

**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.

|     |                                    |                   |
|-----|------------------------------------|-------------------|
| 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.  | Radiated Spurious Emissions        | <u>    x    </u>  |
| 8.  | Conducted Spurious Emissions       | <u>    x    </u>  |
| 9.  | Frequency Stability (Volt/Temp)    | <u>    x    </u>  |
| 10. | Transient Frequency Behavior       | <u>          </u> |
| 11. | Effective Isotropic Radiated Power | <u>    x    </u>  |

**Test Equipment List**

Pursuant To FCC Rules 2.947 (d)

| <b>Equipment</b>                            | <b>S/N</b>    | <b>Calibration Due Date</b> |
|---------------------------------------------|---------------|-----------------------------|
| Personal Computer HP600PD SFF               | SGH351S4V3    | N/A                         |
| HP 6633A DC Power Supply                    | 3223A06939    | 31-Dec-17                   |
| Agilent E4416A Power Meter                  | GB41293748    | 08-Apr-17                   |
| Agilent E9301B Power Sensor (with 30dB Pad) | MY41495388    | 08-Apr-17                   |
| HP 8901B Modulation Analyzer                | 3403A04974    | 04-Nov-17                   |
| HP 8903B Audio Analyzer                     | 3413A13935    | 09-Apr-17                   |
| Agilent 35670A Dynamic Signal Analyzer      | MY42506847    | 20-Oct-17                   |
| Agilent E4440A PSA Spectrum Analyzer        | US45303111    | 07-Jan-17                   |
| Function Generator 33120A                   | US34013620    | 17-Apr-17                   |
| ESPEC Temperature Chamber SH-241            | 92009006      | 07-Nov-15                   |
| Agilent Oscilloscope 54831D MSO             | MY42001936    | 26-Dec-17                   |
| Agilent E4420B RF Signal Generator          | MY41000465(A) | 07-Nov-17                   |
| Microwave Generator                         | 100131        | 25-Jun-16                   |
| Spectrum Analyzer/ESI Test Receiver         | 100336        | 17-Jun-16                   |
| Bilog Antenna [30MHz-2GHz]                  | 2863          | 24-Jul-16                   |
| Bilog Antenna [30MHz-2GHz]                  | 2964          | 23-Jan-16                   |
| DRG Horn Freq. 700MHz-18GHz                 | 1143          | 10-Jun-16                   |
| DRG Horn Freq. 700MHz-18GHz                 | 566           | 02-Aug-16                   |
| Temp/Humidity Monitor                       | 12249289      | 12-Apr -16                  |
| SAC (5m Semi-anechoic Chamber)              | J2308         | 29-Apr-16                   |
| Antenna Positioning Tower (Boresight)       | NA            | No Cal. Req'd               |
| System controller                           | 050806-1      | No Cal. Req'd               |
| Turntable. Flush Mount 2M                   | NA            | No Cal. Req'd               |
| Pre-amplifier                               | 361           | No Cal. Req'd               |
| Signal Analyzer                             | 101103        | 25-Jun-16                   |

Table 1: List of equipments used

| Test Name                                   | FCC Rules Part (47 CFR)                                                                                                                                       | IC Rules                                                        |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| RF Power Output Data                        | 2.1046(a), 2.1033(c)(6),<br>2.1033(c)(7) and 2.1033(c)(8)<br>* 90.545(b)(4) (700 MHz)<br>* 22.565(f) (VHF & UHF),<br>24.132 (900 MHz)<br>* 74.402 (VHF & UHF) | RSS-Gen Sec 4.8,<br>RSS-119 Sec 5.4.1,<br><br>RSS 134 (900 MHz) |
| TX Audio Frequency Response                 | 2.1047 and 2.1033(c)(13)<br>* 74.402 (VHF & UHF)                                                                                                              | -                                                               |
| TX Audio Low Pass Filter Response           | 2.1047<br>* 74.402 (VHF & UHF)                                                                                                                                | -                                                               |
| Modulation Limiting                         | 2.1047<br>* 74.402 (VHF & UHF)                                                                                                                                | -                                                               |
| Occupied Bandwidth                          | 2.1049, 90.210,<br>90.691 (800 MHz),<br>* 22.359 (VHF,UHF),<br>24.133 (900 MHz),<br>* 74.402 (VHF & UHF)                                                      | RSS GEN Sec 4.6,<br>RSS 119 Sec 5.5,<br><br>RSS 134 (900 MHz)   |
| TX Conducted Spurious Emissions             | 2.1051, 90.210,<br>* 22.359 (VHF,UHF),<br>* 80.211(c) (VHF),<br>* 74.402 (VHF & UHF)                                                                          | RSS GEN Sec 6.2,<br>RSS 119,<br>* RSS 182 (VHF)                 |
| TX Radiated Spurious Emissions              | 2.1053, 90.210,<br>* 22.359 (VHF,UHF)<br>* 74.402 (VHF & UHF)                                                                                                 | RSS GEN Sec 4.9,<br>RSS 119 Sec 4.2, 5.8                        |
| Frequency Stability (Temp / Supply Voltage) | 2.1055, 90.213,<br>* 74.402 (VHF & UHF)                                                                                                                       | RSS GEN Sec 4.7<br>RSS 119 Sec 5.3                              |
| Transient Frequency Behavior                | * 90.214<br>* 74.402 (VHF & UHF)                                                                                                                              | * RSS 119 Sec 5.9                                               |

