

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, the required limits, and the test equipment used.

The following procedures are presented with this application.

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Test Equipment List**Measurement Equipment List- Pursuant To FCC Rules 2.947 (d)**

Device	Model	S/N	Due Date
Computer	HP Elite Book 8560w	5CB15110K4	-
RF Signal Generator	Agilent E4425B	US39260299	10-Jun-14
Modulation Analyzer	HP 8901B	3122A03598	22-Nov-14
Audio Analyzer	HP 8903B	2717A02572	31-Jul-13
Dynamic Signal Analyzer	Agilent 35670A	MY42507095	05-Oct-14
Spectrum Analyzer	Agilent E4440B	MY44211425	21-Jul-14
Power Meter	Agilent E4416A	MY45100985	16-Aug-14
Function Generator	HP 33102A	US36005115	16-Aug-14
Power Sensor	Agilent E9301B	MY41495545	16-Aug-14
DC Power Supply	HP 6623A	3417A03540	22-Nov-14
Multimeter	HP 34401A	MY45024149	23-Jun-14
Oscilloscope	Agilent Infinium 54831MSD	MY42003401	11-Sept-14
High Pass Filter	Microwave Circuits H1G618G1	NA	No Cal. Required
USB Programming Cable	PMKN4126A	NA	No Cal. Required
Attenuator Pad	50Ohm, 25 Watts, 30 dB	NA	No Cal. Required
Signal Generator	Rhode & Schwarz SMP22	100015	16-Aug-14
Spectrum Analyzer/ESI Test Receiver	Rhode & Schwarz ESI26	100017	2-May-13
Spectrum Analyzer/ESI Test Receiver	Rhode & Schwarz ESI26	827769/009	7-Aug-13
System controller	Sunol Sciences Corp. SC99V	110901-1	21-Mar-13
Turntable. Flush Mount 2M Part# 15284	Sunol Sciences Corp. FM2011VS	60811	No Cal. Required
Antenna Positioning Tower	Sunol Sciences Corp. TLT2	042304-5	No Cal. Required
OATS RF Tray	Motorola 2000	NA	No Cal. Required
Power Supply	Hewlett Packard 6032A	3542A12712	No Cal. Required
DRG Horn Freq. 700MHZ- 18GHZ	A.H. Systems Inc. SAS-571	511	19-Dec-14
DRG Horn Freq. 700MHZ- 18GHz	A.H. Systems Inc. SAS-571	512	26-Apr-13
Bilog Antenna 30MHz to 2GHz	TESEQ GmbH Berlin, CBL6112D	30991	14-Aug-13
Bilog Antenna	Schaffner-Chase EMC Ltd., CBL6112B	2839	14-Aug-13

Table 1: List of equipment used

Test Name	FCC Rules Part (47 CFR)	IC Rules
RF Power Output Data	2.1046(a), 2.1033(c)(6), 2.1033(c)(7) and 2.1033(c)(8) 90.545(b)(4) (700MHz) & 24D	RSS-Gen Sec 4.8, RSS-119 Sec 5.4.1 RSS-134
TX Audio Frequency Response	2.1047 and 2.1033(c)(13)	-
TX Audio Low Pass Filter Response	2.1047	-
Modulation Limiting	2.1047	-
Occupied Bandwidth	2.1049, 90.210 90.691 (800MHz) & 24 D	RSS GEN Sec 4.6 RSS 119 Sec 5.5, RSS-134
TX Conducted Spurious Emissions	2.1051, 90.210 & 24 D	RSS GEN Sec 6.2 RSS 119, RSS-134
TX Radiated Spurious Emissions	2.1053, 90.210 & 24 D	RSS GEN Sec 4.9 RSS 119 Sec 4.2, 5.8. RSS-134
Frequency Stability (Temp / Supply Voltage)	2.1055, 90.213, 90.539 (700MHz)	RSS GEN Sec 4.7 RSS 119 Sec 5.3

Table 2: List of FCC and IC reference

EXHIBIT 7A - RF Output Power

Conducted power is measured in accordance with TIA/EIA-603D section 2.2.1.2. The transmitter under test is connected to Power Meter using the forward port of 30dB attenuator and power sensor. Appropriate calibration offsets, derived from a traceable RF attenuator, which has been precision characterized by an outside testing laboratory, are entered into the wattmeter to calibrate for the use of the coupler.

