MAINTENANCE MANUAL

403-512 MHz SYNTHESIZED RANGR

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. 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 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/MPTC00448

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 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 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 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 remove from the mounting bracket.

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.

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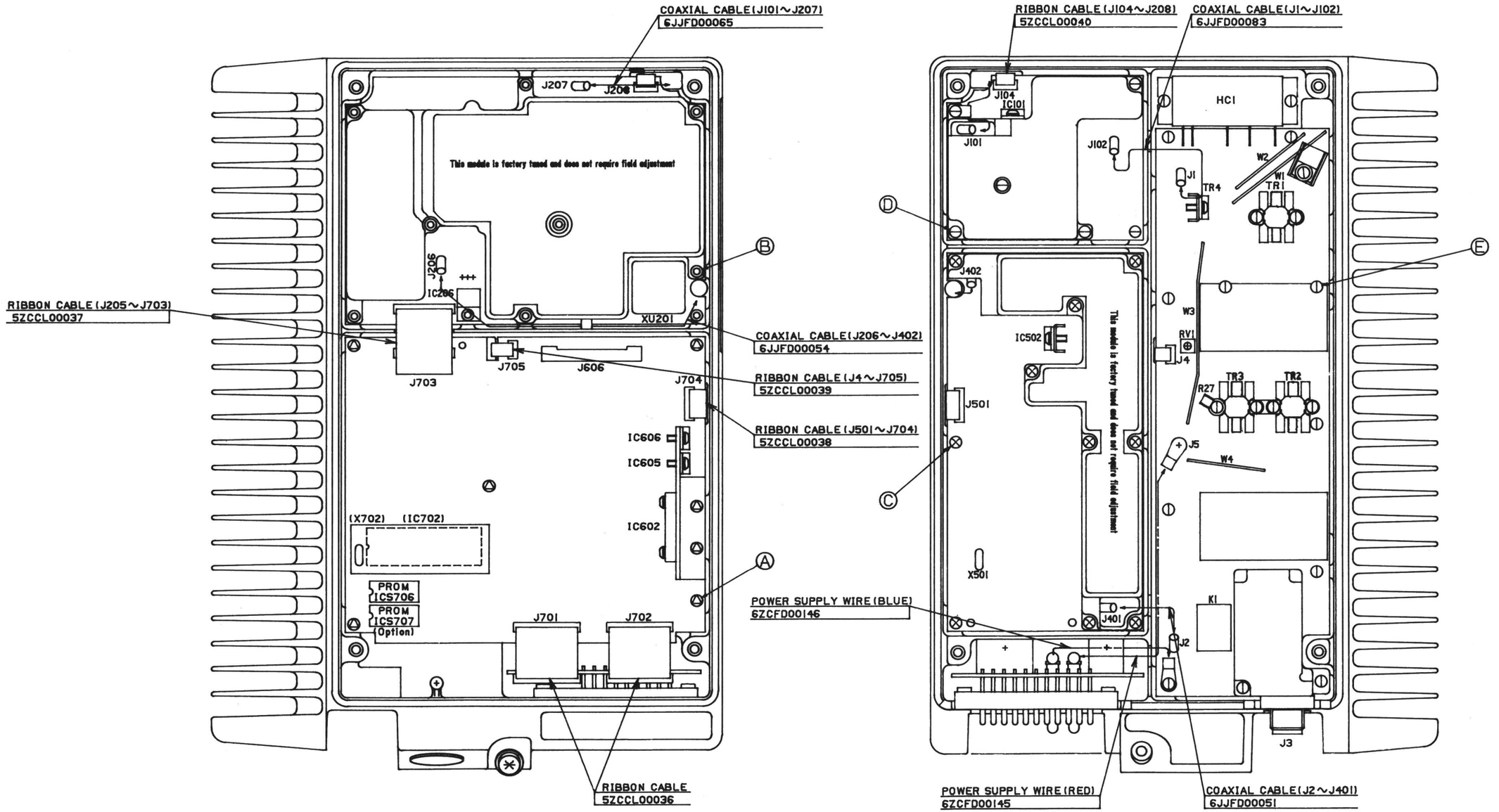


Figure 1

Figure 2

Board name	Cables to be removed	Screws to be removed
System control board	Five 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	20 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 Preceding procedures in reverse order.

CAUTION

After securing the radio, it is important that the screws securing 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 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. Removed the mounting screws.

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.

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 (9.4kg•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. Take care not to use excessive heat that causes 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 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, 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 area 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 automotive 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 at IC701-8 to force the microcomputer 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, disable the watchdog timer by shorting the collector and emitter of TR701, and ground the single-step line at IC702-5.

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. When removing printed circuit boards or shields, 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 exactly, all hardware 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 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, CG DISABLE, ADVANCE CHANGE, and FB4 - FB1 on to 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 alignment instructions.

TEST EQUIPMENT REQUIRED

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

CAUTION

When using the radio with the S550, S950 or S990 control head, the ADVANCE CHANGE line should be disconnected form the control head by removing connector P3. Instead of keying the microphone, ground J606-10.

Key the radio with the microphone on-hook. (Ground J801-11. Make sure that MONITOR Switch is OFF.)

- Apply A+ at J702-9 through a 10K resistor to J702-10.
- Turn radio on.

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 inaccessible then the alert tone can be used to indicate whether the radio passed the tests. 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 radio. If no alert tone is present, then either the ROM or RAM test has failed.

If the radio fails these tests, the microcomputer function is defective. Before replacing the microcomputer, exhaust all other possibilities. Check associated circuits for shorted 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 J702-10. 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, CG DISBL, ADVANCE CHANGE, and FB4-FB1 into the data bus IC702-12 throught 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 Table 3.

UHF TEST PROGRAM FREQUENCY

BAND (MHz)	CH	TX (MHz)	RX (MHz)	CG (Hz)	CCT
403.00	1	412.975	412.950	71.9	
to	2	403.500	403.025	023	
423.00	3	422.975	422.950	71.9	0.30
	4	412.975	412.950		
410.00	1	419.975	419.950	71.9	
to	2	410.500	410.025	023	
430.00	3	429.975	429.950	71.9	0.30
	4	419.975	419.950		
420.00	1	429.975	429.950	71.9	
to	2	420.500	420.025	023	
440.00	3	439.975	439.950	71.9	0.30
	4	429.975	429.950		
430.00	1	439.975	439.950	71.9	
to	2	430.500	430.025	023	
450.00	3	449.975	449.950	71.9	0.30
	4	439.975	439.950		
450.00	1	459.975	459.950	71.9	
to	2	450.500	450.025	023	
470.00	3	469.975	469.950	71.9	0.30
	4	459.975	459.950		
470.00	1	478.975	478.950	71.9	
to	2	470.500	470.025	023	
488.00	3	487.975	487.950	71.9	0.30
	4	478.975	478.950		
482.00	1	490.975	490.950	71.9	
to	2	482.500	482.025	023	
500.00	3	499.975	499.950	71.9	0.30
	4	490.975	490.950		
494.00	1	502.975	502.950	71.9	
to	2	494.500	494.025	023	
512.00	3	511.975	511.950	71.9	0.30
	4	502.975	502.950		

BAND: frequency band

CH : channel number

TX : transmit frequency

RX : receive frequency

CG : channel guard

CCT : carrier control timer

TABLE 3 - TEST PROGRAM

PA TROUBLESHOOTING PROCEDURE

DC VOLTAGE CHECK

First, Check the meter readings for power supply voltage and various stabilized DC voltages, at J606.
The typical readings for the test positions and test points are given in the chart below. The meter readings are typical using General Electric Test Set 4EX3A11 with Test Set Adapter 19C851532G1.

