MEASUREMENT TECHNIQUES

2.991 and 24.238 Measurements Required:Conducted Spurious and Harmonic Emissions at Antenna Terminal

Graph Attached
EXHIBIT NO. 9C and 9C-1 thru 9C-13

Definition - (as used herein) Spurious radiation is the radio frequency voltages or power generated within the equipment and appearing at the equipment's output terminals when properly loaded with its characteristic non-radiating artificial load.

Minimum Standards -

Section 24.238 Emission Limits - On any frequency outside a licensee's frequency block, the power of any emission shall be attenuated below the transmitter power (P) by at least $43 + 10 \log_{10}(P)$ dB. For all power levels +30 dBm to 0 dBm, this becomes a constant specification limit of -13 dBm.

Section 2.991 Requirements - Conducted spurious and harmonic emissions shall be attenuated $43 \text{ dB} + 10\text{Log}_{10}(P)$(the mean power output). In the range of frequencies between 1930 MHz and 1990 MHz, no spur shall exceed -80 dBm.

Method of Measurement - The following steps outline the procedure used to measure the conducted emissions from the mobile station.

1. Determine frequency range for measurements: From CFR 2.997, the spectrum should be investigated from the lowest radio frequency generated in the equipment up to at least the 10th harmonic of the carrier frequency. For the mobile station equipment tested, this equates to a frequency range of 10 MHz to 20 GHz.

2. Determine the mobile station transmit frequencies: Table 12.1 below outlines the band edge frequencies and the mid-band frequency pertinent to conducted emissions testing.

USPCS Channel	Transmitter Frequency
25	1851.25 MHz
600	1880 MHz
1175	1908.75 MHz

Table 12.1: Transmit frequencies for conducted emissions testing.

The carrier frequencies for each of the 1.25 MHz wide channels of the USPCS transmit band (1850 to 1910 MHz) begins with the first channel 1.25 MHz higher than the lower band edge, at 1851.25 MHz for channel number 25, and ends with the last channel 1.25 MHz lower than the upper band edge, at 1908.75 MHz for channel number 1175.

3. Measure attenuator and cable losses:

a) Connect a Band Rejection Filter and nominal 10 dB attenuator together, and place cables at input of the filter and output of the attenuator.
b) The rejection response of the filter was measured using a signal generator and the spectrum analyzer. This attenuation was used to offset the analyzer and verify the band edge readings were not affected by the carrier.

4. Power up Mobile Station:

a) Tune to desired frequency.
b) Set the desired output power.
c) Modulated the carrier with OQPSK modulation using the mobile station's internal pseudo random data sequence.
d) Set the appropriate spectrum analyzer offset level to account for external attenuation.

5. Measure the spectrum:

a) In the 1st 1 MHz band outside the band edge nearest the channel of interest use a 1 kHz resolution bandwidth.

b) In the 2nd and 3rd 1 MHz bands outside the band edge nearest the channel of interest use a “Brickwall filter” technique with a 1 kHz resolution bandwidth and integrate the power in the two 1 MHz bands. This measurement method is intended to overcome limitations caused by non-ideal filter roll-off within the measurement equipment (Hewlett Packard Spectrum Analyzer). The 3 MHz cut-off was determined from the spectrum analyzer filter plot shown in Exhibit 9C-13 and the roll-off of the carrier. At 3 MHz from the carrier, the attenuation is sufficient enough to guarantee against non-compliance readings.
c) From 3 MHz outside the band edge nearest the channel of interest to the min./max. frequency limits, a 1 MHz resolution bandwidth was used.

6. Repeat steps 4 & 5 for each carrier frequency listed in Table 12.1.

2.993 Measurement Required: Radiated Spurious and Harmonic Emissions

Graph Attached
EXHIBIT NO. 9D

Definition - Radiated spurious and harmonic emissions from the equipment at a frequency or frequencies which are outside an occupied band sufficient to insure transmission of information of required quality for the class of communications desired. The reduction in the level of these spurious emissions will not effect the quality of information being transmitted.

Minimum Standard - Radiated spurious and harmonic emissions shall be attenuated 43 dB + 10Log_{10}(the mean power output). In the range of frequencies between 1930 MHz and 1990 MHz, no spur shall exceed -80 dBm.

Method of Measurement:

Test Site - All testing reported herein was performed at the Motorola Schaumburg open area test facility, located at 1301 E. Algonquin Road, Schaumburg IL 60196.

Installation of Equipment

The equipment under test is placed on the turntable in normal operation using the intended power source. A receiving antenna located 3 meters from the turntable picks up any signal radiated from the transmitter and its operating accessories. The antenna is adjustable in height from 1 to 4 meters and can be horizontally and vertically polarized. Tunable receivers covering the necessary frequency range are used to detect and measure any radiation picked up by the antenna.

Measurement Procedure

The equipment is adjusted to obtain peak readings 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 meters built into the receiver. To obtain actual radiated signal strength, a standard signal generator with calibrated output is substituted for the transmitter under test. The signal generator is adjusted in output until a reading identical to that obtained with the actual transmitter is obtained at the receiver. Signal strength is then read directly from the generator. Actual measurements are recorded on the attached graph.

2.995 Measurement Required: Frequency Stability

Definition - The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

Minimum Standard - The minimum frequency stability shall be +/-150Hz at any time during closed loop operation.

Method of Measurement - Frequency measurements shall be made at the extremes of the temperature range -30°C to +60°C and at intervals of not more than 10° C throughout the range. A period of time sufficient to stabilize all of the components in the equipment shall be allowed prior to each frequency measurement. The frequency of the transmitter shall be measured by supplying a received signal to the transceiver and the transmitter carrier frequency offset shall be measured with respect to the received signal frequency. The frequency stability of transmitting equipment shall be checked with variations in:

(a) Temperature:
Vary the ambient temperature from -30°C to +60°C.

Graph Attached : EXHIBIT NO. 9E

(b) Primary Supply Voltage:
Vary the primary supply voltage from 2.9V to 5.4 V at the input to the power cable supplied or at the power supply terminals if cables are not normally supplied.

Graph Attached : EXHIBIT NO. 9F

TIMING PERIOD AND PROCEDURE

1. The carrier frequency of the transmitter and the individual oscillators were measured at room temperature (usually between 25°C and 27°C) to provide a reference.

2. The equipment was then subjected to an overnight "soak" at -30° C without any power applied.

3. After an overnight "soak" at -30°C (usually 14 to 16 hours) the equipment was turned on in a "standby" condition for one minute before applying power to the transmitter. Measurement of the carrier frequency of the transmitter and the individual oscillators was made within a three minute interval after applying power to the transmitter.

4. Frequency measurements were made at each 10°C interval up to room temperature (-30°C, -20°C, -10°C, 0°C, +10°C, +20°C). At least a period of one and one half hours was provided to allow stabilization of the equipment at each temperature level.

5. Again the transmitter carrier frequency and the individual oscillators were measured at room temperature to begin measurement of the upper temperature extreme.

6. Frequency measurements were made at 10°C intervals starting at +30°C and ending at +60°C allowing at least two hours at each temperature for stabilization. In all measurements the frequency was measured within three minutes after applying power to the transmitter.

7. In all measurements, at the various temperature intervals, the temperature was held to +1° C from the temperature level and the equipment turned on for one minute standby condition before applying transmitter power.

8.The artificial load was mounted external to the temperature chamber.