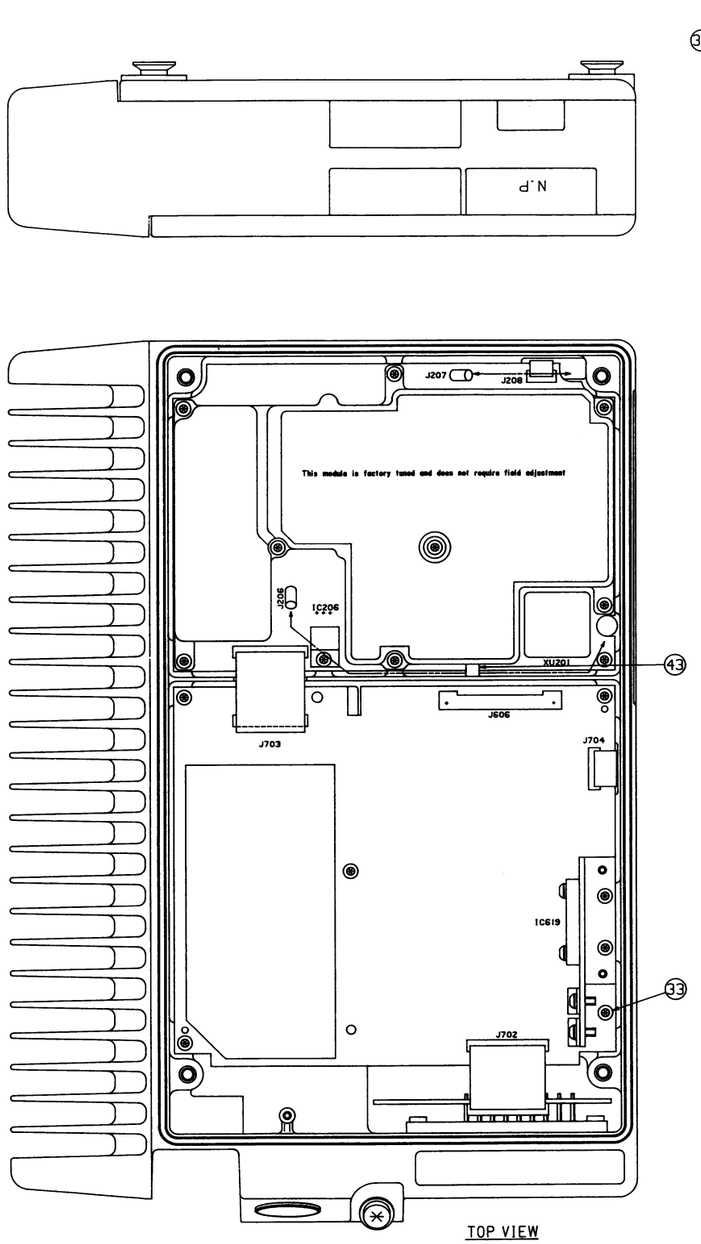
Printed in Japan



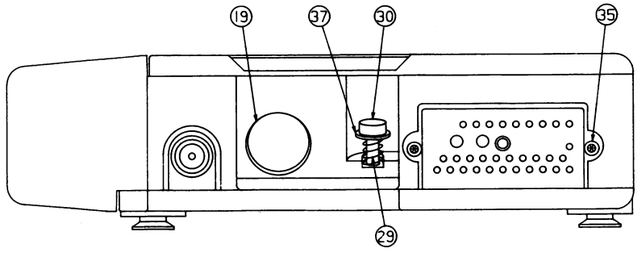


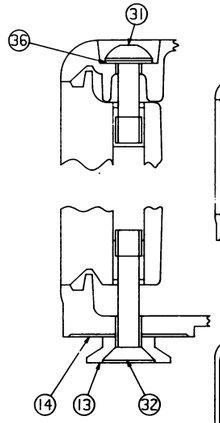
NO.	NOMENCLATOR	CODE
4	CASE,SHIELD	B19/MTC002425B
5	CASE,SHIELD	B19/MTC002426B
6	CASE,SHIELD	B19/MTC002428A
7	CASE,SHIELD	B19/MTC002430A
10	PLATE,GROUNDING	B19/MTB147822
15	SEAL	B19/MTT021171A
16	SEAL	B19/MTT021172B
20	PLATE,SERIAL NO.	B19/MPNN20187
21	OVER LAY	B19/MPNN19349
22	GASKET,ANTENNA CONNECTOR	B19/MPPK01254A
23	GASKET,INTERFASE CONNECTOR	B19/MPPK01255A
24	GASKET,SHIELD	B19/MPPK01286
25	GASKET,SHIELD	B19/MPPK01286
26	GASKET,SHIELD	B19/MPPK01161
27	GASKET,SHIELD	B19/MPPK01162
28	GASKET,SHIELD	B19/MPPK01163
45	PLATE,HEAT SINK	B19/MTB150008
46	CASE,SHIELD	B19/MTB158603
47	COVER,SHIELD	B19/MTB158604
48	ADHESIVE TAPE	B19/MTZ002812
49	FRAME ASM (COMPLETE ASM)	B19/MPBC07182
50	TOP COVER ASM (COMPLETE ASM)	B19/MPBC07411
51	BOTTOM COVER ASM (COMPLETE ASM)	B19/MPBC07112
52	MOUNTING BRACKET	B19/MPBX14964
53	MOUNTING HARDWARE	B19/MPXP01744A
54	PLATE,GROUNDING	B19/MTB160805