Table 2: List of FCC and IC reference

**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 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.

**Audio Low Pass Filter Response**

Pursuant FCC Rules 2.1047 (a)

**Method of Measurement**

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)

**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.

**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 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.

**Radiated Spurious Emissions**

Pursuant to FCC Rules 2.1053

**Test Site:**

The site, located at Penang, Malaysia 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.

**Note:**

RBW setting is adjusted to 100kHz for frequency below 1GHz and 1MHz for frequency above 1GHz

**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.

**Note:**

RBW setting is adjusted to 100kHz for frequency below 1GHz and 1MHz for frequency above 1GHz

**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.

**Transient Frequency Behavior**

Pursuant to FCC Rule 90.214

Transient frequency behavior is a measure of the difference, as a function in time, of the actual transmitter frequency to the assigned transmitter frequency when the transmitted RF output power is switched on or off.

Setup -- Per TIA/EIA 603-D, Section 2.2.19

Connect the output port of the transmitter under test (TUT) to an attenuator and this to a directional coupler. Connect an RF peak detector to the coupled output of the directional coupler, and connect the output of the RF peak detector to the external trigger on a storage oscilloscope. The output of the directional coupler is mixed, via an RF combining network, with the output of a signal generator. Verify that the TUT signal level present at the combining network output is approximately 40 dB below the maximum input level of the test receiver as per step (f). Set the signal generator at the same frequency as the TUT, modulated with a 1 kHz tone, with an FM deviation equal to the assigned channel spacing (+25 kHz).

Following step (h), adjust the signal generator to provide 20 dB less power at the combiner output than the level set in step (f). Connect the output of the RF combiner to a test receiver, and the test receiver's output

port to a vertical input channel of the storage scope. Adjust the horizontal sweep rate on the oscilloscope to 10msec/div, and the vertical amplitude to display the 1 kHz tone over +/- 4 divisions centered on the display. Reduce the transmit attenuation by 30 dB as per step (l) so that the difference in the power between the reference signal and the TUT signal at the combiner is 50 dB when the TUT is turned on. Following step (k), adjust the oscilloscope to trigger on an increasing signal from the RF detector at one division from the left side of the display when the TUT is turned on. Switch on the TUT and record the display (for RF Output Power ON). Following step (q), adjust the oscilloscope trigger controls to trigger on a decreasing signal from the RF peak detector, at 1 division from the right side of the display when the TUT is turned off. Switch off the transmitter and record the display (for RF Output Power OFF).

\* Steps (f), (h), (k), (l), and (q) - section 2.2.19 of the TIA/EIA 603-C were followed.

Method of Measurement -- Per TIA/EIA-603-C, Section 2.2 19.

For RF Output Power ON: Turn the transmitter ON. Once the demodulator output has been captured by the transmitter power, the 1 kHz test signal will be completely suppressed. This point in time is named T-on. The display will then show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. Two time intervals will be measured following T-on: T-1 and T-2. So, the RF ON time intervals are as follows: T-on -----> T-1 -----> T-2

For RF Output Power OFF: Turn the transmitter OFF. The display will show the transmitter frequency difference versus time, and when the 1 kHz test signal starts to rise, it indicates total absence of the transmitter output at the specified frequency. This point is named T-off. Time interval T-3 precedes T-off. So, the RF OFF time intervals are as follows: T-3 -----> T-off.

### **Effective Isotropic Radiated Power**

#### **Test Site:**

The site, located at Penang, Malaysia is in a region which is reasonably free from RF interference and has been approved by the Commission for Spurious Measurements.

In the semi-anechoic chamber, the EUT is placed on the 0.8m height of Turn Table, rotated the table 45 degree each interval to search the maximum radiation power and receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum polar radiated power for each degree interval. The "Read Value" is the spectrum reading of maximum power value.

The substitution antenna is substituted for EUT at the same position and signals generator (S.G) export the CW signal to the substitution antenna via a TX cable. The receiver antenna shall be rotated vertical and horizontal polarization and moved height from 1m to 4m to find the maximum radiation power. Record the power level of maximum radiation power from spectrum. So, the Measured substitution value = Ref level of S.G + TX cables loss – Substituted Antenna Gain.

EIRP = "Read Value" + Measured substitution value + 2.15.

The spectrum setting for Equivalent Isotropically Radiated Power (EIRP) is RBW = 100 kHz, VBW = 300 kHz. Detector Mode is RMS.