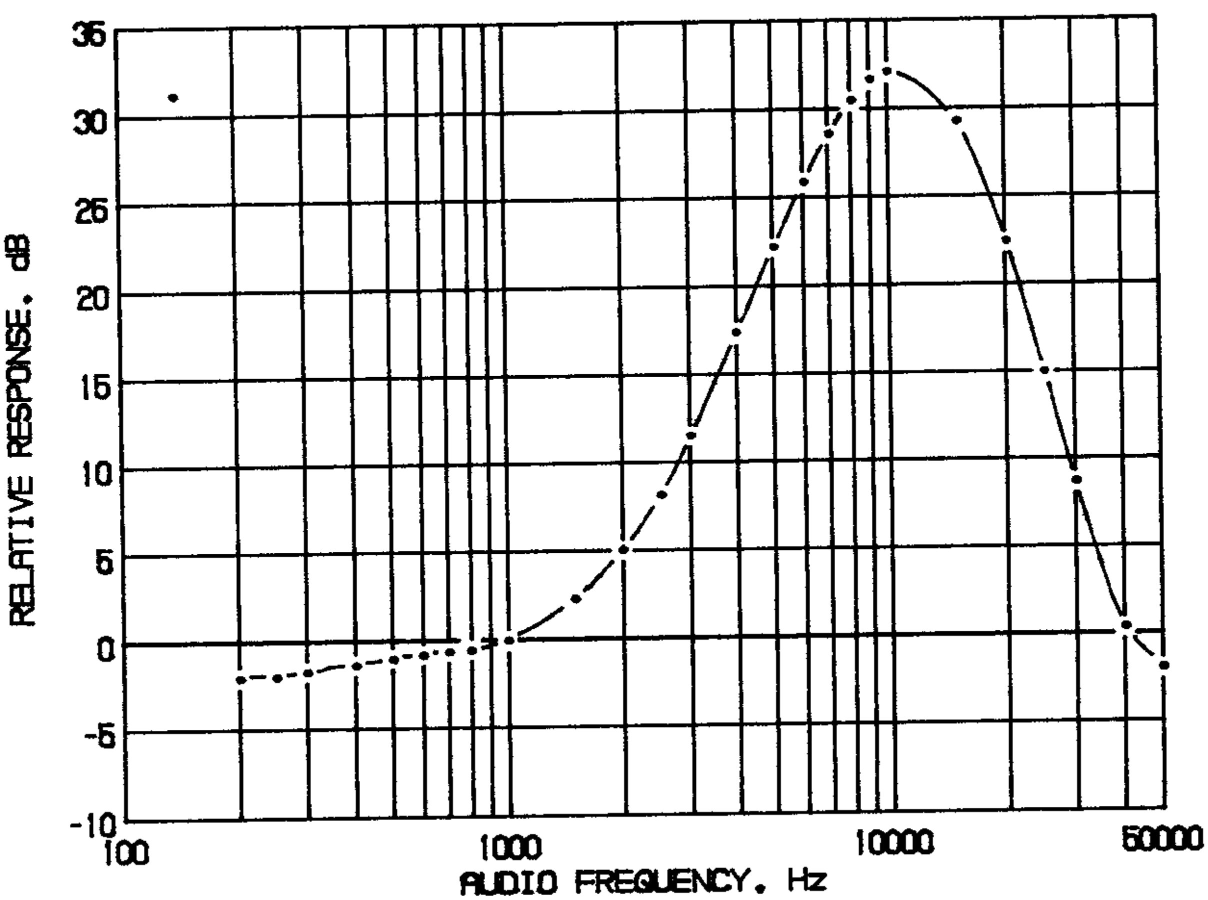
FIGURE 1

MODULATION FREQUENCY RESPONSE

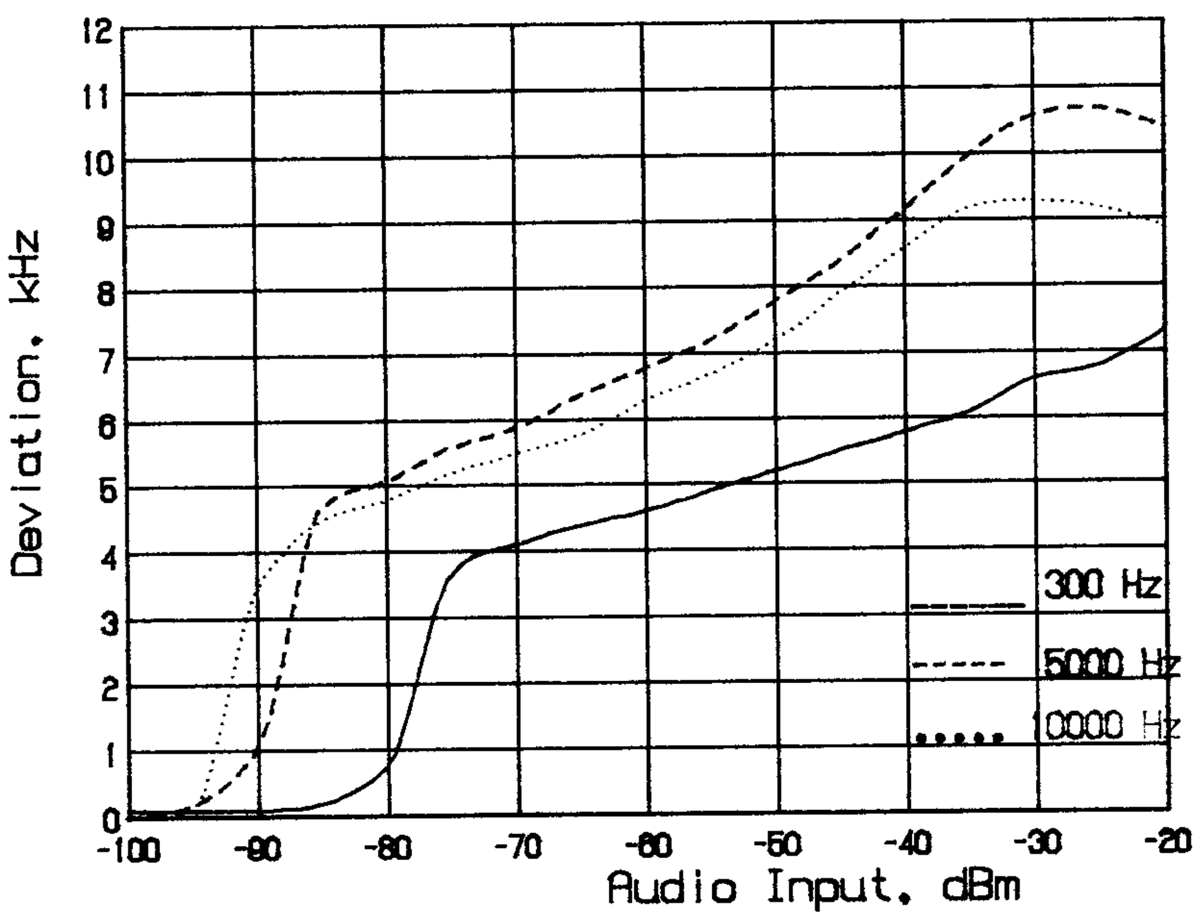


MODULATION FREQUENCY RESPONSE
FCC ID: CNMT1-216

FIGURE 1

FIGURE 2

MODULATION LIMITING



MODULATION LIMITING CHARACTERISTICS

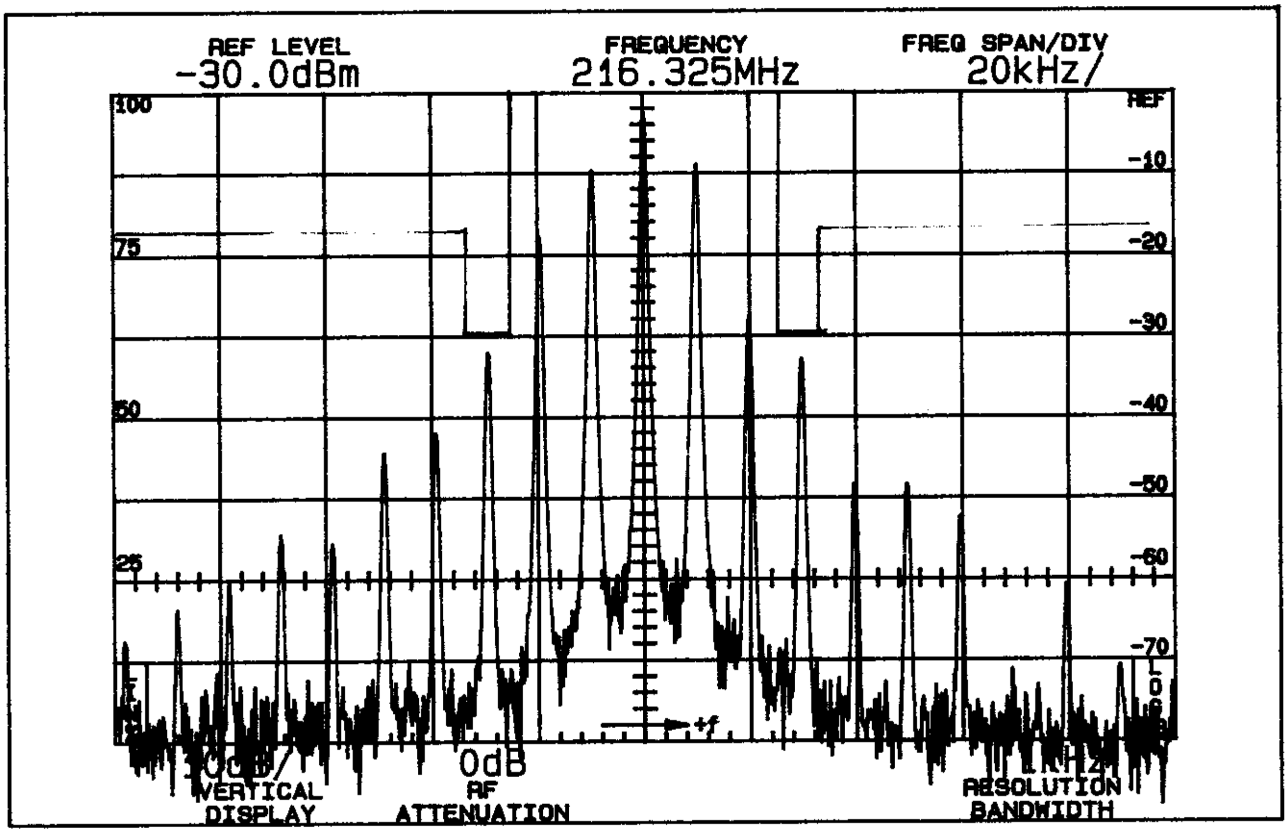
Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 5000 Hz, and 10,000 Hz tones.

MODULATION LIMITING
FCC ID: CNMT1-216

FIGURE 2

FIGURE 3

OCCUPIED BANDWIDTH



95.635:

(2) Emissions for LPRS transmitters operating on extra band channels (50 kHz) shall be attenuated below the unmodulated carrier in accordance with the following:

(i) Emissions 25 kHz to 35 kHz from the channel center frequency: at least 30 dB;

(ii) Emissions more than 35 kHz away from the channel center frequency: at least 43 + 10 log (carrier power in watts) dB.

E. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION (Paragraph 2.993(a) (b) (2) of the Rules)

Field intensity measurements of radiated spurious emissions from the T1-216 were made with a Tektronix 494P spectrum analyzer using Singer DM-105A calibrated test antennas. The transmitter was located in an open field 3 meters from the test antenna. Supply voltage was a fresh set of batteries. The transmitter and test antennas were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed. (The radiation test range is currently listed as an accepted site.)

TABLE 1

TRANSMITTER RADIATED SPURIOUS
216.325 MHz; 3 Vdc; 2.4 mW

Emission Frequency MHz	Field Intensity @ 3m dBV/m	dB Below Carrier Reference
216.326	79432.8	0.0
432.658	144.5	54.8V*
648.984	48.4	64.3V*
865.312	190.5	52.4V*
1081.640	117.5	56.6H*
1297.970	50.7	63.9V*
1514.297	199.5	52.0V*
1730.632	18.0	72.0H*
1946.951	117.5	56.6H*
2163.259	58.9	62.6V*

Required: 43+10Log(P) = 17

1. Worst-case polarization, H-horizontal, V-vertical.

* Reference data; more than 20 dB below FCC limit.

