

## 6. Measurement Procedures

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

**Equipment Used:** Hewlett Packard HP8922M GSM MS Test Set with HP83220E DCS/PCS MS Test Set

Kikusui PAB 18-3A Regulated DC Power Supply

RF Insertion Loss: 0.5 dB - cabling

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 mobile station 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 mobile station 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.

## 6.2 Occupied Bandwidth Measurement Procedure {2.989(h)}

**Equipment Used:** Hewlett Packard HP8562E Spectrum Analyzer  
Hewlett Packard HP8753D Network Analyzer  
Hewlett Packard HP8498A 30dB Attenuator  
Kikusui PAB 18-3A Regulated DC Power Supply

RF Insertion Loss: 30.5 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 and cable losses:
  - a) Connect a nominal 30 dB attenuator, and place cables at input of the attenuator.
  - b) Using a network analyzer, calculate the loss through the attenuator and cables 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 and cables measured in 3. above from the output of the mobile station to the input of the HP8562E 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. Use the built in Occupied Bandwidth function of the HP8562E spectrum analyzer to create a measured plot of the spectrum.

*Note: Hewlett Packard's Occupied Bandwidth 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 HP8566B Spectrum Analyzer w/ options:  
Hewlett Packard HP8753D Network Analyzer  
Hewlett Packard HP8498A 30dB Attenuator  
Kikusui PAB 18-3A Regulated DC Power Supply

RF Insertion Loss: 30.5 dB - attenuator and cabling

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 and cable losses:
  - a) Connect a nominal 30 dB attenuator and place cables at input of the attenuator.
  - b) Using a network analyzer, calculate the loss through attenuator and cable 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  $43 + 10 \cdot \log$  (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 dB $\mu$ V/m

RA = Receiver Amplitude in dB $\mu$ V

CL = Cable Loss in dB

AF = Antenna Factor in dB

AG = Amplifier Gain in dB

Assume a receiver reading of 33.5 dB $\mu$ V 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 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

$$\begin{array}{ll} RA = 33.5 \text{ dB}\mu\text{V/m} & AF = 25.6 \text{ dB} \\ CL = 1.0 \text{ dB} & AG = 0.0 \text{ dB} \end{array}$$

$$FS = 33.5 + 25.6 + 1.0 = 60.1 \text{ dB}\mu\text{V/m}$$

## 6.5 Frequency Stability Measurement Procedure {2.995}

**Equipment Used:** Hewlett Packard HP8922M GSM MS Test Set with HP83220E DCS/PCS MS Test Set  
Kikusui PAB 18-3A Regulated DC Power Supply  
Tabai Mini-SubZero MC-810 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  $\pm 10\%$ . This corresponds to an operating voltage range of 3.4 Vdc to 4.2 Vdc.

### Frequency Stability varying Voltage

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.

### Frequency Stability varying Temperature

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 8922H 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.