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FCC Part 80/90 Certification Application

FCC Form 731

For The

**Guardian 200
VHF RADIO MODEM**

FCC ID: NP4-5026-500

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NAME OF TEST: Transmitter Rated Power Output

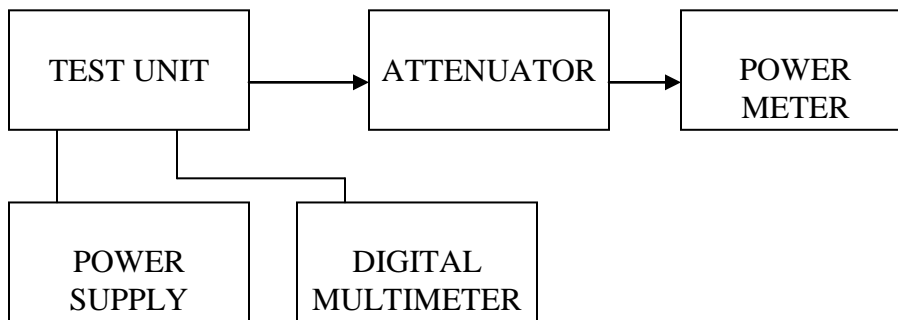
RULE PART NUMBER: FCC: 2.1046 (a) (c), 80.215
 Note: All data taken at 12 watts is to be applied to Part 80 and Part 90 (220-222 MHz) only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: 50-Ohm Attenuator, Bird 50-A-FFN-20 / 20 dB / 50 Watt
 Power Supply, Instek Model GPS-3303
 Digital Multimeter, Fluke 87
 Power Meter, Model HP-8901B

TEST SET-UP:



TEST RESULTS:

Frequency (MHz)	DC Voltage at Final (Vdc)	DC Current into Final (Adc)	DC Power into Final (W)	RF Power Output (W)
217.50625	11.9	2.246	26.7	12.0
217.50625	8.4	.972	8.1	2.0
217.50625	8.0	.724	5.8	1.0
219.50625	11.9	2.148	25.5	12.0
219.50625	8.4	.945	7.9	2.0
219.50625	8.0	.697	5.6	1.0

NAME OF TEST: Transmitter Spurious and Harmonic Outputs

RULE PART NUMBER: 2.1051, 90.210 (c,3)(d,3), 80.211 (f)
 Note: All data taken at 12 watts is to be applied to Part 80 and Part 90 (220-222 MHz) only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

MINIMUM STANDARDS: For 12 Watts: $55+10\text{Log}_{10}(12 \text{ Watts}) = -65.8 \text{ dBc}$
 or -70 dBc , whichever is the lesser attenuation.

For 2 Watts: $50+10\text{Log}_{10}(2 \text{ Watts}) = -50.3 \text{ dBc}$
 or -65dBc , whichever is the lesser attenuation.

For 1 Watt: $55+10\text{Log}_{10}(1 \text{ Watt}) = -55 \text{ dBc}$
 or -70 dBc , whichever is the lesser attenuation.

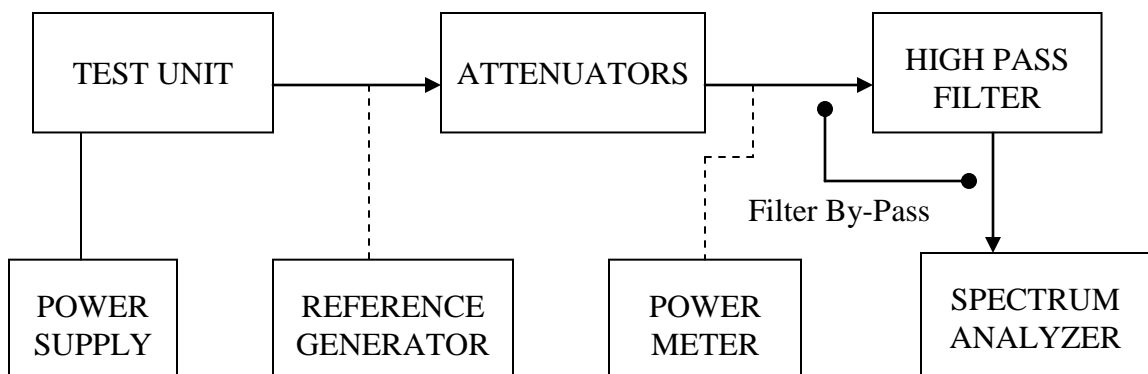
TEST RESULTS: Meets minimum standards (see data on following pages)

TEST CONDITIONS: Standard Test Conditions, 25 C
 RF Voltage measured at antenna terminals

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Narda 765-10 / 10 dB / 50 Watts
 50-Ohm Attenuator, Bird 10-A-MFN-10 / 10 dB / 10 Watts
 Power Supply, Instek Model GPS-3303
 Spectrum Analyzer, HP-8563E
 Reference Generator, Agilent E8257D
 High Pass Filter, Mini Circuits VHF-740, $F_c = 740 \text{ MHz}$

TEST SET-UP:



MEASUREMENT PROCEDURE:

1. The transmitter carrier output frequency is 217.50625 and 219.50625 MHz. The reference oscillator frequency is 23.040 MHz. The power amplifier has voltage levels at 11.9 Volts and 8.0 Volts for 12 watts and 1 watt, respectively.
2. The carrier reference was established on the spectrum analyzer with the filter by-pass in place. Then the spectrum was scanned from DC to 2 Fc. Finally, the high pass filter was inserted to null

the carrier fundamental and extend the range of the spectrum analyzer for harmonic measurements above $2 F_c$.

3. At each spurious frequency, generation substitution was used to establish the true spurious level.
4. The spectrum was scanned to the 10th harmonic of the highest internally generated frequency.

Tuned	1	
Frequency	217.025	MHz
Power	12.0	Watts
	40.8	dBm
Min		
Specification	-65.0	dBc
Worse Case	-68	dBc
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
436.050	2	-86
654.075	3	-68
872.100	4	-106
1090.125	5	-113
1308.150	6	-117
.1526.175	7	-122
1744.200	8	-122
1962.225	9	-122
4360.500	10	-122

Tuned		
Frequency	217.025	MHz
Power	1.0	Watts
	30.0	dBm
Min		
Specification	-55.0	dBc
Worse Case	-87	dBc
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
436.050	2	-87
654.075	3	-91
872.100	4	-112
1090.125	5	-112
1308.150	6	-112
.1526.175	7	-112
1744.200	8	-112
1962.225	9	-112
4360.500	10	-112

Tuned		
Frequency	218.025	MHz
Power	2.0	Watts
	33	dBm
Min		
Specification	-65.0	dBc
Worse Case	-92.44	dBc
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
436.050	2	-92.44
654.075	3	-99.94
872.100	4	-117.17
1090.125	5	-121.42
1308.150	6	-125.45
.1526.175	7	-126.8
1744.200	8	-126.8
1962.225	9	-126.8
2180.250	10	-126.8

Tuned	1	
Frequency	219.925	MHz
Power	12.0	Watts
	40.8	dBm
Min		
Specification	-65.0	dBc
Worse Case	-66	dBc
Spurious		Relative to
Frequency	Harmonic	Carrier
(MHz)		(dBc)
436.050	2	-80
654.075	3	-66
872.100	4	-105
1090.125	5	-114
1308.150	6	-116
.1526.175	7	-122
1744.200	8	-122
1962.225	9	-122
4360.500	10	-122

Tuned		
Frequency	219.925	MHz
Power	1.0	Watts
	30.0	dBm
Min		
Specification	-55.0	dBc
Worse Case	-87	dBc
Spurious		Relative to
Frequency	Harmonic	Carrier
(MHz)		(dBc)
436.050	2	-87
654.075	3	-88
872.100	4	-112
1090.125	5	-112
1308.150	6	-112
.1526.175	7	-112
1744.200	8	-112
1962.225	9	-112
4360.500	10	-112

Tuned Frequency	220.1 MHz	
Power	12.0 Watts	
	40.8 dBm	
Min Specification	-65.0 dBc	
Worse Case	-66 dBc	
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
442.050	2	-79
663.075	3	-66
884.100	4	-105
1105.125	5	-113
1326.150	6	-117
1547.175	7	-122
1768.200	8	-122
1989.225	9	-122
4420.500	10	-122

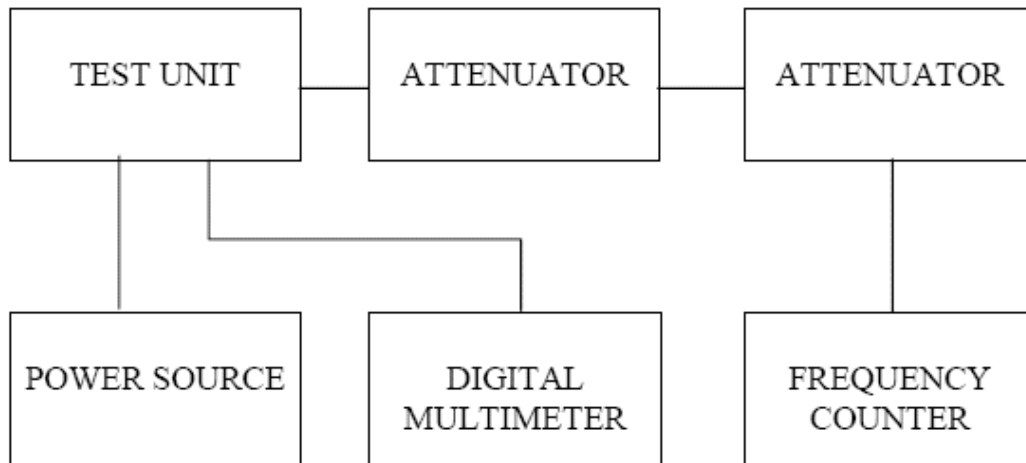
Tuned Frequency	220.1 MHz	
Power	1.0 Watts	
	30.0 dBm	
Min Specification	-55.0 dBc	
Worse Case	-87 dBc	
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
442.050	2	-87
663.075	3	-88
884.100	4	-112
1105.125	5	-112
1326.150	6	-112
1547.175	7	-112
1768.200	8	-112
1989.225	9	-112
4420.500	10	-112

Tuned Frequency	221.025 MHz	
Power	12.0 Watts	
	40.8 dBm	
Min Specification	-65.0 dBc	
Worse Case	-65 dBc	
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
442.050	2	-78
663.075	3	-65
884.100	4	-104
1105.125	5	-114
1326.150	6	-117
1547.175	7	-122
1768.200	8	-122
1989.225	9	-122
4420.500	10	-122

Tuned Frequency	221.025 MHz	
Power	1.0 Watts	
	30.0 dBm	
Min Specification	-55.0 dBc	
Worse Case	-86 dBc	
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
442.050	2	-86
663.075	3	-87
884.100	4	-112
1105.125	5	-112
1326.150	6	-112
1547.175	7	-112
1768.200	8	-112
1989.225	9	-112
4420.500	10	-112

NAME OF TEST: Frequency Stability with Variation in Supply Voltage
RULE PART NUMBER: 2.1055 (d)(1), 90.213 (a), 80.209
MINIMUM STANDARD: Shall not exceed 1.0 ppm.
TEST RESULTS: Meets minimum standard, see data on following page
TEST CONDITIONS: Standard Test Conditions, 25 C
TEST EQUIPMENT: Frequency Counter, Fluke 7220A
DC Power Supply, Instek Model GPS-2303
Digital Voltmeter, Fluke Model 8012A
50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)

TEST SET-UP:



TEST SET-UP

Channel Frequency: 220.0 MHz			
Tolerance Requirements: 1.0 ppm			
Highest Variation: -0.41			
Spec: <1.0ppm			
Input Voltage (Vdc)	Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
10	219.999910	-90	-0.41
20	220.000010	10	0.05
30	220.000030	30	0.14

NAME OF TEST: Frequency Stability with Variation in Ambient Temperature

RULE PART NUMBER: FCC: 2.1055 (a) (b), 90.213 (a), 80.209
Note: All data taken at 12 watts is to be applied to Part 80 and Part 90 (220-222 MHz) only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

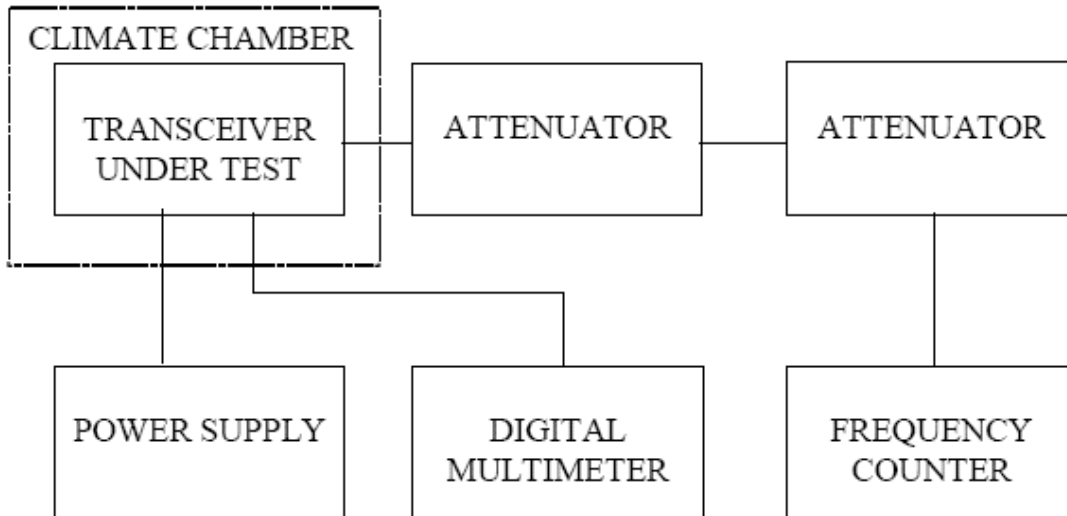
MINIMUM STANDARD: Shall not exceed 1.0 ppm from test frequency

