

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-603A).

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

Pursuant To FCC Rules 2.947 (d)

1. HP 8901B Modulation Analyzer
2. HP 5334B Universal Counter
3. Thermotron 2800 Temperature Chamber
4. HP 6652A Power Supply
5. HP 6033A Power Supply
6. HP 89441A Vector Signal Analyzer
7. HP 8903B Audio Analyzer.
8. HP 34401A Digital Multimeter
9. Philips PM 2534 System Multimeter
10. JFW Industries 50FHE-030-200 200 Watt 30 dB Attenuator
11. Rohde and Schwarz Model FSEA Spectrum Analyzer
12. Rohde and Schwarz Model UPD Audio Analyzer
13. Telonic Berkeley Model TTF-750-5-5EE Tunable Bandpass Filter
14. Channel Microwave Corp. Model UL621C Circulator
15. Weinschel Model WA1426-4 RF Terminating Load
16. Weinschel Model WA53 30 dB attenuator (DC - 1.5 GHz)
17. Rohde and Schwarz Model SMP22 Signal Generator
18. Rohde and Schwarz Model ESI26 Spectrum Analyzer/ ESI Test Receiver
19. 7/800 MHz Antenna Set: Quarter Wave, Low Profile, Collinear and Elevated Feed
20. HP 438A Power Meter with 8482H Power Sensor

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 7 to give the value of voltage and current as specified in Exhibit 4 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 were made using a Hewlett Packard series 438A power meter with 8482H power sensor 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 603A Section 5.2.6.2 mask.

POST LIMITER FILTER FREQUENCY RESPONSE

Pursuant FCC Rules 2.1047 (a)

Method of Measurement

Operate the transmitter under standard test conditions and monitor the output of the post limiter low-pass filter with an audio spectrum analyzer or AC voltmeter. Adjust the audio input frequency to 1000 Hz and the input level to 20 dB greater than that required to produce standard test modulation. Note the output level on the audio spectrum analyzer or AC voltmeter. Use this output dB level as reference (LEVREF), vary the modulating frequency from 3000 Hz to the upper low pass filter limit and record the dB level on the audio spectrum analyzer or AC voltmeter as LEVFREQ while maintaining a constant input level. The audio frequency response of the low-pass filter in accordance with the following formula:

$$\text{Low-Pass Filter Response} = \text{LEVREQ} - \text{LEVREF}$$

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 of 300, 1000 and 3000 Hz. 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.

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.

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.

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 UnderTest 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).

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.

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 10 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 = $43 + 10 \log_{10}(\text{Power output in watts})$.

1559-1610 MHz RADIATED EMISSIONS

Pursuant to FCC Rules 2.1053 & 90.543e

Test Site:

The test site used is the Motorola Plantation OATS (Open Area Test Site) Lab, located at 8000 West Sunrise Blvd, Plantation, Florida 33322. This region is reasonably free from RF interference and has been approved by the Commission for Spurious Measurements (FCC Registration: 91932 / Industry of Canada: IC3679 / ISO 25 certified).

The equipment is placed on the turntable, connected to the applicable radio antenna 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 GNSS spectrum (1559-1610 MHz) 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 tables.

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.

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. In addition, the primary voltage will be reduced to the point where the radio performs a reset (battery operating end point).

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.

MODEL NUMBERS

DESCRIPTION

M20URS9PW1AN

764-870 MHz Digital XTL 5000 / 512 Channels
3.5-36 Watt (764-806 MHz)
3.5-42 Watt (806-870 MHz)
2-3 Watt (700 MHz Itinerant)