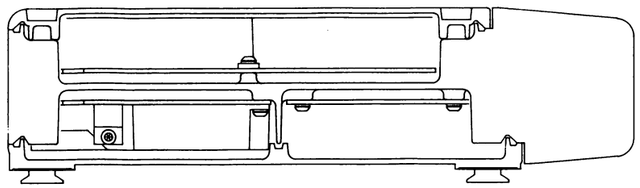
MECHANICAL LAYOUT DIAGRAM

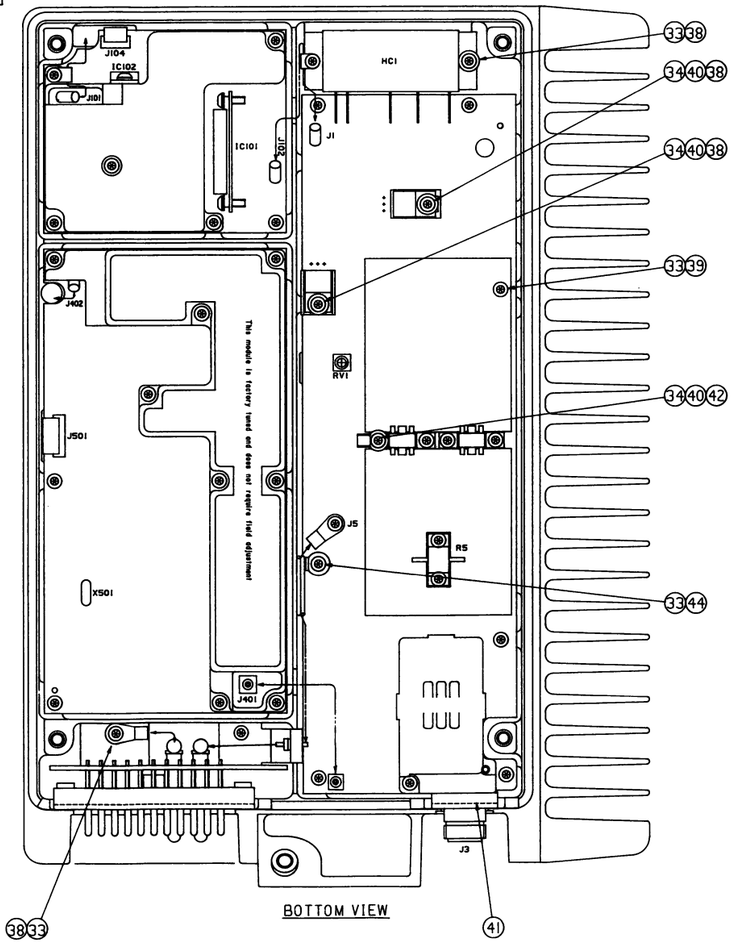


TOP VIEW





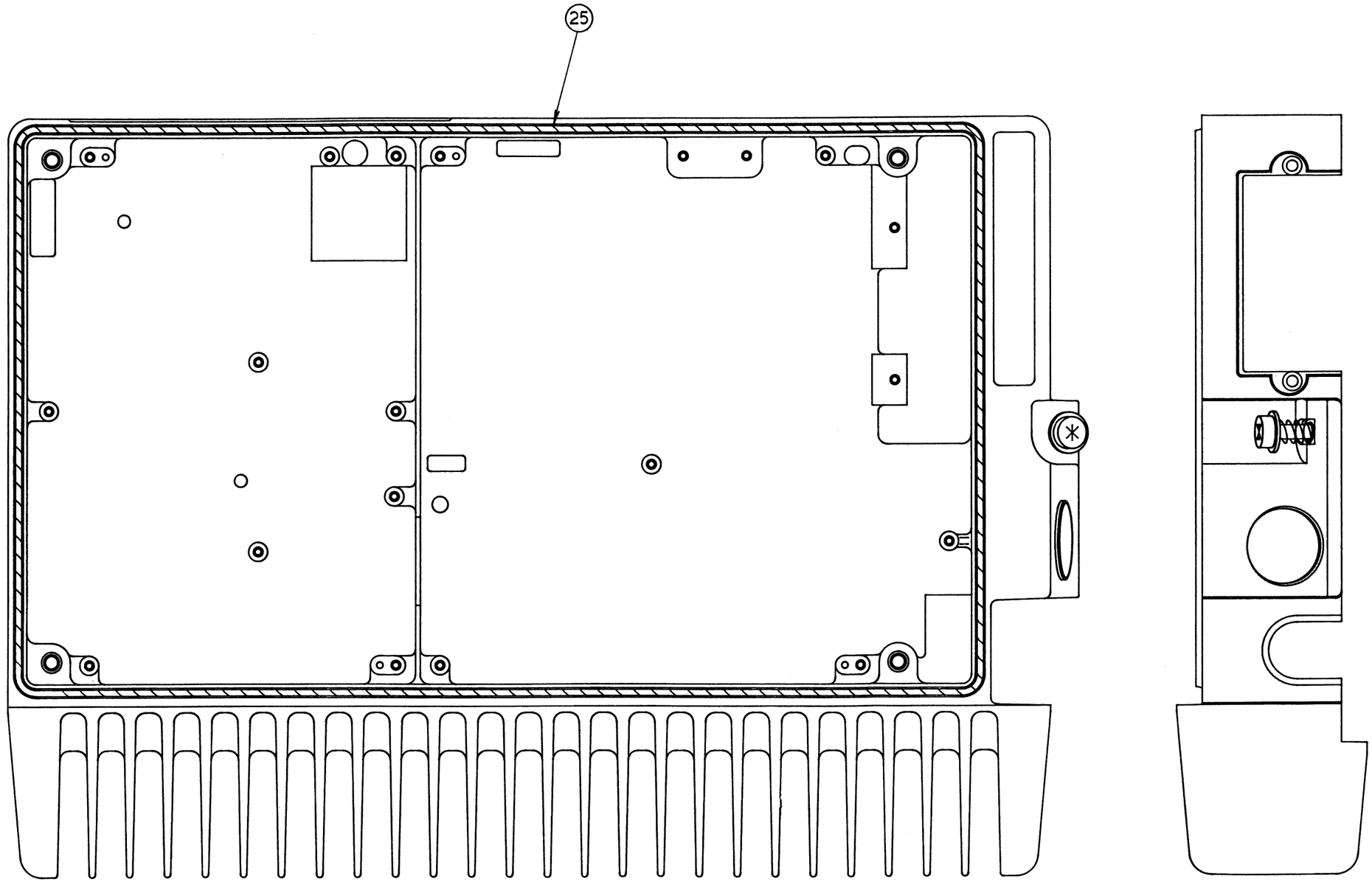




BOTTOM VIEW

NO.	NOMENCLATOR	CODE	QTY PER KIT
13	FOOT	B19/MTL032906B	4
14	SPACER	B19/MTT021134A	4
19	COVER	B19/MTV002836	1
