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FCC Part 80/90 Certification Application

FCC Form 731

For The

**Viper 200
VHF RADIO MODEM**

FCC ID: NP4-5028-502

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NAME OF TEST: Transmitter Rated Power Output

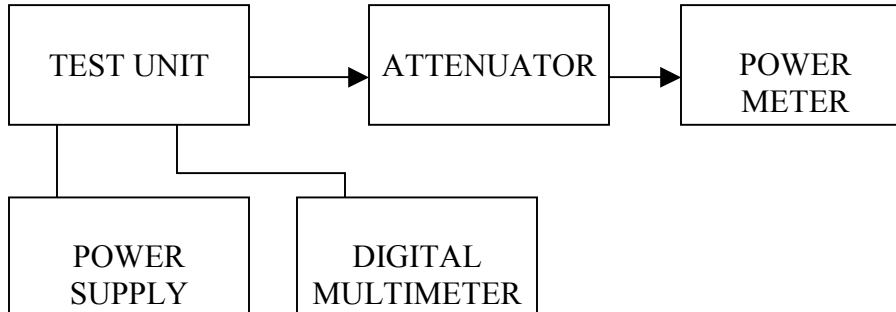
RULE PART NUMBER: FCC: 2.1046 (a) (c), 80.215
 IC: RSS-119 5.4
 Note: All data taken at 12 watts is to be applied to Part 80 and Part 90 (220-222 MHz) only. Data taken at 2 watts is to be applied to Part 90 (217-220 MHz).

TEST RESULTS: See results below

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: 50-Ohm Atten, Bird Electronics Model 50-A-MFN-20 (20dB, 50W)
 50-Ohm Atten, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
 Power Supply, Hewlett Packard Model 6653A
 Digital Multimeter, HP 3478A
 Power Meter, Model HP437B

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)
220.00	11.9	2.206	26.25	12.0
220.00	8.4	0.910	7.644	2.0
220.00	8.1	.706	5.7186	1.0

NAME OF TEST: Transmitter Spurious and Harmonic Outputs

RULE PART NUMBER: FCC: 2.1051, 90.210 (c,3)(d,3)(e,3), 80.211 (f)
 IC: RSS-119 5.8.2, 5.8.3, 5.8.4
 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 -65dBc , whichever is the lesser attenuation.

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

For 1 Watt: $55+10\text{Log}_{10}(1 \text{ Watt}) = -55 \text{ dBc}$
 or -65 dBc , whichever is the lesser attenuation.

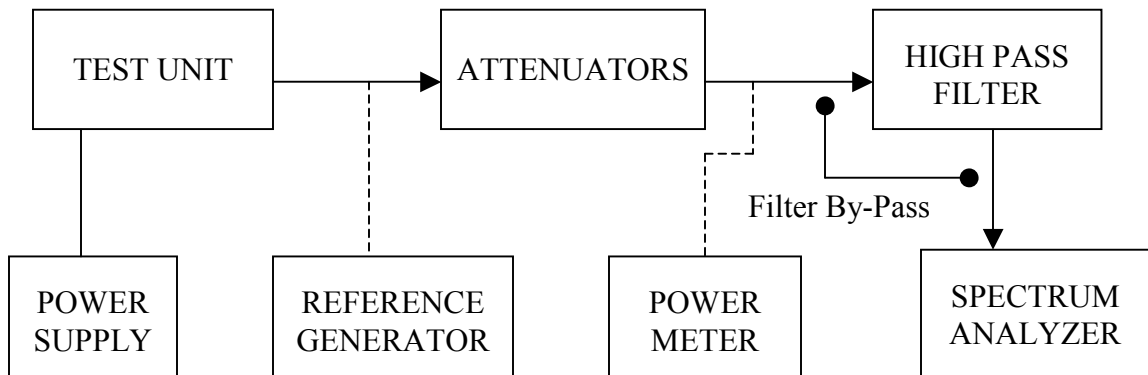
TEST RESULTS: Meets minimum standards (see data on following pages)

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

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

TEST EQUIPMENT: 50-Ohm Atten, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
 50-Ohm Atten, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
 Power Supply, Hewlett Packard Model 6653A
 Spectrum Analyzer, HP 8563E
 Power Meter, Model HP437B
 Reference Generator, Agilent E8257D
 High Pass Filter, Mini Circuits BHP-300

TEST SET-UP:



MEASUREMENT PROCEDURE:

1. The transmitter carrier output frequency is 218.025 and 221.025. The reference oscillator frequency is 23.040 MHz. The power amplifier has voltage levels at 11.9 Volts, 8.4 Volts and 8.1 Volts for 12 watts, 2 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.

