

ENGINEERING REPORT

**IC-M402**

GENERAL INFORMATION

Receivers

Frequency Range : 156.025MHz to 163.275MHz  
Number of Channels : 93CH  
Intermediate Frequency : 1<sup>st</sup> 21.7MHz , 2<sup>nd</sup> 450kHz  
Input Impedance(RF) : 50 ohm  
Output Impedance(SP) : 4 ohm  
Audio Output Power (Resistive Load) : 3.5W

Transmitters

Frequency Range : 156.025MHz to 157.425MHz  
Number of Channels : 53CH  
Input Impedance(MIC) : 600ohm  
Output Impedance(RF) : 50ohm nominal

Voltage Requirements : 13.8V DC nominal value

Model Name : IC-M402

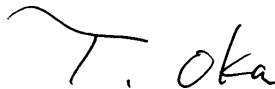
Serial No. : 6

Manufacturer : ICOM INCORPORATED

This Report was prepared by ICOM INCORPORATED.

Test performed by T.Oka

21 / December / 2000



NAME OF TEST: R.F. Power Output  
SPECIFICATION: 47 CFR 2.1046(a)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.1  
TEST EQUIPMENT: As per attached page

MEASUREMENT PROCEDURE

1. The EUT was connectred to a resistive coaxial attenuator of Normal load impedance, and the unmodulated output power was Measured by means of an R.F. Power Meter.
2. Mesurement accuracy +3%

MEASUREMENT RESULTS

NOMINAL, MHz	CHANNEL	R.F.POWER, WATTS	
		LOW	HIGH
156.300	06	0.852	25.0
156.550	11	0.849	24.9
156.600	12	0.841	24.7
156.650	13*	0.843	**0.843/24.7
156.700	14	0.838	24.7
156.750	15*	0.838	**0.838/24.7
156.800	16	0.835	24.6
156.850	17*	0.836	***0.836
156.875	67*	0.842	**0.842/24.7

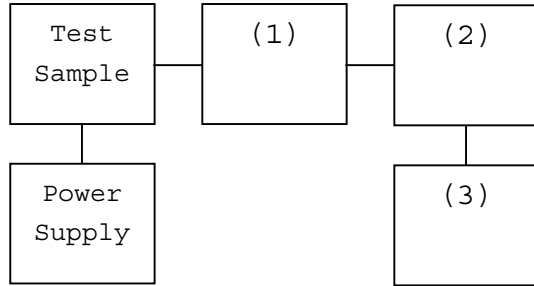
\*Automatic Switching to low power

\*\*High power with manual over-ride, see attached manual

\*\*\*Low power only

TRANSMITTER POWER CONDUCTED MEASUREMENTS

TEST 1: R.F. POWER OUTPUT  
TEST 2: FREQUENCY STABILITY



Instruments	Description	Serial Number
(1) COAXIAL ATTENUATOR	WEINSHELL 45-30-43	KC841
(2) POWER METERS	HP 436A	2101A08334
(3) FREQUENCY COUNTER	HP TR521P	82520016

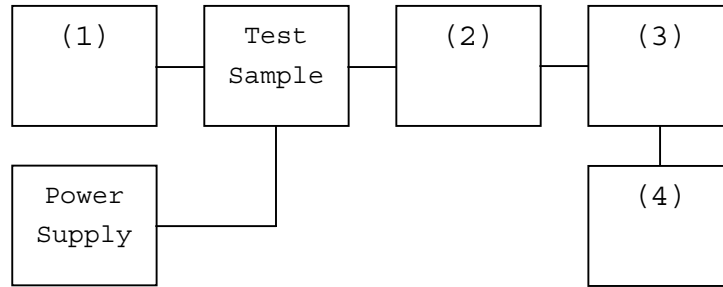
NAME OF TEST: Audio Frequency Response  
SPECIFICATION: 47 CFR 2.1047(a)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.6  
TEST EQUIPMENT: As per attached page

MEASUREMENT PROCEDURE

1. The EUT and test equipment were set up as shown on the following page.
2. The audio signal generator was connected to the audio input circuit/microphone of the EUT.
3. The audio signal input was adjusted to obtain 50% modulation at 1kHz, and this point was taken as the 0 dB reference level.
4. With input levels held constant and below limiting at all frequencies, the audio signal generator was varied from 100 Hz to 50 kHz.
5. The response in dB relative to 1 kHz was then measured, using the Modulation Analyzer.
6. MEASUREMENT RESULTS: ATTACHED

TRANSMITTER TEST SET-UP

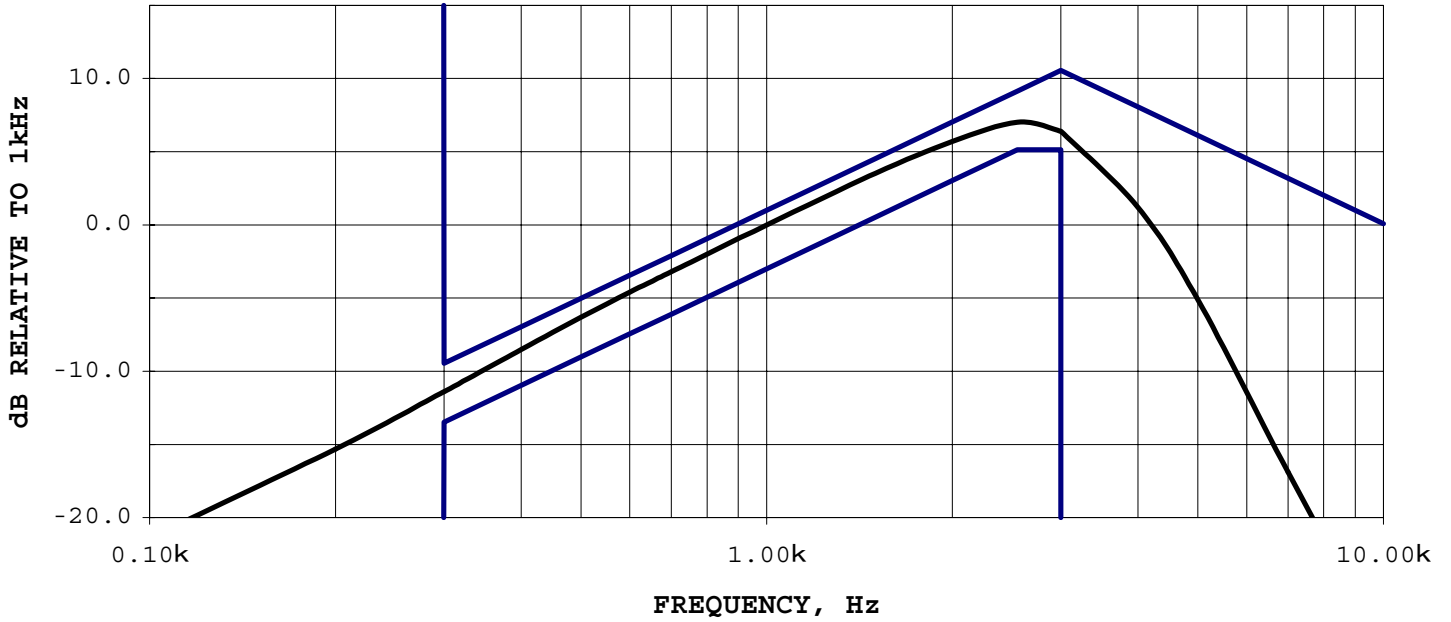
- TEST A. MODULATION CAPABILITY
- TEST B. AUDIO FREQUENCY RESPONSE
- TEST C. HUM AND NOISE LEVEL
- TEST D. RESPONSE OF LOW PASS FILTER
- TEST E. MODULATION LIMITING