TEST POSITION	METERING POINT	FUNCTION MEASURED	SCALE	TYPICAL READING
B	J606-3	9V-RX	0-15V	9V
C	J606-4	5V	0-15V	5V
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

EXCITER QUICK CHECK

When troubleshooting the transmitter check for typical readings for the DC voltages across Exciter resistor R116, the Synthesizer output (J207), and the Exciter output (J102) as listed in Table 5.

SYMPTOM	PROCEDURE	ANALYSIS
Little or No RF Output	Unkey transmitter and check IC101-3 for +9.0 VDC	Verify +9.0 Volt supply. Check IC101.
	Key transmitter and Check DC voltages on TR101-TR106. (No RF Present)	If voltages are incorrect, check L101, L103, L105-L108, and all resistors for each stage. Check R106, R112, R123, R126, and R132. Check TR101-TR105. Replace components if defective.
	Key transmitter and check DC voltages on TR101-TR105. (RF Present)	Voltage should decrease when the transmitter is keyed. If not, check C101, C103, C107, C108, C112, C113, C116, C125, C140 and L109-L111.
	Disconnect the coaxial cable ZC601 from PA and measure RF input power from exciter. Should be 0.25 Watts or more.	If exciter output is low, check TR105 and associated circuitry. Check FL101-FL103. **If output power is correct, be sure** ZC601 is soldered securely and that it mates properly with the contact on the power amplifier.

TABLE 5 - EXCITER 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
$\overline{\text{SQ DSBL}}$, Input	Logic Low (Sq. Dis)	0 VDC
	Logic High(Sq)	2.4 VDC
	Rx Un-Sq	0.14 VDC
$\overline{\text{CCT PA ENBL}}$	Logic Low	0.35 VDC
	Logic High	5.5 VDC
$\overline{\text{Tx ENBL}}$	Logic Low	2.0 VDC
	Logic High	9.0 VDC
PTT, Input	Logic Low	0 VDC
	Logic High	13 VDC

TABLE 6 - SIGNAL LEVELS

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

TABLE 7 - RADIO CONNECTOR INDENTIFICATION

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 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 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 19C851532G1

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-31731 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. Remove P605.

2. Rotate RV201 and RV603 fully counterclockwise.

3. Apply a 1 kHz tone at 1 Vrms through a 100μF capacitor to MIC HI at J701-16 (+ lead of capacitor).

   Connect the deviation monitor to the antenna connector J2 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. 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 the center frequency).

   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$3.75 kHz.

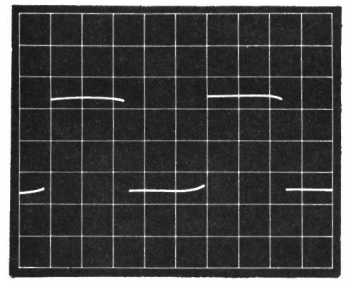
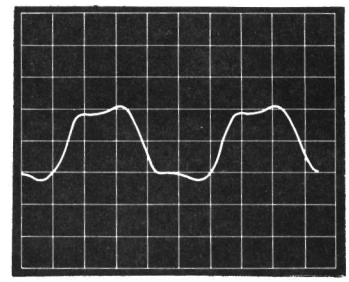
AUDIO CHECKS

TEST EQUIPMENT REQUIRED

- Audio Oscillator
- AC Voltmeter
- Oscilloscope
- 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 SETTING HORIZONTAL	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 19C851532G1

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

- SYNTHESIZER -

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
				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-31731 and "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 existing holes in the shield. These hole locations are shown in Figure 3. **NOTE** Should it become necesary to adjust the synthesizer, program a PROM to the highest frequency of the split (400 MHz for A board, 470 MHz for B board or 512 MHz for C board) for proper alignment.
1.	TP201 (Control Voltage Monitor)	CV202	7.0 VDC	Select highest frequency transmit channel in the split (440 MHz-A, 470 MHz-B, 512 MHz-C). 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 $\pm$0.1 VDC. Check that CD710 remains out. Unkey the radio.

- SYNTHESIZER -

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
2.	TP201 (Control Voltage Monitor)	CV201	7.0 VDC	Select highest receive channel in the split as in Step 1 (release PTT switch). Adjust CV201 until lock detector indicator CD710 goes out. Monitor TP201 with a digital voltmeter and adjust CV201 for a reading of 7.5±0.1VDC. Check that CD710 remains out.
3.	TP201 (Control Voltage Monitor)		3.5 to 7.5 VDC	Select each receive and transmit channel. Voltage at TP201 should be between 3.5 and 7.5 VDC.
4.	J207 J206		-3 to +6 dBm	Monitor TX injection at J207 and Rx injection at J206 Tx injection -3 to +6 dBm Rx injection -3 to +6 dBm

- REFERENCE OSCILLATOR FREQUENCY -

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
5.	J207	FREQ TRIM Control on VC-TCXO	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. Press the PTT switch while monitoring the Tx injection frequency at J207. Adjust FREQ TRIM Control on VC-TCXO for the assigned channel frequency within ±0.5 ppm. Note: The receiver injection frequency will automatically be correct.

STEP	METERING POINT	TUNING CONTROL	METER READING	PROCEDURE
				NOTE The Exciter requires no adjustment. If it becomes necessary to check the Exciter, proceed as follows.
6.	J102		250 mW	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 J102. Apply **a 0 dBm on-frequency signal to J101.** Check output power on the wattmeter. It should be greater than 250 milliwatts.
7.	J3	RV1	**Rated Output Power**	NOTE Disconnect wattmeter from J102. Reinstall Z608 and Z610 if removed. Connect a (0-150 watts) wattmeter set to antenna jack J3. 80/100 WATT POWER AMPLIFIER Monitor the transmitter output power on each channel. Select the channel with the lowest output power and set RV1 for 80/100 watts output. 30/35 WATT POWER AMPLIFIER Monitor the transmitter output power on each channel. Select the channel with the lowest output power and set RV1 for 30/35 watts output.