Applicable to Part 80 (216-220 MHz) only

Tuned	1	
Frequency	218.025	MHz
Power	12.0	Watts
	40.8	dBm
Min		
Specification	-65.0	dBc
Worse Case	-89.19	dBc
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
436.050	2	-89.19
654.075	3	-97.8
872.100	4	-108.8
1090.125	5	-111.8
1308.150	6	-116.8
1526.175	7	-122.8
1744.200	8	-126.8
1962.225	9	-126.8
2180.250	10	-126.8
2398.275	11	-126.8
2616.300	12	-126.8
2834.325	13	-126.8
3052.350	14	-126.8
3270.375	15	-122.27
3488.400	16	-114.4
3706.425	17	-126.8
3924.450	18	-126.8
4142.475	19	-126.8
4360.500	20	-126.8

Tuned		
Frequency	218.025	MHz
Power	1.0	Watts
	30.0	dBm
Min		
Specification	-55.0	dBc
Worse Case	-85.5	dBc
Spurious Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
436.050	2	-85.5
654.075	3	-104.75
872.100	4	-109.0
1090.125	5	-111.0
1308.150	6	-111.0
1526.175	7	-111.0
1744.200	8	-111.0
1962.225	9	-111.0
2180.250	10	-111.0
2398.275	11	-111.0
2616.300	12	-111.0
2834.325	13	-111.0
3052.350	14	-111.0
3270.375	15	-111.0
3488.400	16	-111.0
3706.425	17	-111.0
3924.450	18	-111.0
4142.475	19	-111.0
4360.500	20	-111.0

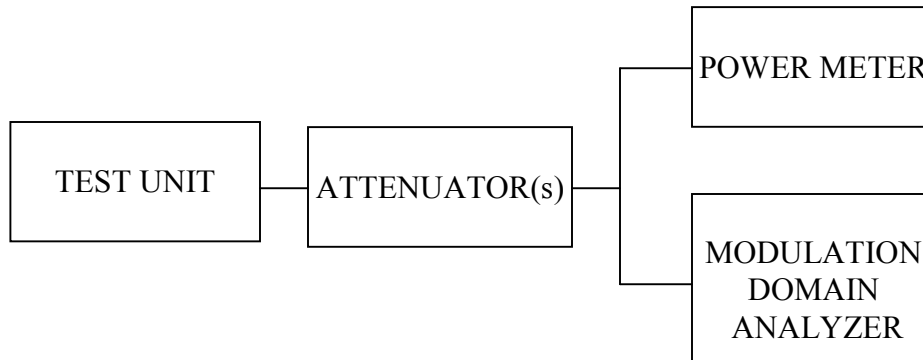
Applicable to Part 90 (220-222 MHz) only

Tuned		
Frequency	221.025	MHz
Power	12.0	Watts
	40.8	dBm
Min		
Specification	-65.0	dBc
Worse Case	-73	dBc
Spurious		
Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
442.050	2	-89.1
663.075	3	-93.9
884.100	4	-108.1
1105.125	5	-112.3
1326.150	6	-118.8
1547.175	7	-122.8
1768.200	8	-126.6
1989.225	9	-126.8
2210.250	10	-126.8
2431.275	11	-126.8
2652.300	12	-126.8
2873.325	13	-126.8
3094.350	14	-126.8
3315.375	15	-123.0
3536.400	16	-118.0
3757.425	17	-126.8
3978.450	18	-126.8
4199.475	19	-126.8
4420.500	20	-126.8

Tuned		
Frequency	221.025	MHz
Power	1.0	Watts
	30.0	dBm
Min		
Specification	-55.0	dBc
Worse Case	-69.2	dBc
Spurious		
Frequency (MHz)	Harmonic	Relative to Carrier (dBc)
442.050	2	-69.2
663.075	3	-101.8
884.100	4	-116.0
1105.125	5	-116.0
1326.150	6	-116.0
1547.175	7	-116.0
1768.200	8	-116.0
1989.225	9	-116.0
2210.250	10	-116.0
2431.275	11	-116.0
2652.300	12	-116.0
2873.325	13	-116.0
3094.350	14	-116.0
3315.375	15	-116.0
3536.400	16	-116.0
3757.425	17	-116.0
3978.450	18	-116.0
4199.475	19	-116.0
4420.500	20	-116.0

