Measurement Procedure And 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.	Frequency Stability (Temp/Volt)	x
10.	Transient Frequency Behavior	x

Test Equipment List

Pursuant To FCC Rules 2.947 (d)

1. HP 8562A Spectrum Analyzer.
2. Rohde & Schwarz FSIQ Spectrum Analyzer.
3. HP 8624B Signal Generator
4. Agilent Power Meter HP 437B.
5. Power sensor HP8482A
6. HP 8901B Modulation Analyzer.
7. Agilent 35670A Dynamic Signal Analyzer
8. Tenney (Model TJR) Temperature Chamber.
9. HP 6032A System DC Power Supply.
10. HP 8903B Audio Analyzer.
11. HP 34401A Digital Multimeter.
12. Narda Model 3020A Bi-Directional Coupler
13. MiniCircuits 15542 ZAPD-21 Combiner
14. Weinschel Model 6127-10-34 attenuator
15. Weinschel Model 6127-30-34 attenuator
16. Weinschel Model WA1426-4 RF Terminating load.
17. Microtronics HPM13161 High Pass filter
18. HP 5328A Universal Counter
19. HP53310A Modulation Domain Analyzer

Open Air Test Site Equipment List

Manufacturer Name	Item Name Description	Item Version/ Model #	Serial Number
OATS Test Equipment			
Rohde & Schwarz	Signal Generator	SMP22	DE21162
Rhode & Schwarz	Spectrum Analyzer/ESI Test Receiver	ESI 26	8277691009
Rhode & Schwarz	Spectrum Analyzer/ESI Test Receiver	ESI 26	100017
Hewlett Packard	Power Supply	6032A	3542A12712
Sunol Sciences Corp.	System controller	SC98V	213981
Sunol Sciences Corp.	System controller	SC99V	110901-1
Sunol Sciences Corp.	System controller	SC98V	313981
Sunol Sciences Corp.	Turntable. Flush Mount 2M	FM2011	NA
Sunol Sciences Corp.	Antenna Positioning Tower	TLT95	NA
Sunol Sciences Corp.	Antenna Positioning Tower	TLT2	NA
Motorola	OATS RF Tray	2000	NA
High Pass Filter			
Trilithic	High Pass Filter	X5HX1612-0-75-AA	9811186
OATS ANTENNAS			
A.H. Systems Inc.	DRG Horn Freq. 700MHZ-18GHZ	SAS-571	511
A.H. Systems Inc.	DRG Horn Freq. 700MHZ-18GHZ	SAS-571	512
A.H. Systems Inc.	DRG Horn Freq. 700MHZ-18GHZ	SAS-200/571	271
EMCO	Biconilog. Freq. 20MHZ-1GHZ	3141	9703-1047
Schaffner-Chase EMC Ltd.	Bilog Antenna	CBL6112B	2660
Schaffner-Chase EMC Ltd.	Bilog Antenna	CBL6112B	2839
AC Line Conducted			
EMCO	Line Impedance Stabalization Network	3810/2NM LISN	9612-1740
OATS PreAmplifier			
MITEQ	25 dB Gain Amplifier 1-18GHz	AFS5-00101800-25-ULN	

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 HP 437B power meter and 40 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 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 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.

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 and data, 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 ± 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 2.2.19.2

Connect the output port of the unit under test (UUT) to the RF attenuator. Connect the output of the RF attenuator with a sufficient attenuation to the RF power meter in order to determine the nominal output power level of the UUT, which is approximately 40dB below the maximum allowable input to the HP53310A modulation domain analyzer. Next, set the envelope trigger on the modulation domain analyzer, based on the HP53310A Option 031 User's Guide, to the minimum level that will trigger when the transmitter is keyed.

I. Steps to adjust the RF Envelope trigger level using a signal generator as a RF source:

a. Set the RF source to output a power level 30dB below the nominal power level of the transmitter (Pc – 30dB) and at the same frequency as the transmitter. Any attenuation required must be factored in when setting the trigger level of the HP53310A.
b. Connect the RF source to the HP53310A Channel C
c. Press the Preset key on the HP 53310A and select the C channel on the Function menu
d. Press the Autoscale key on the HP 53310A to measure and display the input signal. The green LED trigger light at the C channel input should be flashing.
e. Press the Configure Input softkey and select the C input
f. Rotate the knob slowly clockwise until the green LED stops flashing
g. Press the Fine key near the knob and rotate the knob slowly counterclockwise until the green LED starts flashing again.

Disconnect the RF power meter and connect the output of the standard transmitter load to the C channel of Modulation domain analyzer.

II. Performing the following steps to set up the HP53310A to measure the UUT:
a. Press the Timebase key and select the time/div field. Set the appropriate value in ms/div
b. Set the Reference to Left for observing the transmitter turn-on transient as in step (g) or to Right for the transmitter turn-off transient as in step (k)
c. Press the Vertical key and set the Center value to the center frequency of the transmitter, if not already done
d. Enter the span value that is twice the channel spacing for the UUT (e.g. 25kHz span for the 12.5 spacing, and 50kHz span for 25kHz, etc.)
e. Press the Trigger key, select Triggered, then select RF Env.
f. Set the HP 53310A to trigger on the rising edge or the falling edge of the waveform in order to capture a single shot turn-on or turn-off transient of the transmitter signal respectively as per step (f) or (j).

Method of Measurement – Per TIA/EIA – 603 – 2.2.19.2

For the turn-on transient: Set the HP 53310A with the Reference to Left and on the rising edge. Set the span to 25kHz for the 12.5 channel spacing (or to 50kHz for the 25kHz spacing). Press the Stop/Single key. Turn on the transmitter and key with a dummy microphone. Observe the stored display of the HP 53310A. The signal trace shall be maintained within the allowable window limits, or the FCC limits, during the period T_1 and T_2 and shall also remain within limits following T_2. Set the span to 500Hz to view a closer look of the frequency error.

For the turn-off transient: Set the HP 53310A to the Right Reference and on the falling edge. Set the span to 25kHz for the 12.5 channel spacing (or to 50kHz for the 25kHz spacing). Press the Stop/Single key. Press the dummy microphone for 5 seconds and de-key it. The signal trace shall be maintained within the allowable during the period T_3. Set the span to 500Hz to view a closer look of the frequency error.

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