29	SPRING	B19/MPSR02159A	1
30	SCREW	B19/MPTG02014A	1
31	SCREW	B19/MPTG02015	4
32	SCREW	B19/MPTG02016	4
33	SCREW,PAN HEAD M3x8	B19/BRTG03830	62
34	SCREW,PAN HEAD M3x12	B19/BRTG03291	3
35	SCREW,FLAT HEAD M3x10	B19/BRTG03293	6
36	WASHER,THRUST	B19/BRTG01781	4
37	WASHER	B19/BRTG03301	1
38	WASHER	B19/BSFW03000S	6
39	WASHER	B19/BSLW03000S	2
40	LOCK WASHER	B19/BRTG03493	3
41	SPACER	B19/MTB150077	1
42	SPACER	B19/MTL035255	1
43	CLAMP,CABLE	B19/MTT021147	1
44	CLAMP,CABLE	B19/MPBP02587	1

HARDWARE (SCREW) KIT
KIT CODE: B19/MPXP01954



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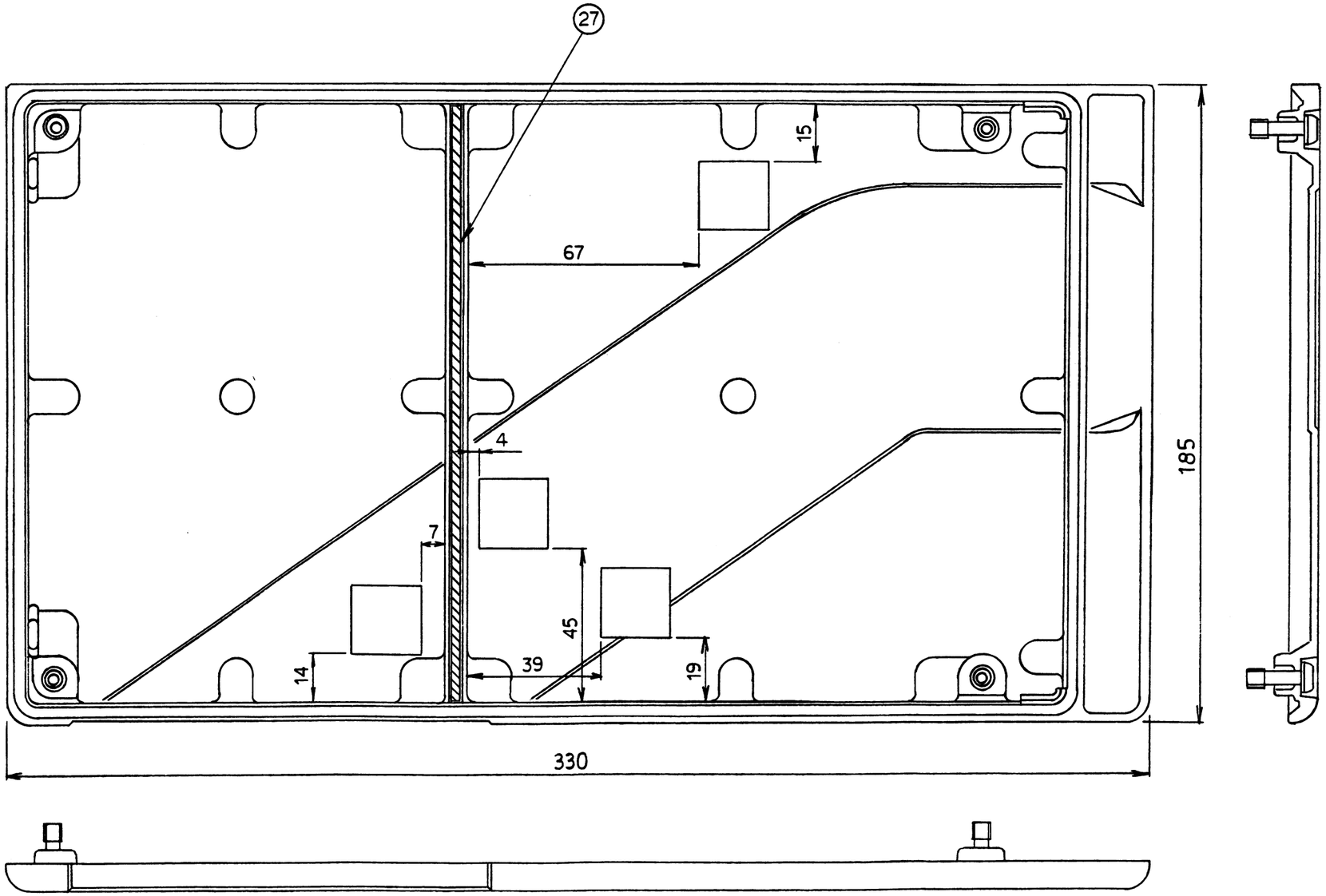