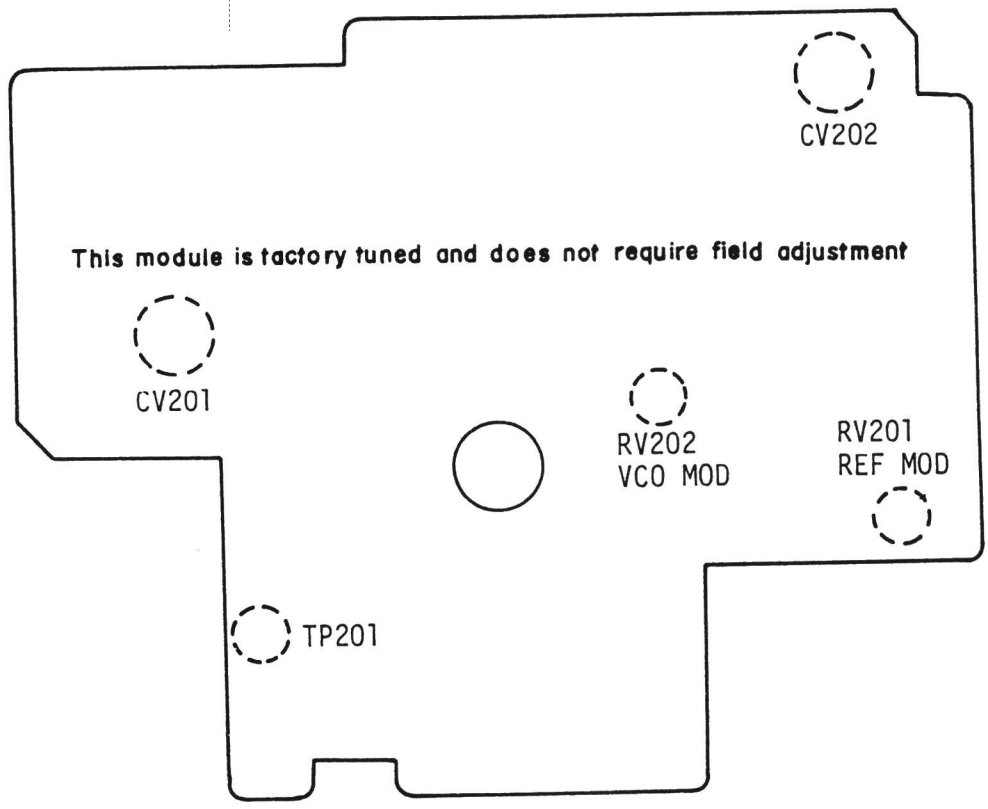


Figure 3 - Hole locations for synthesizer tuning and transmitter deviation adjustment

RECEIVER ALIGNMENT

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

TEST EQUIPMENT REQUIRED

- GE TEST Set 4EX3A11, 4EX8K12, or 20,000 ohms-per-volt multimeter.
- AC Voltmeter
- RF Signal Generator
- Frequency Counter (403 to 512 MHz)
- 4-ohm 15 watt resistor.
- 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 L509 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 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 12 dB SINAD at audio output.

Adjust coils L504 to L508 to obtain minimum 12 dB SINAD.

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

Adjust L511 for maximum audio output.

Adjust RV602 for audio output level at TP1 of 300 mVrms.

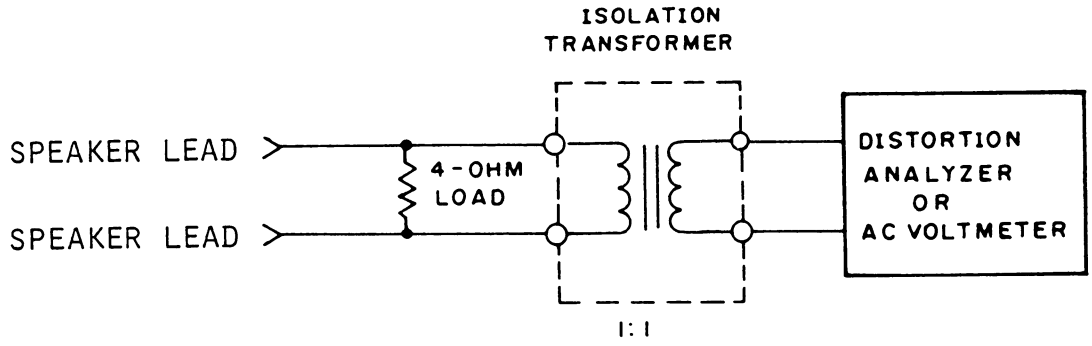


Figure 5 - Audio Isolation Transformer

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 radios of different frequency bands.

1) Connect a signal generator to the antenna connector.

2) Set the squelch control on the Control Head fully clockwise.

3) Set RV605 on the System Control board fully clockwise.

4) Set the signal generator to the level to produce 20dB quieting.

5) Raise the generator level by 4dB.

6) Set the squelch control on the Control Head fully counterclockwise.

7) Adjust RV605 until the squelch just closes.

8) Set the modulation frequency to 1kHz with 3kHz deviation.

9) Check the signal generator level required to just open the squelch. It should be greater than the 20dB level and less than 1μV.

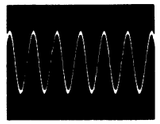
RECEIVER AUDIO AND SQUELCH CHECKS

SQUELCH CIRCUIT TEST WITH 6kHz SIGNAL

PRELIMINARY STEPS

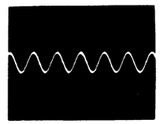
1. Set the squelch volume on the control head to close at 8 dB SINAD level.
2. Quiet receiver with 1000 uV modulated signal applied to antenna jack J3.
3. Set modulation frequency to 6 kHz.
4. Set deviation to 3 kHz.
5. Use 10 megohm probe.

Ⓐ



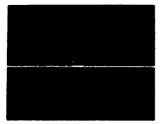
HOR .1 MSEC/DIV
VERT 0.1 V/DIV
(0.3-0.6 V p-p)

Ⓑ



HOR .1 MSEC/DIV
VERT 0.1 V/DIV
(0.15 V p-p)

Ⓒ



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

SQUELCH CIRCUIT CHECKS WITH NOISE

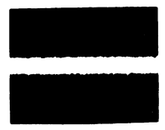
PRELIMINARY STEPS

1. Set the squelch on the control head to close at 8 dB SINAD level.
2. Remove input signal.
3. Use 10 megohm probe.

Ⓐ

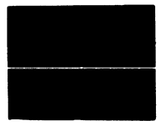
HOR .5 MSEC/DIV
VERT 1 V/DIV
(3.5 ∿4.0V P-P)

Ⓑ



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

Ⓒ



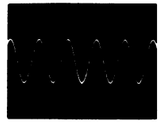
HOR .5 MSEC/DIV
VERT 2 V/DIV
(7.5 ∿8.0 VDC)

AUDIO CIRCUIT

PRELIMINARY STEPS

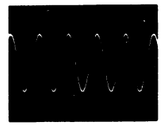
1. Apply 1000 uV on frequency signal with 1000 Hz modulation and 3 kHz deviation to antenna jack J3.
2. Output set to 10 Watts (6.3 VRMS) into 4-ohm load.
3. Use 1 megohm probe.

Ⓓ



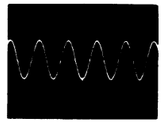
HOR .5 MSEC/DIV
VERT 50 mV/DIV
(160 mV P-P)

Ⓔ



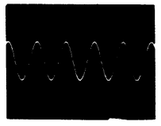
HOR .5 MSEC/DIV
VERT .2 V/DIV
(.84 V P-P)

Ⓕ



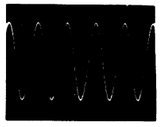
HOR .5 MSEC/DIV
VERT .1 V/DIV
(.28 V P-P)

