

**Measurement Procedure & Test Equipment Used**

Except where otherwise stated, all measurements are made following the Electronic Industries Association (EIA) Minimum Standard for Portable/Personal Land Mobile Communications FM or PM Equipment 25-1000 MHz-(EIA/TIA-603-D).

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

The following procedures are presented with this application.

1.	Test Equipment List	<u>  x  </u>
2.	RF Power Output Data	<u>  x  </u>
3.	Audio Frequency Response	<u>  x  </u>
4.	Audio Low Pass Filter Response	<u>  x  </u>
5.	Modulation Limiting	<u>  x  </u>
6.	Occupied Bandwidth	<u>  x  </u>
7.	Adjacent Channel Coupled Power Ratio	<u>  x  </u>
8.	Radiated Spurious Emissions	<u>  x  </u>
9.	Conducted Spurious Emissions	<u>  x  </u>
10.	1559-1610 MHz Radiated Emissions	<u>  x  </u>
11.	Frequency Stability (Volt/Temp)	<u>  x  </u>

**Test Equipment List**

Pursuant To FCC Rules 2.947 (d)

No	Equipment	Calibration Date (next due)
1	HP 6033A Power Supply	23-Apr-14
2	HP 8903B Audio Analyzer.	6-May-14
3	HP 34401A Digital Multimeter	14-Apr-14
4	HP 8901B Modulation Analyzer	30-Mar-14
5	Weinschel Model WA53 30 dB attenuator (DC - 1.5 GHz)	*Calibration not required*
6	Agilent E4416A Power Meter with E9301B Power Sensor	26-May-14
7	Agilent Technologies MXA Signal Analyzer N9020A (20 Hz – 3.6 GHz)	
8	Agilent E4440A PSA Spectrum Analyzer (3 Hz – 26.5 GHz)	11-Jun-14
9	Mini-Circuits, VHF High Pass Filter, NHP 300	*Calibration not required*
10	Agilent infiniium 54831D Oscilloscope	9-Jan-14
11	Weinschel Model1440-4 RF Terminating Load	*Calibration not required*
12	Agilent 778D, Bi directional coupler	*Calibration not required*
13	Chase CBL6111 Antenna	7-Jan-13
14	EMCO 3108 Antenna	30-Nov-13
15	EMCO 3146 Antenna	30-Nov-13
16	EMCO 3115 Antenna	2-Mar-13
17	HP 8447D Amplifiers	18-Jan-14
18	ACS Boca Chamber EMI cable set	2-Jan-13
19	ACS Boca Substitution cable set	12-Jan-13
20	Agilent 8573A Spectrum Analyzers	12-Dec-13
21	HP 8673D Signal Generator	22-Feb-13
22	Agilent 83017A Amplifier	
23	ESPEC Temperature Chamber	13-Aug-13

**RF Power Output**

Pursuant to FCC Rules 2.1046 (a)

The RF power output is measured with the transmitter adjusted in accordance with the tune-up procedure outlined in Exhibit 10 to give the value of voltage and current as specified in Exhibit 12 as required by 2.1033(c) (8). A 50-ohm RF attenuator of proper power rating was used as a load for making these measurements.

The power measurements are made using RF power meter and 30 dB attenuator.

**Audio Frequency Response**

Pursuant FCC Rules 2.1047 (a)

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.

**Audio Low Pass Filter Response**

Pursuant FCC Rules 2.1047 (a)

A Dynamic Signal Analyzer is used to sweep the response from 1kHz to 25kHz. The source of the analyzer is connected to the AUDIO IN port of the radio interface box. The audio input level is adjusted to produce a standard test modulation. The transmitter is operated under standard test conditions and the output of the Switch Cap Filter is monitored, with the post limiter low pass filter within the lineup. The output is connected to channel 2 of the analyzer and referenced to its input signal. A sinusoidal sweep from 1K to 25kHz will produce the frequency response of the low pass filter during TX mode.

**Modulation Limiting**

Pursuant FCC Rules 2.1047 (b)

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 between 300 and 3000 Hz in 100Hz steps. Record the system deviation obtained as a function of the input level.