Instruments	Description	Serial Number
(1)AUDIO OSCILLATOR	KIKUSUI 418B	6130785
(2)COAXIAL ATTENUATOR	WEINSHELL 45-30-43	KC841
(3)MODULATION ANALYZER	ANRITSU MT2605B	MT84636
(4)AUDIO ANALYZER	HP8903A	2016A00214

NAME OF TEST: Emission Masks (Occupied Bandwidth)  
2001-Dec-11  
STATE: 0:General

**TRANSMITTER AUDIO FREQUENCY RESPONSE**



Additional points :

FREQUENCY, Hz	LEVEL, dB
300	-11.4
20000	5.7
30000	6.4
50000	- 5.1

NAME OF TEST: Audio Low Pass Filter (Voice Input)  
SPECIFICATION: 47 CFR 2.1047(a)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.15  
TEST EQUIPMENT: As per previous page

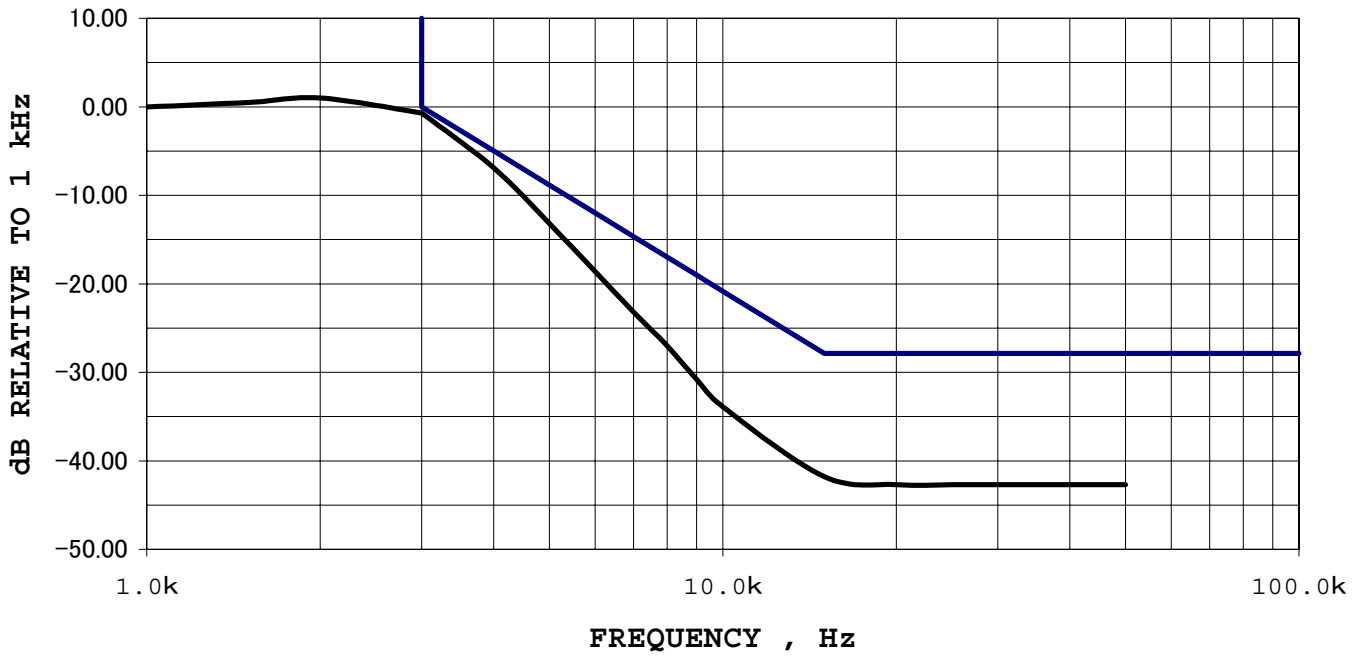
MEASUREMENT PROCEDURE

1. The EUT and test equipment were set up such that the audio input was connected at the input to the modulation limiter, and the modulated stage.
2. The audio output was connected at the output to the modulated stage.
3. MEASUREMENT RESULTS: ATTACHED



NAME OF TEST: Audio Low Pass Filter (Voice Input)  
2001-Dec-11  
STATE: 0:General

**FREQUENCY RESPONSE OF AUDIO LOWPASS FILTER**



NAME OF TEST: Modulation Limiting  
SPECIFICATION: 47 CFR 2.1047(b), 80.211, 80.213  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.3  
TEST EQUIPMENT: As per previous page

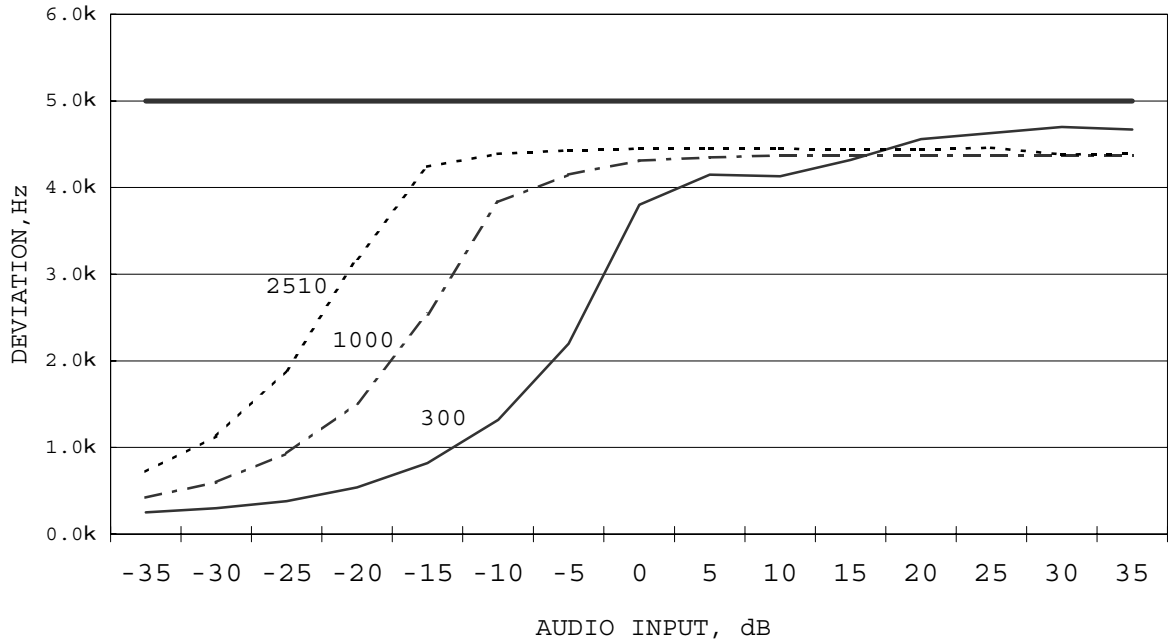
MEASUREMENT PROCEDURE

1. The signal generator was connected to the input of the EUT as for "Frequency Response of the Modulating Circuit."
2. The modulation response was measured for each of three frequencies (one of which was the frequency of maximum response), and the input voltage was varied and was observed on an Modulation Analyzer.
3. The input level was varied from 30% modulation (±1.5 kHz deviation) to at least 20 dB higher than the saturation point.
4. Measurements were performed for both negative and positive modulation and the respective results were recorded.
5. MEASUREMENT RESULTS: ATTACHED