TEST RESULTS: Meets minimum standard, see data on following page

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: Frequency Counter, Fluke 7220A
DC Power Supply, Instek Model GPS-2303
Digital Voltmeter, Fluke Model 8012A
50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
Climate Chamber, Test Equity Half Cube Model 105

TEST SET-UP:



Applicable to Part 80 (216-220 MHz) and Part 90 (220-222 MHz) only

Channel Frequency: 220 MHz			
Voltage & Power Level: 20 Volts @ 12 Watts			
Highest Variation: -0.72			
Spec: < 1.0 ppm			
Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	219.999840	-160	-0.72
-20	220.000000	0	0.00
-10	219.999930	-70	-0.32
0	219.999930	-70	-0.32
10	219.999840	-160	-0.72
20	219.999920	-80	-0.36
30	219.999880	-120	-0.54
40	219.999920	-80	-0.36
50	219.999890	-110	-0.50
60	219.999890	-110	-0.50

Applicable to Part 90 (217-220 MHz)

Channel Frequency: 220 MHz			
Voltage & Power Level: 20 Volts @ 2 Watts			
Highest Variation: 0.59			
Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	219.999970	-30	0.14
-20	219.999950	-50	0.22
-10	220.000040	40	0.18
0	219.999990	-10	0.05
10	219.999960	-40	0.18
20	220.000000	0	0.00
30	219.999950	-50	0.22
40	219.999900	-100	0.45
50	219.999870	-130	0.59
60	219.999890	-110	0.50

Channel Frequency:		220	MHz
Voltage & Power Level:		20 Volts @ 1 Watts	
Highest Variation:		0.68	
Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	219.999960	-40	0.18
-20	219.999930	-70	0.32
-10	220.000040	40	0.18
0	219.999980	-20	0.09
10	219.999970	-30	0.14
20	219.999990	-10	0.05
30	219.999940	-60	0.27
40	219.999910	-90	0.41
50	219.999850	-150	0.68
60	219.999870	-130	0.59

NAME OF TEST: Transmitter Occupied Bandwidth

RULE PART NUMBER: 2.201, 2.202, 2.1033 (c)(14), 2.1049 (h), 2.1041;90.203(j)(3); 80.211 (f)

Necessary Bandwidth Measurement

This radio modem uses digital modulation signals, passing through a linear 8th order low-pass filter (Raise-Cosine alpha 1 approximation), to an FM transceiver. The necessary bandwidth calculation for this type of modulation (DRCMSK) is not covered by paragraphs (1), (2) or (3) from 2.202(c). Therefore, the approach outlined in (2.202(c)(4)) is applicable in this case.

The measurement explanations are provided below.

Necessary Bandwidth Measurement:

Channel Spacing	12.5 kHz	12.5 kHz	25 kHz	25 kHz	25 kHz
Emission Type	9K55 F1D	9K35 F1D	11K6 F1D	14K6 F1D	16K4 F1D
Data Rate	4800 bps	9600 bps	4800 bps	9600 bps	19200 bps
Measured Peak Deviation	3.55 Hz	2.76 kHz	4.43 kHz	4.40 kHz	4.30 kHz
Measured 99% Occupied BW	9.55 kHz	9.35 kHz	11.55 kHz	14.55 kHz	16.35 kHz

THEORY OF MEASUREMENT

The way to define the Occupied Bandwidth is “the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission” (FCC 2.202), the mathematics are as follows:

$$0.005 * TP = P_{(f1)} = \int_0^{f1} PSD_{(f)} df$$

$$0.995 * TP = P_{(f2)} = \int_0^{f2} PSD_{(f)} df$$

$$OBW = f2 - f1$$

where TP (total mean power) is

$$TP = \int_0^{+\infty} PSD_{(f)} df = (1/t) \int_{-\infty}^{+\infty} |z_{(t)}|^2 dt$$

and PSD (power spectral distribution) is

$$PSD_{(f)} = |Z_{(f)}|^2 + |Z_{(-f)}|^2 \quad 0 \leq f < \infty$$

and expresses the positive frequency representation of the transmitter output power for z(t) signal.

By applying these mathematics to the measurements, it is possible to measure the Occupied Bandwidth using a digital spectrum analyzer.

The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a computational part related to measured trace.

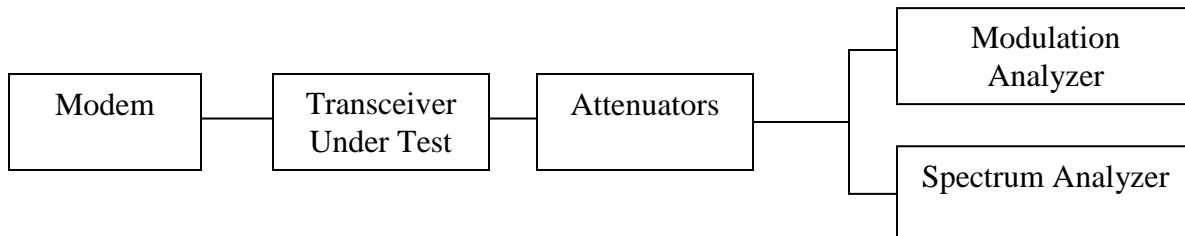
TEST EQUIPMENT:

- 50-Ohm Attenuator, Bird Electronics Model 25-A-MFN-20 (20dB, 25W)
- 50-Ohm Power Splitter, Mini Circuits Model ZFSC-3-4 (5.5dB IL at UHF)
- Power Supply, Instek Model GPS-3303
- Spectrum Analyzer, Hewlett Packard Model HP8563E
- Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

For the above requirements, the occupied bandwidth of a transmitter was measured using an Advantest Model R3162 using the following settings:

- Occupied BW % Power: 99%
- Trace: Max Hold A
- RBW: 100 Hz (12.5 kHz channels)
- RBW: 300 Hz (25 kHz channels)
- VBW: 3 kHz
- SPAN: 50 kHz (12.5 kHz channels)
- SPAN: 150 kHz (25 kHz channels)



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators
9K55F1D and **9K35F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(d), 2.1049 (c)(1); 80.211 (f)
Note: All data taken at 12 watts is to be applied to Part 80 only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

MINIMUM STANDARDS: **Mask D**
Sidebands and Spurious [Rule 90.210 (d), P = 12 Watts and P=1 Watt]
Authorized Bandwidth = 11.25 kHz [Rule 90.209(b) (5)]
From Fo to 5.625 kHz, down 0 dB.
Greater than 5.625 kHz to 12.5 kHz, down 7.27($f_d-2.88\text{kHz}$) dB.
Greater than 12.5 kHz, at least 50+10log₁₀(P) or 70 dB, whichever is the lesser attenuation.

Attenuation = 0 dB at Fo to 5.625 kHz
Attenuation = 20 dB at 5.625 kHz and 70 dB at 12.5 kHz
Attenuation = 60.8 dB at frequencies greater than 12.5 kHz @ 12 W
Attenuation = 50 dB at frequencies greater than 12.5 kHz @ 1 W

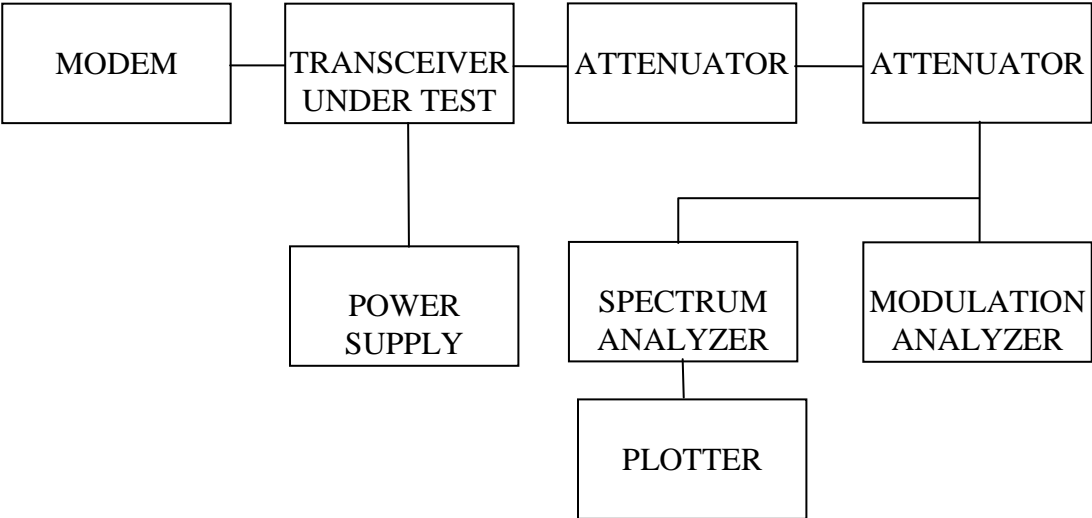
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 12 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits ZFSC-3-4 (5.5dB IL at UHF)
Power Supply, Instek Model GPS-3303
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

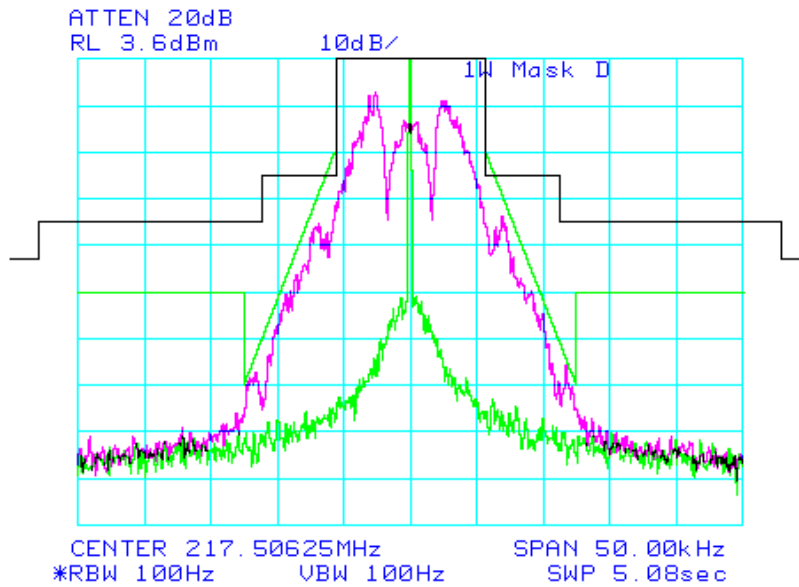


Mask: D, 1W
Output Power = 1 Watt

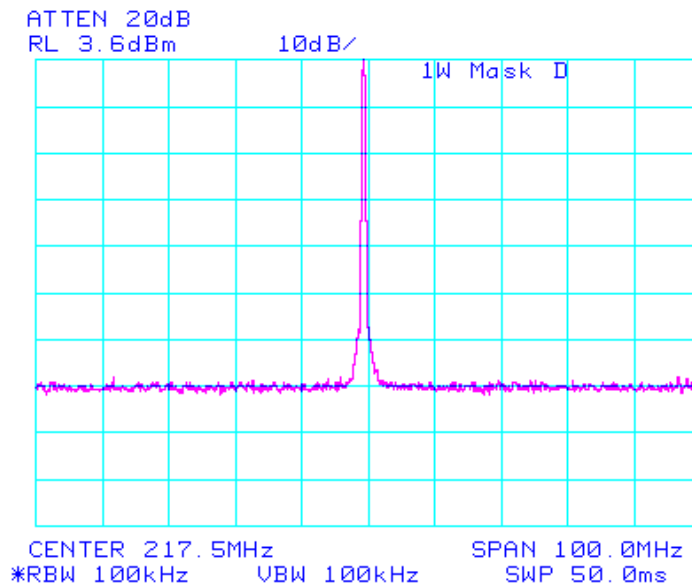
Spectrum for Emission: 9K55 F1D
Data Rate: 4800 bps Peak Deviation with Data: 3.55 kHz

