MEASUREMENT PROCEDURE AND TEST EQUIPMENT USED

Except where otherwise stated, all measurements are made according to:

1. Electronic Industries Association (EIA) Minimum Standard for Portable/Personal Land Mobile Communications FM or PM Equipment 25-1000 MHz (EIA/TIA-603A).
2. Electronic Industries Association (EIA) Digital C4FM/CQPSK Transceiver Measurement Method (EIA/TIA-102.CAAA) And Digital C4FM/CQPSK Transceiver Performance Recommendations (EIA/TIA/IS-102.CAAB).

This exhibit presents a brief summary of how the measurements were made, the required limits, and the test equipment used.

The following procedures are presented with this application.

1.	Test Equipment List	X
2.	RF Power Output	X
3.	Audio Frequency Response	X
4.	Low Pass Filter Frequency Response	X
5.	Modulation Limiting	X
6.	Occupied Bandwidth	X
7.	Conducted Spurious Emissions	X
8.	Radiated Spurious Emissions	X
9.	Frequency Stability	X
10.	Transient Frequency Behavior	X

TEST EQUIPMENT LIST

Pursuant To FCC Rules 2.947 (d)

	Description	Manufacture	Model
1.	Vector Signal Analyzer (V.S.A)	Hewlett Packard	89410A
2.	Audio Analyzer	Hewlett Packard	8903B
3.	Modulation Analyzer	Hewlett Packard	8901B
4.	DC Power Supply	Hewlett Packard	6286A
5.	Oscilloscope	Tektronix	TDS 420
6.	Universal Counter	Agilent	53132A
7.	DC Power Supply	Hewlett Packard	6653A
8.	Temperature chamber	THERMOTRON	2800
9.	Audio Network Analyzer 5Hz – 200 MHz	Hewlett Packard	3577B
10.	Spectrum Analyzer	Hewlett Packard	8563E
11.	DC Power Supply	Hewlett Packard	6023A
12.	20 dB Attenuator	Weinschel	53-20-34
13.	Dual Directional Coupler	Hewlett Packard	778D
14.	30 dB Attenuator	Weinschel	53-30-34
15.	Peak Detector Negative	Hewlett Packard	8471D
16.	RF Signal Generator	Hewlett Packard	E4432B
17.	Spectrum Analyzer	Hewlett Packard	8560E
18.	Oscilloscope 500 MHz 1GSa/s	Hewlett Packard	Infinium
19.	DC Power Supply	Hewlett Packard	6032A
20.	Power Meter	Hewlett Packard	437B
21.	Power Meter Sensor	Hewlett Packard	8481H

Test equipment used by Hermon Laboratories Test House

	Description	Manufacture	Model
22.	Antenna, dipole, tunable 30-200 MHz	Electro-Metrics	TDA 25/30
23.	Double ridged guide antenna, 1 - 18 GHz	Electro-Metrics	RGA 50/60
24.	Active Loop Antenna 10 kHz-30 MHz	Electro-Mechanics	6502
25.	Anechoic Chamber 9 (L) x 6.5 (W) x 5.5 (H) m	Hermon Labs	AC-1
26.	Spectrum Analyzer with RF filter section (EMI Receiver 9 kHz - 6.5 GHz)	Hewlett Packard	8546A
27.	Cable Coaxial, GORE A2POL118.2, 3m	Hermon Labs	GORE-3
28.	Position controller	Hermon Labs	L2-SR3000
29.	Antenna Mast, 1-4 m/1-6 m Pneumatic	Hermon Labs	AM-F1
30.	Turntable for Anechoic Chamber, flush mounted, d=1.2 m, pneumatic	Hermon Labs	WDC1
31.	Antenna Biconilog Log-Periodic/T Bow-Tie, 26 - 2000 MHz	EMCO	3141
32.	Generator Swept Signal, 10MHz to 40GHz+ 10dBm	Hewlett Packard	83640B
33.	Cable coaxial, ANDREW PSWJ4, 6 m	Hermon Labs	ANDREW-6
34.	Cable RF, 8 m	Alpha Wire	RG-214
35.	Cable 40GHz, 1.5 m, green	Rhophase Microwave Ltd.	KPS-1503A-1500-KPS
36.	Modulation Domain Analyzer	Hewlett Packard	53310A

RF POWER OUTPUT

Pursuant to FCC Rules 2.1046 (a)

Method of Measurement

The transmitter is operated under normal conditions at the specified nominal DC input voltage. The antenna output is terminated in 50 ohms. This measurement is performed at center frequency, 154.225MHz, of the VHF frequency band. The measurement is performed at the High and low limits of the specified adjustable power range.