NAME OF TEST: Modulation Limiting  
2001-Dec-11  
STATE: 0:General

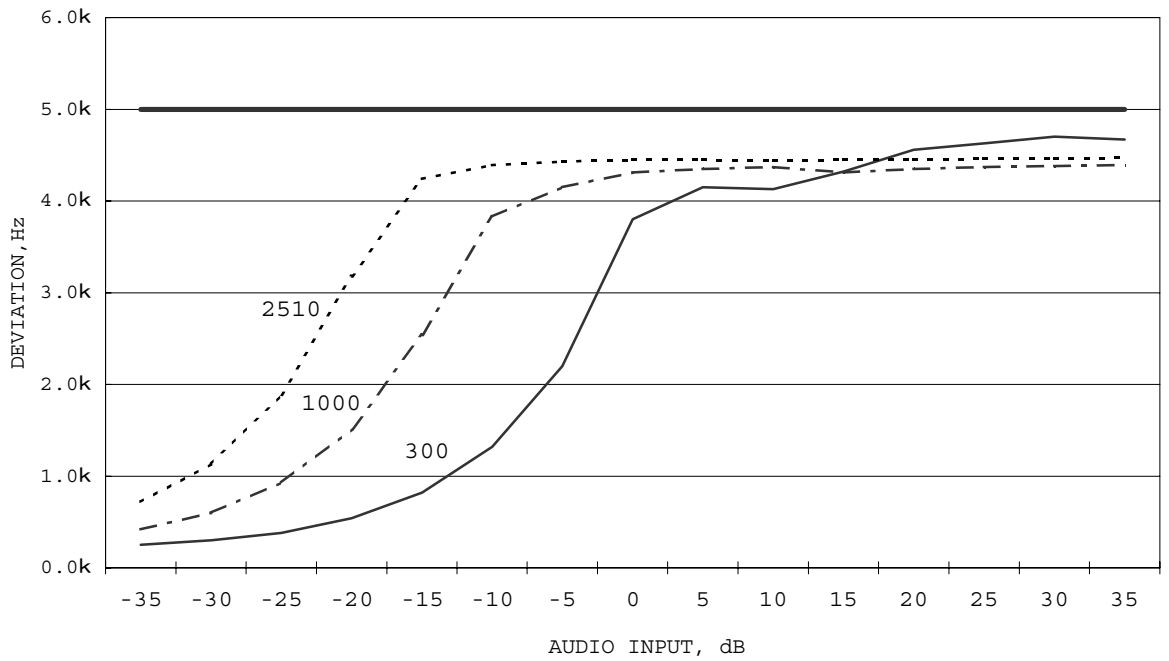
### MODULATION LIMITING

Positive  
Peaks :



### MODULATION LIMITING

Negative  
Peaks :

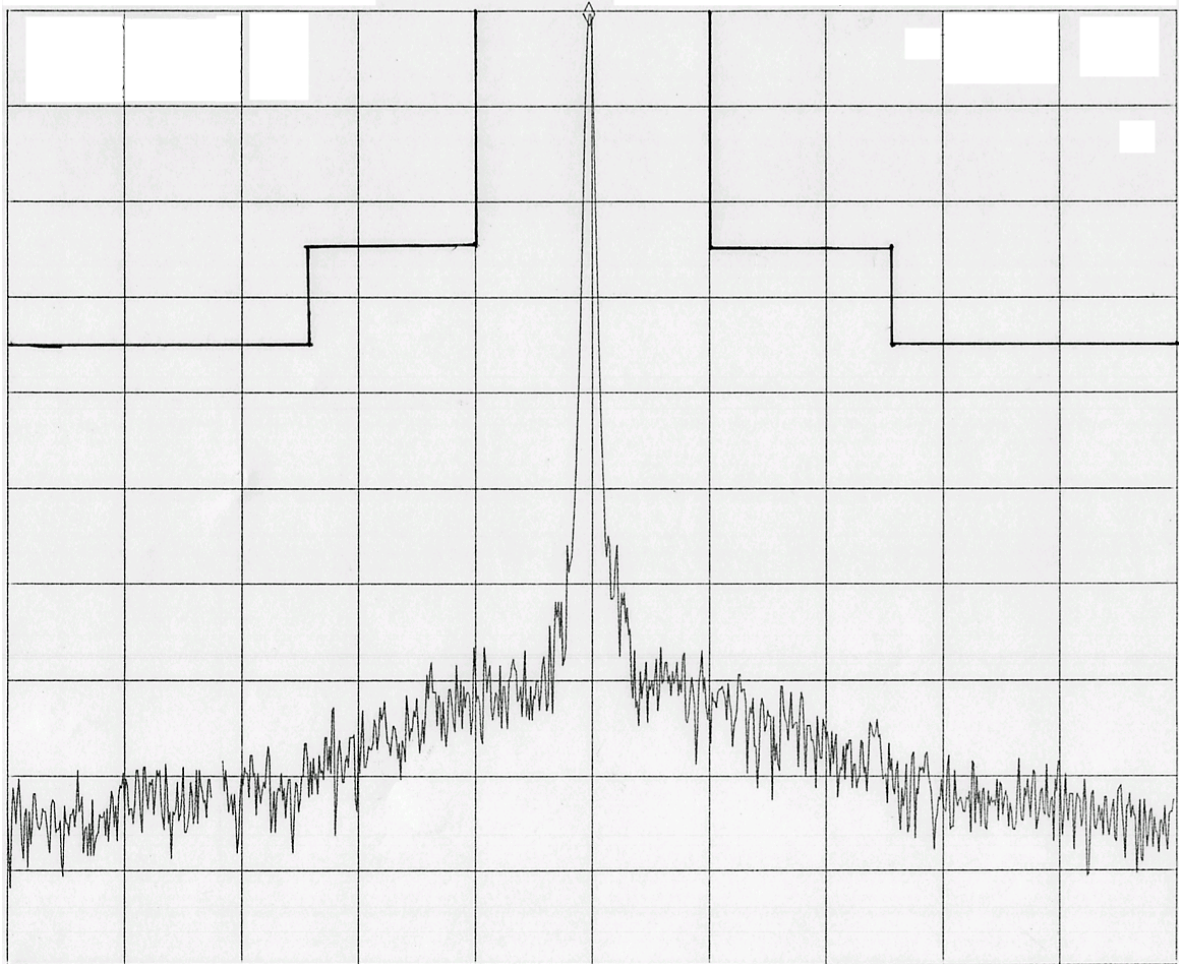


NAME OF TEST: Emission Masks (Occupied Bandwidth)  
SPECIFICATION: 47 CFR 2.1049(c)(1)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.11  
TEST EQUIPMENT: As per previous page