NAME OF TEST: Transient Frequency Behavior

RULE PART NUMBER: FCC: 90.214
IC: RSS-119 5.9



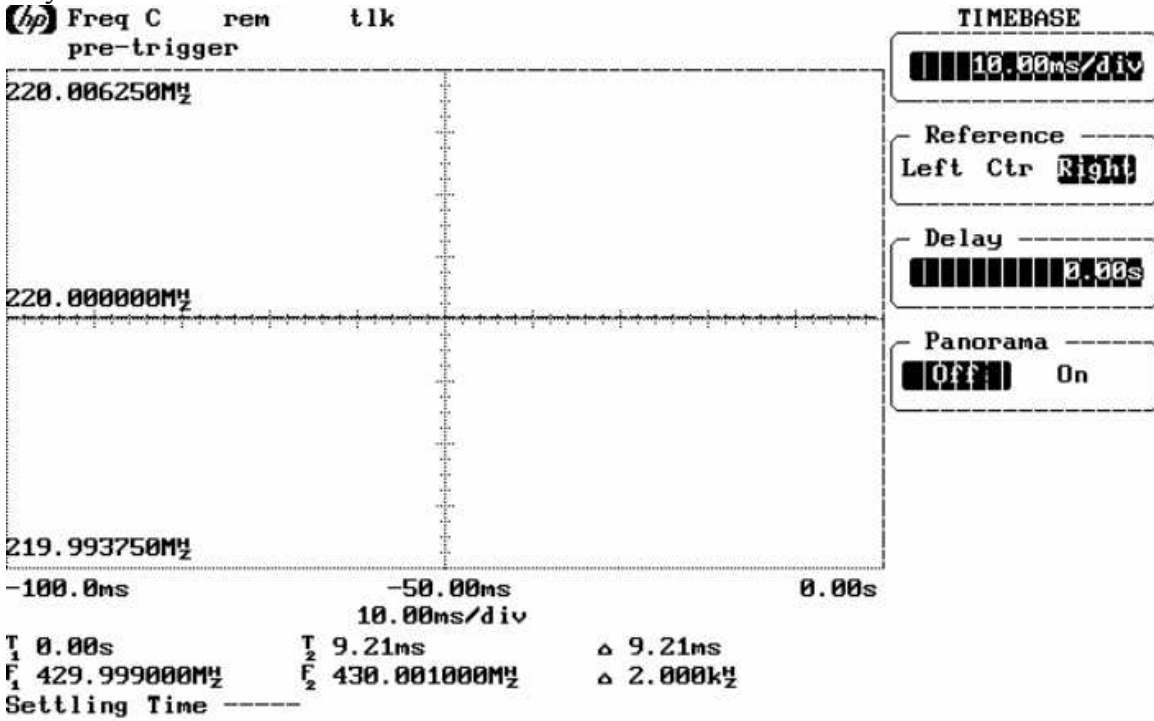
TEST CONDITIONS: RF Power Level = 12 Watts and 1.0 Watt
Standard Test Conditions, 25 C

TEST PROCEDURE: TIA/EIA – 603-C, 2.2.19.2

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)
Power Supply, Hewlett Packard Model 6653A
Modulation Domain Analyzer, HP-53310A
Power Meter, Model HP437B