Mask B = Black Line
Mask D = Green Line

Narrow Span

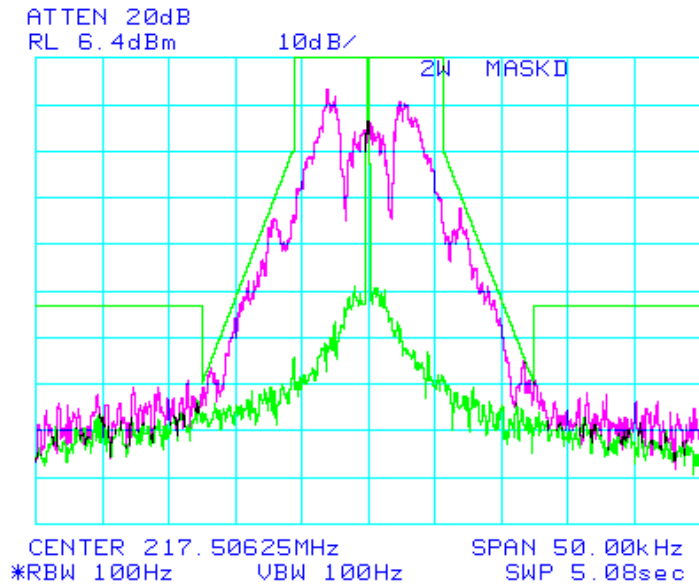


Wide Span



Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

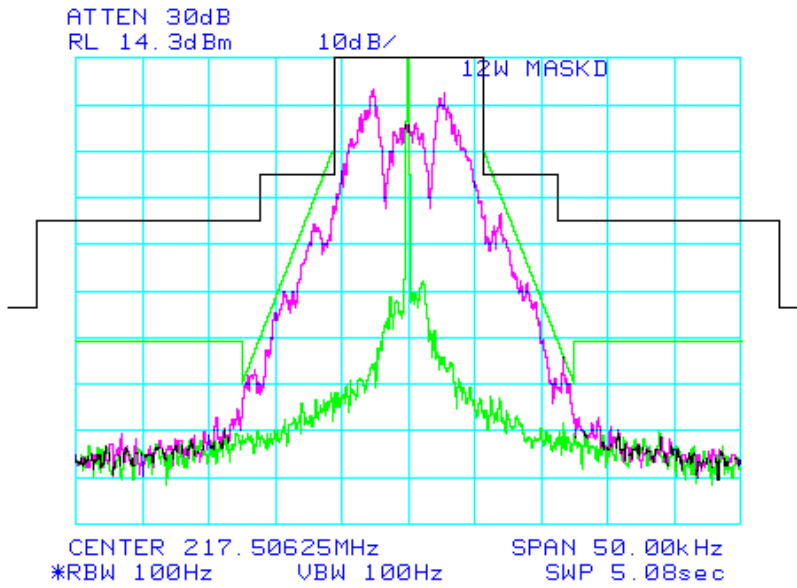
Mask B = Black Line
Mask D = Green Line



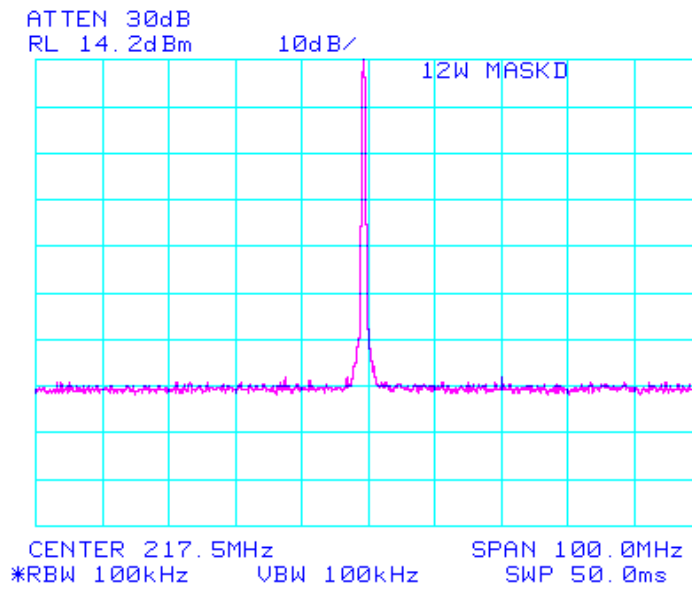
Output Power = 12 Watts
Applicable to Part 80 (216-220 MHz) only

Mask B = Black Line
Mask D = Green Line

Narrow Span



Wide Span

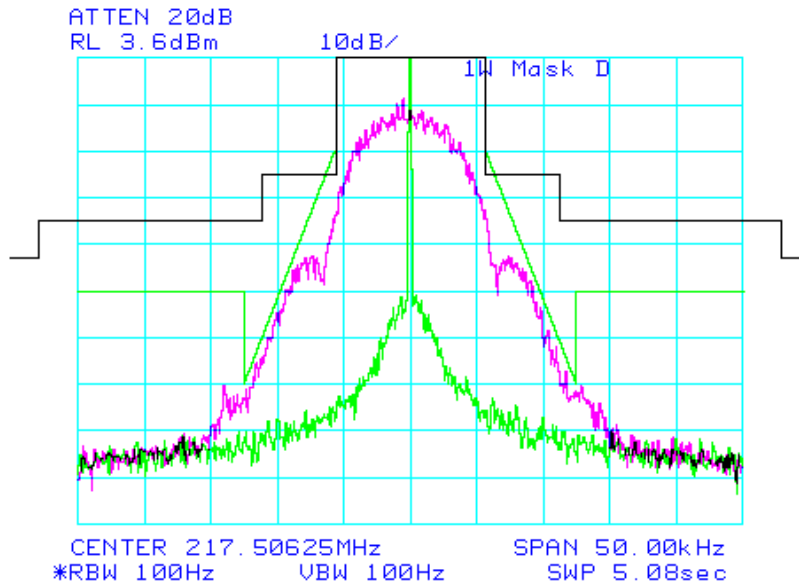


Mask: D, 1W
Output Power = 1 Watt

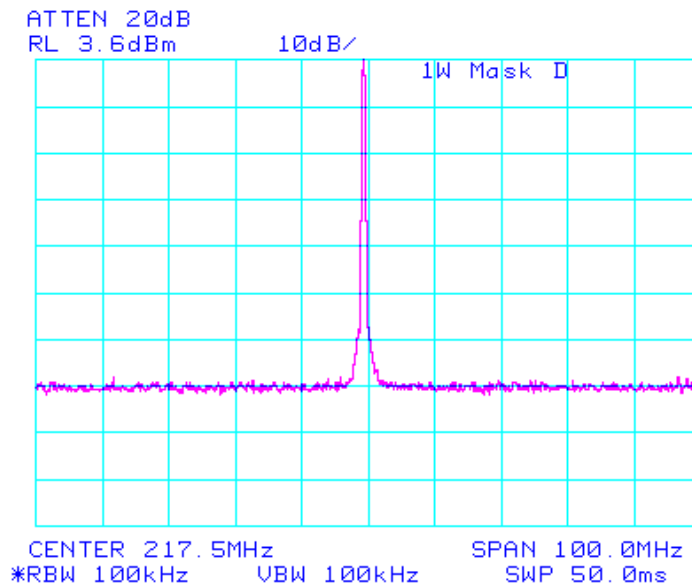
Spectrum for Emission: 9K35 F1D
Data Rate: 9600 bps Peak Deviation with Data: 2.76 kHz

Mask B = Black Line
Mask D = Green Line

Narrow Span

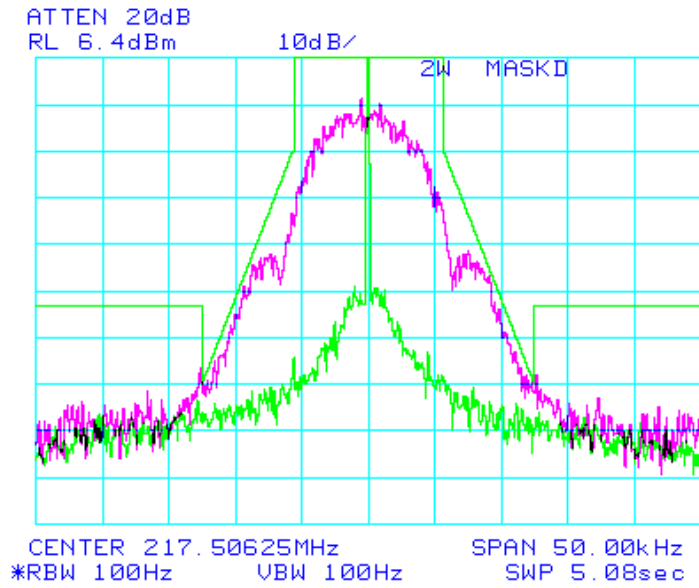


Wide Span



Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

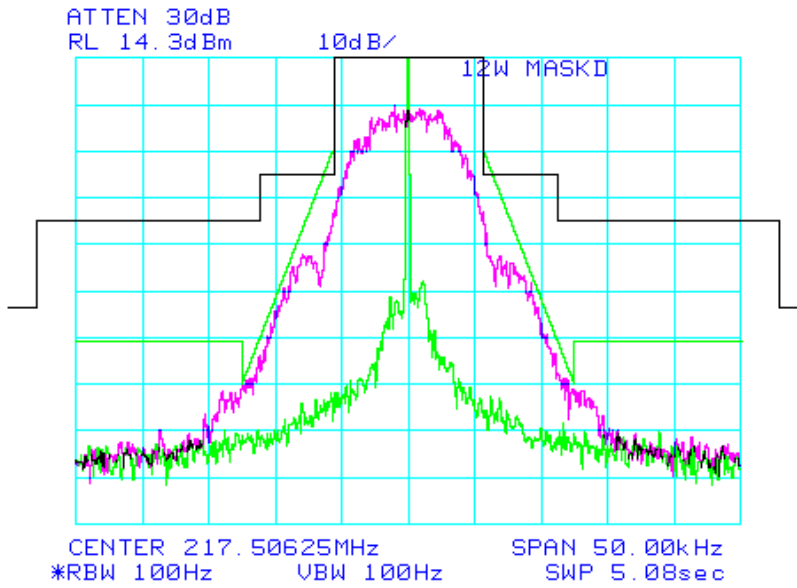
Mask B = Black Line
Mask D = Green Line



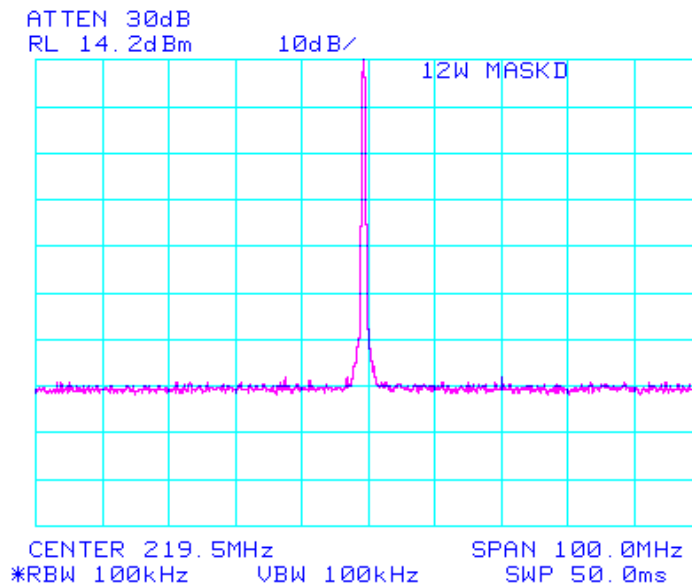
Output Power = 12 Watts
Applicable to Part 80 (216-220 MHz) only

Mask B = Black Line
Mask D = Green Line

Narrow Span



Wide Span



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **16K5F1D** and **16K8F1D**

RULE PART NUMBER: 2.202, 90.209 (b)(5), 90.210(c), 2.1049 (c)(1); 80.211 (f)
Note: All data taken at 12 watts is to be applied to Part 80 only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

MINIMUM STANDARDS: **Mask C**
Sidebands and Spurious [Rule 90.210 (c), P = 12 Watts and P=1 Watt]
Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5)]
From Fo to 5 kHz, down 0 dB.
Greater than 5 kHz to 10 kHz, down $83 * \log_{10}(f_d / 5)$ dB.
Greater than 10 kHz to 250% of authorized BW, at least $29 * \log_{10}(f_d^2 / 11)$ or 50 dB, whichever is the lesser attenuation
Greater than 250% of authorized BW, $43 + 10\log_{10}(P)$

Attenuation = 0 dB at Fo to 5 kHz
Attenuation = 25 dB at 10 kHz
Attenuation = 50 dB at 24.1 kHz
Attenuation = 50 dB at 50 kHz
Attenuation = 53.8 dB at frequencies greater than 50 kHz @ 12 W
Attenuation = 43 dB at frequencies greater than 50 kHz @ 1 W

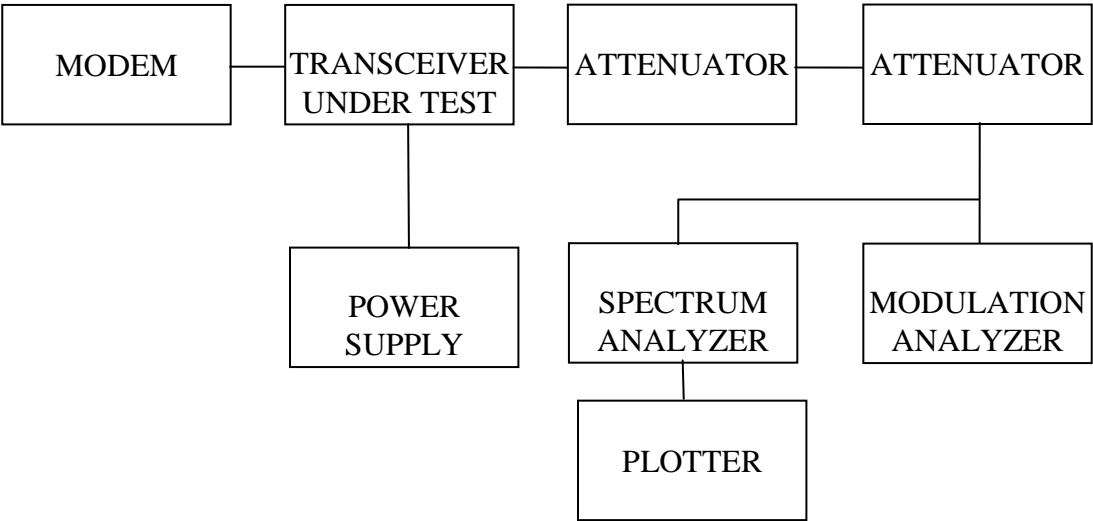
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 12 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits ZFSC-3-4 (5.5dB IL at UHF)
Power Supply, Instek Model GPS-3303
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