MEASUREMENT PROCEDURE

1. The EUT and test equipment were set up as shown on the following page, with the Spectrum Analyzer connected.
2. For EUTs supporting audio modulation, the audio signal generator was adjusted to the frequency of maximum response and with output level set for  $\pm 2.5$  kHz deviation (or 50% modulation). With level constant, the signal level was increased 16 dB.
3. For EUTS supporting digital modulation, the digital modulation mode was operated to its maximum extent.
4. The Occupied Bandwidth was measured with the Spectrum Analyzer controls set as shown on the test results.
5. MEASUREMENT RESULTS: ATTACHED

NAME OF TEST: Emission Masks (Occupied Bandwidth)  
2001-Dec-11  
STATE: 1:Low Power  
156.800MHz

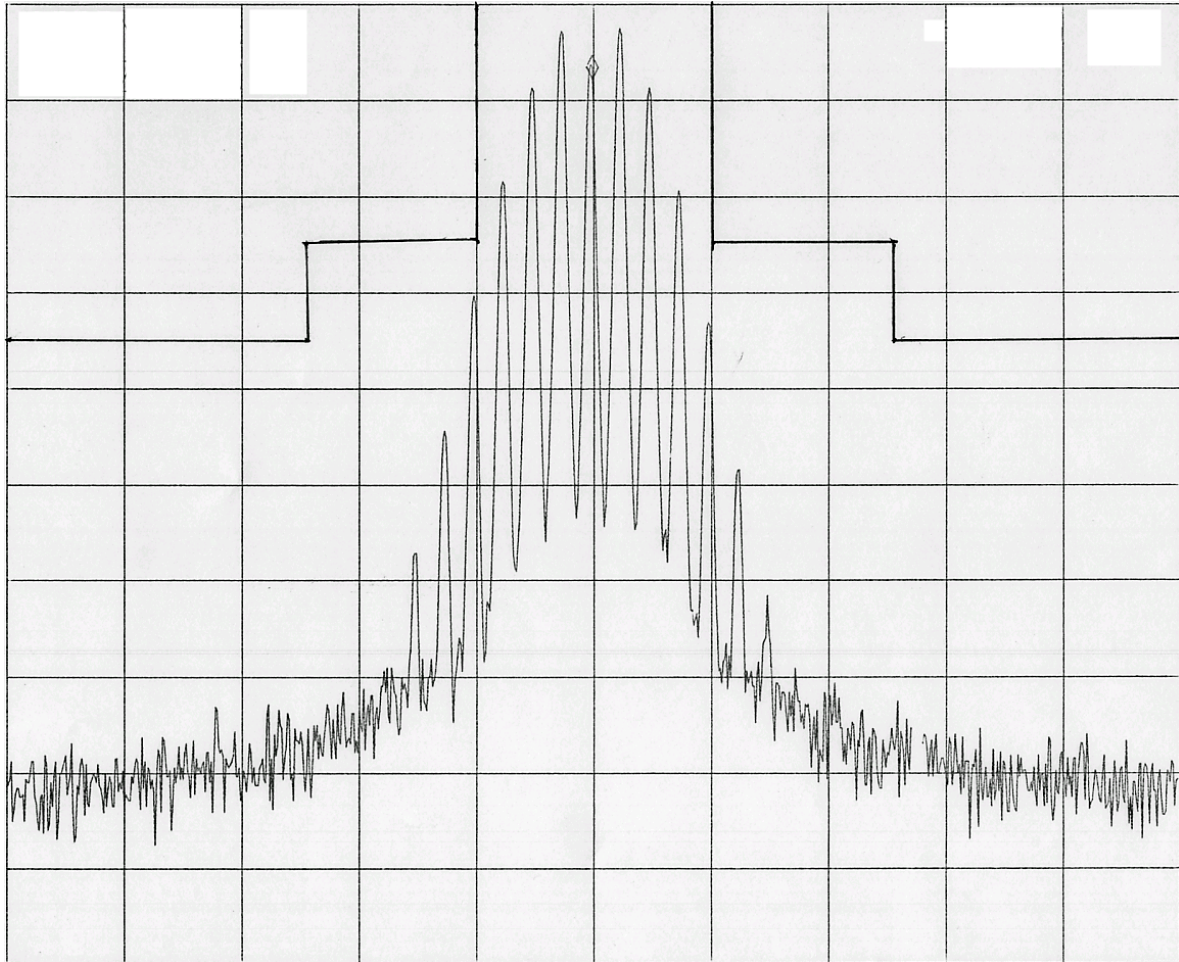


POWER: LOW  
MODULATION: NONE

NAME OF TEST: Emission Masks (Occupied Bandwidth)

2001-Dec-11

STATE: 1:Low Power  
156.800MHz



POWER :

LOW

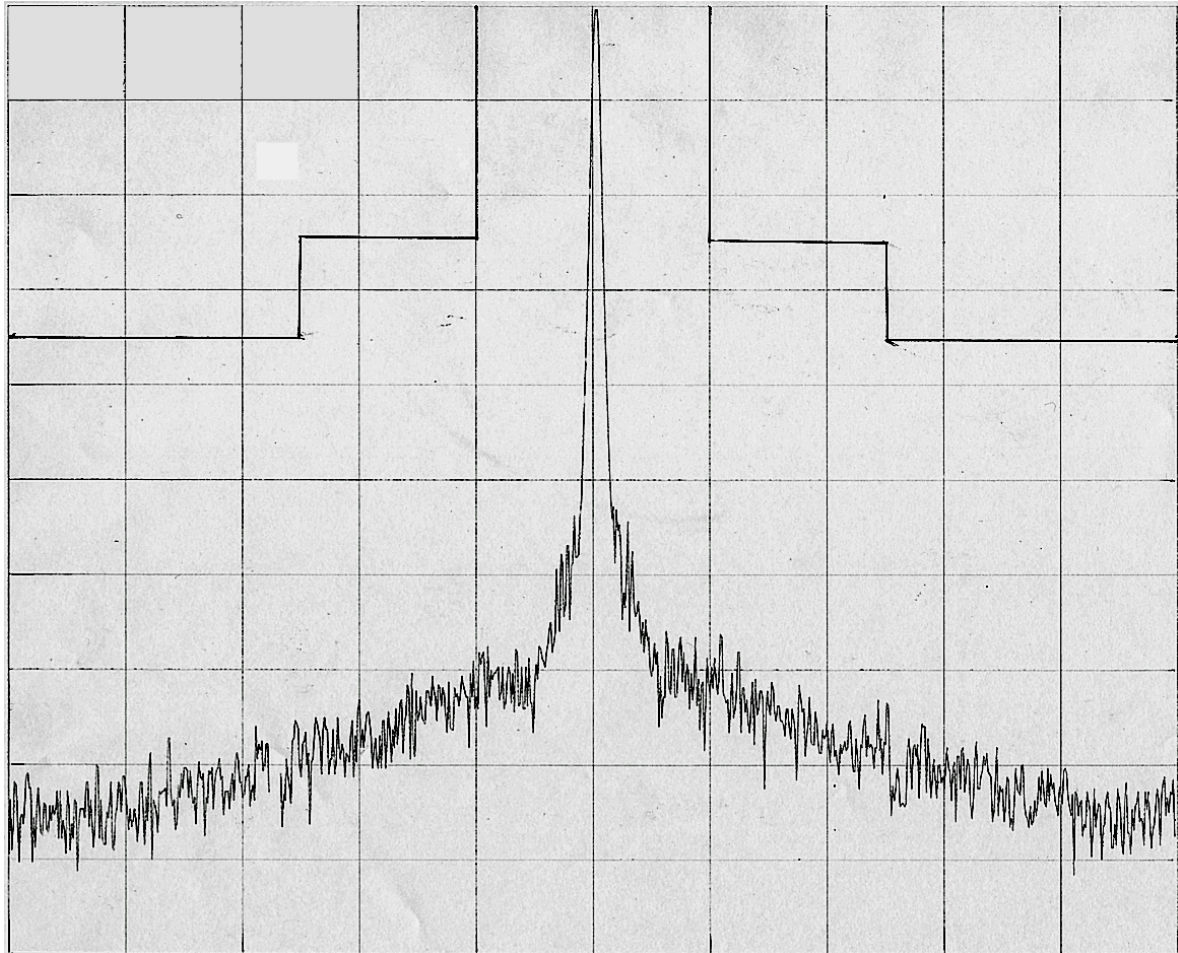
MODULATION :