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TOP COVER ASSEMBLY

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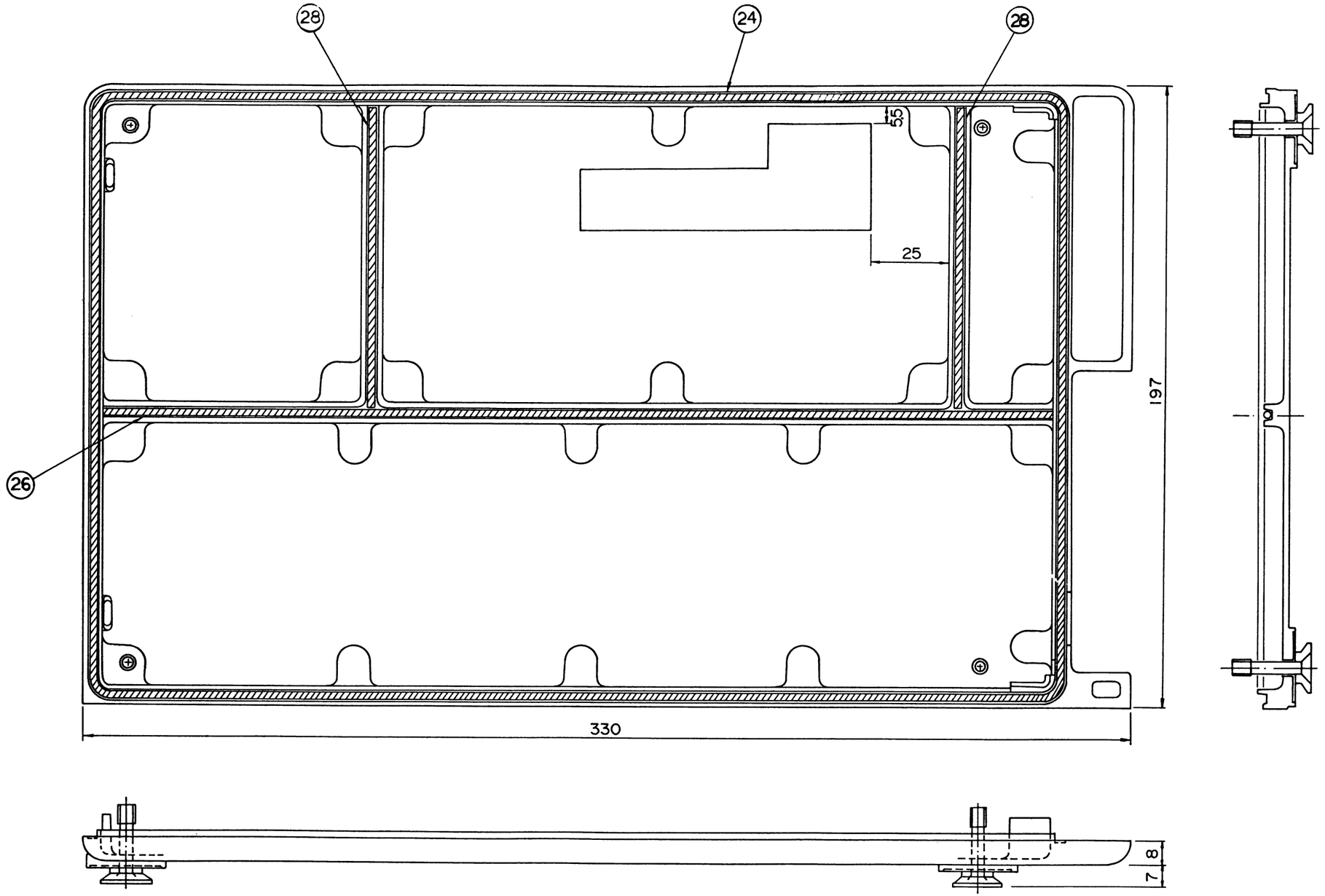