Ⓖ



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

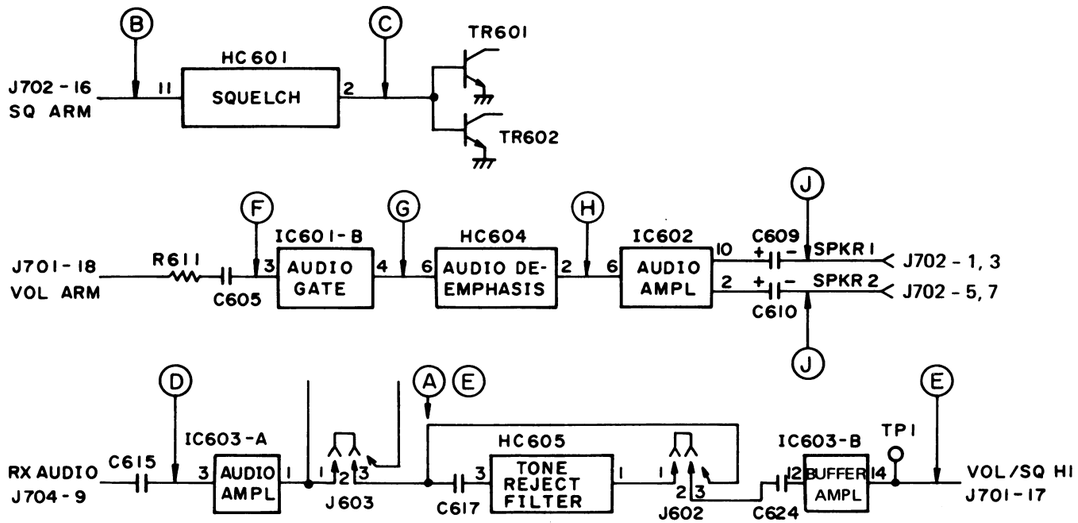
Ⓗ

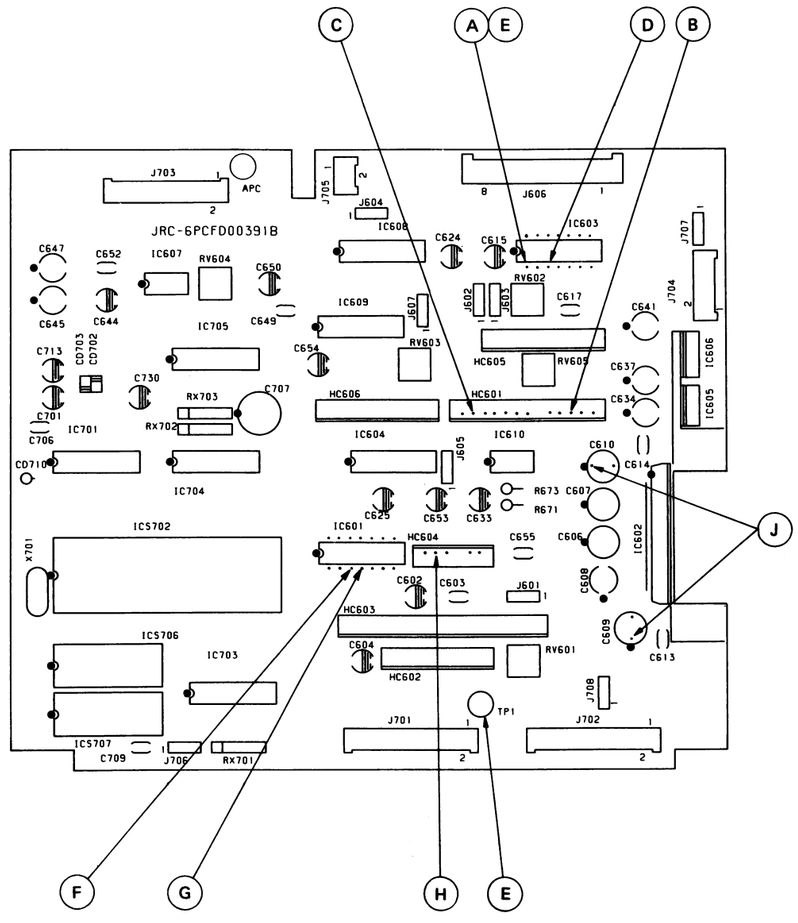


HOR .5 MSEC/DIV
VERT 50 mV/DIV
(280 mV P-P)

Ⓙ

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





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 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 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-watt output (6.32 VRMS) using the Distortion Analyzer as a voltmenter.

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-watt, make the following checks:

E. Battery and regulator voltage---low 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. It should be more than +7.0 kHz.

