75 MHz Link
Simulcast

MOBILE RADIO

LBI30636
(DF3164)

DESCRIPTION AND MAINTENANCE

66—88 MHz, 25-WATT CUSTOM MVP TRANSMITTER

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DESCRIPTION

CUSTOM MVP transmitters are crystal controlled, phase modulated transmitters designed for one through four frequency operation in the 66-88 MHz frequency band. This solid state, high reliability transmitter uses two integrated circuits, a crystal module and discrete components to provide 25 watts of transmitted RF power. The transmitter consists of:

- Exciter Board; with audio IC, divide by 2 IC, crystal module modulator, amplifier and multiplier stages.
- Power Amplifier Assembly; with amplifier, PA final, power control and low pass filter assembly.
- Multi-frequency board; used with multi-frequency radios only (common to transmitter and receiver).

Figure 1 is a block diagram of the Custom MVP transmitter showing the exciter, PA board and multi-frequency board.

The exciter contains the oscillator, audio IC, divide by 2 IC, modulator and multipliers to provide 300 milliwatts of modulated RF power to the power amplifier.

The power amplifier assembly contains two transistor stages (driver amplifier and power amplifier) to provide rated output power, a low pass filter and antenna transfer relay, and a power adjust circuit to adjust the output power level.

MAINTENANCE

DISASSEMBLY

- To service the transmitter remove the wing nut at the rear of the radio and pull radio out of case assembly.
- To remove exciter board:
  (1) Unplug cables W201 (exciter output) and when present W2602 (multi-frequency cable).
  (2) Remove the six screws holding the exciter board to the mounting frame and gently lift exciter board out of radio.

NOTE

When replacing the PA board it is necessary to first remove the exciter board to allow installation of the PA transistor mounting hardward.

To remove PA board:

1. Unplug the exciter/PA cable from J201 and remove the exciter board. Then unsolder the center conductor of the PA/low pass filter cable W202 from W2. The shield will come loose when the PA board mounting screws are removed.
2. Unsolder power lead W203 at E1, and remove the retaining screw from power adjust transistor Q215. Be careful not to damage the mica insulator between the transistor and the chassis.