VOICE: 2500Hz SINE WAVE

MASK: B, VHF/UHF 25kHz

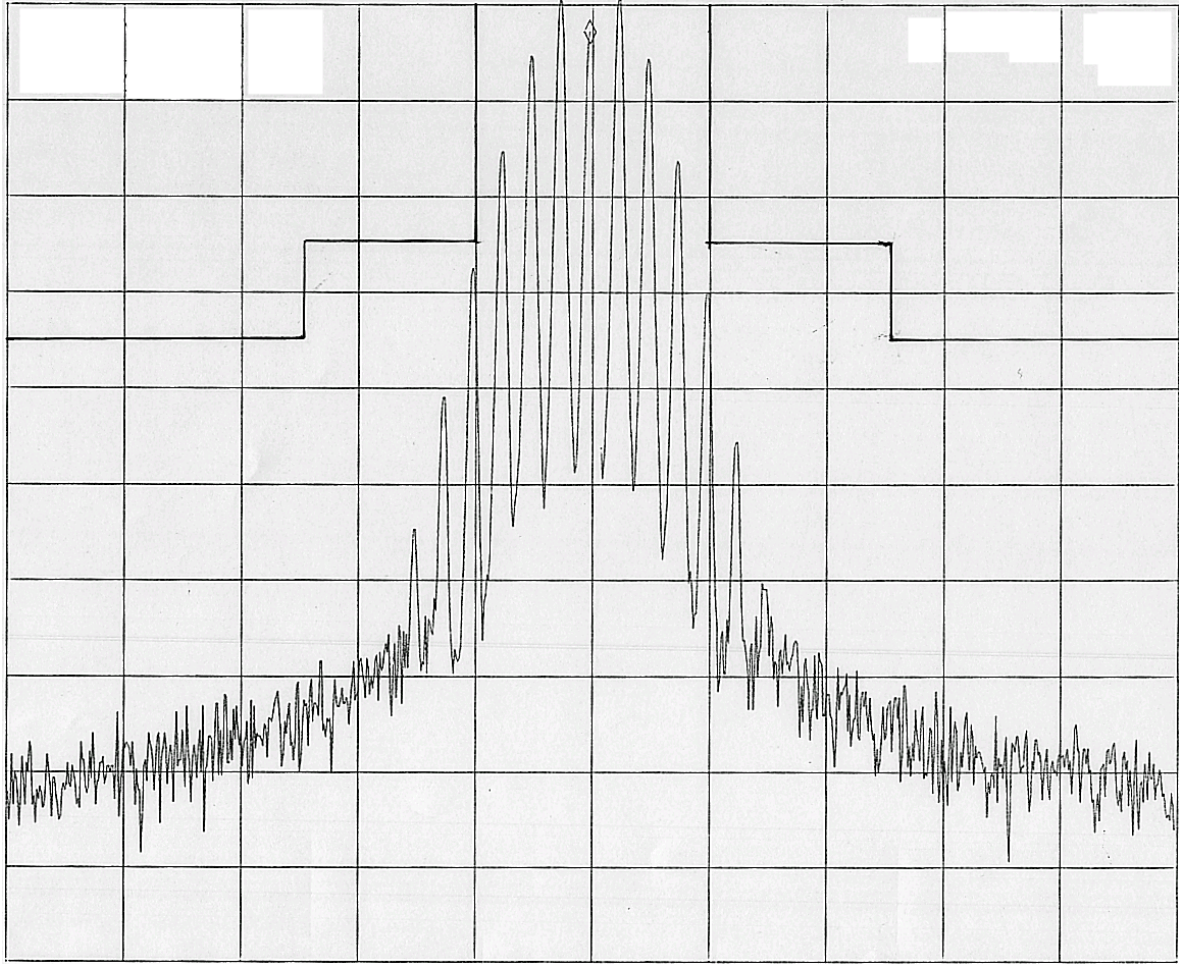
W/LPF

NAME OF TEST: Emission Masks (Occupied Bandwidth)  
2001-Dec-11  
STATE: 2:High Power  
156.800MHz



POWER: HIGH  
MODULATION: NONE

NAME OF TEST: Emission Masks (Occupied Bandwidth)  
2001-Dec-11  
STATE: 2:High Power  
156.800MHz



POWER: HIGH  
MODULATION: VOICE: 2500Hz SINE WAVE  
MASK: B, VHF/UHF 25kHz  
W/LPF



NAME OF TEST: Spurious Emissions at Antenna Terminals  
SPECIFICATION: 47 CFR 2.1051  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.13  
TEST EQUIPMENT: As per previous page

MEASUREMENT PROCEDURE

1. The emissions were measured for the worst case as follows:
  - (a): within a band of frequencies defined by the carrier frequency plus and minus one channel.
  - (b): from the lowest frequency generated in the EUT and to at least the 10th harmonic of the carrier frequency, or 40 GHz, whichever is lower.
2. The magnitude of spurious emissions that are attenuated more than 20dB below the permissible value need not be specified.

3. MEASUREMENT RESULTS: ATTACHED FOR WORST CASE

FREQUENCY OF CARRIER, MHz = 156. 8

SPECTRUM SEARCHED, GHz = 0 to 10 x Fc

MAXIMUM RESPONSE, Hz = 2820

ALL OTHER EMISSIONS =  $\geq$  20dB BELOW LIMIT

LIMIT(S), dBc

- (43+10xLOG P) = -43 (1 Watt)

- (43+10xLOG P) = -57 (25 Watts)]

NAME OF TEST: Spurious Emissions at Antenna Terminals

2001-Dec-11

STATE: 1:Low Power

FREQUENCY TUNED, MHz	FREQUENCY EMISSION, MHz	LEVEL, dBc	MARGIN, dB
156.800000	313.600000	-86.4	-43.4
156.800000	470.470000	-	(>20.0)
156.800000	627.200000	-	(>20.0)
156.800000	784.000000	-	(>20.0)
156.800000	940.800000	-	(>20.0)
156.800000	1097.600000	-	(>20.0)
156.800000	1254.400000	-	(>20.0)
156.800000	1411.200000	-	(>20.0)
156.800000	1568.000000	-	(>20.0)

NAME OF TEST: Spurious Emissions at Antenna Terminals  
 2001-Dec-11  
 STATE: 1:High Power