All other spurious from 6 MHz to the tenth harmonic were 20 dB or more below limit.

ERP Calculation:

$$P = \frac{(E + D)^2}{30\ G} \qquad (1)$$

Where

P = Power input (same as power radiated assuming 100% efficient antenna)

E = Electric Field in V/M

D = Distance in meters

G = Gain of the antenna over isotropic. (For a monopole, gain = 0.8)

$$P = \frac{(.079432 \times 3)^2}{30 \times 0.8}$$

P = 2.4 mW

(1) Kraus, J.D., Antennas p.55.

F. FREQUENCY STABILITY
(Paragraph 2.995(2) and 90.213 of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -30°C to +50°C. At each temperature, the unit was exposed to test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following the 1 hour soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes. Test temperature was sequenced in the order shown in Table 3, starting with -30°C.

A Thermotron S1.2 temperature chamber was used. Temperature was monitored with a Keithley 871 digital temperature probe. The transmitter output stage was terminated in a 50 ohm dummy load. Primary supply was 3 volts. Frequency was measured with a HP5385A digital frequency counter. Measurements were made at 216.325 MHz.

TABLE 2

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE

216.325 MHz; 3 Vdc; 2.4 mW

Temperature, °C	Output Frequency, MHz	p.p.m.
-29.3	216.329359	20.2
-19.9	216.329758	22.0
-10.0	216.329735	21.9
- 0.2	216.329353	20.1
10.6	216.328578	16.5
19.7	216.327438	11.3
30.2	216.326235	5.7
39.7	216.325169	0.8
49.7	216.324138	-4.0

Maximum frequency error: 216.329758
216.325000
\+ .004758 MHz

Rule 95.629(c)(i) specifies 50 ppm or ± 0.108163 MHz. Corresponding to:

Maximum	216.433163 MHz
Minimum	216.216838 MHz

G. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE (Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with a HP 5385A digital frequency counter as supply voltage provided by a HP 6264B variable dc power supply was varied ±15% from the nominal 3 volt rating. A Keithley 177 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20 °C ambient.

TABLE 3

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE

216.325 MHz; 3 Volt Nominal; 2.4 mW

Supply Voltage	Output Frequency, MHz	p.p.m.
3.45	216.327485	11.5
3.30	216.327467	11.4
3.15	216.327452	11.3
3.00	216.327438	11.3
2.85	216.327428	11.2
2.70	216.327420	11.2
2.55	216.327409	11.1
2.40	216.327397	11.1

Maximum frequency error: 216.327485
216.325000

\+ .002485 MHz

Rule 95.629(c)(i) specifies 50 ppm or ± 0.108163 MHz corresponding to:

Maximum	216.433163 MHz
Minimum	216.216838 MHz

APPENDIX 3

ACTIVE SEMICONDUCTOR FUNCTIONS

Reference	Type	Function
Q1	MMBR5179	VCO
IC 101	SSM2166	Audio Processor
IC 001	MC13175/1376	Synthesizer/PLL/ Final RF

APPENDIX 4

SCHEMATIC DIAGRAM

ONE (1) PAGE SCHEMATIC DIAGRAM FOLLOWS THIS SHEET

APPENDIX 6

TRANSMITTER ALIGNMENT

FOUR (4) PAGES FOLLOW THIS SHEET

Test Specification
Circuit Board, T1-216

This test specification provides only criteria for acceptance of assembled boards. *It is not intended to diagnose defects.*

The audio test tone frequency is 400 Hz, +-10 Hz unless otherwise specified.

AC (audio) voltage measurements must be made with a meter that is able to give accurate readings at the frequencies involved. *Digital multimeters are not, as a rule, capable of operating at these frequencies.* Further, the meter must be able to operate properly in the presence on strong RF signals. An average responding - RMS calibrated, or RMS responding - RMS calibrated meter is required. When a meter whose basic accuracy is +- 2 percent or less of full scale and when the reading is equal to or greater than one half of full scale is used, the meter may be considered to be in exact calibration and no consideration need be made for meter accuracy.

Acceptable test results are given as minimum and maximum limits. An acceptable unit must have all of its readings within the stated limits. Within these limits, there is no correct "exact" value. Nominal values are given for information only.