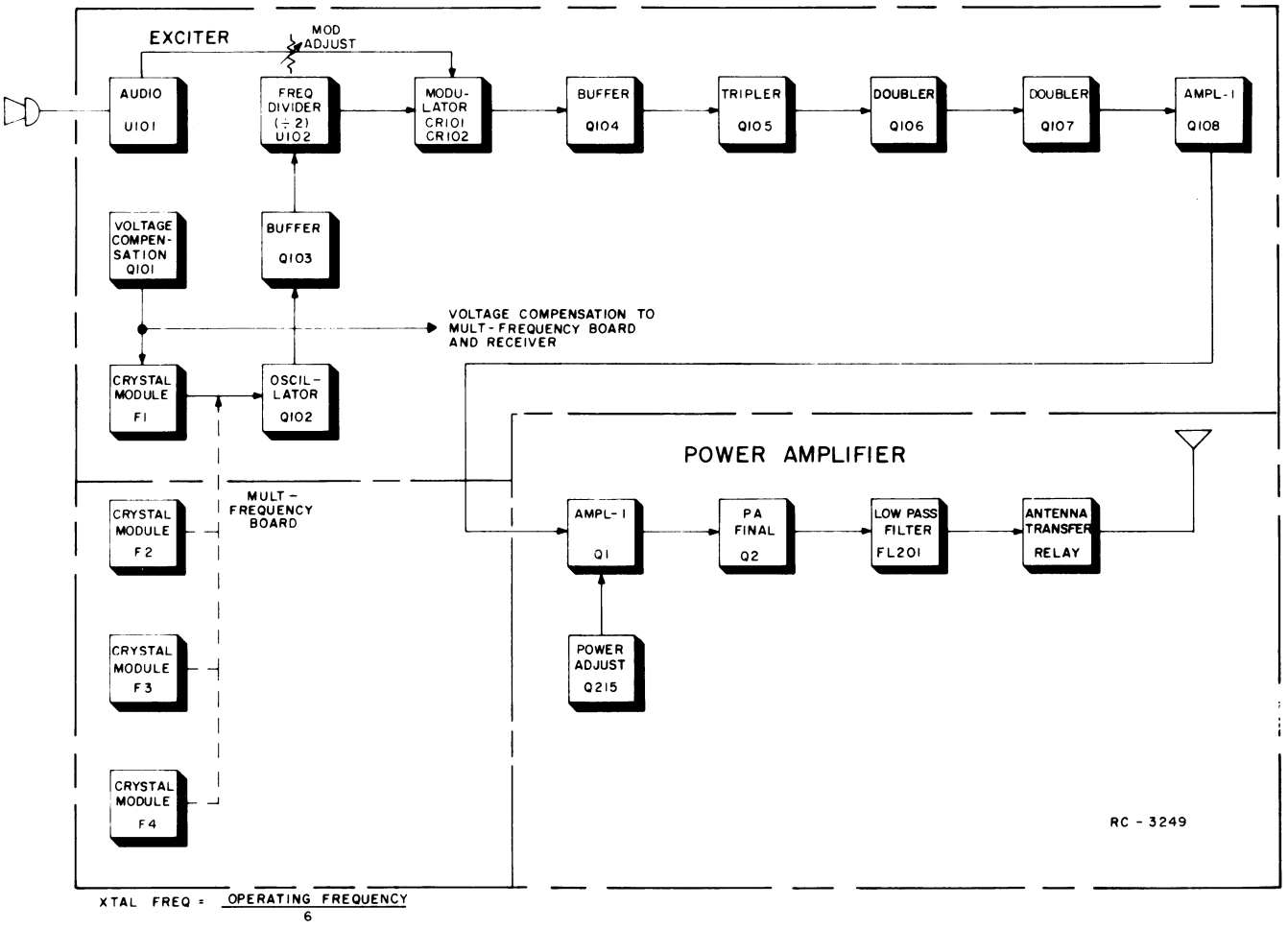


Figure 1 - Transmitter Block Diagram

3. Remove the two screws securing each of the two flange transistors to the mounting shelf.

4. Remove the four PA board mounting screws, and lift the board out.

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. Remove exciter and PA boards.

2. 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.

3. Lift out the transistor, and remove the old solder from the printed circuit board with a de-soldering tool such as a SOLDA PULLT®. Special care should be taken to prevent damage to the printed circuit board runs because part of the matching network is included in the base and collector runs.

4. Trim the new transistor leads to the lead length of the removed transistor. The letter "C" on the top of the transistor also indicates the collector (see Figure 2).

5. 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 hold the body of the transistor and replace the transistor mounting hardware, using moderate torque (6 inch-pounds). A torque wrench must be used for this adjustment since transistor damage can result if too little or too much torque is used.

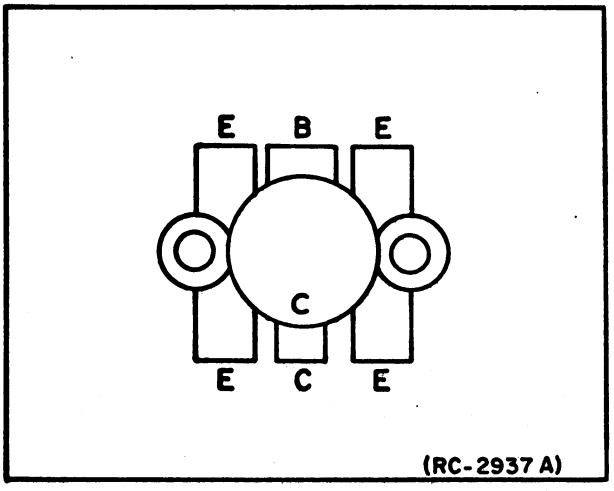


Figure 2 - Lead Identification

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

CAUTION

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

TROUBLESHOOTING

A Troubleshooting Procedure, including QUICK CHECKS, permits rapid fault location in the exciter and power amplifier.