FREQUENCY TUNED, MHz	FREQUENCY EMISSION, MHz	LEVEL, dBc	MARGIN, dB
156.800000	313.600000	-84.2	-27.2
156.800000	470.470000	-82.4	-25.4
156.800000	627.200000	-	( <u>&gt;</u> 20.0)
156.800000	784.000000	-	( <u>&gt;</u> 20.0)
156.800000	940.800000	-	( <u>&gt;</u> 20.0)
156.800000	1097.600000	-	( <u>&gt;</u> 20.0)
156.800000	1254.400000	-	( <u>&gt;</u> 20.0)
156.800000	1411.200000	-	( <u>&gt;</u> 20.0)
156.800000	1568.000000	-	( <u>&gt;</u> 20.0)

NAME OF TEST: Field Strength of Spurious Radiation  
SPECIFICATION: 47 CFR 2.1053(a)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.12  
TEST EQUIPMENT: As per previous page

MEASUREMENT PROCEDURE

1. At first, in order to locate all spurious frequencies and approximate amplitudes, and to determine proper equipment functioning, the test sample was set up at a distance of three meters from the test instrument. Valid spurious signals were determined by switching the power on and off.
2. In the fields the test sample was placed on a wooden turntable above ground at three (or thirty) meters away from the search antenna. Excess power leads were coiled near the power supply.

In order to obtain the maximum response at each spurious frequency, the turntable was rotated. Also, the search Antennas were raised and lowered vertically, and all cables were oriented. Excess power lead was coiled near the power supply.

3. A signal generator, connected with a non-radiating cable to a vertically polarized half-wave antenna (for each frequency involved) was substituted for the transmitter. The Search Antenna was raised and lowered to obtain maximum indicated.
4. The signal generator output was adjusted until a signal level indication equal to that from the transmitter was obtained.
5. Steps 3 and 4 were repeated, using a horizontally polarized half-wave antenna. The higher of the two observations was noted.

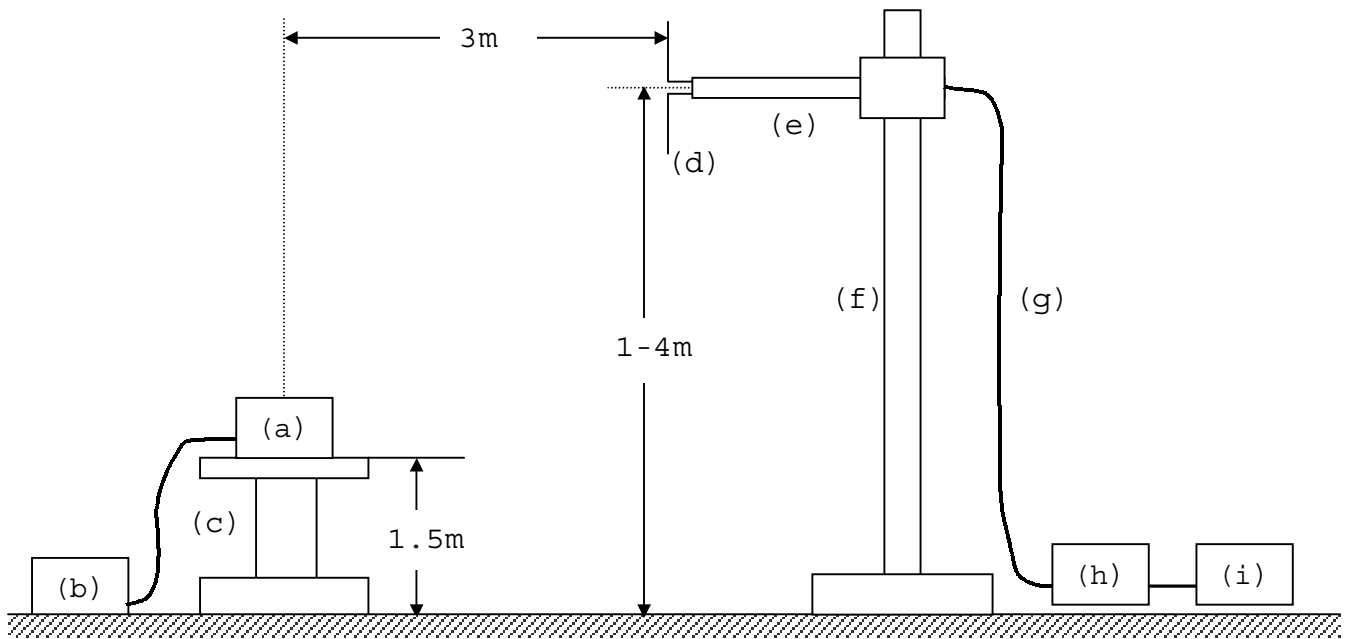
Power into the half-wave antenna was calculated from the characteristic impedance of the line, and the voltage output from the signal generator.

NAME OF TEST: Field Strength of Spurious Radiation  
SPECIFICATION: 47 CFR 2.1053(a)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.12  
TEST EQUIPMENT: As per attached page

MEASUREMENT PROCEDURE

6. Measurement summary:
- |                           |                            |
|---------------------------|----------------------------|
| FREQUENCY OF CARRIER, MHz | = 156.8                    |
| SPECTRUM SEARCHED, GHz    | = 0 to 10 x Fc             |
| ALL OTHER EMISSIONS       | = $\geq$ 20 dB BELOW LIMIT |
| LIMIT, dBc                | = -57                      |
7. Measurement results: ATTACHED

RADIATED TEST SETUP



NOTES:

- (a) Equipment Under Test
- (b) External power source
- (c) Turntable
- (d) Search Anntena (rotatable on boom / adjustable horizontally)
- (e) Non-metalic boom (adjustable in height)
- (f) Non-metaric mast
- (g) Calibrated Cable
- (h) Frequency converter (over 2GHz to under 1GHz)
- (i) Measuring receiver (under 1GHz)

Instruments	Description	Serial Number
TRANSDUCER	ANRITSU MP534A : 25-300MHz	
	ANRITSU MP663A : 300-2000MHz	
MEASURING RECEIVER	ANRITSU ML524C1	MT86948

NAME OF TEST: Field Strength of Spurious Radiation  
2001-Dec-13

ALL OTHER EMISSIONS =  $\geq$  20dB BELOW LIMIT

EMISSION, MHz/HARMONICS	SPURIOUS LEVEL, dBc
313.600	-80.1
470.400	-72.4
627.200	-91.6
784.000	-94.2
940.800	-90.3
1097.600	-87.8
1254.400	-86.5
1411.200	-78.8
1568.000	-83.9

NAME OF TEST: Receiver Spurious Emissions (Radiated)  
SPECIFICATION:  
15.109: Radiated Interference Limits  
15.33: Frequency Range of Radiated Measurements  
80.217: Suppression of Interference Aboard Ships  
GUIDE: See measurement procedure below  
TEST EQUIPMENT: As per previous page

MEASUREMENT PROCEDURE

1. At first, bench tests were performed to locate the spurious emissions at the antenna terminals.
2. In the field, tests were conducted over the range shown, The test Sample was set up on a wooden turntable above ground, and at a distance of three meters from the antenna connected to the Spectrum Analyzer.
3. In order to obtain the maximum response at each frequency, the turntable was rotated, and the search antenna was raised and lowered. The EUT was also adjusted for maximum response - Tests were conducted in Horizontal & Vertical polarization modes.
4. The field strength was calculated from:  
$$\text{EuV/m @ 3 m} = \text{Log}_{10}^{-1} \frac{(\text{dBuV} + \text{A.F.} + \text{C.L.})}{20}$$
5. MEASUREMENT RESULTS: Attached for "Worst Case" conditions.