**Occupied Bandwidth**

Pursuant to FCC Rules 2.1049

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.

### **ADJACENT CHANNEL COUPLED POWER RATIO**

Pursuant to FCC Rules 90.543

A reference level of the radio was obtained by setting the measurement bandwidth of the spectrum analyzer to the channel size and measuring the power in the channel. Measurements were then taken at specified offsets and measurement bandwidths as specified in 90.543(a). For the far-out offsets, the dynamic range of the spectrum analyzer had to be extended. This was accomplished by connecting the output of the Unit Under Test to Port 1 of a circulator, connecting a tunable bandpass filter with a terminating load to Port 2 and connecting Port 3 of the circulator to the spectrum analyzer. With the spectrum analyzer swept over the desired measurement offset, the bandpass filter was slowly tuned from a higher frequency setting toward the current transmitter frequency. As the bandpass filter is tuned, frequencies outside of the filter's bandpass response are reflected back to the circulator where they are then passed to the spectrum analyzer. Frequencies inside the filter's response are passed to the terminating load and thus eliminated from the input of the spectrum analyzer. As the bandpass filter is tuned, the display of the spectrum analyzer is observed. As the center frequency of the filter approaches the current transmitter frequency, the level of the transmitter signal on the display of the spectrum analyzer will drop. The bandpass filter was tuned to the point where sufficient dynamic range of the spectrum analyzer was obtained. Actual measurements are recorded in the attached table.

### **Radiated Spurious Emissions**

Pursuant to FCC Rules 2.1053

#### Test Site:

Advanced Compliance Solutions (ACS) lab, located at Boca Raton, Florida, is in a region which is reasonably free from RF interference and has been approved by the Commission for Spurious Measurements.

The equipment is placed on the turntable, connected to a dummy RF load and then placed in normal operation using the intended power source. A broadband receiving antenna, located 3 meters from the transmitter-under-test (TUT), picks up any signals radiated from the transmitter and its operation accessories. The antenna is adjustable in height and can be horizontally and vertically polarized. A spectrum analyzer covering the necessary frequency range is used to detect and measure any radiation picked up by the above mentioned receiving antenna.

#### 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 directly from the generator. Actual measurements are recorded on the attached graphs.

### **Conducted Spurious Emissions**

Pursuant to FCC Rule 2.1051

The output of the transmitter is connected, via a suitable attenuator, to the input of a Spectrum Analyzer. This data is measured at the upper and lower frequency limits of the frequency range. If transmit power is adjusted, the measurement is repeated at various power levels including minimum and maximum.

### **1559-1610 MHz RADIATED EMISSIONS**

Pursuant to FCC Rules 2.1053 & 90.543 (e)

Measurements were conducted per TIA-102.CAAA-B Section 2.2.6.4. The transmitter is terminated into a 50 ohm load and interfaced through a suitable high pass filter to a spectrum analyzer. This allows for the measurement of spurious emission levels in the GNSS band. The transmitter is replaced with a signal generator to determine the loss of the setup at the measurement frequencies. And, the radiated emissions in the GNSS band are calculated as follows:

$EIRP \text{ (dBm)} = \text{Level (dBm)} - \text{Loss (dB)} + \text{Antenna Gain (dBi)}$

### **Frequency Stability**

Pursuant to FCC Rule 2.1055

A. Temperature (Non-heated type crystal oscillators):

Frequency Stability vs. Temperature data is measured in accordance with FCC Rules Part 2.1055 (a) (1). Modulation analyzer is used to measure the frequency of the signal transmitted by the radio. The radio is placed in a Temperature and Humidity Chamber, and the frequency is measured as the temperature is incremented from -30 to +50 degrees C in 10 degrees increments. Sufficient time is allowed prior to each measurement for the circuit components to stabilize.

B. Power Supply Voltage:

Frequency Stability versus Voltage data is measured in accordance with FCC Rules Part 2.1055 (d). Modulation analyzer is used to measure the frequency of the signal transmitted by the radio. 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.