

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-603D).

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

The following procedures are presented with this application.

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|-----|--------------------------------------|------------------|
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Test Equipment List

Pursuant To FCC Rules 2.947 (d)

No	Equipment	Calibration Date (next due)
1	Computer: DELL Latitude D600 Notebook, Window 2000.	*calibration not required*
2	Spectrum Analyzer: Agilent E4445A, 3 Hz – 13.2 GHz	7 th July 2014
3	Spectrum Analyzer: HP 8560E, 30 Hz - 2.9 GHz	7 th May 2014
4	Dynamic Signal Analyzer: HP35665A	13 th February 2013
5	RF Signal Generator: E4420BB, 250 kHz – 2 GHz RF Signal Generator	14 th May 2014
6	Modulation Analyzer. HP 8901B	15 th January 2013
7	Audio Analyzer .HP 8903B	11 th May 2014
8	Power Meter. HP437B. Sensor 80401A	26 nd May 2014
9	Oscilloscope. Phillips PM3382	4 th January 2013
10	Multimeter: Hewlett Packard 34401A	15 th July 2014
11	DC Power Supply: Hewlett Packard 6623A	7 th June 2014
12	Directional Coupler: Hewlett Packard 778D, Dual Directional Coupler	*calibration not required*
13	Temperature Chamber: VOTSCH, VT4010	21 st January 2013
14	30 dB attenuator: MCE/Weinschel, model 33-30-34	*calibration not required*
15	High Pass Filter, Mini-Circuit NHP 300 & 25W	*calibration not required*
16	MCE/Weinschel 1429-4, 50 ohms terminating load	*calibration not required*
17	Microwave Generator, SMP04	23-Mar-13
18	Spectrum Analyzer/ESI Test Receiver, ESIB 40	30-Mar-13
19	Bilog Antenna [30MHz-2GHz], CBL6112B	30-May-13
20	Bilog Antenna [30MHz-2GHz], CBL6112D	28-Dec-12
21	DRG Horn Freq. 700MHz-18GHz, SAS-571	
22	DRG Horn Freq. 700MHz-18GHz, SAS-571	17-Apr-13
23	Temp/Humidity Monitor, TM 320	12-Jun-13
24	SAC (5m Semi-anechoic Chamber), S800-HX	Dec-12
25	Antenna Positioning Tower (Boresight), TLT2	*calibration not required*
26	System controller, SC104V	*calibration not required*
27	Turntable. Flush Mount 2M, FM2011	*calibration not required*
28	Pre-amplifier, PAM-0118	*calibration not required*

RF Power Output

Pursuant to FCC Rules 2.1046 (a)

Method of Measurement

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 an Agilent series E4419B RF power meter and 30 dB attenuator.

Audio Frequency Response

Pursuant FCC Rules 2.1047 (a)

Method of Measurement

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.

Minimum Standard

The audio frequency response shall not vary more than +1 or -3 dB from 300 to 3000 Hz from a true 6 dB per octave pre-emphasis characteristic as referenced to 1000 Hz level, with the exception of a permissible 6 dB/octave roll off below 500 Hz. Equivalent to TIA/EIA 603 DSection 5.2.6.2 mask.

Audio Low Pass Filter Response

Pursuant FCC Rules 2.1047 (a)

Method of Measurement

The audio oscillator portion of an HP8903B audio analyzer is connected to the input of the post limiter low pass filter. The oscillator is adjusted, at 1000 Hz and level 16dB greater than that required to produce standard test modulation. The output of the low pass filter is measured with an HP35665A dynamic signal analyzer. The response is swept between the limits of 1000 Hz - 30000 Hz. Oscillator level is chosen to be as high as possible and that will not cause limiting at any frequency, and maintaining a constant input level versus frequency.

FCC Limits -- Per applicable rule parts.

450 to 869 MHz & VHF Marine.

Frequencies between 3 kHz and 20 kHz shall be attenuated greater than the attenuation at 1 kHz by $60 \log_{10} (f/3)$ dB.

Frequencies above 20 kHz shall be attenuated at least 50 dB.

Modulation Limiting

Pursuant FCC Rules 2.1047 (b)

Method of Measurement

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.

FCC Limits

Minimum Standard - The transmitter modulation must not exceed rated system deviation at any audio frequency input or reasonable change in input level. In the exhibit, 100% corresponds to the maximum rated system deviation for the given channel bandwidth.

Occupied Bandwidth

Pursuant to FCC Rules 2.1049

Method of Measurement

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, data, and TDMA, the reference line for the data plot is that of the peak value of the modulated carrier. For digital data, the Standard Transmitter Test Pattern 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.

FCC Limits - Per Applicable Rule Parts.

Emission Mask B. For transmitters that are equipped with an audio low-pass filter pursuant to Sec. 90.211(a), the power of any emission must be below the unmodulated carrier power (P) as follows:

- (1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
- (2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
- (3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB, where P is the mean output power in watts.

ADJACENT CHANNEL COUPLED POWER RATIO

Pursuant to FCC Rules 90.543

Method of Measurement

A reference level of the Unit Under Test 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.

FCC Limits - Per Rule 90.543(a).

Radiated Spurious Emissions

Pursuant to FCC Rules 2.1053

Test Site:

The site, located at Penang, Malaysia EMC laboratory 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.

FCC Limits -- Per Applicable Rule Parts.

Radiated spurious emissions shall be attenuated below the maximum level of emission of the carrier frequency in accordance with the following formula:

Spurious attenuation in dB = $43 + 10 \log_{10}$ (Power output in watts) for 25 kHz Channelization.

Spurious attenuation in dB = $50 + 10 \log_{10}$ (Power output in watts) for 12.5 kHz Channelization.

1559-1610 MHz RADIATED EMISSIONS

Pursuant to FCC Rules 2.1053 & 90.543 (e)

Method of Measurement:

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 (dBm) = Level (dBm) - Loss (dB) + Antenna Gain (dBi)

FCC Limits -- Per 47 CFR 90.543(e).

All emissions including harmonics in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth.

Conducted Spurious Emissions

Pursuant to FCC Rule 2.1051

Method of Measurement:

The transmitter is terminated into a 50 ohm load and interfaced with a spectrum analyzer which allows the spurious emission level relative to the carrier level to be measured directly. Modulate the transmitter with a 2500 Hz sine wave at an input level 16 dB greater than that required to produce 50% of rated system deviation at 1000 Hz. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier or as high as the state of the art permits except for that region close to the carrier equal to $\pm 250\%$ of the authorized bandwidth.

FCC Limits - Per Applicable Rule Parts.

Conducted spurious emissions shall be attenuated below the maximum level of emission of the carrier frequency in accordance with the following formula:

Spurious attenuation in dB = $43 + 10 \log_{10}$ (Power output in watts) for 25 kHz Channelization.

Spurious attenuation in dB = $50 + 10 \log_{10}$ (Power output in watts) for 12.5 kHz Channelization.

Frequency Stability

Pursuant to FCC Rule 2.1055

Method of Measurement:

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

Frequency measurements are made at the extremes of the temperature range -30 to +60 degrees centigrade and at intervals of not more than 10 degrees centigrade throughout the range. Sufficient time is allowed prior to each measurement for the circuit components to stabilize.

B. Power Supply Voltage:

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.

FCC Limits -- Per FCC Rule 90.213

Temperature - Frequency Stability of ± 1.5 ppm from -30 to +60 degrees centigrade.

Power Supply Voltage - Frequency Stability of ± 1.5 ppm from 85% to 115% of nominal voltage.