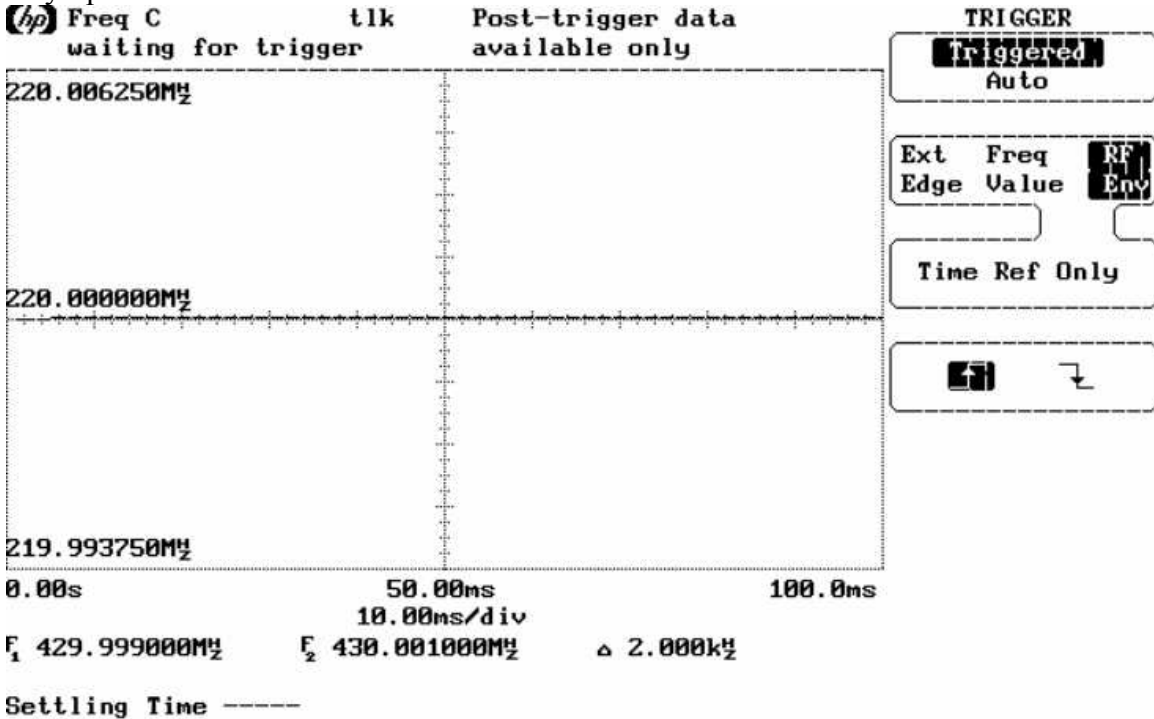
Frequency : 220.000000 MHz
 Power: 12 W

Key-Down



ref ext

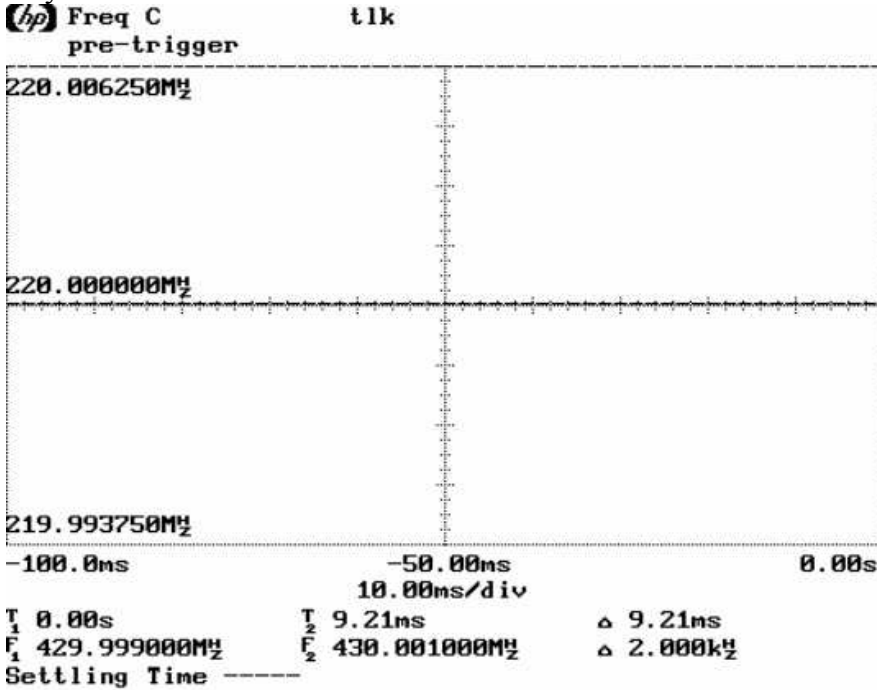
Key-up



ref ext fine

Frequency : 220.000000 MHz
 Power: 1.0 W

Key-Down



TRIGGER
 Triggered
 Auto

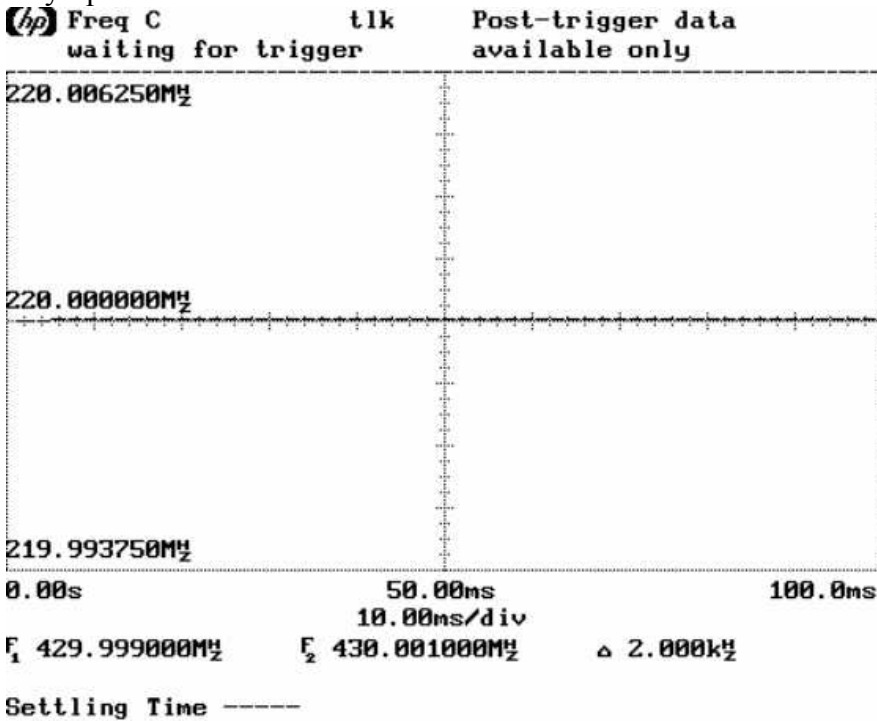
Ext Freq RF
 Edge Value Env

Arm Only

↵ ↶

ref ext fine

Key-up



Post-trigger data available only

TRIGGER
 Triggered
 Auto

Ext Freq RF
 Edge Value Env

Time Ref Only

↵ ↷

ref ext fine

NAME OF TEST: Frequency Stability with Variation in Supply Voltage

RULE PART NUMBER: FCC: 2.1055 (d)(1), 90.213 (a), 80.209
IC: RSS-119 5.3