The power measurements were made using a Hewlett Packard 437B power meter with 8481H power sensor and 30 dB attenuator.

AUDIO FREQUENCY RESPONSE

Pursuant FCC Rules 2.1047 (a)

Method of Measurement

Operate the transmitter under standard test conditions and monitor the output with a frequency deviation meter or calibrated test receiver. With 1000 Hz sine wave audio input applied through a dummy microphone circuit, adjust the audio input to give 20% of full rated system deviation Maintaining a constant input voltage, vary the input frequency from 300 to 3000 Hz, and observe the deviation.

Minimum Standard

The audio frequency response shall not vary more than +1 or -3 dB from 300 to 3000 Hz from a true 6 dB per octave pre-emphasis characteristic as referenced to 1000 Hz level, with the exception of a permissible 6 dB/octave roll off below 500 Hz. Equivalent to TIA/EIA 603A Section 5.2.6.2 mask.

POST LIMITER FILTER FREQUENCY RESPONSE

Pursuant FCC Rules 2.1047 (a)

Method of Measurement

Operate the transmitter under standard test conditions and monitor the output of the post limiter low-pass filter with an audio spectrum analyzer. Adjust the audio input frequency to 1000 Hz and the input level to 20 dB greater than that required to produce standard test modulation. Note the output level on the audio spectrum analyzer. Use this output dB level as reference (LEVREF), vary the modulating frequency from 3000 Hz to the upper low pass filter limit and record the dB level on the audio spectrum analyzer as LEVFRE while maintaining a constant input level. The audio frequency response of the low-pass filter in accordance with the following formula:

Low-Pass Filter Response = LEVFREQ-LEVREF

FCC Limits – Per EIA/TIA 603 3.2.15.

a) For equipment operating on 20, 25 or 30 kHz channel spacing in the 25 MHz to 174 MHz range:
At frequencies from 3000 Hz through 15,000 Hz the attenuation shall be greater than the attenuation at 1000 Hz by at least: 40 log10 (f / 3000) dB, where: f is the audio frequency in Hz.
At frequencies above 15,000 Hz, the attenuation shall be greater than the attenuation at 1000 Hz, by at least: 28 dB.

c) For equipment operating on channels between 896 MHz through 901 MHz, between 935 MHz through 940 MHz, and 12.5 or 15 kHz spaced channels in the frequency range 138-174 MHz and 406-512 MHz.
At frequencies from 3000 Hz through 20,000 Hz the attenuation shall be greater than the attenuation at 1000 Hz by at least: 100 log10 (f / 3000) dB, where: f is the audio frequency in Hz.

MODULATION LIMITING

Pursuant FCC Rules 2.1047 (b)

Method of Measurement

The transmitter shall be adjusted for full rated system deviation. Adjust the audio input for 60% of rated system deviation at 1000 Hz. Using this level as a reference (0 dB) vary the audio input level from the reference to a level 20 dB above it for modulation frequencies from 300 to 3000 Hz. Record the system deviation obtained as a function of the input level.

FCC Limits

Minimum Standard - The transmitter modulation must not exceed rated system deviation at any audio frequency input or reasonable change in input level.

OCCUPIED BANDWIDTH

Pursuant to FCC Rules 2.1049

Method of Measurement

Data on occupied bandwidth is presented in the form of a spectrum analyzer photograph, which illustrates the transmitter sidebands. For analog signals, the reference line for the data plot is taken of the unmodulated carrier, to which is superimposed the sideband display generated by modulating the carrier with a 2500 Hz tone at a level 16 dB greater than that required to produce 50 percent modulation. For digital voice and data, the reference line for the data plot is that of the peak value of the modulated carrier. For digital voice, the carrier with a 2500 Hz tone at a level 16 dB greater than that required to produce 50 percent modulation. For digital data, the carrier is modulated with a Standard Transmitter Test Pattern, which is a continuously repeating 511 bit pseudo-random bit sequence based on ITU-T 0.153. If tone or digital coded squelch is indicated, photographs using both the 2500 Hz tone and the indicated squelch signal are used to modulate the transmitter. During these measurements, the instantaneous Deviation Control is set for a maximum of +5 kHz.

FCC Limits - Per 90.210 (b)(d).

Emission Mask B. For transmitters that are equipped with an audio low-pass filter pursuant to Sec. 90.211(a), the power of any emission must be below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB, where P is the mean output power in watts.

