6. Measurement Procedures

6.1 Radio Frequency Power Output Measurement Procedure {2.985(a)}

6.1.1 Conducted Power Output Measurement Procedure

Equipment Used: Hewlett Packard HP8922M GSM MS Test Set with HP83220E DCS/PCS MS Test Set
KENWOOD PA18-6A Regulated DC Power Supply

RF Insertion Loss: 0 dB (directly connected to equipment with a dedicated RF cable for the MS the measurements includes loss of the cable.)

The following steps outline the procedure used to measure the RF power output from the mobile station.

1. Connect cable from RF connector on MS to RF IN/OUT of the HP83220E.
2. Apply 3.8Vdc to the MS. Power up MS.
3. Setup the MS for maximum output power (power level 0) with pseudo random data modulation.
4. Use HP8922M to obtain time mask and peak output power levels.
5. Repeat measurements for carrier frequencies at 1850.2 MHz, 1880.0 MHz, and 1909.8 MHz. Channels 512, 661, and 810 respectively (bottom, middle, and top of operational frequency range.
6. Repeat for power levels 7 (mid power level) and 15 (lowest power level).
7. For time mask plots put the MS into a simulated, plot out graphical representations of the rising, middle, and falling portions of the transmit burst.
8. Repeat for channels 512, 661, and 810 and for high and low power levels.

6.1.2 Radiated Power Output Measurement Procedure

To measure radiated power (EIRP) using antenna substitution method, the EUT is placed on a support of non-metallic material, the height of which is 1 m above the ground plane. Measurements are made by the substitution method with the antenna having both horizontal and vertical polarizations and the turntable with the EUT is rotated. The highest level of radiation is noted at each measuring frequency. The EUT is replaced by a transmitting antenna supplied by a standard generator and having the same characteristics of the receiving antenna. For each measuring frequency the output level of the generator is adjusted in order to give the same reference indication on the measuring set. The level of available power of the generator, increased by the radiating antenna gain above the half-wave dipole, is taken as the level of the radiated power of the EUT at the considered frequency.

6.2 Occupied Bandwidth Measurement Procedure {2.989(h)}

Equipment Used: Hewlett Packard HP8562E Spectrum Analyzer
Hewlett Packard HP8753D Network Analyzer
Hewlett Packard HP8498A 30dB Attenuator
KENWOOD PA18-6A Regulated DC Power Supply

RF Insertion Loss: 30.0 dB - attenuator and cabling

The following steps outline the procedure used to measure the occupied bandwidth from the mobile station.

1. Determine the measurement bandwidth: 1% of the occupied bandwidth of 250 KHz corresponds to a resolution bandwidth of 2.5 KHz, for this test a resolution bandwidth of 3.0 KHz was used.

2. Outline measurement frequencies: Table 6.2.1 below lists the measurement frequencies for the top and bottom of each PCS frequency block. For each frequency at which an occupied bandwidth measurement is made a transmitter output power of the +30 dBm maximum was used.

PCS 1900 Block	Lower Edge Chan. Freq.	Lower Edge Chan. Num.	Upper Edge Chan. Freq.	Upper Edge Chan. Num.
Block A	1850.2 MHz	512	1864.8 MHz	585
Block D	1865.2 MHz	587	1869.8 MHz	610
Block B	1870.2 MHz	612	1884.8 MHz	685
Block E	1885.2 MHz	687	1889.8 MHz	710
Block F	1890.2 MHz	712	1894.8 MHz	735
Block C	1895.2 MHz	737	1909.8 MHz	810

Table 6.2.1 Occupied Bandwidth Measurement Frequencies

3. Measure attenuator loss:
 a) Connect a nominal 30 dB attenuator.
 b) Using a network analyzer, calculate the loss through the attenuator at 1880.0 MHz. Use this measurement to properly set the spectrum analyzer amplitude offset.

4. Connect the test set-up:
 a) Connect the attenuator measured in 3. above from the output of the MS to the input of the *HP8562E* spectrum analyzer. Apply 3.8Vdc to the MS.

5. Power up MS:
 a) Tune to desired frequency.
 b) Set output power to power level 0.
 c) Modulate carrier with the mobile station's internal pseudo random data sequence.

6. Set appropriate spectrum analyzer offset level to account for input attenuator using values measured in 3. above.

7. Use the built in <u>*Occupied Bandwidth*</u> function of the HP8562E spectrum analyzer to create a measured plot of the spectrum.

Note: Hewlett Packard's <u>Occupied Bandwidth</u> function automatically integrates the power of the displayed spectrum and puts markers at the frequencies containing the selected percent of power. The power-bandwidth routine first computes the combined power over all signal responses in the trace. For 99% occupied power bandwidth, it then puts markers at the frequencies at which 0.5% of the power lies to the right of the right marker and to the left of the left marker. Thus 99% of the power lies between the markers. The difference of the marker frequencies is the 99% power bandwidth and is the value displayed.