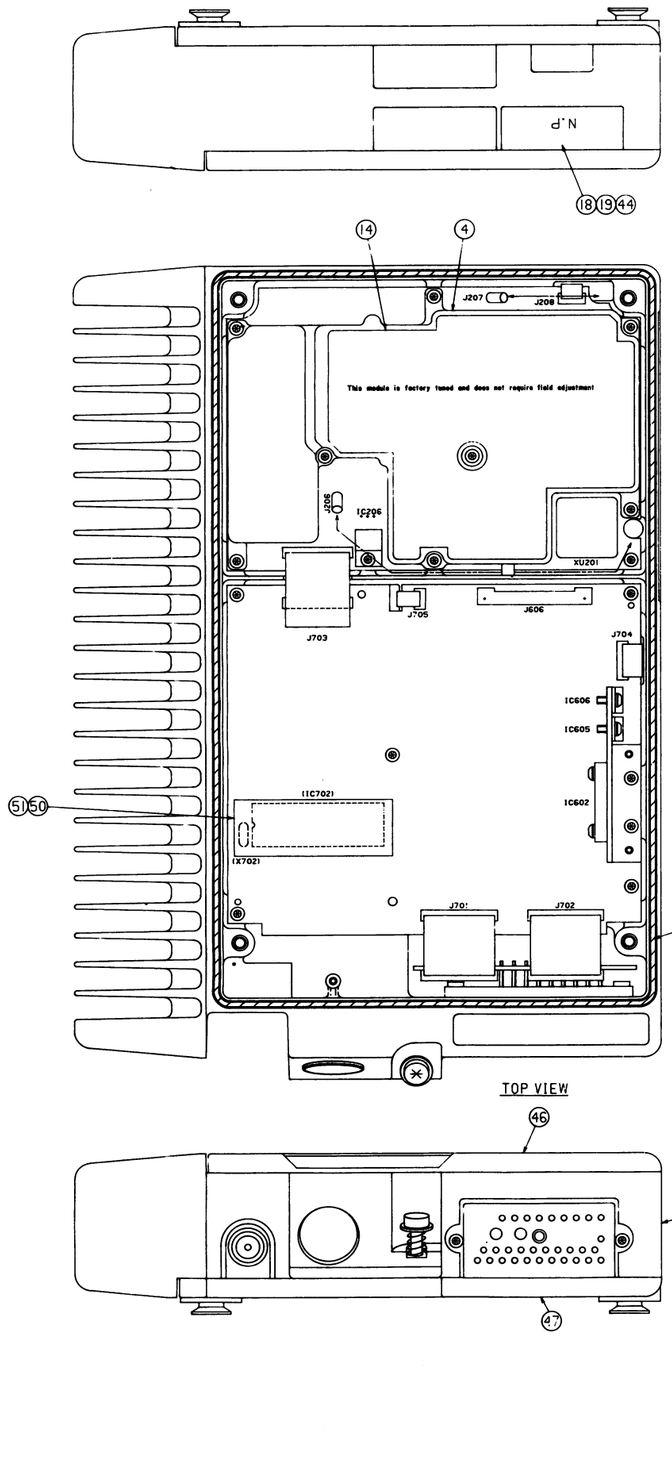
SERVICE CHECK

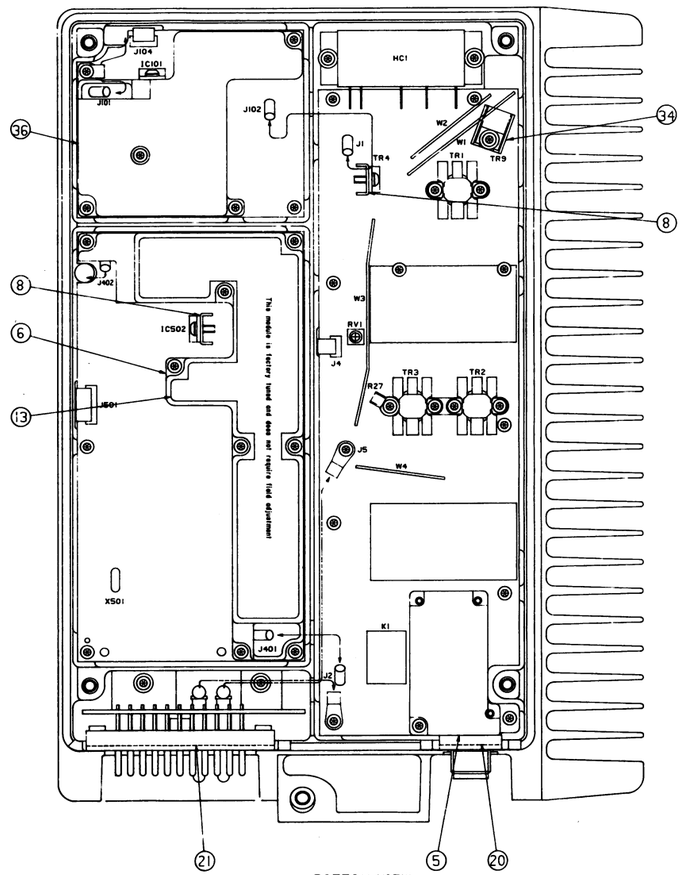
If the Modulation Acceptance Bandwidth test does not indicate the proper width, check the synthesizer frequency and then refer to the alignment of IF stages.

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

GENERAL ELECTRIC*
U.S.A.

