MEASUREMENT TECHNIQUES

2.991 Measurements Required: Conducted Spurious and Harmonic Emissions at Antenna Terminals - Analog Mode

Graph Attached
EXHIBIT NO. 9G

Definition - (as used herein) Spurious radiations are 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 Standard - Conducted spurious and harmonic emissions shall be attenuated 43 dB - 10Log10(the mean power output). In the range of frequencies between 869 MHz and 894 MHz, no spur shall exceed -80dBm.

Method of Measurement - The transmitter was modulated with a 2500 Hz tone at a level 16 dB greater than that required to provide 50 % modulation. The Antenna port of the sample was directly coupled to the input of the EMI receiver through a special coupling cable and a 10 dB passive attenuator. Scans were then performed from 30 to 2.9GHz, while observing the fundamental signal level, plus low order harmonics or other spurious signals. A high pass filter (Fc=1300MHz) was then inserted. The frequency range of 1 to 6.5GHz was then inspected, and the level of the harmonics was measured and recorded. The output of the sample, with the attenuator and High Pass filter was then switched to a Hewlett Packard HP8596e spectrum analyzer to verify harmonic signal levels out to the tenth harmonic. The bandwidth was initially set to 1 MHz for signature scans, and then reduced to 30 kHz to measure individual signal strengths.

Measurements Required: Conducted Spurious and Harmonic Emissions at Antenna Terminals - Digital Mode

Graph Attached
EXHIBIT NO. 9G

Definition - (as used herein) Spurious radiations are 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 Standard - Conducted spurious and harmonic emissions shall be attenuated 43 dB - 10Log10(the mean power output). In the range of frequencies between 869 MHz and 894 MHz, no spur shall exceed -80dBm.

Method of Measurement - The transmitter was modulated with p/4 DQPSK modulation using pseudo random data. The Antenna port of the sample was directly coupled to the input of the EMI receiver through a special coupling cable and a 10 dB passive attenuator. Scans were then performed from 30 to 2.9GHz, while observing the fundamental signal level, plus low order harmonics or other spurious signals. A high pass filter (Fc=1300MHz) was then inserted. The frequency range of 1 to 6.5GHz was then inspected, and the level of the harmonics was measured and recorded. The output of the sample, with the attenuator and High Pass filter was then switched to a Hewlett Packard HP8596e spectrum analyzer to verify harmonic signal levels out to the tenth harmonic. The bandwidth was initially set to 1 MHz for signature scans, and then reduced to 30 kHz to measure individual signal strengths.

2.993 Measurement Required: Radiated Spurious and Harmonic Emissions -Analog and Digital Modes.

Graph Attached: EXHIBIT NO. 9H

Definition - Radiated spurious and harmonic emissions from the equipment when loaded into a non-radiating load 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 - 10Log10(the mean power output). In the range of frequencies between 869 MHz and 894 MHz, no spur shall exceed -80dBm.

Method of Measurement:

Test Site - The test sample was operated within the 3 meter Semi-Anechoic, FCC listed chamber located at L.S. Compliance in Cedarburg, WI.

Installation of Equipment – The sample was placed on an 80cm high small wooden pedestal, which was centered on the flush-mounted 2m diameter metal turntable. The test sample was operated on its internal rechargeable battery. The test sample was configured to run in a continuous transmit mode during the Radiated measurements. The test sample was set to operate on one of three standard channels within the Cellular frequency assignment: one at the low end of the band (333), one in the middle of the band (799) and one near the top of the band (991).

All equipment is calibrated and used according to the user manuals supplied by the manufacturer. All antenna calibrations were performed at a N.I.S.T traceable site, and the resultant correction factors were entered into the Hewlett Packard 8546A EMI receiver software database. The connecting cables used were also measured for loss using a calibrated signal generator and the HP 8546A EMI receiver. The resulting loss factors were entered into the HP 8546A database. This allowed for automatic changes in the antenna correction factor, as well as cable loss or other corrections, to be added to the EMI receiver display while taking measurements. Thus, the resulting data taken from the HP 8546A is an actual reading and can be entered into the database as a corrected meter reading. When a reading is taken using the peak detector, a duty cycle correction factor can be applied for conversion to an average reading. This operation can be used when measuring periodic data transmission, under FCC part 15.231b, and Part 15.35c. The resulting average reading was then compared to the appropriate limit in order to determine compliance. The HP 8546A EMI receiver was operated with a bandwidth of 120kHz when receiving signals below 1GHz, and with a bandwidth of 1MHz when receiving signals above 1GHz, in accordance with CISPR 16. While performing the Part 15 measurements. Other IF and Video bandwidths, narrower than stated above, were used where appropriate and allowable.

Measurement Procedure – The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47 CFR, FCC Part 22.917e limits for transmitters in the Public mobile services, and were also compared with the general limits laid out in Part 15.209. The samples were tested from the lowest frequency generated by the transmitter (without going below 9 kHz) to the 10th harmonic of the fundamental frequency generated by the device. The limits described in part 15.209 were also observed for observation and measurement of spurious signals. The samples were placed on a nonconductive (wooden) pedestal in the 3 Meter chamber and the antenna mast was placed such that the antenna was 3m from the test object. A biconical antenna was used to measure emissions from 30 to 200 MHz, a log periodic was used to measure emissions from 200 to 1000 MHz, and a double ridged waveguide horn was used to measure emissions above 1GHz. The test object was programmed to operate in continuous transmit, either in the analog mode or digital mode; and the resultant signals were maximized by rotating the turntable 360 degrees, and by raising and lowering the antenna between 1 and 4 meters. The test object was also given several different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities.

2.995 Measurement Required: Frequency Stability - Analog & Digital Modes

Graph Attached
EXHIBIT NO. 9J1 & 9J2

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 +/-0.00025% at any time during normal operation.

Method of Measurement - Frequency measurements shall be made at the extremes of the temperature range -30° to +60° 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. In the analog mode, the frequency of the transmitter shall be measured by extracting a sample of the carrier and measuring its center frequency by equipment having a degree of accuracy of at least 10 times that of the minimum to be measured. In the digital mode, a received signal shall be supplied 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. 9K1 & 9K2

(b) Primary Supply Voltage:
Vary the primary supply voltage over the operational input voltage range normally measured at the input to the power cable supplied or at the power supply terminals if cables are not normally supplied.

TIMING PERIOD AND PROCEDURE

1. The carrier frequency of the transmitter and the individual oscillators were measured at room temperature (usually between 25° 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°, -20°, -10°, 0°, +10°, +20°). 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° 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.

Addendum for Exhibits 9C and 9D:

See Confidential Exhibit 5C-4 for measurement procedures used to create these exhibits.