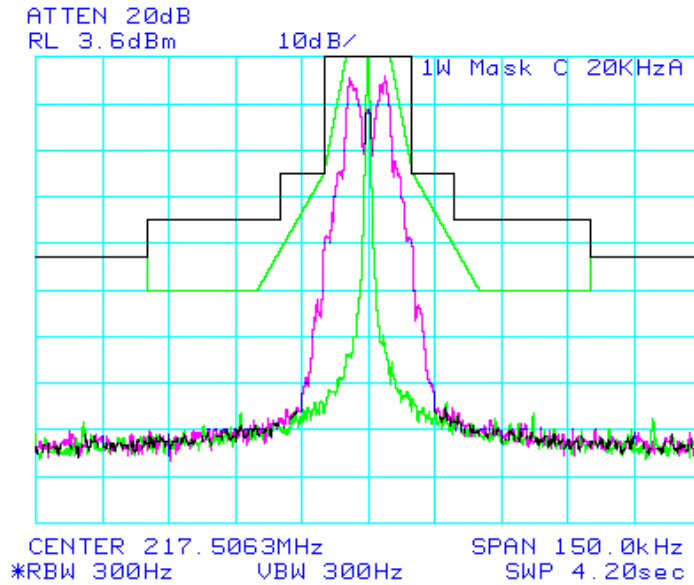


Mask: C, 1W
Output Power = 1 Watt

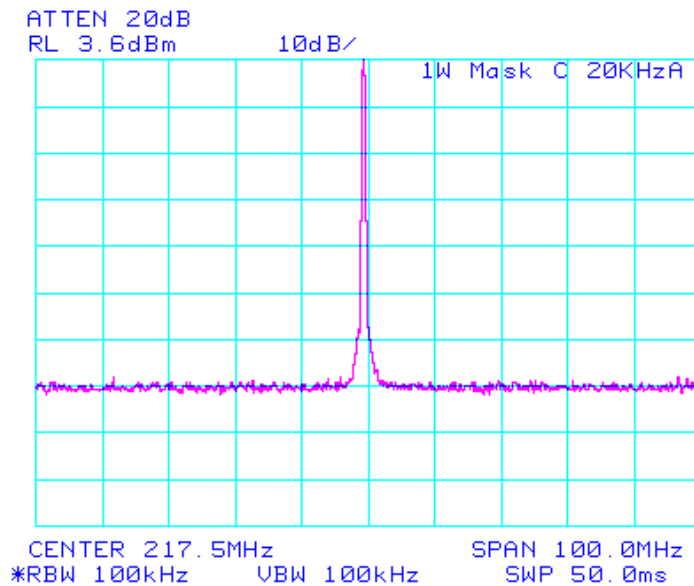
Spectrum for Emission: 11K6 F1D
Data Rate: 4800 bps Peak Deviation with Data: 4.43 kHz

Mask B = Black Line
Mask D = Green Line

Narrow Span

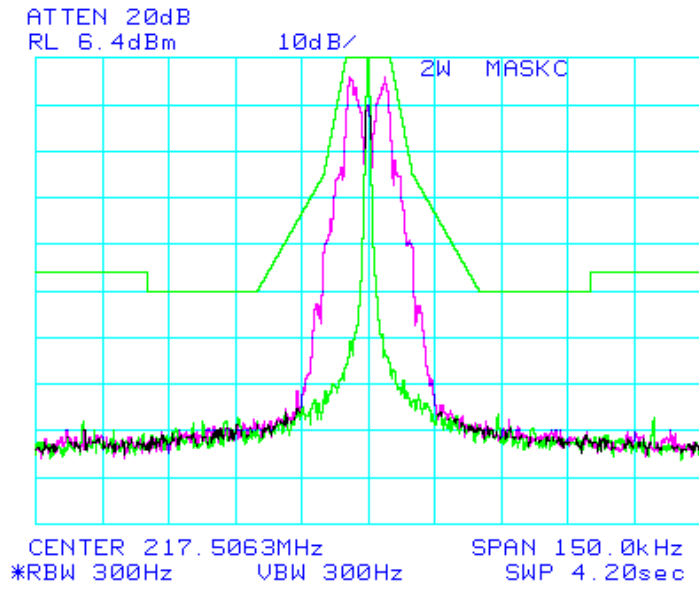


Wide Span



Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

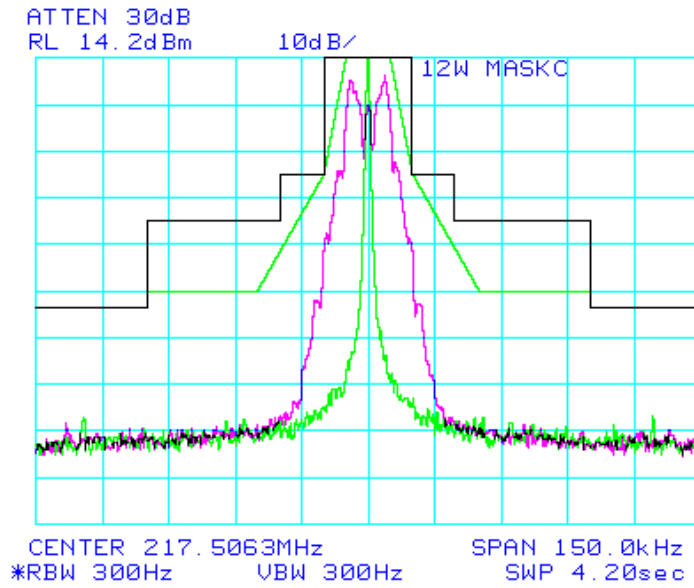
Mask B = Black Line
Mask D = Green Line



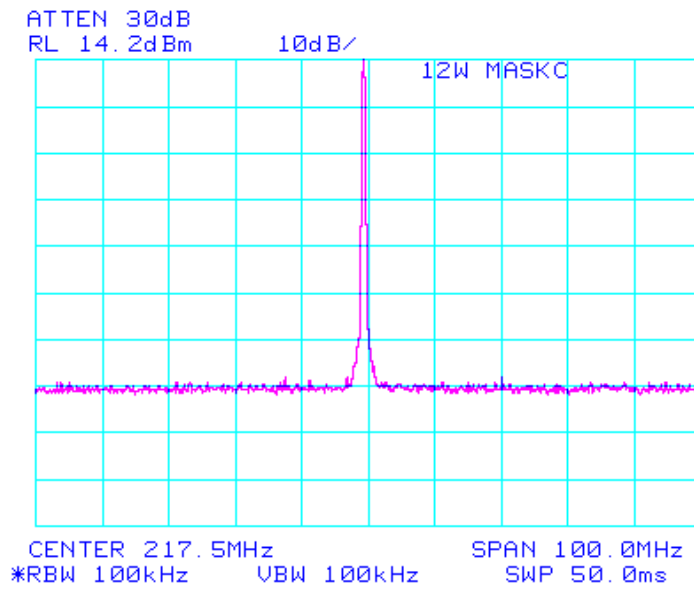
Output Power = 12 Watts
Applicable to Part 80 (216-220 MHz) only

Mask B = Black Line
Mask D = Green Line

Narrow Span



Wide Span

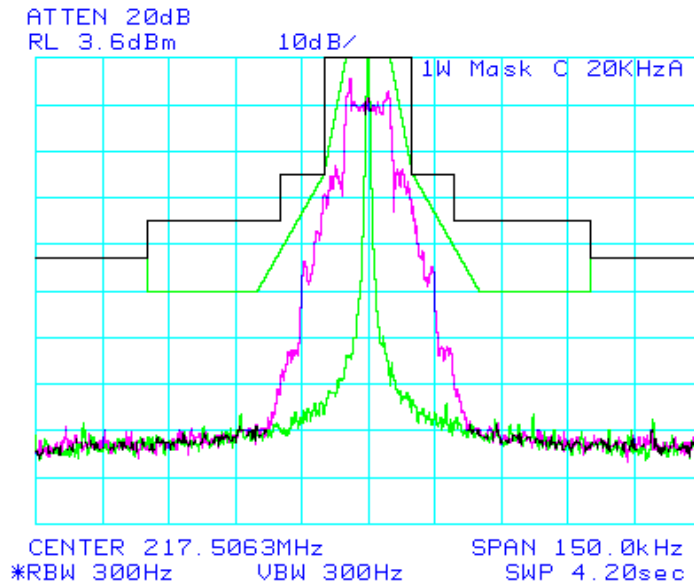


Mask: C, 1W
Output Power = 1 Watt

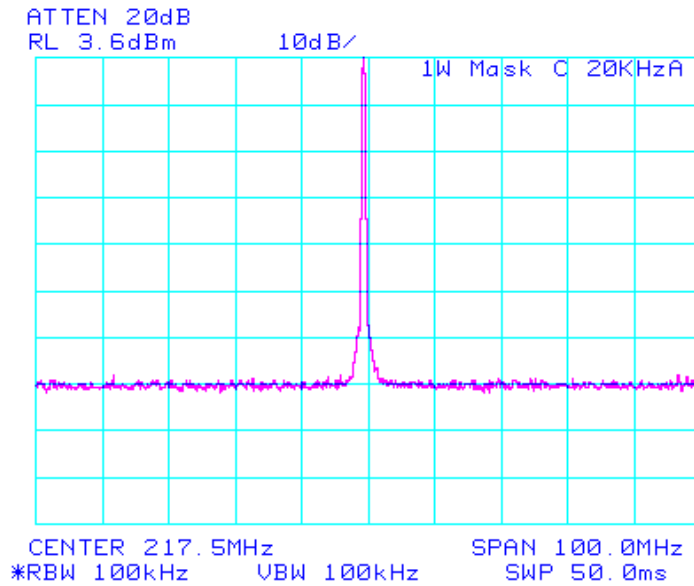
Spectrum for Emission: 14K6 F1D
Data Rate: 9600 bps Peak Deviation with Data: 4.40 kHz

Mask B = Black Line
Mask D = Green Line

Narrow Span

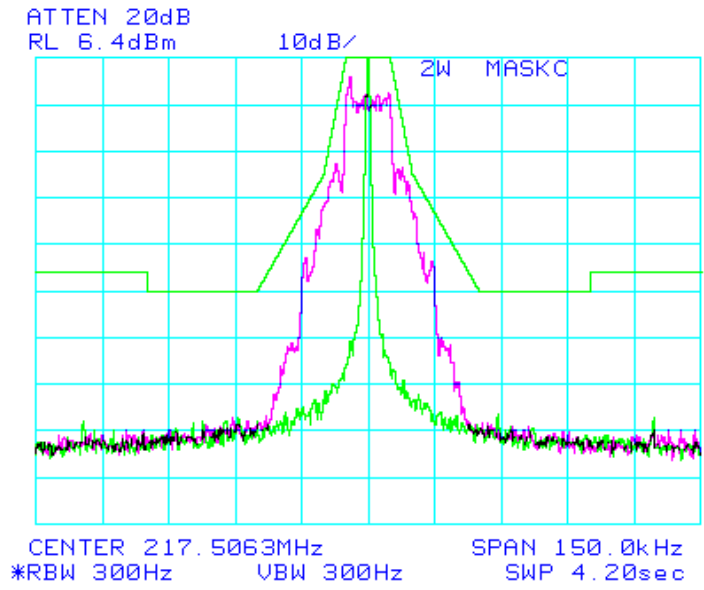


Wide Span



Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

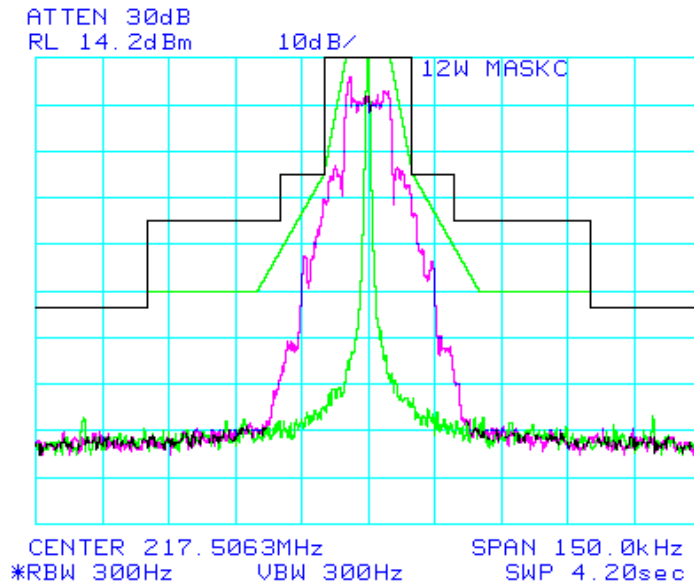
Mask B = Black Line
Mask D = Green Line



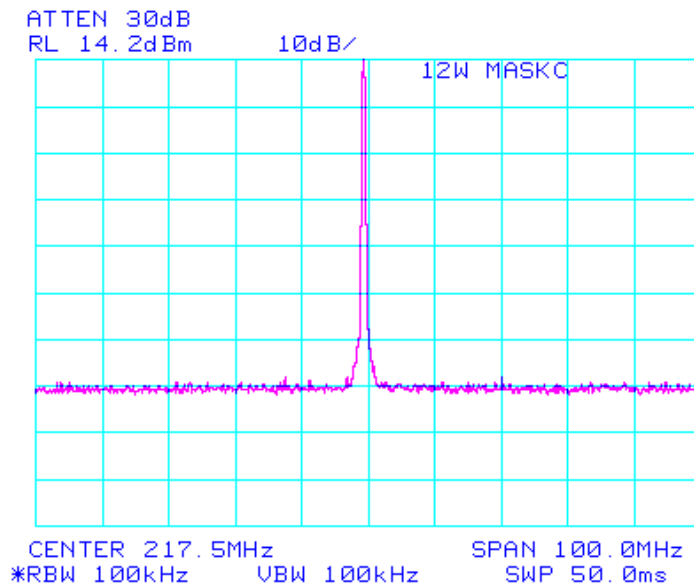
Output Power = 12 Watts
Applicable to Part 80 (216-220 MHz) only