Voltage levels specified have been rounded to three and sometimes two significant figures to make for easier reading of instruments. Rounding is always made in the direction which makes the result a tighter specification. There is then the possibility of a unit having all good parts, but at the limit of their tolerances, yield an out of limit reading. This is highly unlikely and the degree of exceeding the limit would be very small. *Such a unit can be accepted, but only with the approval of the design engineer.*

All voltage measurements are referenced to CIRCUIT COMMON unless otherwise specified.

Note that AC voltage readings are frequently taken at points in the circuit where DC voltages are also present. Make sure that the voltmeter used is AC coupled so as to not be affected by the presence of DC.

All AC voltage measurements are made directly at the circuit point specified without intervening filters unless otherwise specified.

Level of Assembly: Assembled PCF T1-216 circuit board assembly with all leaded parts installed.

Inspect each new board assembly. Look for missing parts, tomb-stoned parts, raised parts, damaged parts and solder bridges. (Certain parts are required to be mounted flush on the board surface. See the Assembly Drawing.) If any of these or any other mechanical defects are found, reject the assembly at this point. Do not proceed to test it.

Listen to the output of a receiver receiving the transmitter under test with the monitor amplifier during the entire test procedure. You can often hear a defect in performance even though you are measuring something else at the time. *Defects that are audible but not deliberately measured are still grounds for rejection.* You may adjust the volume as required for comfort, but do not have it so low that you don't hear small defects.

The tests are intended to be carried out in sequence. Connections may not be made to the unit under test until called for in a test step. Test connections made in individual steps must remain in effect until changed by another step. Connections must be made to the points specified even though some other point (such as a connector pin) might be available.

No connections are to be made until called for in a test step.

I. Equipment Required

This is a list of major equipment required to test the T1-216. No other test equipment is required for alignment, but trouble shooting a malfunctioning unit may require other items. The list does not include tools, cables, adapters and other small items.

A. Test Equipment

1. R1-216 Receiver
2. Oscilloscope
3. Audio Generator
4. Digital Multimeter
5. FM Deviation Meter
6. RF Spectrum Analyzer
7. Test Fixture TESTPCB139
8. - 100 mW RF wattmeter suitable for operation at 150 to 250 MHz (with in-line power measuring adapter, see engineer).

B. Special tools

1. Small metal screwdriver for trimmer capacitors
2. Nonmetallic adjustment tool for variable inductors

II. Control and Adjustment Presets

A. Control Settings

These settings are performed before the board is installed in the fixture.

1. Set the compression pot (R107) at 7 o'clock (just past half way going clockwise).
2. Set the deviation pot (R108) fully CCW, then back up ¼ turn
3. Set the Noise gate pot (R105) at 9 o'clock (about ¾ of the way going clockwise).
4. Set the gain pot (R106) fully CCW

B. Switch Settings

1. Set S1 to OFF (Bat toward edge of circuit board)

III. Initial Tests

Various DC checks are accomplished in this section.

1. Install the board in the fixture.
2. Make sure the fixture is connected as shown in the ____________
3. Turn on the transmitter (S1). Observe that the LED turns on. Smoking is not permitted at any time.
4. Using a DC multimeter, measure the DC voltage present at pin 5 of the DC and audio test connector. Use pin 6 as a ground reference. This voltage must measure between 4.9 and 5.1 volts.
5. Wait 10 seconds. Observe (on the spectrum analyzer) that the transmitter is producing RF.

IV. RF System Alignment

Tests must be made with 2.35 VDC minimum, 2.45 maximum applied at the DC input (where the battery connects).

A. Voltage Controlled Oscillator Adjustment

1. Connect a DC voltmeter to the positive terminal of C39 at R30 through a 10K resistor. (Negative lead to circuit common.)
2. Adjust L01 to achieve 2.25 VDC minimum, 2.35 VDC maximum. (Clockwise rotation reduces voltage, counterclockwise rotation increases voltage.) Remove the voltmeter leads. Remove the test lead. Observe the frequency counter. The RF output should now be locked and close to the correct frequency.

B. Crystal Trim

Adjust C07A to achieve a transmitter output frequency of within 1000Hz of the designated channel frequency. (+/- 1000 Hz).
C07A must not be adjusted to either its minimum or maximum of capacitance.