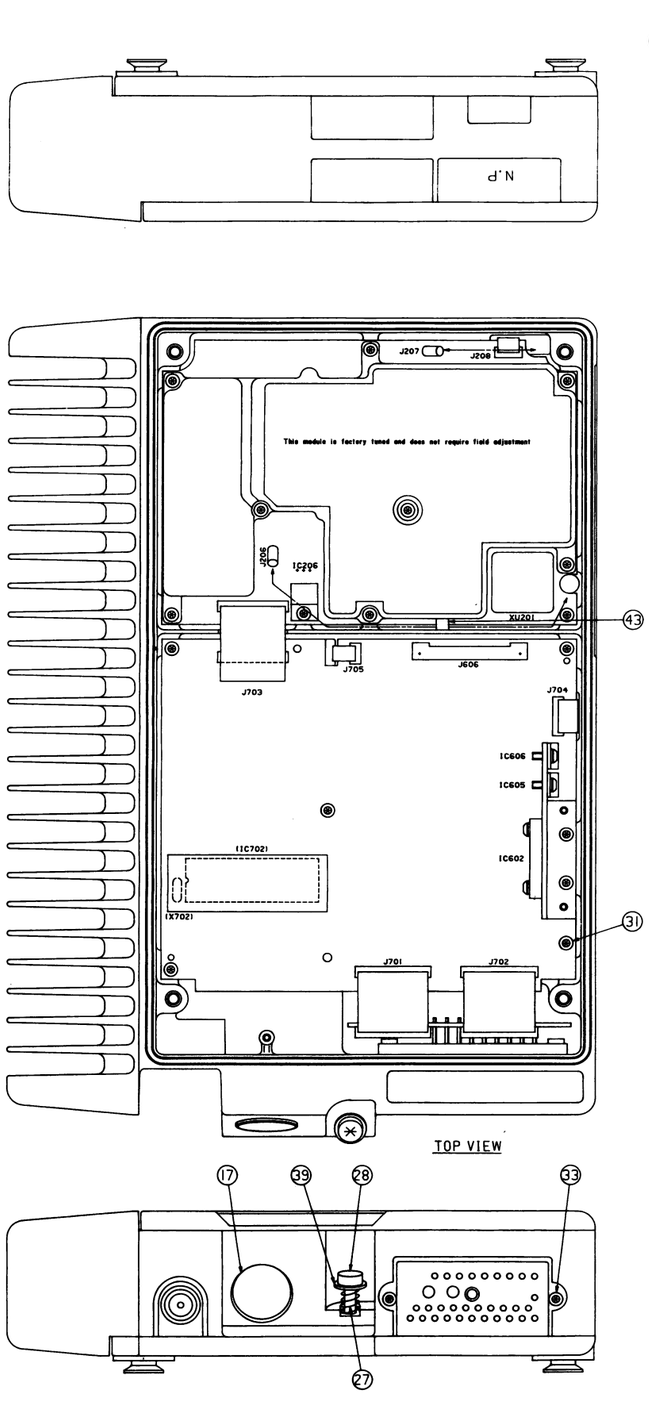
Printed in Japan



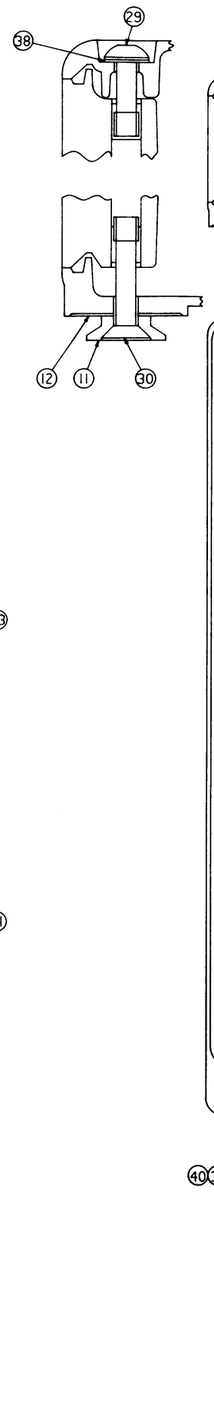


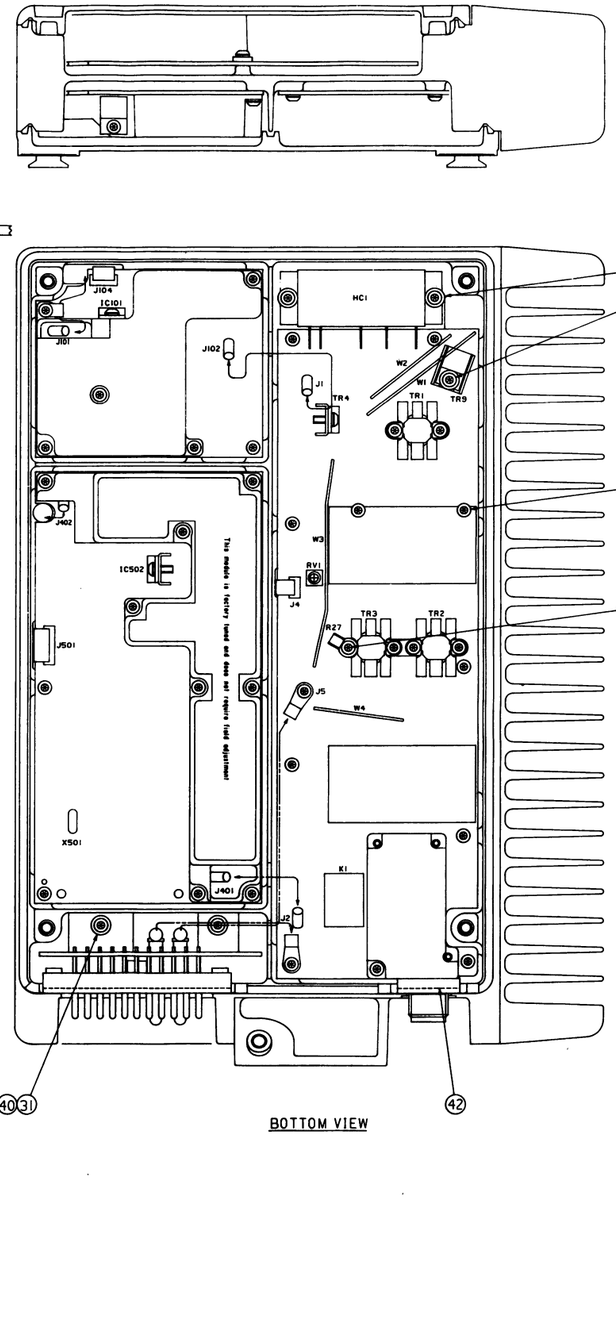
NO.	NOMENCLATOR	CODE
4	CASE,SHIELD	B19/MTC002425B
5	CASE,SHIELD	B19/MTC002426B
6	CASE,SHIELD	B19/MTC002428A
8	PLATE,HEAT SINK	B19/MTB147952A
13	SEAL	B19/MTT021171A
14	SEAL	B19/MTT021172B
18	PLATE,SERIAL NO.	B19/MPNN18119
19	OVER LAY	B19/MPNN19349
20	GASKET,ANTENNA CONNECTOR	B19/MPPK01254A
21	GASKET,INTERFASE CONNECTOR	B19/MPPK01255A
22	GASKET,SHIELD	B19/MPPK01286
23	GASKET,SHIELD	B19/MPPK01286
24	GASKET,SHIELD	B19/MPPK01161
25	GASKET,SHIELD	B19/MPPK01162
26	GASKET,SHIELD	B19/MPPK01163
34	PLATE,HEAT SINK	B19/MTB150008
36	CASE,SHIELD	B19/MTC002430A
44	ADHESIVE TAPE	B19/MTZ002812
45	FRAME ASM (COMPLETE ASM)	B19/MPBC07182
46	TOP COVER ASM (COMPLETE ASM)	B19/MPBC07110
47	BOTTOM COVER ASM (COMRLETE ASM)	B19/MPBC07112
48	MOUNTING BRACKET	B19/MPBX14964
49	MOUNTING HARDWARE	B19/MPXP01744A
50	CASE,SHIELD	B19/MTB153924
51	COVER,SHIELD	B19/MTB153925A