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BOTTOM COVER ASSEMBLY

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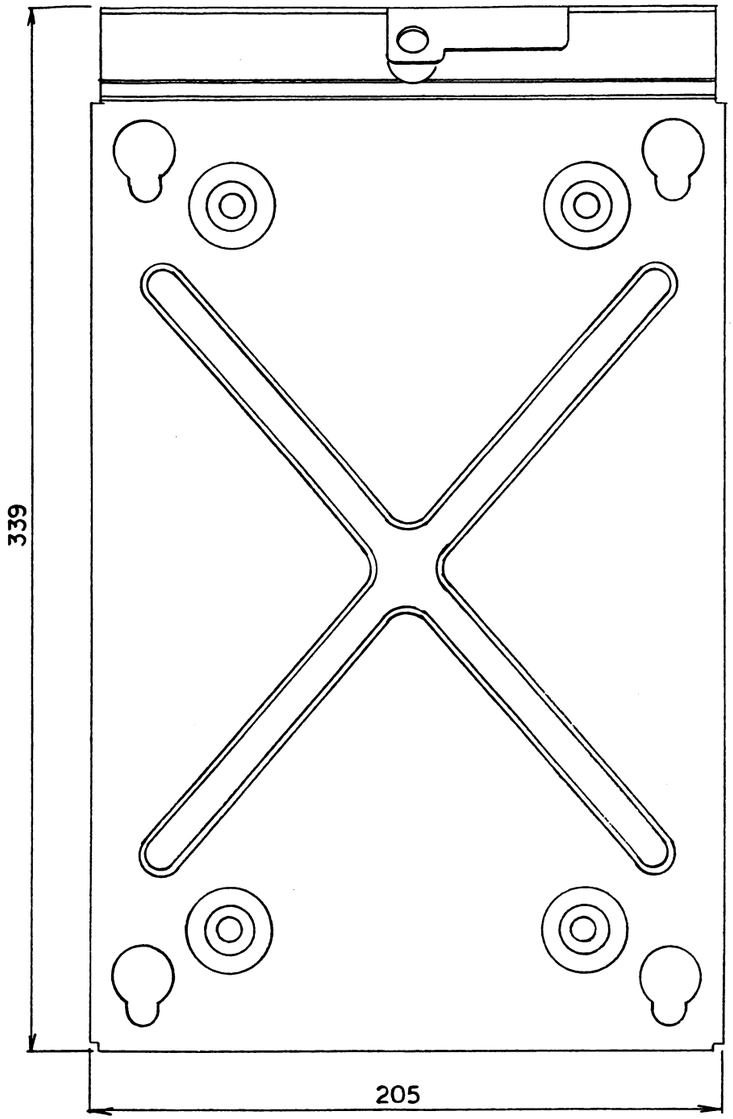