Mask B = Black Line
Mask D = Green Line

Narrow Span



Wide Span

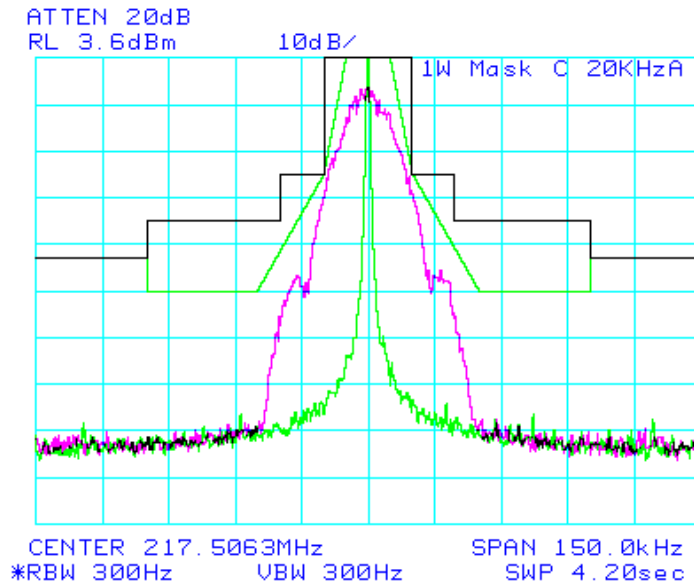


Mask: C, 1W
Output Power = 1 Watt

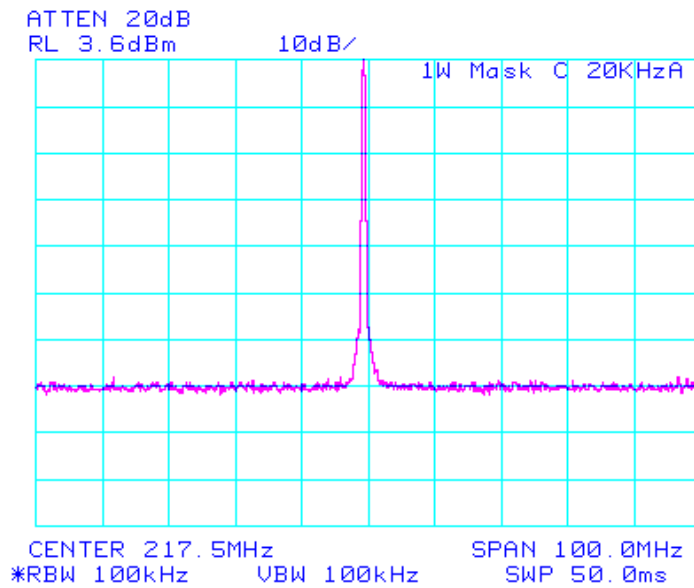
Spectrum for Emission: 16K4 F1D
Data Rate: 19200 bps Peak Deviation with Data: 4.30 kHz

Mask B = Black Line
Mask D = Green Line

Narrow Span

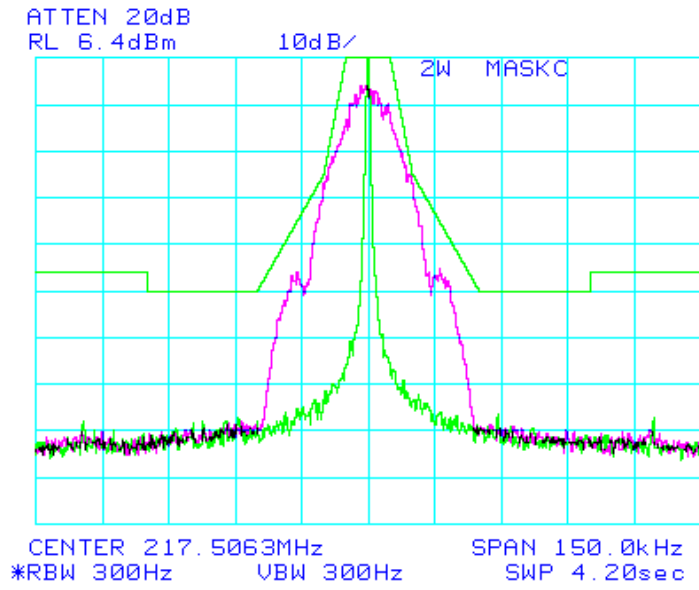


Wide Span



Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

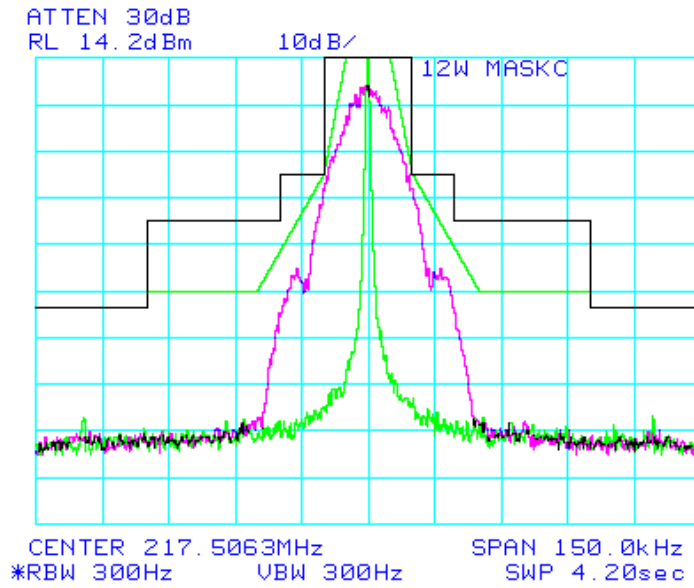
Mask B = Black Line
Mask D = Green Line



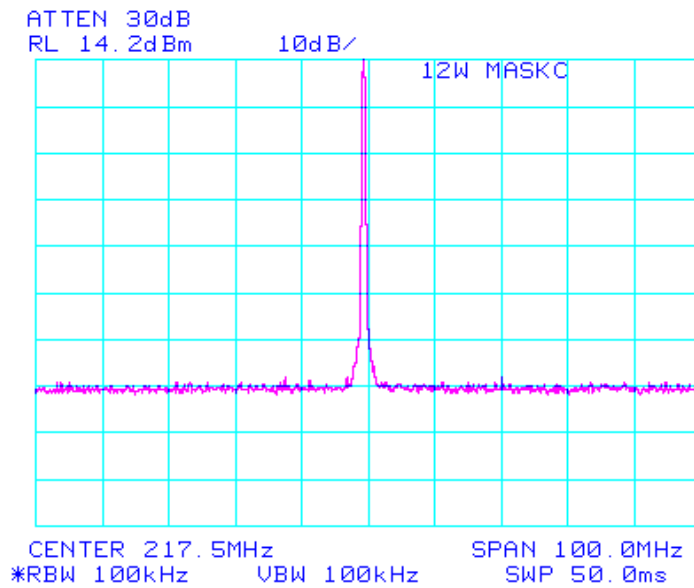
Output Power = 12 Watts
Applicable to Part 80 (216-220 MHz) only

Mask B = Black Line
Mask D = Green Line

Narrow Span



Wide Span



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **9K55F1D, 9K35F1D, 11K6F1D, 14K6F1D, 16K4F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(f), 2.1049 (c) (1)

MINIMUM STANDARDS: **Mask F**
 Sidebands and Spurious [Rule 90.210 (c), P = 12 Watts and P=1 Watt]
 Authorized Bandwidth = 5 kHz [Rule 90.209(b) (5)]

From Fo to 2 kHz, down 0 dB.
 Greater than 2 kHz to 3.75 kHz, down 30 + 20(fd -2) dB.
 On any frequency beyond 3.75 kHz removed from the center of the authorized bandwidth fd: At least 55 + 10 log (P) dB.

The equipment under test will not function inside a single channel in the 220 to 222MHz band. Therefore the EUT was tested using aggregate combinations of channels as follows:

9K55F1D	5 contiguous channels
9K35F1D	5 contiguous channels
11K6F1D	6 contiguous channels
14K6F1D	8 contiguous channels
16K4F1D	9 contiguous channels

For emission designators 9K55F1D, 9K35F1D
 Attenuation = 0 dB at Fo to 12 kHz
 Attenuation = 30 dB at 12 kHz
 Attenuation = 55 dB at 13.25 kHz @ 1W
 Attenuation = 65 dB at 13.75 kHz @ 12W

For emission designator 11K6F1D
 Attenuation = 0 dB at Fo to 14.5 kHz
 Attenuation = 30 dB at 12 kHz
 Attenuation = 55 dB at 15.75 kHz @ 1W
 Attenuation = 65 dB at 16.25 kHz @ 12W

For emission designator 14K6F1D
 Attenuation = 0 dB at Fo to 19.5 kHz
 Attenuation = 30 dB at 19.5 kHz
 Attenuation = 55 dB at 20.75 kHz @ 1W
 Attenuation = 65 dB at 21.25 kHz @ 12W

For emission designators 16K3F1D
 Attenuation = 0 dB at Fo to 22 kHz
 Attenuation = 30 dB at 22 kHz
 Attenuation = 55 dB at 23.25 kHz @ 1W
 Attenuation = 65 dB at 23.75 kHz @ 12W

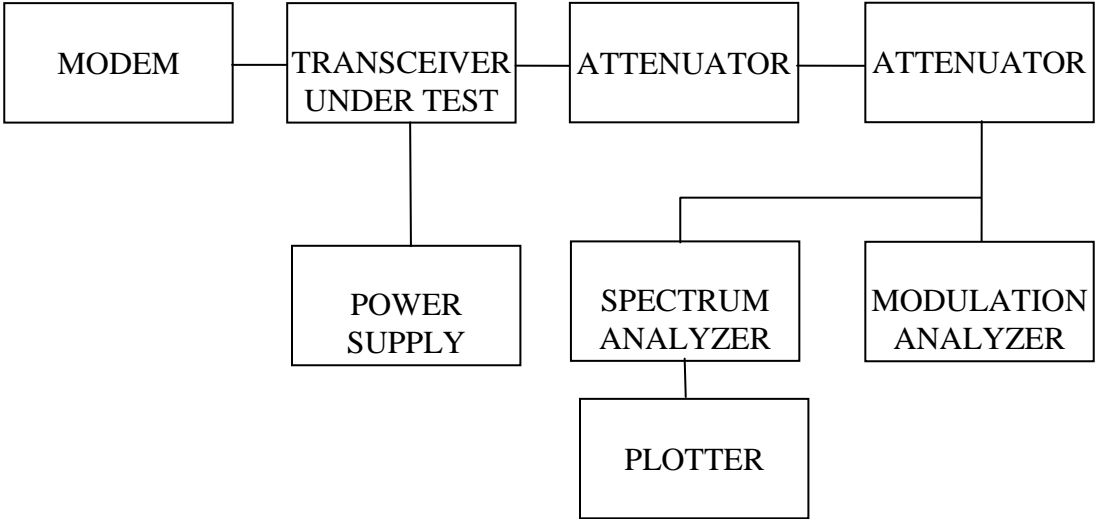
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
 RF Power Level = 1 Watt and 12 Watts
 Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C, 2.2.13, 3.2.11.2

TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
50-Ohm Attenuator, Pasternack Model PE7002-10 (10dB)
DC Power Supply, Hewlett Packard Model 6653A
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901B

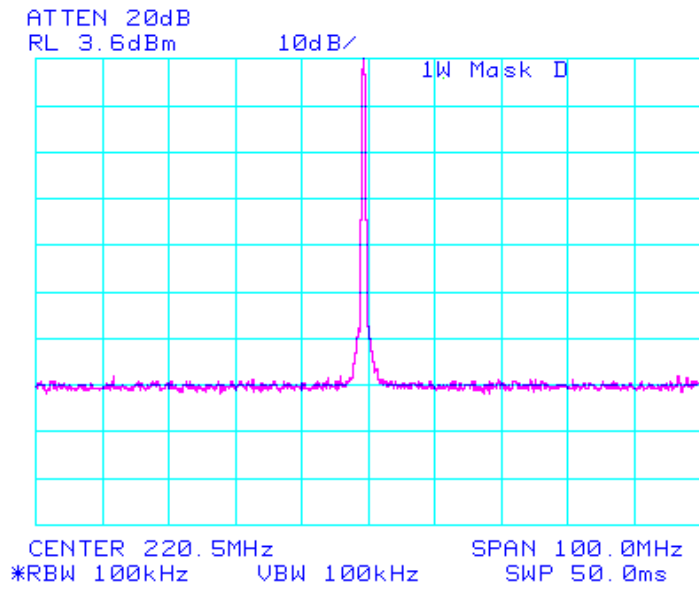
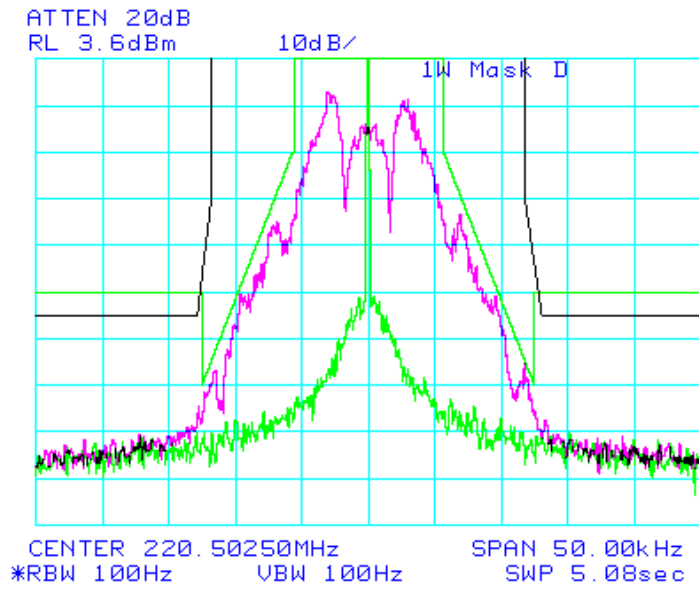
TEST SET-UP:



Mask: F (5 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 9K55 F1D
Data Rate: 4800 bps Peak Deviation with Data: 3.55 kHz

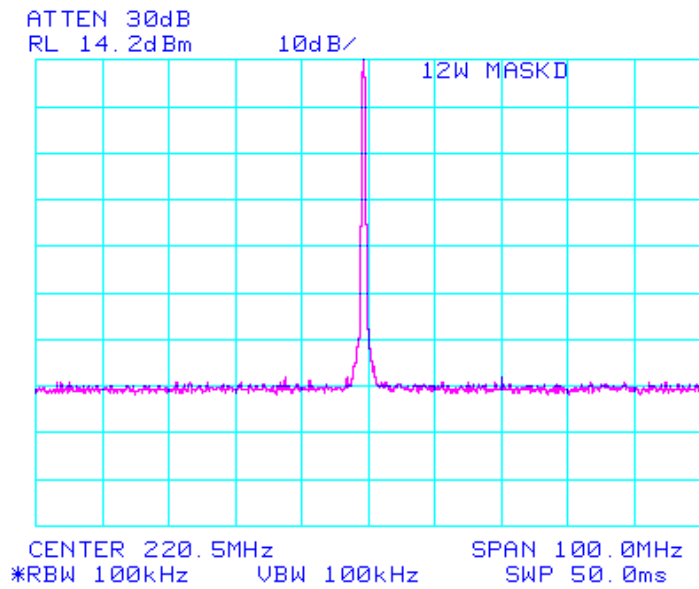
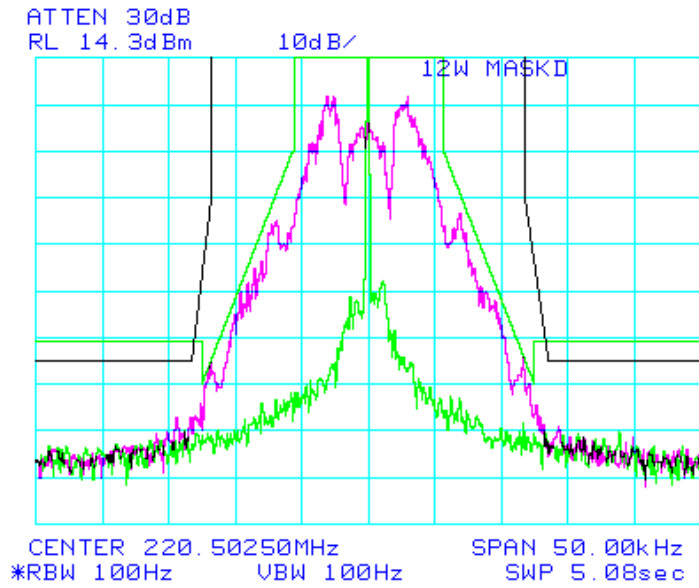
Mask F = Black Line



Mask: F (5 aggregate masks)
Output Power = 12 Watts

Spectrum for Emission: 9K55 F1D
Data Rate: 4800 bps Peak Deviation with Data: 3.55 kHz

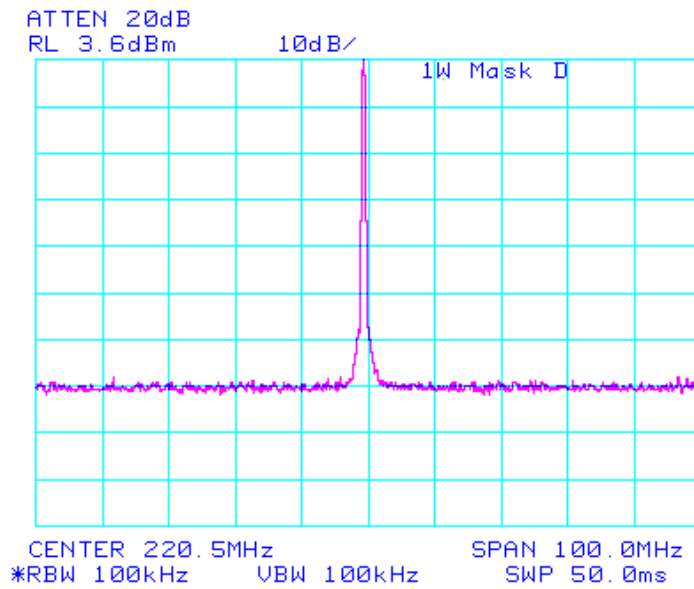
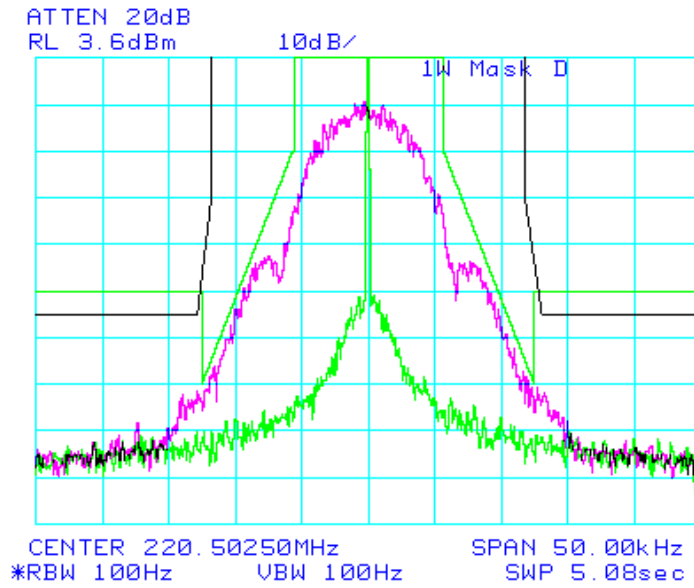
Mask F = Black Line



Mask: F (5 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 9K35 F1D
Data Rate: 9600 bps Peak Deviation with Data: 2.76 kHz

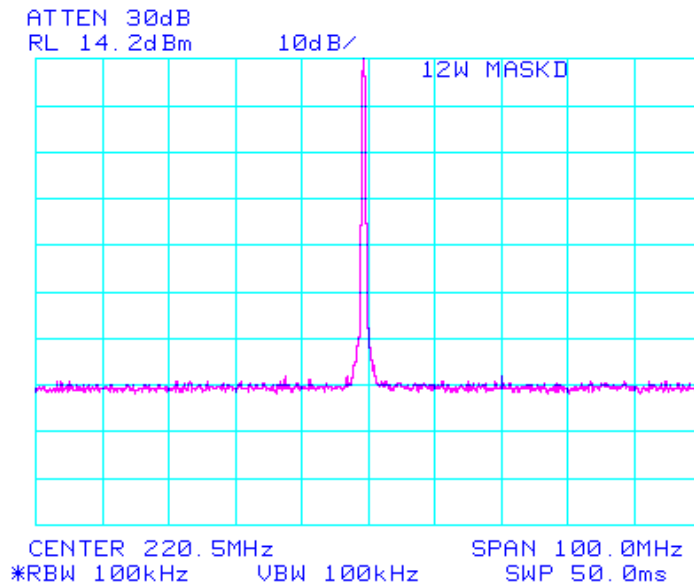
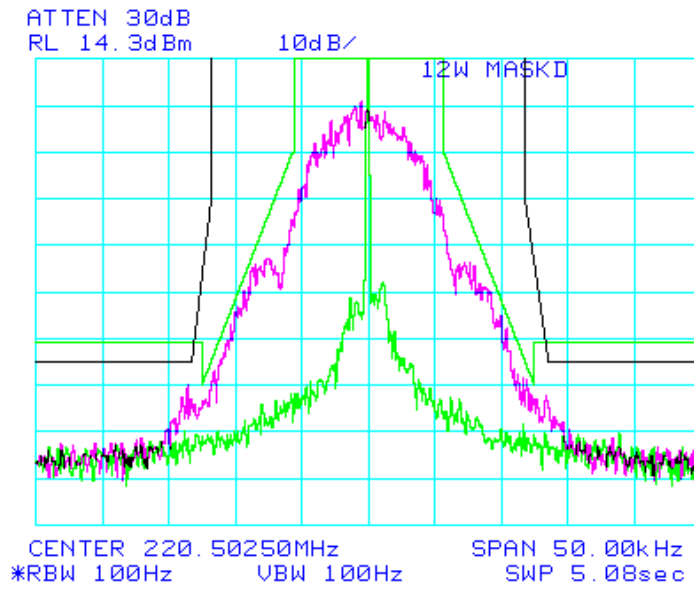
Mask F = Black Line



Mask: F (5 aggregate masks)
Output Power = 12 Watts

Spectrum for Emission: 9K35 F1D
Data Rate: 9600 bps Peak Deviation with Data: 2.76 kHz

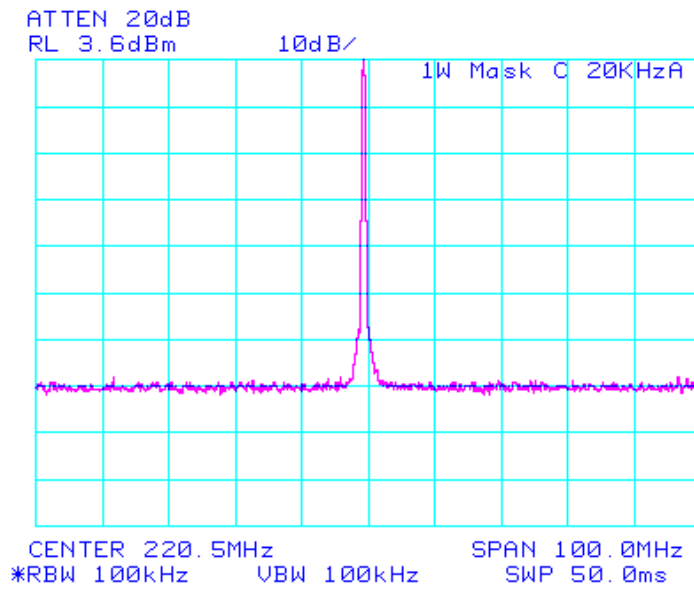
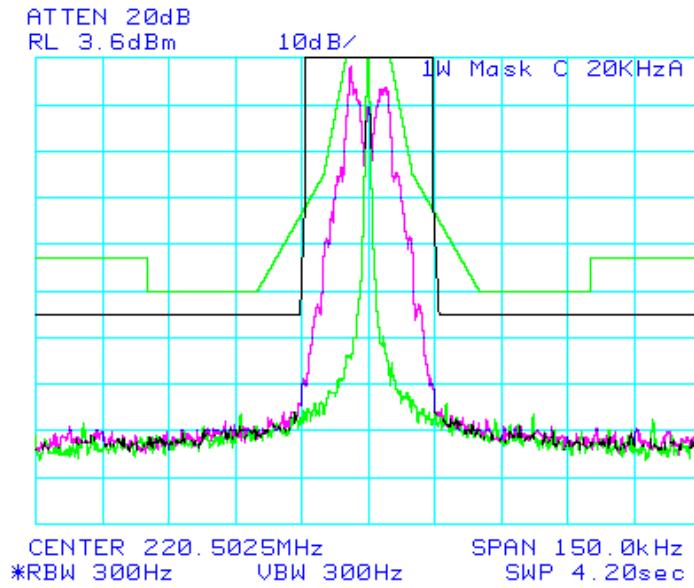
Mask F = Black Line



Mask: F (6 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 11K6 F1D
Data Rate: 4800 bps Peak Deviation with Data: 4.43 kHz

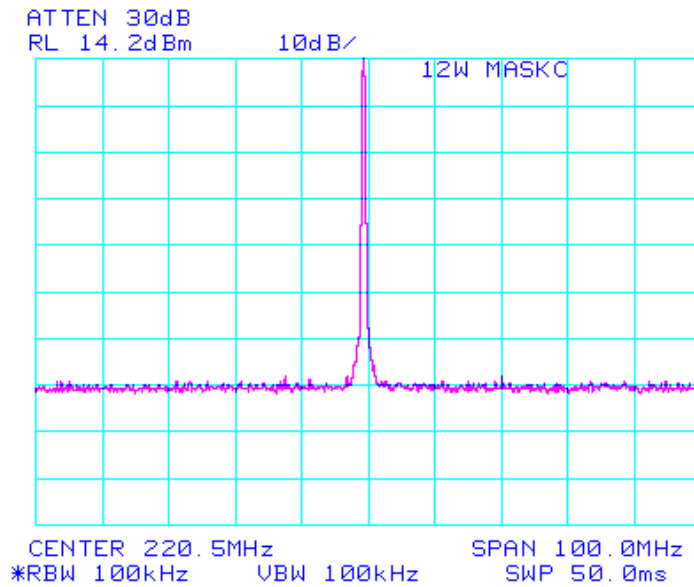
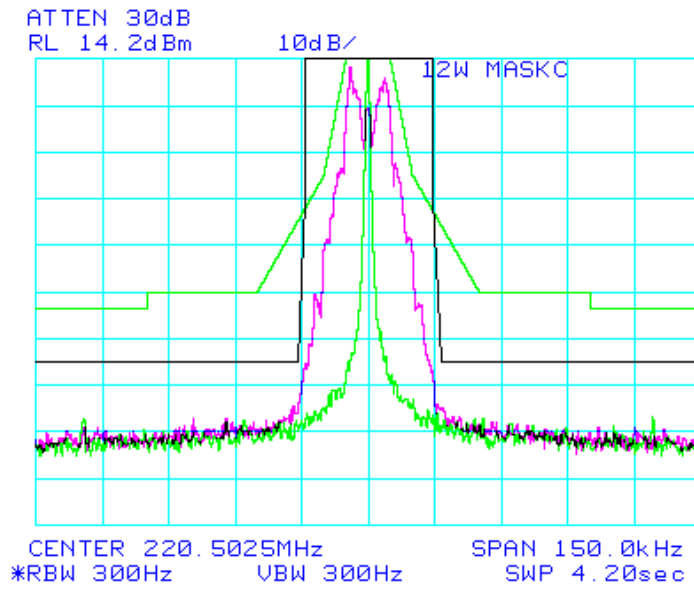
Mask F = Black Line