MECHANICAL LAYOUT DIAGRAM



TOP VIEW



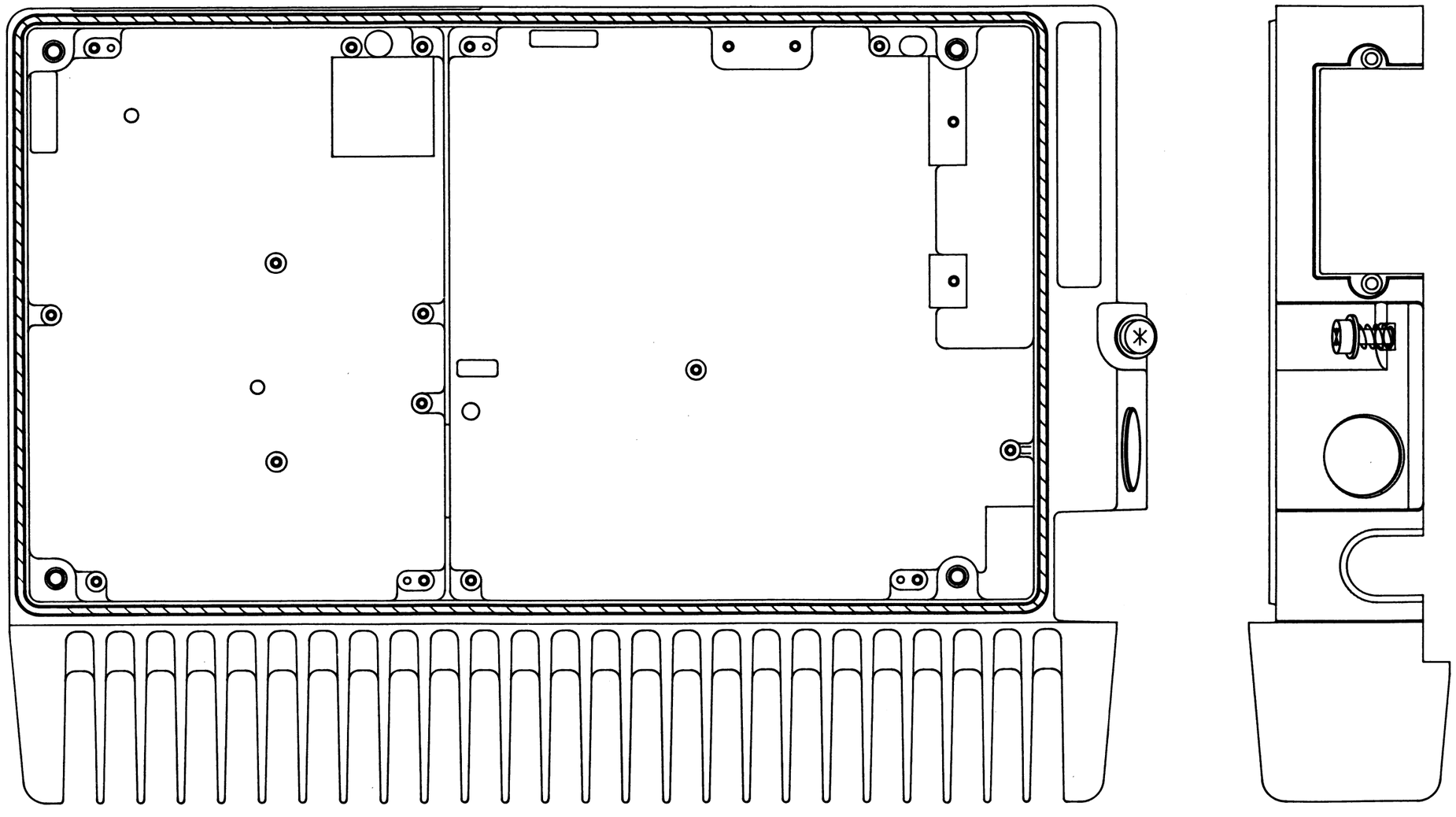


BOTTOM VIEW

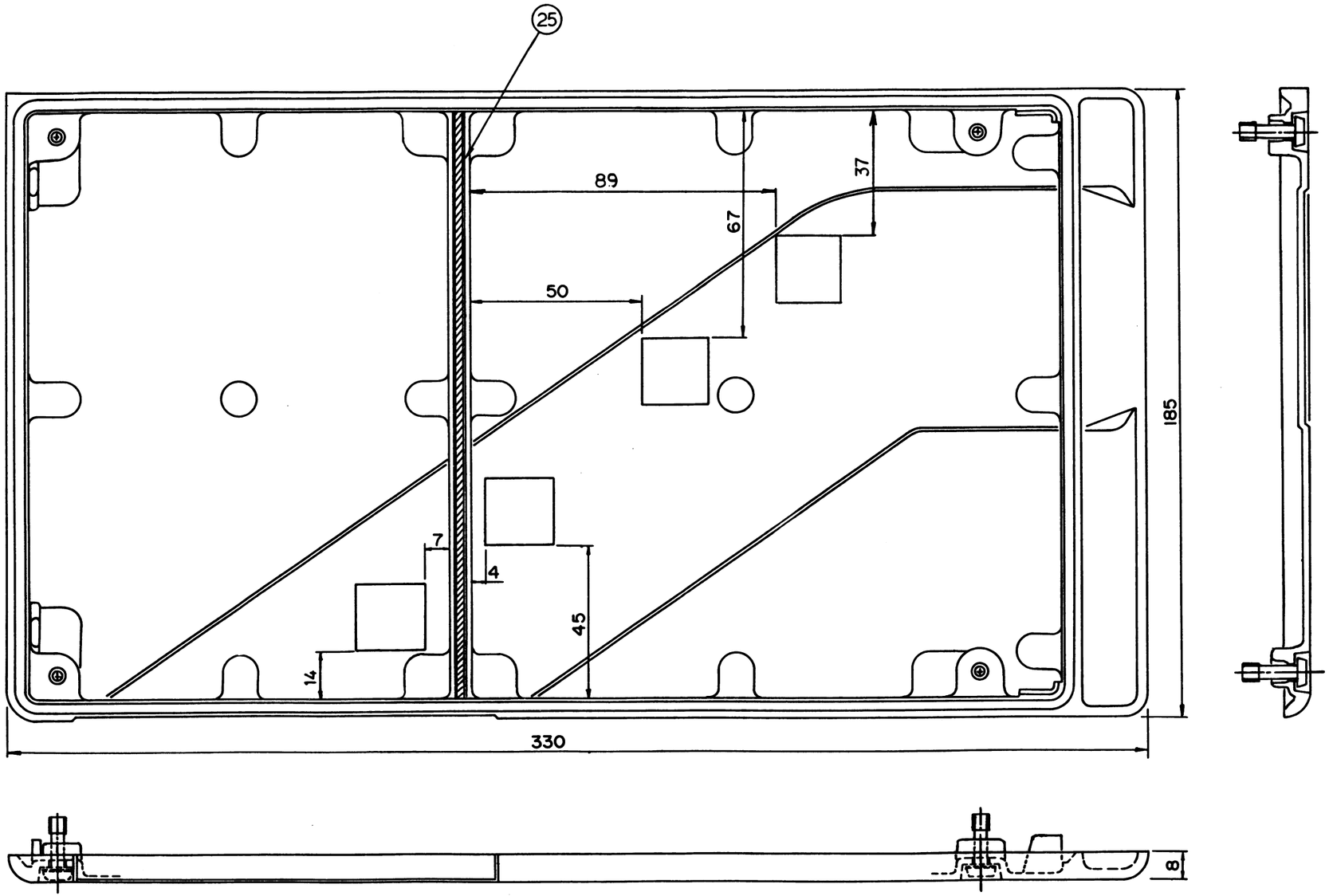
NO.	NOMENCLATOR	CODE	Q'TY PER KIT
11	FOOT	BI9/MTL032906B	4
12	SPACER	BI9/MTT021134A	4
17	COVER	BI9/MTV002836	1
27	SPRING	BI9/MPSR02159A	1
28	SCREW	BI9/MPTG02014A	1
29	SCREW	BI9/MPTG02015	4
30	SCREW	BI9/MPTG02016	4
31	SCREW,PAN HEAD M3x8	BI9/BRTG03830	62
32	SCREW,PAN HEAD M3x12	BI9/BRTG03291	3
33	SCREW,FLAT HEAD M3x10	BI9/BRTG03293	6
37	SPACER	BI9/MTL035255	1
38	WASHER,THRUST	BI9/BRTG01781	4
39	WASHER	BI9/BRTG03301	1
40	WASHER	BI9/BSFW03000S	6
41	LOCK WASHER	BI9/BRTG03493	3
42	SPACER	BI9/MTB150077	1
43	CLAMP,CABLE	BI9/MTT021147	1
50	WASHER	BI9/BSLW03000S	2

HARDWARE (SCREW) KIT

KIT CODE : BI9/MPXP01954



(45)
FRAME ASSEMBLY
ASM CODE:B19/MPBC07182



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TOP COVER ASSEMBLY
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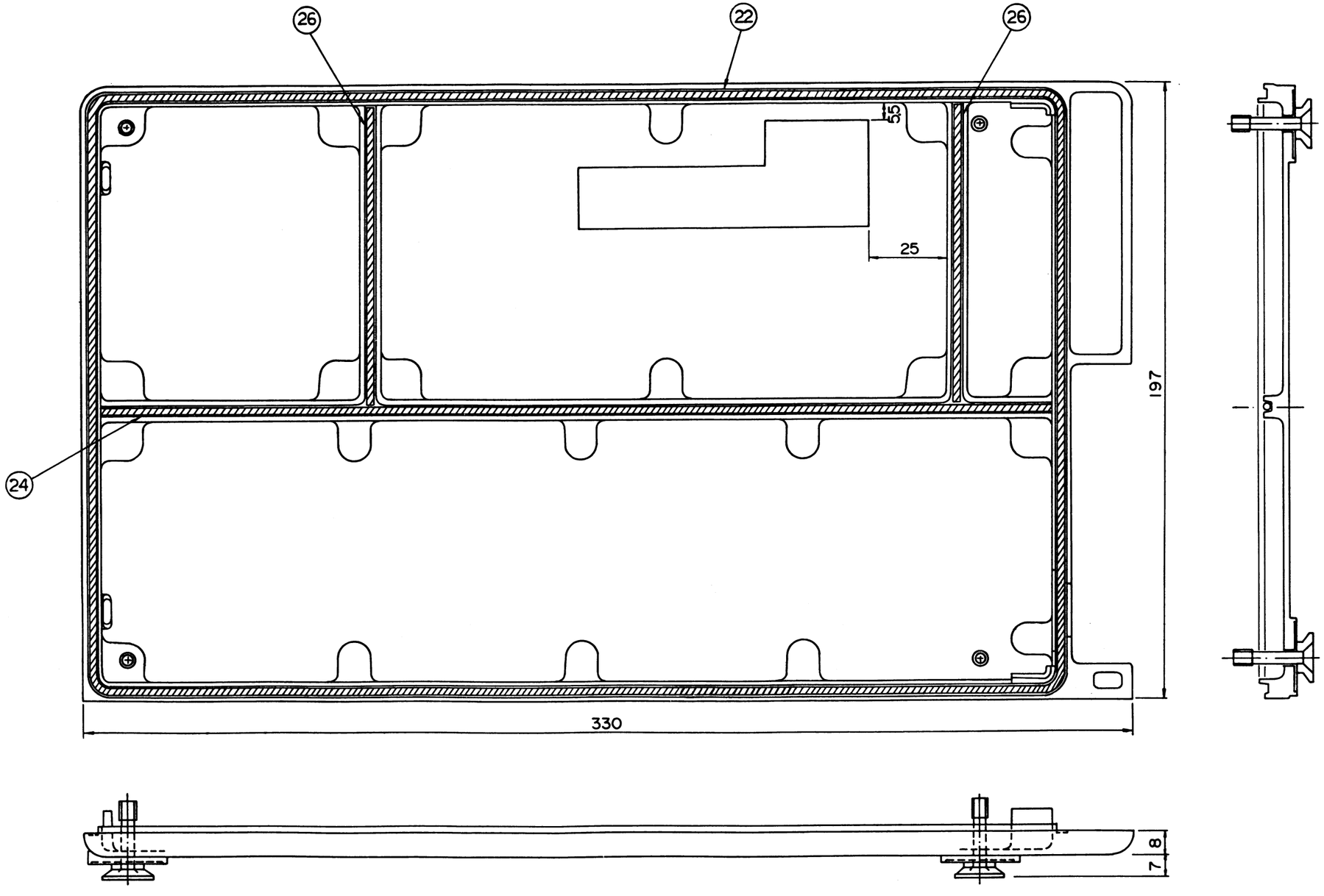