V. Audio System

Microphone Preamplifier and Deviation Adjustment

1. Apply a 400 Hz audio tone at 1 mV RMS to the audio input of the fixture.
2. Observe the audio output of the audio chip at pin 1 of the fixture DC and audio test connector.
3. Adjust the gain pot (R106)until the audio waveform begins to clip. Note the peak to peak voltage this level represents, then (using R106) reduce the signal level to 50% of the peak to peak level noted.
4. Adjust R108 to set the deviation at 5 KHz. (Clockwise rotation increases deviation.)
5. Using the oscilloscope, there must be no visible clipping or other distortion of the waveform at pin 1 of the fixture.
6. Glyptol the deviation and the Gain control pots. (R106 and R108).

VI. Overall Performance

A. Signal to Noise Ratio Does this apply with compression on? Ask David.

Great care must be taken in making these measurements. A ground loop or any other improper connection can cause inaccuracy that would result in a reading that is much greater than maximum allowable reading.

Apply an audio signal to J1 to achieve 5 kHz deviation on the Deviation Meter. Record the voltage level shown on the Ballentine as V1. Next, rotate the input attenuation potentiometer R2 fully clockwise to mute the input and then record the new voltage level (V2), shown on the Ballentine. This second voltage reading (V2) must be a minimum of 60 dB below that of V1 and can be calculated by the formula:

$$\# \text{ dB} = 20 \text{ LOG } (V2/V1)$$

Note: Batteries may have to be used to achieve desired results, because the power supply does emit enough noise to interfere with this measurement.

B. DC Current Consumption

Current consumption from the 2.4 volt supply, must be less than 120 mA.
Move power switch to "OFF" position.

C. Final Test

Readings:
Current < 120 mA
Deviation = 5 kHz
Power Out(For) 1.5 mW +/- 0.1 mW

Remove the unit from the test fixture.

TEST COMPLETE, PASS UNIT TO NEXT STAGE OF PRODUCTION.

LJH 10/06/98, revised:

Filename: T1-216.DOC

APPENDIX 7

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

Phase Locked Loop. The PLL circuit is based around the MC13176 chip. An external VCO (Q1) is used because the VCO internal to the chip will not work at the (low) frequencies needed here. Internal to the chip are the prescaler, phase detector, reference oscillator, and RF amplifier. The reference oscillator is controlled by the crystal, X01. The crystal is a parallel resonant fundamental mode crystal cut for resonance with 32 pF. C074 trims the crystal frequency to more closely match the exact desired output frequency. The phase detector compares the output of the prescaler (VCO/32) to the reference oscillator. The output of the phase detector is developed by a current source amplifier, and is present at pin 7.

APPENDIX 8

CIRCUITS TO SUPPRESS SPURIOUS RADIATION

1. **Harmonic Filter and Match Network.** The MC13176 chip offers a balanced RF output at pins 13 and 14. Use of the balanced-to-unbalanced transformer T01 permits cancellation of most of the second harmonic of the RF output, simplifying the requirements on the harmonic filter because it need only deal with third and higher harmonics. R31 is a balancing resistor that absorbs any imbalance in the RF power output. L11 provides a low impedance path for the supply current to the balanced amplifier. Harmonic filtering is provided by C17, C20, C21, C18, C19, L06, and L07. Matching and additional filtering is provided by L08 and C22. The audio input is routed from J01 through L09 and L10 to the audio processor. C24 provides an RF short across J01, promoting good coupling to the antenna. Microphone bias is provided and de-coupled by R20, R21, and C27, and is passed back to J01 through L09.

2. **Audio Processor Circuit.** IC101 is the audio processor chip. The input buffer amp (pins 5, 6 and 7) provides gain and pre-emphasis to the input audio. Included in this function are R101-R103, C102-C104, with blocking provided by C101 and C105. The voltage controlled amplifier, pins 3 and 13, is controlled by an RMS level detector. Controls are provided (R107, R106, and R105) to set the compression ratio, gain, and noise gate level. R108 selects the modulation level for the system.

3. **Antenna/Microphone.** The antenna and microphone are one and the same. The RF output is matched to the nominal RF impedance of the microphone. Audio is sensed with that same microphone. A nominal level of 1 mV RMS is expected.