NAME OF TEST: Receiver Spurious Emissions (Radiated)

MESUREMENT DETAILS

SPECTRUM SEARCHED = 0 to 10 x Fr  
WORST CASE = V  
LIMITS = 15.109(a) (Attached)  
ALL OTHER EMISSIONS = 20 dB OR MORE BELOW LIMIT

TESTS WERE CONDUCTED WITH:

- a. All controls and switches operated.
- b. Half-wave dipole antenna or manufacturer/applicant supplied antenna.

MEASUREMENT RESULTS = ATTACHED

NOTE: WORST CASE OF SCAN AND NON-SCAN MODES REPORTED.

NAME OF TEST: Receiver Spurious Emissions (Radiated)  
STATE: 0:General

All other emissions in the required measurement range were more than 20 dB below the required limits.

FREQUENCY TUNED, MHz	FREQUENCY EMISSION, MHz	LEVEL, uV/m	MARGIN, dB
156.025	134.325	39.2	11.7
156.800	135.100	43.4	10.8
163.425	141.725	31.8	13.5

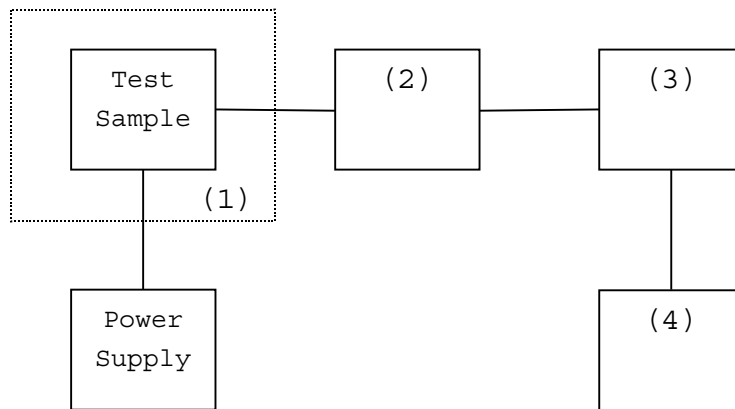
NAME OF TEST: Frequency Stability (Temperature Variation)  
SPECIFICATION: 47 CFR 2.1055(a)(1)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.2  
TEST EQUIPMENT: As per previous page

MEASUREMENT PROCEDURE

1. The EUT and test equipment were Set up as shown on the following page.
2. With all power removed, the temperature was decreased to -30deg.C and permitted to stabilize for three hours. Power was applied and the maximum change in frequency was noted within one minute.
3. With power OFF, the temperature was raised in 10deg.C steps. The sample was permitted to stabilize at each step for at least one-half hour. Power was applied and the maximum frequency change was noted within one minute.
4. The temperature tests were performed for the worst case.
5. MEASUREMENT RESULTS: ATTACHED

TRANSMITTER TEST SET-UP

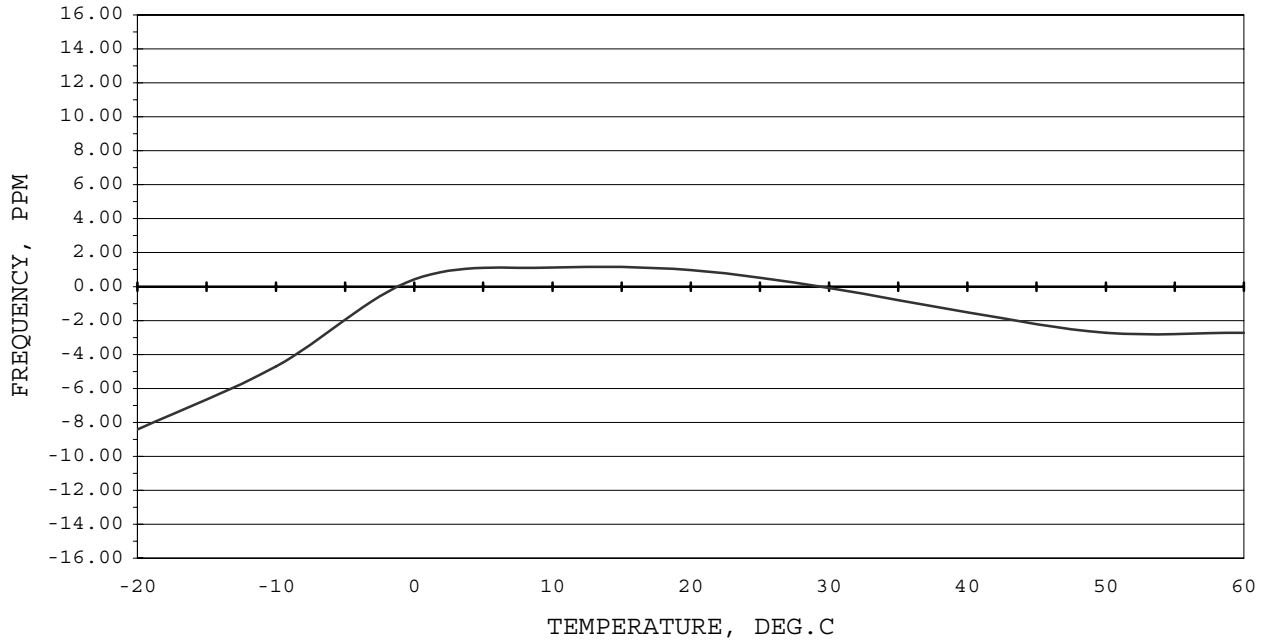
- TEST A. OPERATIONAL STABILITY
- TEST B. CARRIER FREQUENCY STABILITY
- TEST C. OPERATIONAL PERFORMRNC E STABILITY
- TEST D. HUMIDITY
- TEST E. VIBRATION
- TEST F. ENVIRONMENTAL TEMPERATURE
- TEST G. FREQUENCY STABILITY: TEMPERATURE VARIATION
- TEST H. FREQUENCY STABILITY: VOLTAGE VARIATION



Instruments	Description	Serial Number
(1) TEMPERATURE	TABAI MC-710	250344
(2) COAXIAL ATTENUATOR	WEINSHELL 45-30-43	KC841
(3) POWER METERS	HP 436A	2101A08334
(4) FREQUENCY COUNTER	HP TR521P	82520016

NAME OF TEST: Frequency Stability (Temperature Variation)  
2001-Dec-12  
STATE: 0:General

### TRANSMITTER FREQUENCY STABILITY



NAME OF TEST: Frequency Stability (Voltage Variation)  
SPECIFICATION: 47 CFR 2.1055(b) (1)  
GUIDE: ANSI/TIA/EIA-603-1992, Paragraph 2.2.2  
TEST EQUIPMENT: As per previous page

MEASUREMENT PROCEDURE

1. The EUT was placed in a temperature chamber at 25+roC and connected as for "Frequency Stability - Temperature Variation" test.
2. The power supply voltage to the EUT was varied from 85% to 115% of the nominal value measured at the input to the EUT.
3. The variation in frequency was measured. for the worst case.