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BOTTOM COVER ASSEMBLY
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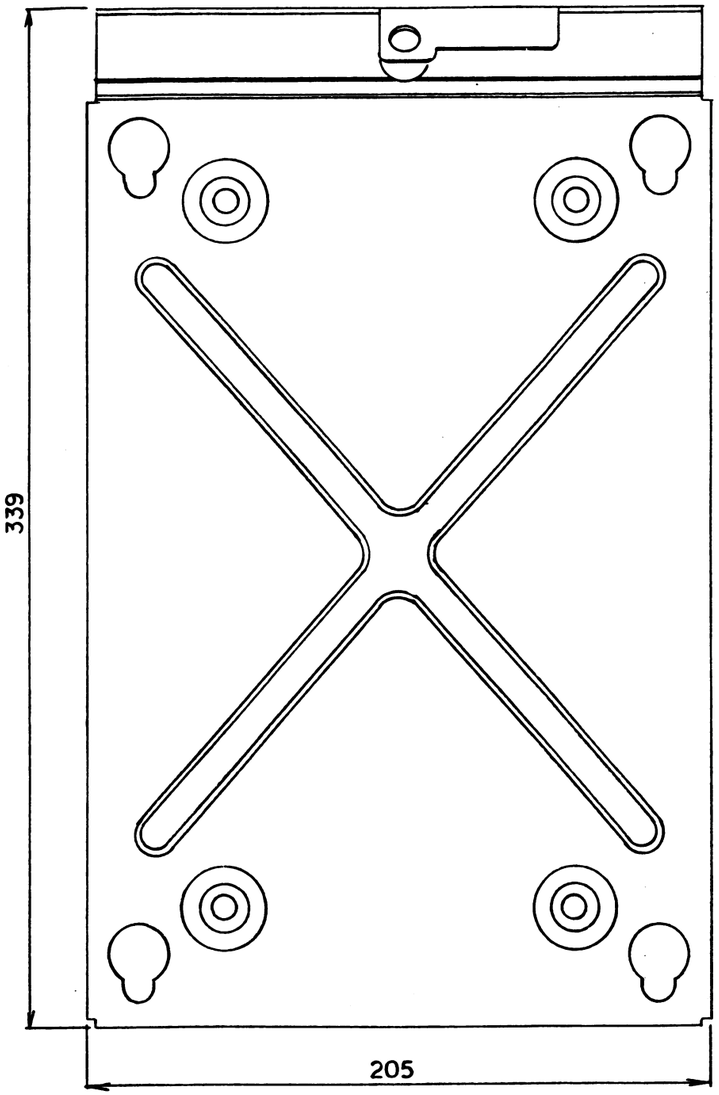
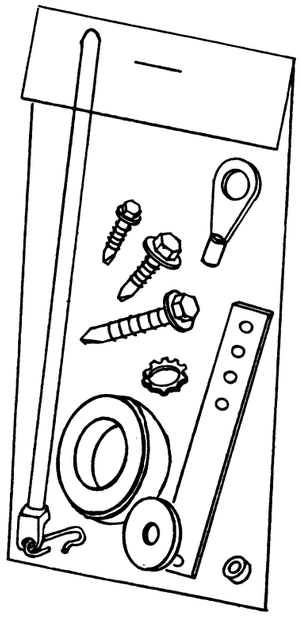


(48)
MOUNTING BRACKET
CODE:B19/MPBX14964



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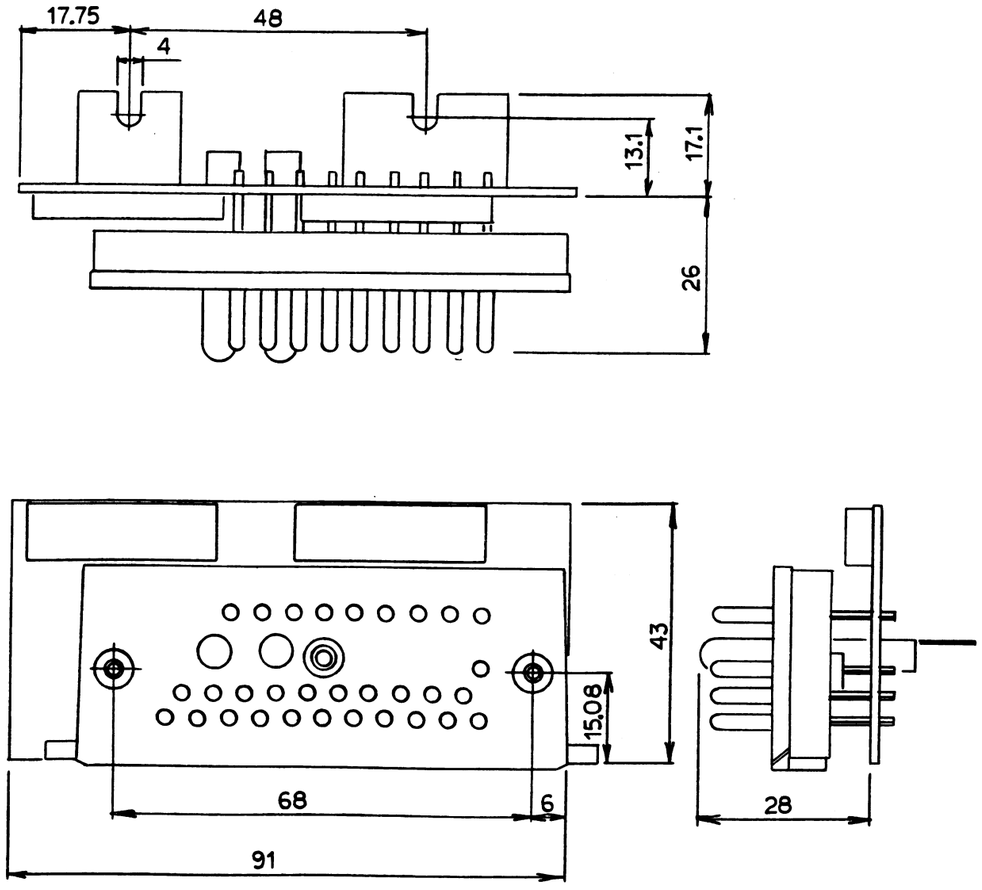

INTERFACE BOARD ASSEMBLY
ASM CODE:B19/CFQ-2223