CAUTION

Before bench testing the Custom MVP Mobile 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: 20 Volts
Transmitter keyed (50 ohm resistive load): 18 Volts
Transmitter keyed (no load or non-resistive load): 16.0 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 18 Volt figure.

Routine transmitter tests should be performed at EIA Standard Test Voltages (13.8 VDC for loads of 0 to 6 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.

TEST EQUIPMENT

1. An audio oscillator (GE Model 4EX6A10)
2. A deviation meter
3. An output meter or an AC Voltmeter
4. GE Test Set Models 4EX3A11 or 4EX8K12
5. Wattmeter, 50-ohm
6. Oscilloscope
7. Frequency counter

MODULATION LEVEL ADJUSTMENT

MOD ADJUST Control R108 has been adjusted to the proper setting before shipment and should not normally require readjustment. This setting permits approximately 75% modulation for the average voice level.

NOTE

The Tone Deviation Test Procedures should be repeated every time the Channel Guard Tone Frequency is changed.

PROCEDURE

1. Connect the audio oscillator and the meter across audio input terminals J10 (Green-Hi) and J11 (Black-Lo) on GE Test Set, or across P902-4 (Mike High) through a 0.5 microfarad (or larger) DC blocking capacitor, and P902-5 (Mike-Low) on the SAS board.
2. Adjust the audio oscillator for 1-Volt RMS at 1000 Hz.

NOTE

If the deviation reading plus (+) or minus (-) differs by more than 0.5 kHz, recheck Step 1 as shown in the Transmitter Alignment Chart.

3. For transmitters without Channel Guard, set MOD ADJUST R108 for a 4.5-kilohertz swing with the deviation polarity set to give the highest reading as indicated on the deviation meter.
4. For transmitters with Channel Guard, set Channel Guard MOD ADJUST R1060 for zero tone deviation. Next, with the 1-Volt signal at 1000 Hz applied, set MOD ADJUST R108 for a 3.75 kHz deviation. Then remove the signal from the audio oscillator and set Channel Guard MOD ADJUST for 0.75 kHz tone deviation.
5. For multi-frequency transmitters, set the deviation as described in Step 3 or 4 on the channel producing the largest amount of deviation.

PA POWER INPUT

For FCC purposes, the DC input power input to the final amplifier can be determined by measuring the PA supply voltage and PA current, and using the following formula:

P_i = PA voltage x PA current

where:

P_i is the DC power input in watts.

PA voltage is measured with Test Set Model 4EX3A11 in Position G on the 15-Volt range (read as 15 Volts full scale), and with the polarity switch in the (-) position. With Test Set Model 4EX8K12, use the B+ position and the 1-Volt range (read as 15 Volts full scale), with the HIGH SENSITIVITY button pressed and the polarity switch in the (-) position.

PA current is measured with the Test Set in Position G in the Test 1 position, and with the HIGH SENSITIVITY button pressed (10 amperes full scale).

Example:

P_i = 13.2 Volts x 4.2 amperes = 56 watts

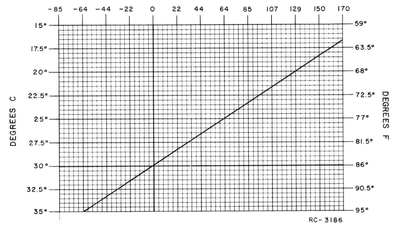


Figure 3 - Frequency Offset Chart

OSCILLATOR FREQUENCY ADJUSTMENT

First, check the frequency to determine if any adjustment is required. The frequency should be set using a frequency meter or counter with an absolute accuracy that is 5 to 10 times better than the tolerance to be maintained, and with the entire radio as near as possible to an ambient temperature of 30°C (86°F).