MOUNTING BRACKET
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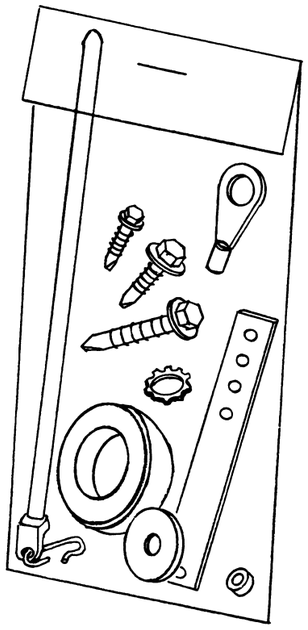

MOUNTING HARDWARE KIT
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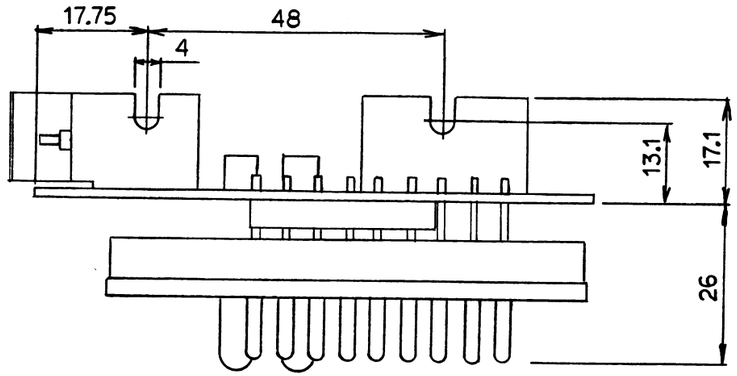

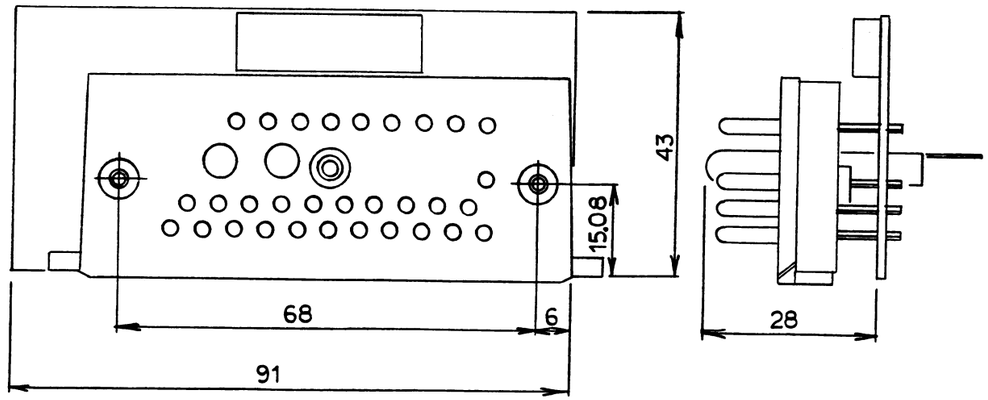

INTERFACE BOARD ASSEMBLY
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