The transmitter is operated under normal conditions at the specified nominal DC input voltage. The DC supply path to the final stage only (or to the RF power amplifier module, if the final stage only is not accessible) is interrupted to allow insertion of a DC ammeter in series with the DC supply. The DC voltage drop of the ammeter is negligible. A DC voltmeter is used to measure the DC voltage applied to the final stage. The DC input power to the final stage (in watts) is computed as the product of the DC current (in amperes) times the DC voltage (in volts). This measurement is performed at the lowest, the middle, and the highest operating frequencies of the operating bandwidth of the equipment.

The calibration of the power meter, power sensor and attenuator pads is verified on an annual basis. Other power measurement systems that may be used are correlated with this calibrated reference system before measurements are performed, and calibration factors are adjusted as necessary to obtain precise correlation.

EXHIBIT 7B - Transmit Audio Frequency Response

The transmitter output is monitored with an modulation analyzer, whose FM demodulator output is fed to an audio analyzer. De-emphasis or filtering within the test equipment is not used. An audio oscillator signal, derived from the Audio Analyzer, is connected to the microphone audio input of the transmitter. At a frequency of 1 kHz, the level is adjusted to obtain 20% of full system deviation, to ensure that limiting does not occur at any frequency in the range of 300 Hz – 3000 Hz. A constant input level is then maintained and the oscillator frequency is varied between the ranges of 100 Hz to 5000 Hz. The frequency response is plotted, using a reference of 0 dB at 1 kHz.

EXHIBIT 7C - Transmit Audio Post Limiter Low Pass Filter Response

The audio oscillator portion of an audio analyzer is connected to the input of the post limiter low pass filter. The oscillator is adjusted, at 1000 Hz and level 16 dB greater than that required to produce standard test modulation. The output of the low pass filter is measured with 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.

EXHIBIT 7D – Modulation Limiting Characteristic

An audio oscillator is connected to the microphone audio input. The transmitter output is monitored with an modulation analyzer. The flat frequency response FM demodulator output of the modulation analyzer is fed to an audio analyzer. The 20 kHz low pass filter of the modulation analyzer is used to reduce the level of residual high frequency noise. The oscillator level is adjusted, at 1 kHz, to obtain 60% of full system deviation. The oscillator level is then varied over a range of +/-20dB in 5 dB increments, and the resulting deviation is plotted. This measurement is repeated at 300 Hz and 3 kHz. The above procedure is performed three times, for conditions with Tone Private Line, Digital Private Line, and Carrier Squelch Mode (without sub-audible signaling).

EXHIBIT 7E - Occupied Bandwidth**Procedure for Occupied Bandwidth Measurement for Voice Transmission**

The transmitter is connected, via a suitable attenuator, to the Spectrum Analyzer. The spectrum analyzer settings for the reference calibration are in accordance with 47 CFR 90.210 (d) (4). The unmodulated carrier's emission spectrum is captured on the spectrum analyzer and then used to establish a 0 dB reference plot for exhibits.

Audio Analyzer audio source is connected to the microphone audio input of the transmitter. The audio source frequency is set to 2500 Hz and the amplitude is adjusted to a level 16 dB above that required to produce 50% of full system deviation at the frequency of maximum response of the audio modulation circuit, in accordance with 47 CFR Part 2.1049(c)(1). The spectrum analyzer settings are adjusted in accordance with 47 CFR 90.210(d)(4) and the analyzer is swept to record the resultant emission levels using the appropriate emission mask.

This measurement is repeated with Tone Private Line (TPL) sub-audible signaling and audio by adding a 250.3 Hz TPL tone at 15% full system deviation with the previously defined 2500 Hz tone. The amplitude of the modulating signal is adjusted so that the total deviation, which includes the TPL deviation, is the full system deviation. An additional measurement is made with Digital Private Line (DPL) sub-audible signaling and audio by adding a DPL code 131 at 15% full system deviation with the previously defined 2500 Hz tone. The amplitude of the modulating signal is adjusted so that the total deviation, which includes the DPL deviation, is the full system deviation.