The oscillator should be reset only when the frequency shows deviation in excess of the following limits:

A. ±0.5 PPM, when the radio is at 30°C (86°F).

B. ±5 PPM at any other temperature within the range of 30°C to +75°C (-22°F to +167°F).

If an adjustment is required, proceed as follows:

If the radio is at an ambient temperature of 30°C (86°F), set the oscillator for the correct operating frequency.

If the radio is not at an ambient temperature of 30°C, setting errors can be minimized as follows:

A. To hold the setting error to ±0.6 PPM (which is considered reasonable for 5 PPM crystal oscillators):

1. Maintain the radio at 30°C (±5°C) and set the oscillator to desired frequency, or
2. Maintain the radio at 30°C (+5°C, -15°C) offset the operating frequency as a function of actual temperature, by the amount shown in Figure 3.

For example: Assume the ambient temperature of the radio is 20°C (68°F). At that temperature, the curve shows a correction factor of 129.2 Hz.

Set the oscillator for a reading of 129.2 Hz higher than the licensed operating frequency. If a negative correction factor is obtained (at temperatures above 30°C), set the oscillator for the indicated frequency lower than the licensed operating frequency.

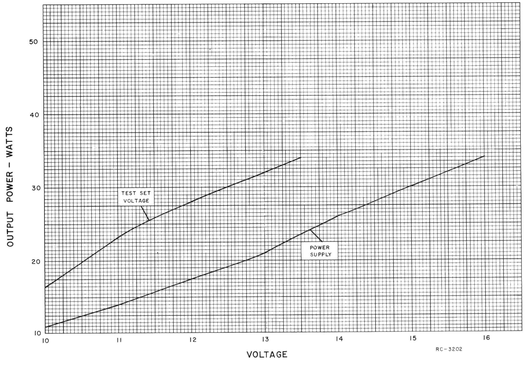
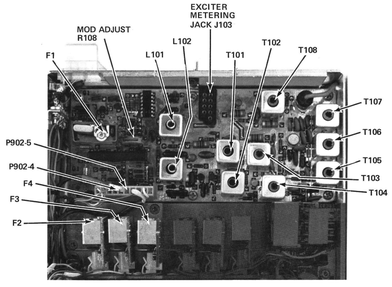
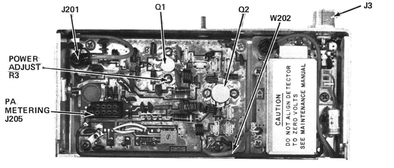


Figure 4 - Power Output Setting Chart





TRANSMITTER ALIGNMENT

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Place crystal modules for F1 on Exciter Board and F2-F4 on multi-frequency board, (crystal frequency = operating frequency ÷ 6).
2. For a large change in frequency or a badly mis-aligned transmitter, preset slugs for L101, L102, T101 and T102 to the bottom of the coil form. Preset slugs for T103 thru T108 to top of coil form.

NOTE

The tuning frequency for multi-frequency transmitters is determined by the operating frequency and the frequency spread between transmitters.

3. For multi-frequency transmitters with a frequency spread less than 0.5 MHz tune the transmitter to the lowest frequency.

   For frequency spread exceeding 0.5 MHz but less than 1.0 MHz tune the transmitter using a center frequency tune up crystal module. These limits can be extended to 1.5 MHz with 1 dB degradation.
4. Connect the red plug on the GE Test Set to the SAS Board metering jack, and the black plug to the Exciter metering jack. Set the polarity to +, and set the range to the Test 1 position (1-Volt position for 4EX8K12) for all adjustments.

   NOTE: With the Test Set connected to the PA metering jack, the voltage reading at position "G" with the HIGH SENSITIVITY button pressed may be converted to PA collector current by reading the current as 10 amperes full scale.
5. Rotate Power Adjust potentiometer R3 on PA Board all the way counterclockwise.
6. All adjustments are made with the transmitter keyed.