3. Repeat for all required frequencies adjusting the *HP8562E* spectrum analyzer as necessary.

6.3 Spurious Emissions at Antenna Terminal Measurement Procedure {2.991}

Equipment Used: Hewlett Packard HP8593E Spectrum Analyzer:
Hewlett Packard HP8753D Network Analyzer
Hewlett Packard HP8498A 30dB Attenuator
KENWOOD PA18-6A Regulated DC Power Supply

RF Insertion Loss: 30.0 dB - attenuator

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 13 MHz to 19.1 GHz, taken up to 20 GHz.
2. Determine mobile station transmit frequencies: Table 6.3.1 below outlines the block edge frequencies pertinent to conducted emissions testing.

PCS 1900 Block	Lower Edge Chan. Freq.	Lower Edge Chan. Num.	Upper Edge Chan. Freq.	Upper Edge Chan. Num.
Block A	1850.2 MHz	512	1864.8 MHz	585
Block D	1865.2 MHz	587	1869.8 MHz	610
Block B	1870.2 MHz	612	1884.8 MHz	685
Block E	1885.2 MHz	687	1889.8 MHz	710
Block F	1890.2 MHz	712	1894.8 MHz	735
Block C	1895.2 MHz	737	1909.8 MHz	810

Table 6.3.1 Transmit Frequencies for Conducted Emissions Testing

The carrier frequencies for each of the 200 KHz wide channels of the PCS1900 transmit band (1850 to 1910 MHz) begins with the first channel 0.2 Mhz higher than the lower band edge, at 1850.2 MHz for channel number 512, and ends with the last channel 0.2 MHz lower than the upper band edge, at 1909.8 Mhz for channel number 810. Furthermore, the PCS1900 band is broken into 6 license blocks A through F, as seen in Table 6.3.1. With the above described channel frequency allocation (and the block boundaries of 1865.0, 1870.0, 1885.0, 1890.0, and 1895.0 MHz) there exists channels that fall exactly on these boundary frequencies. These are deemed "conditionally valid" channels, meaning these channels are valid and may be used only if a licensee owns rights to both adjacent blocks. For example, channel number 686 at 1885.0 Mhz may only be used by a licensee that holds rights to use both blocks B and E. As a result, these conditionally valid channels would never operate as a band edge channel.

3. Measure attenuator:

a) Connect a nominal 30 dB attenuator.

b) Using a network analyzer, calculate the loss through attenuator at 1880.0 MHz. Use this measurement to properly set the spectrum analyzer amplitude offset.

4. Connect test set-up:

a) Connect attenuator and cables measured in 3. above from the output of the mobile station to the input of the spectrum analyzer. Apply 3.8Vdc to the MS.

5. Power up Mobile Station:

a) Tune to desired frequency.

b) Set output power to power level 0.

c) Modulate carrier with the mobile station's internal pseudo random data sequence.

6. Set appropriate spectrum analyzer offset level to account for input attenuator using values measured in 3. above.

7. Measure spectrum:

a) In the 1st 1 MHz band outside the block edge nearest the channel of interest use a 3 KHz res. bw.

b) From 13 MHz to 1 GHz use 1 MHz resolution bandwidth.

c) From 1 GHz to 2.9 GHz use 1 MHz resolution bandwidth.

d) From 2.9 GHz to 20 GHz use 1 MHz resolution bandwidth.

e) Record any peaks greater than -33 dBm (-13 dBm - 20 dB).

8. Repeat 5. through 7. for each carrier frequency listed in Table 6.3.1 recording all significant peaks greater than -33 dBm (-13 dBm - 20 dB).

6.4 Field Strength of Spurious Emission Measurement Procedure {2.993}

The emission limitation specified in FCC Paragraph 24.238(a) is given as 43 + 10 * log (mean output power in watts). This is given for any frequency outside the licensee's frequency block. For 1.00 watt, this equals 43 dB below the carrier for all emissions. All field strength measurement were collected at an antenna to EUT distance of 3 meters.

The transceiver was placed on a rotatable wooden test stand approximately 0.8 meter in height. The emission spectrum was examined up to 10 GHz using an HP566B spectrum analyzer and EMCO 3115 double ridge horn guide. Measurements below 1.0 GHz were made using a Compliance Design "Roberts" tuned dipole antenna. At each frequency, the device was rotated through 360 degrees, and the antenna was raised and lowered between 1 –4 meters. Measurements were made with both test antenna vertically and horizontally polarized. In each case, only the maximum radiation measured was recorded for this report. All emissions not reported were more than 20 dB below the specified limit. The noise floor of the measurement equipment, spectrum analyzer and accessories, was at least 60 dB below the level of the applicable limits.