Procedure for Occupied Bandwidth Measurement for 2000/3000 Hz FSK Data

The transmitter is connected, via a suitable attenuator, to the Spectrum Analyzer. The spectrum analyzer settings for the reference calibration are in accordance with 47 CFR 90.210 (d) (4). The unmodulated carrier's emission spectrum is captured on the spectrum analyzer and then used to establish a 0 dB reference plot for exhibits.

The audio function generator is connected to the flat (non-pre-emphasized) transmit audio input of the radio under test. A second function generator producing a square wave output at a frequency of 1200 Hz is connected to the voltage control input of the first generator. The first generator is set to produce a sine wave signal at a center frequency of 2500 Hz and the amplitude of the square wave from the second generator is adjusted so that the frequency of the first generator is varied ± 500 Hz. The resulting output of the first generator is an AFSK sine wave signal that shifts between two discrete frequencies, 2000 Hz and 3000 Hz, at a rate of 1200 Hz. The amplitude of the first generator, which modulates the transmitter, is adjusted for full system deviation. The spectrum analyzer settings are adjusted in accordance with 47 CFR 90.210 (d) (4) and the analyzer is swept to record the resultant emission levels using the appropriate emission mask.

This measurement is repeated with Tone Private Line (TPL) sub-audible signaling and 2000/3000 Hz FSK data by adding a 250.3 Hz TPL tone at 15% full system deviation with the previously defined data signal. The amplitude of the modulating signal is adjusted so that the total deviation, which includes the TPL deviation, is the full system deviation. An additional measurement is made with Digital Private Line (DPL) sub-audible signaling and 2000/300 Hz FSK data by adding a DPL code 131 at 15% full system deviation with the previously defined 2500 Hz tone. The amplitude of the modulating signal is adjusted so that the total deviation, which includes the DPL deviation, is the full system deviation.

Procedure for Occupied Bandwidth Measurement for DTMF

The transmitter is connected, via a suitable attenuator, to the Spectrum Analyzer. The spectrum analyzer settings for the reference calibration are in accordance with 47 CFR 90.210 (d) (4). The unmodulated carrier's emission spectrum is captured on the spectrum analyzer and then used to establish a 0 dB reference plot for exhibits.

The transmitter is keyed up and the “#” key pressed to generate the worst-case DTMF tones (941 Hz and 1633 Hz). The spectrum analyzer settings are adjusted in accordance with 47 CFR 90.210 (d) (4) and the analyzer is swept to record the resultant emission levels using the appropriate emission mask.

This measurement is repeated with Tone Private Line (TPL) sub-audible signaling and DTMF by adding a 250.3 Hz TPL tone at 15% full system deviation with the previously defined DTMF signal. An additional measurement is made with Digital Private Line (DPL) sub-audible signaling and DTMF by adding a DPL code 131 at 15% full system deviation with the previously defined DTMF signal.

Procedure for Occupied Bandwidth Measurement for 4-Level FSK Data

The transmitter is connected, via a suitable attenuator, to the Spectrum Analyzer. The spectrum analyzer settings for the reference calibration are in accordance with 47 CFR 90.210 (d) (4). The unmodulated carrier's emission spectrum is captured on the spectrum analyzer and then used to establish a 0 dB reference plot for exhibits.

The radio is placed in test mode such that it transmits a 511-bit pseudo-random bit sequence based on ITU-T O.153 in the 2:1 TDMA protocol's payload, which is in accordance to 47 CFR 2.1049 (h). The spectrum analyzer settings are adjusted in accordance with 47 CFR 90.210 (d) (4) and the analyzer is swept to record the resultant emission levels using the appropriate emission mask.

EXHIBIT 7F - Radiated Spurious Emissions

The site, located at Plantation, Florida 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.

EXHIBIT 7G - Conducted Spurious Emissions

The output of the transmitter is connected, via a suitable attenuator, to the input of an 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.

EXHIBIT 7H – Frequency Stability vs. Temperature and vs. Voltage

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.

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.