Emission Mask D. 12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd - 2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (We used 30 KHz, which is more than two times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (m) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, then an alternate procedure may be used provided prior Commission approval is obtained.

(m) Instrumentation. The reference level for showing compliance with the emission mask shall be established, except as indicated in Secs. 90.210 (d), (e), and (k), using standard engineering practices for the modulation characteristic used by the equipment under test. When measuring emissions in the 150-174 MHz and 421-512 MHz the following procedures will apply. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For frequencies more than 50 kHz removed from the edge of the authorized bandwidth a resolution of at least 10 kHz must be used for frequencies below 1000 MHz. Above 1000 MHz the resolution bandwidth of the instrumentation must be at least 1 MHz. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, then an alternate procedure may be used provided prior Commission approval is obtained.

CONDUCTED SPURIOUS EMISSIONS

Pursuant to FCC Rule 2.1051

Method of Measurement:

The transmitter is terminated into a 50-ohm load and interfaced with a spectrum analyzer, which allows the spurious emission level relative to the carrier level to be measured directly. Modulate the transmitter with a 2500 Hz sine wave at an input level 16 dB greater than that required producing 50% of rated system deviation at 1000 Hz. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier or as high as the state of the art permits except for that region close to the carrier equal to ± 250% of the authorized bandwidth.

FCC Limits - Per Applicable Rule Parts.

Conducted spurious emissions shall be attenuated below the maximum level of emission of the carrier frequency in accordance with the following formula:

For 25 kHz Channelization: Spurious attenuation in dB = 43 + 10 log 10 (Power output in watts). Alternatively, an equivalent absolute level of -13 dBm is taken.

For 12.5 kHz Channelization: Spurious attenuation in dB = 50 + 10 log $_{10}$ (Power output in watts). Alternatively, an equivalent absolute level of -20 dBm is taken.

RADIATED SPURIOUS EMISSIONS

Pursuant to FCC Rules 2.1053

Test Site:

The test site is: Motorola EMC Lab, located in Plantation, Florida. The Motorola EMC Lab is listed with FCC and Industry Canada as follows:

1. FCC OATS registration number is: 91932
2. Industry Canada OATS registration number is: IC3679
3. Accredited by A2LA.

Site address:

Motorola EMC Lab – Plantation FL
8000 West Sunrise Blvd
Plantation, FL 33322

This region is reasonably free from RF interference.

Method of Measurement:

The equipment is adjusted to obtain peak reading of received signals wherever they occur in the spectrum by:

1. Rotating the transmitter under test.

2. Adjusting the antenna height.

The testing procedure is repeated for both horizontal and vertical polarization of the receiving antenna. Relative signal strength is indicated on the spectrum analyzer connected to the

receiving antenna. To obtain actual radiated signal strength for each spurious and harmonic frequency observed, a standard signal generator with calibrated output is connected to a dipole antenna adjusted to that particular frequency. This dipole antenna is substituted for the transmitter under test. The signal generator is adjusted in output level until a reading identical to that obtained with the actual transmitter is observed on the spectrum analyzer. Signal strength is then read and recorded directly from the generator.

FCC Limits -- Per Applicable Rule Parts.

Radiated spurious emissions shall be attenuated below the maximum level of emission of the carrier frequency in accordance with the following formula:
Spurious attenuation in dB = 43 + 10 $\log_{10}$(Power output in watts).

FREQUENCY STABILITY

Pursuant to FCC Rule 2.1055

Method of Measurement:

A. Temperature (Non-heated type crystal oscillators):
Frequency measurements are made at the extremes of the temperature range -30 to +60 degrees centigrade and at intervals of 10 degrees centigrade throughout the whole temperature range. Sufficient time is allowed prior to each measurement for the circuit components to stabilize.

B. Power Supply Voltage:
The primary voltage was varied from 85% to 115% of the nominal supply voltage. Voltage is measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. In addition, the primary voltage will be reduced to the point where the radio performs a reset (battery operating end point).

FCC Limits -- Per FCC Rule 90.213

Temperature - Frequency Stability of ± 2.5 ppm from -30 to +60 degrees centigrade.
Power Supply Voltage - Frequency Stability of ± 2.5 ppm from 85% to 115% of nominal Voltage.

TRANSIENT FREQUENCY BEHAVIOR
Pursuant to FCC Rules 90.214

This data measured in accordance with FCC Rules. Applicable method of measurement and definition is illustrated in Section 2.2.19.2 of the TIA/EIA 603A and 2.2.18.3 of the TIA/EIA 102. This method utilizes a Modulation Domain Analyzer, HP53310A, for measurement.