ALIGNMENT PROCEDURE

STEP	METER POSITION	TUNING CONTROL	METER READING	PROCEDURE
1.	A (MULT-1)	L101, L102 & T101	See Procedure	Press HIGH SENS BUTTON and fine tune L101 then L102 for maximum meter reading. Then tune T101 for a dip in meter reading.
2.	B (MULT-2)	T102, T101 & T103	See Procedure	Tune T102 (green) for maximum meter reading and re-adjust T101 (green) for maximum meter reading. Then tune T103 (red) for a dip in meter reading.
3.	C (MULT-3)	T104, T103 & T105	See Procedure	Tune T104 (Blue) for maximum meter reading and re-adjust T103 (Red) for maximum meter reading. Then tune T105 for a dip in meter reading.
4.	D (AMPL-1)	T106, T105 & T107	See Procedure	Tune T106 (Green) for maximum meter reading, and then re-adjust T105 for maximum meter reading. Then tune T107 for dip.
5.	F (Rel. Power out)	T107, T106 & T108	Maximum	Tune T107 and then T106 for maximum meter reading. Retune T107 for maximum meter reading, then tune T108 for maximum meter reading or power out.
6.	B (MULT-2)	T102 & T10[illegible]	Maximum	Tune for maximum meter reading.
7.	C (MULT-3)	T103 & T104	Maximum	Tune T103 and T104 for maximum meter reading.
8.	D (AMPL-1)	T105 & T106	Maximum	Tune T105 and T106 for maximum meter reading.
9.	F	T107 & T108	Maximum	Tune T107 and T108 for maximum power output.
10.	D	T107 & T108	Maximum	Connect the black metering plug to the PA metering jack and tune T107 and T108 for maximum meter reading.
11.	C	R3	See Procedure	With the battery voltage at 13.8 Volts or the PA collector voltage at 13.2 Volts, set Power Adjust potentiometer R3 on the PA board for the desired power output from 8 to 25 watts as read on the wattmeter connected to antenna jack J3. If the battery voltage is not at 13.8 Volts or the collector voltage at 13.2 Volts and full rated output is desired (25 watts at 13.8 Volts), set R3 for the output power according to the battery voltage or collector voltage shown in Figure 4. NOTE The PA collector voltage is measured as described in the PA POWER INPUT section.

STEP 1 - QUICK CHECKS

METER POSITION OR TEST SET	PROBABLE DEFECTIVE STAGE		
	HIGH METER READING	LOW METER READING	ZERO METER READING
EXCITER			
A (MULT-1)	Q104, Q105, T101	Q104, Q105, CR101, CR100, L101, L102, C1102, YB101, Q102	Q105, Q104, T101, Q102, Q100, Q103, YB101
B (MULT-2)	Q106, T102	T101, T102, T103, Q106, R126	T101, T102, T103, Q106, R126
C (MULT-3)	Q107	T103, T104, T105, Q107, R131	T103, T104, Q107, R131
D (AMPL-1)	Q108	T101, T106, Q108, C147, C148, R134	T105, T106, Q108, L107, L105
F (POWER OUT)	W216	CR103, R137, R136, T107, T108	Q108, CR103, R136, C147, C150, T107, T108
POWER AMPLIFIER			
"D" (AMPL-1 DRIVE)	R8	Q108, C147-C150, CR1, Low Output from Exciter	No output from Exciter, CR1, C24, R7, R8
"E" (AMPL-1 POWER CONTROL VOLTAGE)	Q215, R3	Q215, R3	Q215, R3
"G" (PA CURRENT)	Q2	Q1, Q2	Q2, Q1, Q215, R3

STEP 3
CHECK AUDIO AC VOLTAGES →

STEP 4
AUDIO & OSC WAVEFORMS →

STEP 5
AUDIO SENSITIVITY →

CHECK AUDIO SENSITIVITY BY REDUCING GENERATOR OUTPUT UNTIL DEVIATION FALLS TO 3.0 KHZ FOR RADIOS WITHOUT CHANNEL GUARD, OR 2.25 KHZ FOR RADIOS WITH CHANNEL GUARD. VOLTAGE SHOULD BE LESS THAN 120 MILLIVOLTS.