Mask: F (6 aggregate masks)
Output Power = 12 Watts

Spectrum for Emission: 11K6 F1D
Data Rate: 4800 bps Peak Deviation with Data: 4.43 kHz

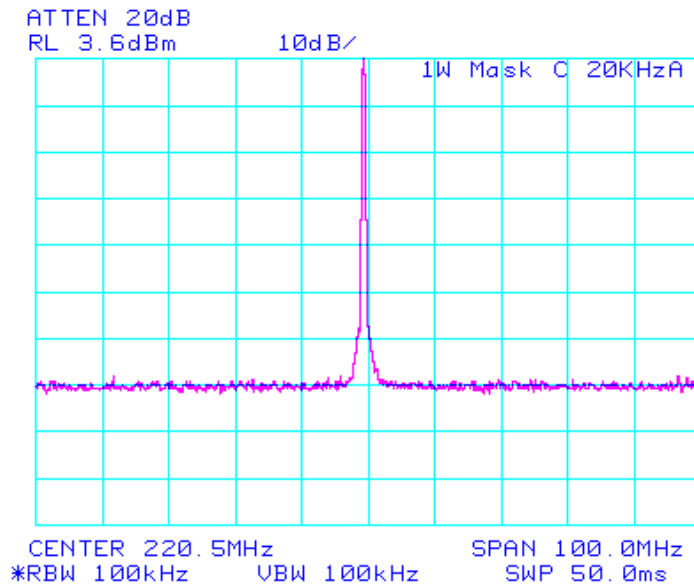
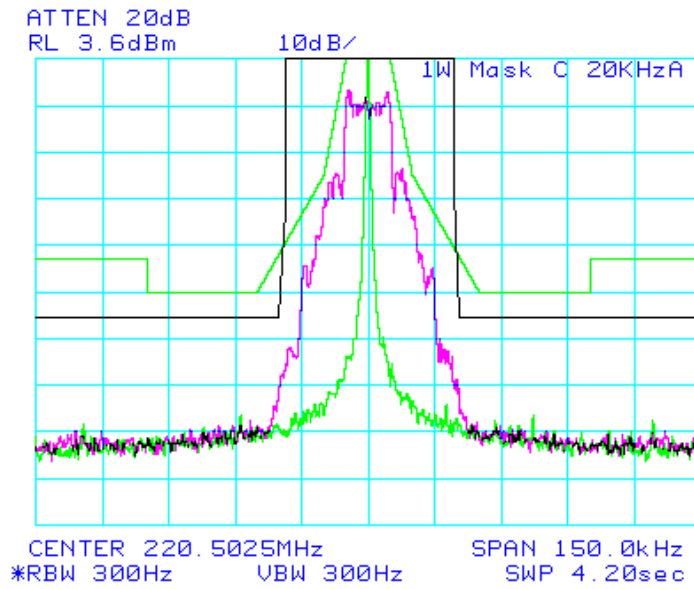
Mask F = Black Line



Mask: F (8 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 14K6 F1D
Data Rate: 9600 bps Peak Deviation with Data: 4.40 kHz

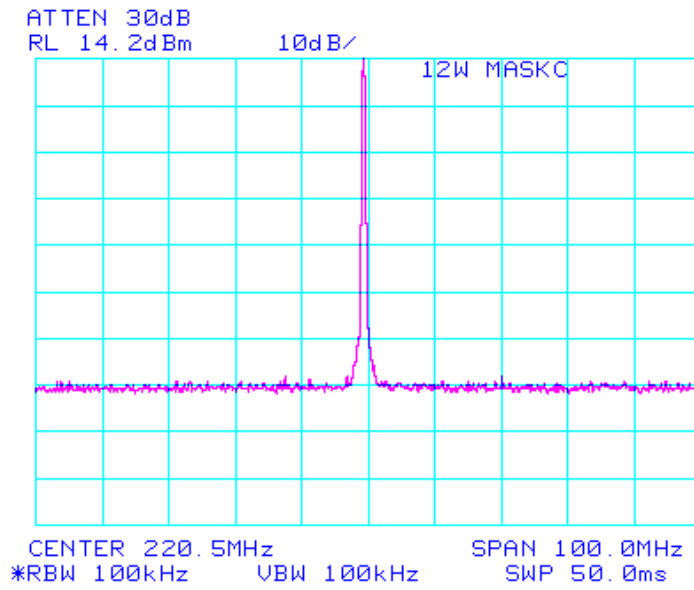
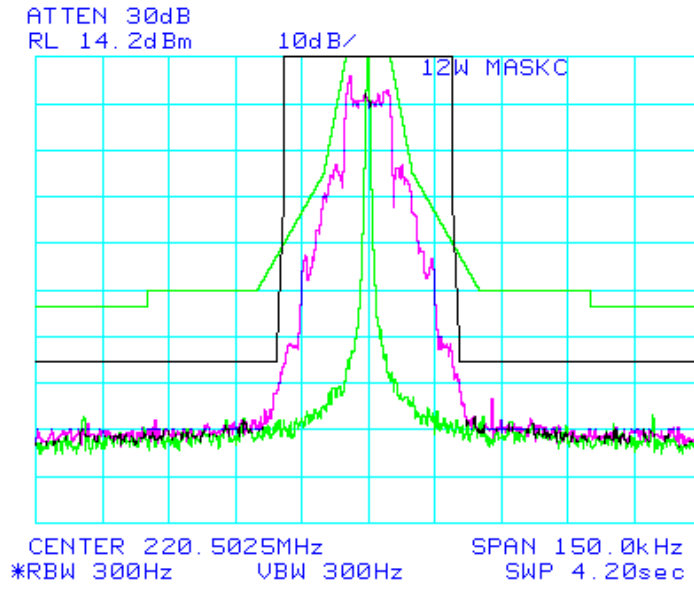
Mask F = Black Line



Mask: F (8 aggregate masks)
Output Power = 12 Watts

Spectrum for Emission: 14K6 F1D
Data Rate: 9600 bps Peak Deviation with Data: 4.40 kHz

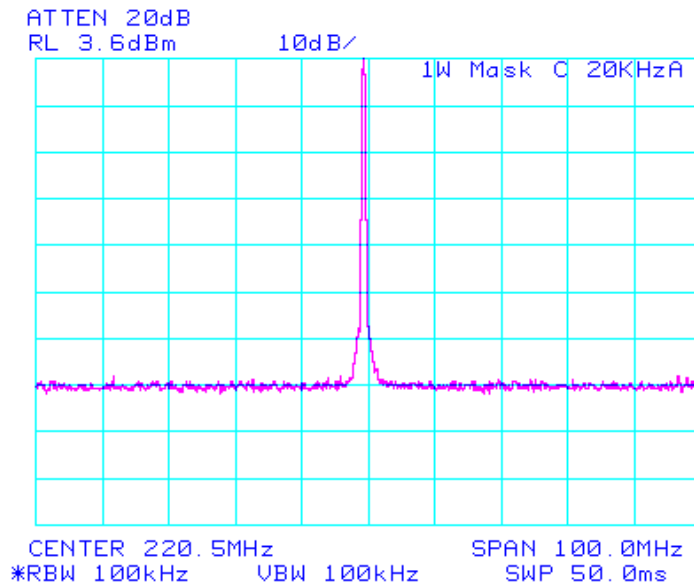
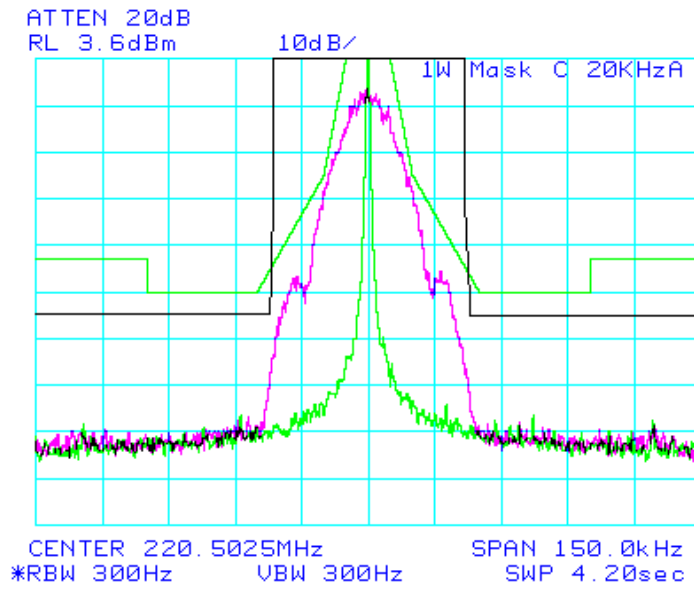
Mask F = Black Line



Mask: F (9 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 16K4 F1D
Data Rate: 19200 bps Peak Deviation with Data: 4.30 kHz

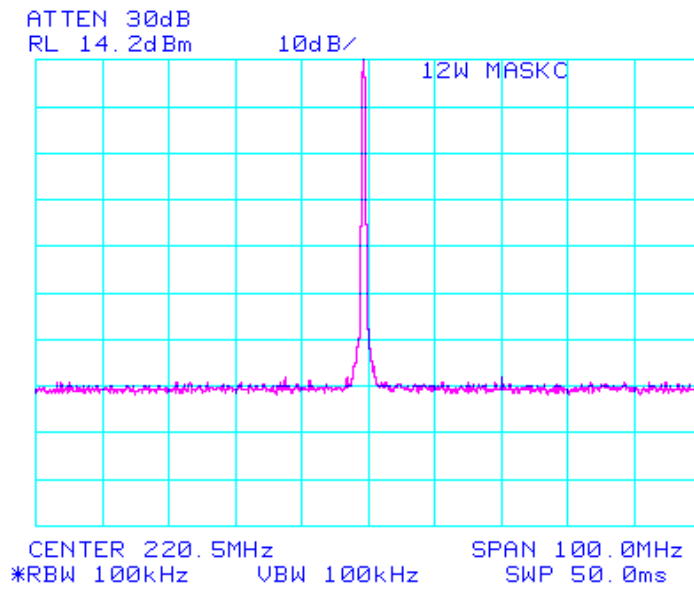
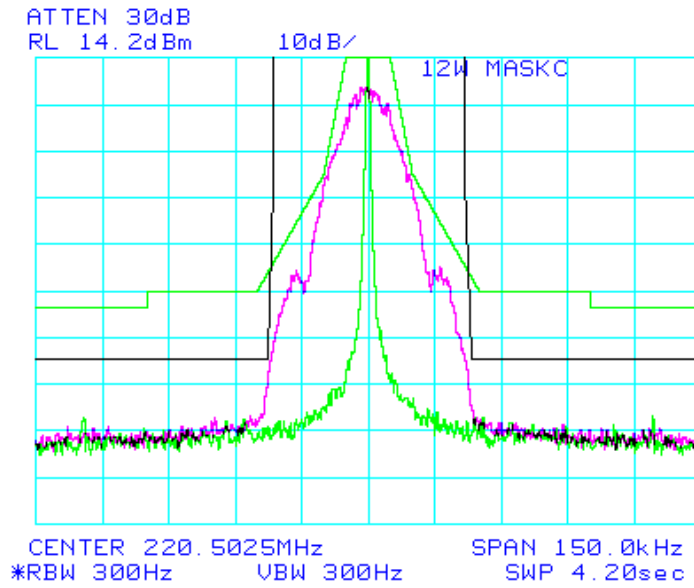
Mask F = Black Line



Mask: F (9 aggregate masks)
Output Power = 12 Watts

Spectrum for Emission: 16K4 F1D
Data Rate: 19200 bps Peak Deviation with Data: 4.30 kHz

Mask F = Black Line



NAME OF TEST: Field Strength of Spurious Radiation

RULE PART NUMBER: 2.1053, 90.210 (c,3)(d,3); 80.211 (f)
 Note: All data taken at 12 watts is to be applied to Part 80 and Part 90 (220-222 MHz) only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

MINIMUM STANDARDS: For 12 Watts: $55+10\text{Log}_{10}(12 \text{ Watts}) = -65.8 \text{ dBc}$
 or -70 dBc , whichever is the lesser attenuation.

For 2 Watts: $55+10\text{Log}_{10}(2 \text{ Watts}) = -58.0 \text{ dBc}$
 or -65 dBc , whichever is the lesser attenuation.

For 1 Watt: $55+10\text{Log}_{10}(1 \text{ Watt}) = -55 \text{ dBc}$
 or -70 dBc , whichever is the lesser attenuation.

