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).

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	x
2.	RF Power Output Data	x
3.	Audio Frequency Response	x
4.	Audio Low Pass Filter Response	x
5.	Modulation Limiting	x
6.	Occupied Bandwidth	x
7.	Radiated Spurious Emissions	x
8.	Conducted Spurious Emissions	x
9.	Transient Frequency Behavior	x
10.	Frequency Stability (Volt/Temp)	x
11.	Power Line Conducted Emissions	x

Test Equipment List

Pursuant To FCC Rules 2.947 (d)

1. HP 8566A Spectrum Analyzer.
2. Rohde & Schwarz ESMI Test Receiver.
3. HP 4436B RF Signal Generator.
4. Rohde & Schwarz SMP22 Signal Generator.
5. HP 8624B Signal Generator
6. Antenna Set:
   - A. A.H. Systems, Inc. SAS-200/571 (0.7-18GHz).
   - B. EMCO 3143 (< 1GHz).
   - C. Watkins Johnson 272 (> 1 GHz).
   - D. Schaffner-Chase CBL6112B Bilog (30MHz – 3GHz).
7. Agilent E4419B RF Power Meter.
8. HP 8901B Modulation Analyzer.
9. Agilent E4402B ESA-E Series Spectrum Analyzer
10. Tenney (Model TJR) Temperature Chamber.
11. HP 6033A System DC Power Supply.
12. HP 8903B Audio Analyzer.
13. HP 34401A Digital Multimeter.
14. Tektronics TDS-7054 Oscilloscope.
15. HP 8902A Measuring Receiver.
16. Rohde & Schwarz ESI26 Receiver / Analyzer
17. Narda Model 3020A Bi-Directional Coupler
18. MiniCircuits 15542 ZAPD-21 Combiner
19. Weinschel Model 33 30dB attenuator
20. Weinschel Model WA1426-4 RF Terminating load.

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 30dB 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 Section 5.2.6.2 mask.

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 1 kHz to 25 kHz. 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.

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 $1og_{10}$ (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.

Measured Data: At least +25 dB down on any frequency removed from the assigned frequency by more than 50 % and up to and including 100% of the authorized bandwidth. At least +35 dB down on any frequency removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth; at least 43 plus 10 $\log_{10}$ (mean output power in watts) decibels or 70 decibels, whichever is the lesser attenuation.

Radiated Spurious Emissions

Pursuant to FCC Rules 2.1053

Test Site:

The site, located at Plantation, 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 by 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)

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 ± 2.0 ppm from -30 to +60 degrees centigrade.
Power Supply Voltage - Frequency Stability of ± 2.0 ppm from 85% to 115% of nominal voltage.

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, 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 to10 msec/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 were followed.

Method of Measurement -- Per TIA/EIA-603-2.2.19

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.

FCC Limits -- Per 90.214.

	Frequency Range (MHz)		
Time Interval	30 to 300	300 to 500	500 to 1000
T-1	5.0 ms	10.0 ms	20.0 ms
T-2	20.0 ms	25.0 ms	50.0 ms
T-3	5.0 ms	10.0 ms	10.0 ms

*Per Applicable Rule Parts.

Power Line Conducted Emissions

Pursuant to FCC Rule 15.107

Method of Measurement:

Connect the equipment to the power line through a line stabilization network. A spectrum analyzer of nominal 50Ω impedance to one terminal of the line stabilization network. The spectrum analyzer is then tuned to search for spurious outputs from 150kHz to 30MHz. Record all spurious outputs found. The spectrum analyzer is then connected to the other terminal of the line stabilization network and record all spurious outputs found. The power line conducted spurious emissions is the largest reading obtained.