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL – AG

Where FS = Field Strength in dBμV/m

RA = Receiver Amplitude in dBμV

CL = Cable Loss in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

Assume a receiver reading of 33.5 dBμV is obtained at 1763.0 MHz. The antenna factor of 25.6 dB and cable loss of 1.0 dB is added. No amplifier gain is subtracted, giving a field strength of 60.1 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 33.5 dBμV/m	AF = 25.6 dB
CL = 1.0 dB	AG = 0.0 dB

FS = 33.5 + 25.6 + 1.0 = 60.1 dBμV/m

6.5 Frequency Stability Measurement Procedure {2.995}

Equipment Used: Hewlett Packard HP8922M GSM MS Test Set with HP83220E DCS/PCS MS Test Set
KENWOOD PA18-6A Regulated DC Power Supply
Tabai ESPEC SH-240 Temperature Chamber

In order to measure the carrier frequency under the condition of AFC lock it is necessary to make measurements with the mobile station in a "call mode." This is accomplished with the use of a Hewlett Packard 8922M GSM MS Test Set.

It should be noted that the unit will only operate at 3.8 Vdc ±10%. This corresponds to an operating voltage range of 3.4 Vdc to 4.2 Vdc.

<u>Frequency Stability varying Voltage</u>

1. Measure 1880.0 MHz (Ch 661) carrier frequency offset at room temperature with nominal 3.8 volts. Vary supply voltage from minimum 3.4 Volts to maximum 4.2 Volts, in 0.1 Volt increments remeasuring carrier frequency at each voltage.

<u>Frequency Stability varying Temperature</u>

1. Measure 1880.0 MHz (Ch 661) carrier frequency at room temperature.
2. Subject the mobile station to overnight soak at -30° C.
3. With the mobile station powered via 3.8 volts, connected to the 8922M and in a simulated call on channel 661 (center channel), measure 1880.0 MHz (Ch 661) carrier frequency offset. These measurements should be made within 2 minutes of powering up the mobile station, to prevent significant self warming.
4. Repeat the above measurements at 10°C increments from -30°C to +50°C. Allow at least 1 1/2 hours at each temperature, unpowered, before making measurements.

6.6 Conducted Emission at the Band Edges of PCS Frequency Blocks {24.238(b)(c)}

Equipment Used: Hewlett Packard HP8593E Spectrum Analyzer
Hewlett Packard HP8498A 30dB Attenuator
KENWOOD PA18-6A Regulated DC Power Supply

RF Insertion Loss: 30.0 dB - attenuator and cabling

The following steps outline the procedure used to obtain conducted spectrum emission plots at lower and upper bandedges of PCS frequency blocks from the mobile station.

1. Configure the spectrum analyzer as the following: Use a span of 500 KHz and two resolution bandwidth of 300 KHz and 3 KHz will be used. Use video bandwidth that is greater than resolution bandwidth.

2. Determine the mobile station transmit frequencies: Table 6.6.1 below outlines the block edge frequencies pertinent to this conducted emission testing.

PCS 1900 Block	Lower Edge Chan. Freq.	Lower Edge Chan. Num.	Upper Edge Chan. Freq.	Upper Edge Chan. Num.
Block A	1850.2 MHz	512	1864.8 MHz	585
Block D	1865.2 MHz	587	1869.8 MHz	610
Block B	1870.2 MHz	612	1884.8 MHz	685
Block E	1885.2 MHz	687	1889.8 MHz	710
Block F	1890.2 MHz	712	1894.8 MHz	735
Block C	1895.2 MHz	737	1909.8 MHz	810

Table 6.6.1 Transmit Frequencies for Conducted Emission

3. Measure attenuator loss:
   a) Connect a nominal 30 dB attenuator.
   b) Using a network analyzer, calculate the loss through the attenuator at 1880.0 MHz. Use this measurement to properly set the spectrum analyzer amplitude offset.

4. Connect the test set-up:
   a) Connect the attenuator measured in 3. above from the output of the MS to the input of the *HP8593E* spectrum analyzer. Apply 3.8Vdc to the MS.

5. Power up MS:
   a) Tune to desired frequency.
   b) Set output power to power level 0.
   c) Modulate carrier with the mobile station's internal pseudo random data sequence.

6. Set appropriate spectrum analyzer offset level to account for input attenuator using values measured in 3. above.

7. Use the dual trace function of HP8562E spectrum analyzer to obtain spectrum emission plots with a resolution bandwidth of 300 KHz and 3 KHz

8. Repeat for all required frequencies adjusting the *HP8593E* spectrum analyzer as necessary.