TEST RESULTS: Meets minimum standards (see data on following page)

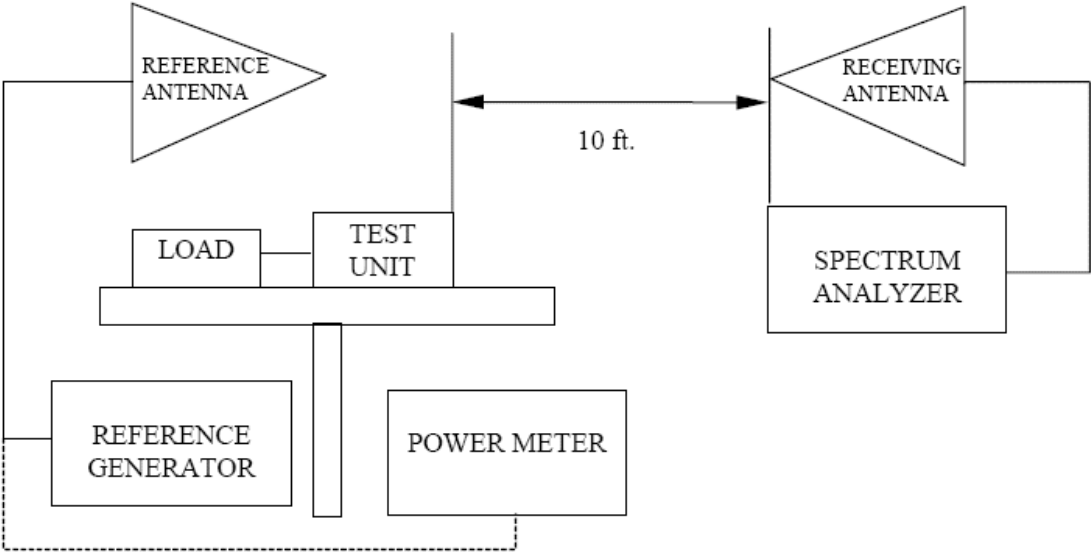
TEST CONDITIONS: Standard Test Conditions, 25 C
 RF Power Level = 1 Watt and 12 Watts
 Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

TEST EQUIPMENT: Waveguide Horn Antenna, EMCO Model 3115
 Waveguide Horn Antenna, Electro-Metrics EM-6961
 Bilog Antenna, Chase Model CBL6111B
 Dipole Antenna, Electro-Metrics Model EM-6924
 Power Supply, Model Instek GPS-3303
 Spectrum Analyzer, Model HP-8563E
 Reference Generator, Agilent Model E82570
 Power Meter, Model HP436A
 50-Ohm Attenuator, Bird Electronics 50-A-FFN-20 (20dB, 50W)
 50-Ohm Load, Lucas Weinschel 58-30-43

MEASUREMENT PROCEDURE: Radiated spurious attenuation was measured according to TIA/EIA Standard 603-C

TEST SET-UP:



Applicable to Part 80 (216-220 MHz) only
Half Duplex

Frequency:	218.025	MHz	Spec =	dBc	dBm
			Highest	-65.8	-25.0
Power:	12	Watts	Spur =	-90.5	-49.7
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation (dBc)	Spurious Attenuation (dBm)
436.05	H	-100.5	-74.3	-1.67	-0.53	-114.0	-73.2
	V	-92.8	-58.8	-1.67	-0.53	-98.5	-57.7
654.075	H	-110.7	-80.4	-1.83	-0.54	-119.9	-79.1
	V	-110.5	-73.2	-1.83	-0.54	-112.7	-71.9
872.1	H	-108.7	-72.0	-2.50	-0.46	-110.8	-70.0
	V	-105.0	-67.0	-2.50	-0.46	-105.8	-65.0
1090.125	H	-98.2	-62.3	-2.67	3.11	-97.4	-56.6
	V	-95.0	-59.0	-2.67	3.11	-94.0	-53.2
1308.15	H	-104.8	-68.3	-3.00	3.98	-102.1	-61.3
	V	-104.5	-64.5	-3.00	3.98	-98.3	-57.5
1526.175	H	-103.8	-64.3	-3.17	4.76	-97.2	-56.4
	V	-104.2	-63.2	-3.17	4.76	-96.1	-55.3
1744.2	H	-104.5	-63.2	-3.33	4.85	-95.8	-55.0
	V	-104.8	-64.0	-3.33	4.85	-96.6	-55.8
1962.225	H	-103.8	-61.5	-3.83	4.93	-93.5	-52.7
	V	-105.0	-63.5	-3.83	4.93	-95.5	-54.7
2180.25	H	-103.7	-60.0	-4.50	5.17	-91.2	-50.4
	V	-103.2	-59.4	-4.50	5.17	-90.5	-49.7

Frequency: 218.025 MHz Spec = dBc dBm
 Power: 1 Watts Highest -55.0 -25.0
 30.0 dBm Spur = -79.7 -49.7

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation (dBc)	Spurious Attenuation (dBm)
436.05	H	-102.3	-76.1	-1.67	-0.53	-105.0	-75.0
	V	-95.8	-61.8	-1.67	-0.53	-90.7	-60.7
654.075	H	-111.5	-81.2	-1.83	-0.54	-109.9	-79.9
	V	-109.8	-72.5	-1.83	-0.54	-101.2	-71.2
872.1	H	-110.2	-73.5	-2.50	1.70	-99.3	-69.3
	V	-107.7	-69.7	-2.50	1.70	-95.5	-65.5
1090.125	H	-102.0	-66.2	-2.67	3.11	-90.4	-60.4
	V	-103.5	-67.5	-2.67	3.11	-91.7	-61.7
1308.15	H	-104.8	-68.3	-3.00	3.98	-91.3	-61.3
	V	-104.5	-64.5	-3.00	3.98	-87.5	-57.5
1526.175	H	-103.8	-64.3	-3.17	4.76	-86.4	-56.4
	V	-104.2	-63.2	-3.17	4.76	-85.3	-55.3
1744.2	H	-104.5	-63.2	-3.33	4.85	-85.0	-55.0
	V	-104.8	-64.0	-3.33	4.85	-85.8	-55.8
1962.225	H	-103.8	-61.5	-3.83	4.93	-82.7	-52.7
	V	-105.0	-63.5	-3.83	4.93	-84.7	-54.7
2180.25	H	-103.7	-60.0	-4.50	5.17	-80.4	-50.4
	V	-103.2	-59.4	-4.50	5.17	-79.7	-49.7

Applicable to Part 90 (217-220 MHz)
Half Duplex Radio

Frequency:	218.025 MHz	Spec =	dBc	dBm
			-58.0	-25.0
Power:	2 Watts	Highest Spur =		
			-77.6	-44.6
	33.0 dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc	Spurious Attenuation dBc
436.05	H	-99.6	-73.5	-1.67	-0.53	-105.3	-72.3
	V	-99.1	-65.1	-1.67	-0.53	-97.0	-64.0
654.075	H	-106.0	-75.7	-1.83	-0.54	-107.4	-74.4
	V	-107.0	-69.7	-1.83	-0.54	-101.4	-68.4
872.1	H	-96.8	-60.1	-2.50	1.70	-88.9	-55.9
	V	-97.1	-59.1	-2.50	1.70	-87.9	-54.9
1090.125	H	-102.3	-66.5	-2.67	3.11	-93.7	-60.7
	V	-103.5	-67.5	-2.67	3.11	-94.7	-61.7
1308.15	H	-99.0	-62.5	-3.00	3.98	-88.5	-55.5
	V	-101.0	-61.0	-3.00	3.98	-87.0	-54.0
1526.175	H	-108.3	-68.8	-3.17	4.76	-93.9	-60.9
	V	-109.5	-68.5	-3.17	4.76	-93.6	-60.6
1744.2	H	-105.3	-64.0	-3.33	4.85	-88.8	-55.8
	V	-93.6	-52.8	-3.33	4.85	-77.6	-44.6
1962.225	H	-105.1	-62.8	-3.83	4.93	-87.0	-54.0
	V	-106.1	-64.6	-3.83	4.93	-88.9	-55.9
2180.25	H	-109.1	-65.4	-4.50	5.17	-88.8	-55.8
	V	-106.5	-62.7	-4.50	5.17	-86.0	-53.0

Applicable to Part 80 (216-220 MHz) only
Full Duplex

Frequency:	219.025	MHz	Spec =	dBc	dBm
			Highest	-65.8	-25.0
Power:	12	Watts	Spur =	-99.8	-59.0
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation (dBc)	Spurious Attenuation (dBm)
438.05	H	-99.7	-73.7	-1.50	-0.53	-113.5	-72.7
	V	-91.0	-60.0	-1.50	-0.53	-99.8	-59.0
657.075	H	-107.3	-76.6	-2.00	-0.51	-115.9	-75.1
	V	-105.3	-68.3	-2.00	-0.51	-107.6	-66.8
876.1	H	-116.0	-80.0	-2.50	-0.46	-118.8	-78.0
	V	-115.0	-75.0	-2.50	-0.46	-113.8	-73.0
1095.125	H	-116.0	-78.5	-2.67	3.11	-113.5	-72.7
	V	-115.0	-78.0	-2.67	3.11	-113.0	-72.2
1314.15	H	-116.0	-79.3	-3.17	3.98	-113.0	-72.2
	V	-116.0	-76.3	-3.17	3.98	-110.0	-69.2
1533.175	H	-115.0	-76.0	-3.17	4.76	-108.9	-68.1
	V	-116.0	-75.2	-3.17	4.76	-108.0	-67.2
1752.2	H	-113.0	-71.5	-3.50	4.85	-103.9	-63.2
	V	-115.0	-73.5	-3.50	4.85	-105.9	-65.2
1971.225	H	-113.0	-71.0	-3.83	4.93	-103.0	-62.2
	V	-114.0	-72.7	-3.83	4.93	-104.7	-63.9
2190.25	H	-116.0	-72.0	-4.17	5.17	-103.5	-62.7
	V	-116.0	-72.5	-4.17	5.17	-104.0	-63.2

Frequency: 219.025 MHz Spec = dBc dBc
 Highest -55.0 -25.0
 Power: 1 Watts Spur = -92.2 -62.2
 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation (dBc)	Spurious Attenuation (dBm)
438.05	H	-107.2	-81.2	-1.50	-0.53	-110.2	-80.2
	V	-101.7	-70.7	-1.50	-0.53	-99.7	-69.7
657.075	H	-116.0	-85.3	-2.00	-0.51	-113.8	-83.8
	V	-116.0	-79.0	-2.00	-0.51	-107.5	-77.5
876.1	H	-116.0	-80.0	-2.50	-0.46	-108.0	-78.0
	V	-116.0	-76.0	-2.50	-0.46	-104.0	-74.0
1095.125	H	-116.0	-78.5	-2.67	3.11	-102.7	-72.7
	V	-115.0	-78.0	-2.67	3.11	-102.2	-72.2
1314.15	H	-116.0	-79.3	-3.17	3.98	-102.2	-72.2
	V	-116.0	-76.3	-3.17	3.98	-99.2	-69.2
1533.175	H	-115.0	-76.0	-3.17	4.76	-98.1	-68.1
	V	-116.0	-75.2	-3.17	4.76	-97.2	-67.2
1752.2	H	-113.0	-71.5	-3.50	4.85	-93.2	-63.2
	V	-115.0	-73.5	-3.50	4.85	-95.2	-65.2
1971.225	H	-113.0	-71.0	-3.83	4.93	-92.2	-62.2
	V	-114.0	-72.7	-3.83	4.93	-93.9	-63.9
2190.25	H	-116.0	-72.0	-4.17	5.17	-92.7	-62.7
	V	-116.0	-72.5	-4.17	5.17	-93.2	-63.2

Applicable to Part 90 (220-222 MHz) only
Half Duplex

Frequency:	221.025	MHz	Spec =	dBc	dBm
			Highest	-65.8	-25.0
Power:	12	Watts	Spur =	-88.5	-47.7
	40.8	dBm			

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation (dBc)	Spurious Attenuation (dBm)
442.05	H	-100.7	-74.7	-1.50	-0.53	-114.5	-73.7
	V	-93.0	-62.0	-1.50	-0.53	-101.8	-61.0
663.075	H	-108.3	-77.6	-2.00	-0.51	-116.9	-76.1
	V	-110.2	-73.2	-2.00	-0.51	-112.5	-71.7
884.1	H	-91.0	-55.0	-2.50	-0.46	-93.8	-53.0
	V	-95.3	-55.3	-2.50	-0.46	-94.1	-53.3
1105.125	H	-91.0	-53.5	-2.67	3.11	-88.5	-47.7
	V	-91.2	-54.2	-2.67	3.11	-89.2	-48.4
1326.15	H	-103.8	-67.1	-3.17	3.98	-100.8	-60.0
	V	-105.5	-65.8	-3.17	3.98	-99.5	-58.7
1547.175	H	-104.7	-65.7	-3.17	4.76	-98.6	-57.8
	V	-104.2	-63.4	-3.17	4.76	-96.2	-55.4
1768.2	H	-105.3	-63.8	-3.50	4.85	-96.2	-55.5
	V	-103.2	-61.7	-3.50	4.85	-94.1	-53.4
1989.225	H	-104.3	-62.3	-3.83	4.93	-94.3	-53.5
	V	-104.5	-63.2	-3.83	4.93	-95.2	-54.4
2210.25	H	-104.2	-60.2	-4.17	5.17	-91.7	-50.9
	V	-104.7	-61.2	-4.17	5.17	-92.7	-51.9

Equipment Calibration Information

Equipment	Serial Number	Cal Date	Cal Due
HP 8563E Spectrum Analyzer	3221A00149	4/15/2010	4/15/2012
Agilent E8257D Signal Generator	MY44320507	4/20/2010	4/20/2012
HP 8901A Modulation Analyzer	2950A05551	4/12/2010	4/12/2012
Advantest R3162	111000901	7/24/2009	7/24/2011
HP 437B Power Meter	3125U13882	4/12/2010	4/12/2012

Instruments have been calibrated using standards with accuracies traceable to NIST standards.

Part 90.729

It is the responsibility of the professional installer to ensure that the Effective Radiated Power (ERP) does not exceed the limitations set forth by the FCC in the table listed below for transmitting on frequencies in the 220-221 MHz band.

ERP VS. ANTENNA HEIGHT TABLE

Antenna height above average terrain (HAAT), (Meters)	Effective Radiated power, (watts)
Up to 150	500
150 to 225	250
225 to 300	125
300 to 450	60
450 to 600	30
600 to 750	20
750 to 900	15
900 to 1050	10
Above 1050	5