RESULTS: Frequency Stability (Voltage Variation)  
 2001-Dec.-13  
 STATE: O:General

LIMIT, ppm = 10  
 LIMIT, Hz = 1568  
 BATTERY END POINT (Voltage) = 8.7

% of STV	Voltage	Frequency, MHz	Change, Hz	Change, ppm
85	11.73	156.800324	324	2.07
100	13.80	156.800315	315	2.01
115	15.87	156.800308	308	1.96
63	8.70	156.800282	282	1.80

NAME OF TEST: User Controls  
SPECIFICATION: 47 CFR 80.203 (b)

STATEMENT

The external controls of the maritime station transmitter capable of operation in the 156-162 MHz band only provides for selection of maritime channels for which the maritime station is authorized. This transmitter is not capable of being programmed by station operators using external controls to transmit on channels other than those programmed by the manufacturer, service or maintenance personal.

The EUT fully complied with the requirements, of 47 CFR 80.203 (b).

NAME OF TEST: Power Output Over Time  
SPECIFICATION: 47 CFR 80.959(c) (1) (2) & (3)

MEASUREMENT PROCEDURE

The EUT was connected to a resistive coaxial attenuator of normal load impedance, and the unmodulated output power was measured by means of an R.F. Power meter.

Measurement accuracy is +3%

The transmitter was operated continuously.

Measurements summary:

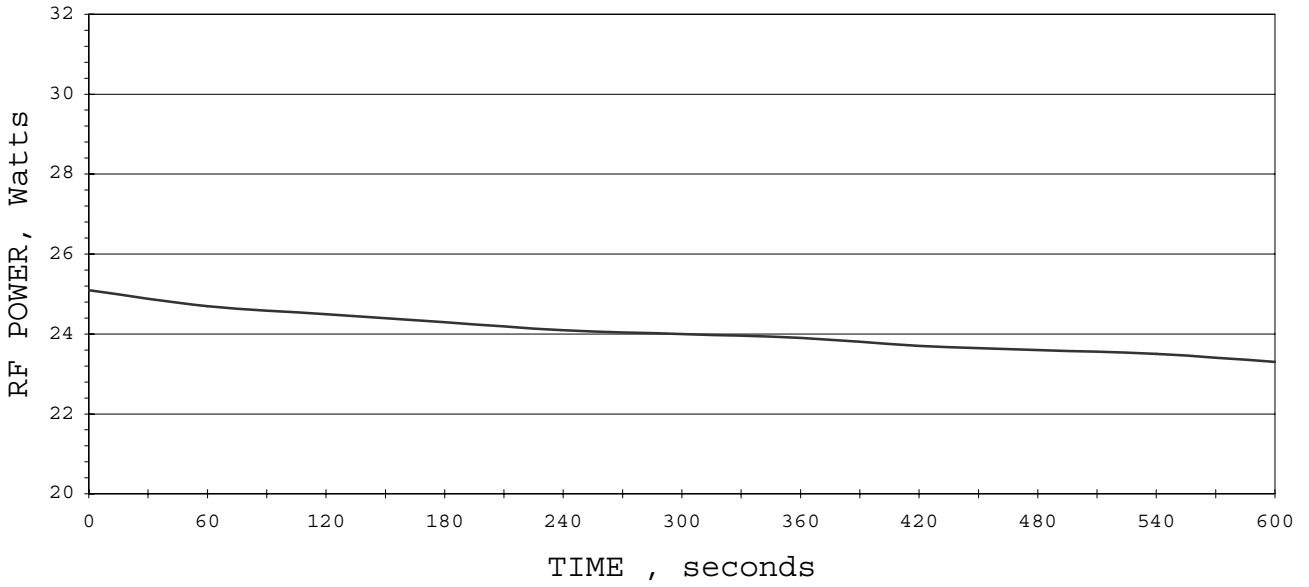
TIME, Min.	SUPPLY VOLTAGE, Vdc	R.F. Power Output, Watts
0	13.8	25
10	13.8	23

Measurement Results: Attached



NAME OF TEST: RF POWER VS TIME  
2001-Dec-12

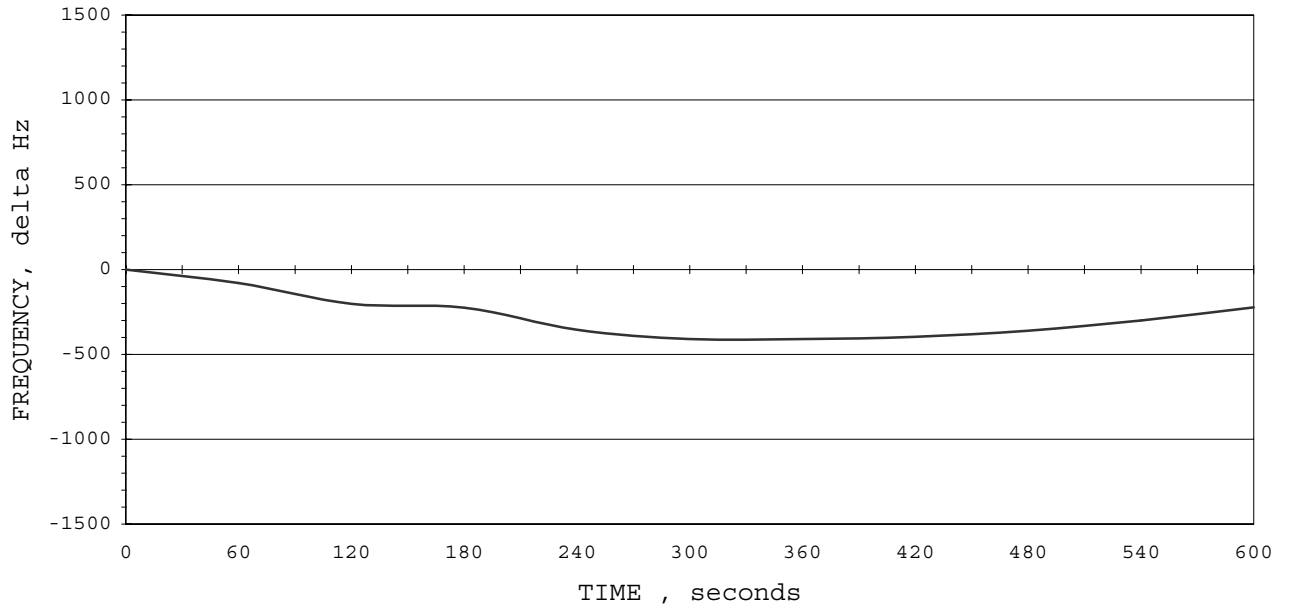
RF POWER VS TIME



NOMINAL, Watts	= 25
UPPER LIMIT, dB	= 1.0
UPPER LIMIT, Watts	= 31.5
LOWER LIMIT, dB	= 1.0
LOWER LIMIT, Watts	= 19.9

NAME OF TEST: RF FREQUENCY VS TIME  
2001-Dec-12

### RF FREQUENCY VS TIME



NOMINAL, MHz = 156.800

LOWER LIMIT, PPM = 10.0

LOWER LIMIT, Hz = 19.9