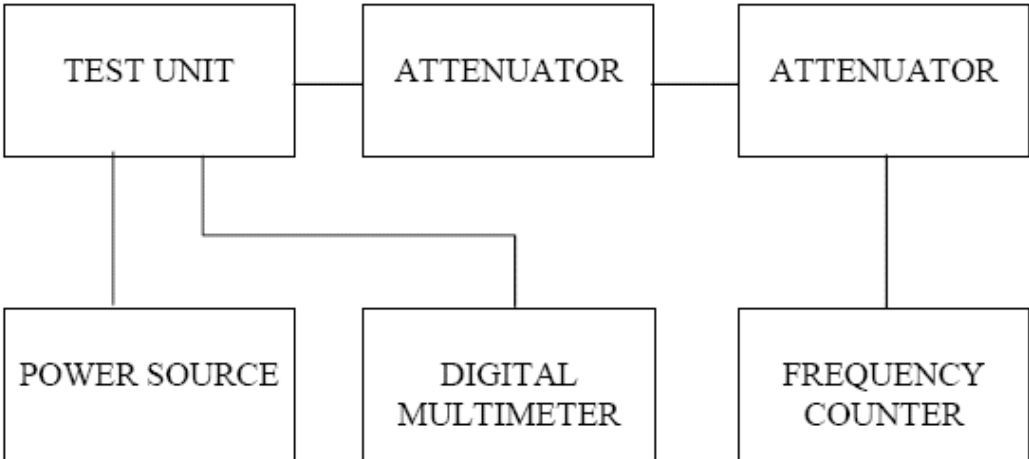
MINIMUM STANDARD: Shall not exceed 1.0 ppm.

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

TEST CONDITIONS: Standard Test Conditions, 25 C

TEST EQUIPMENT: Frequency Counter, HP 8901B Modulation Analyzer
DC Power Supply, Hewlett Packard Model 6653A
Digital Voltmeter, HP 3478A DMM
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: 0.00			
Spec: <1.0ppm			
Input Voltage (Vdc)	Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
10	220.000080	80	0.36
20	220.000080	80	0.36
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
IC: RSS-119 5.3
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).

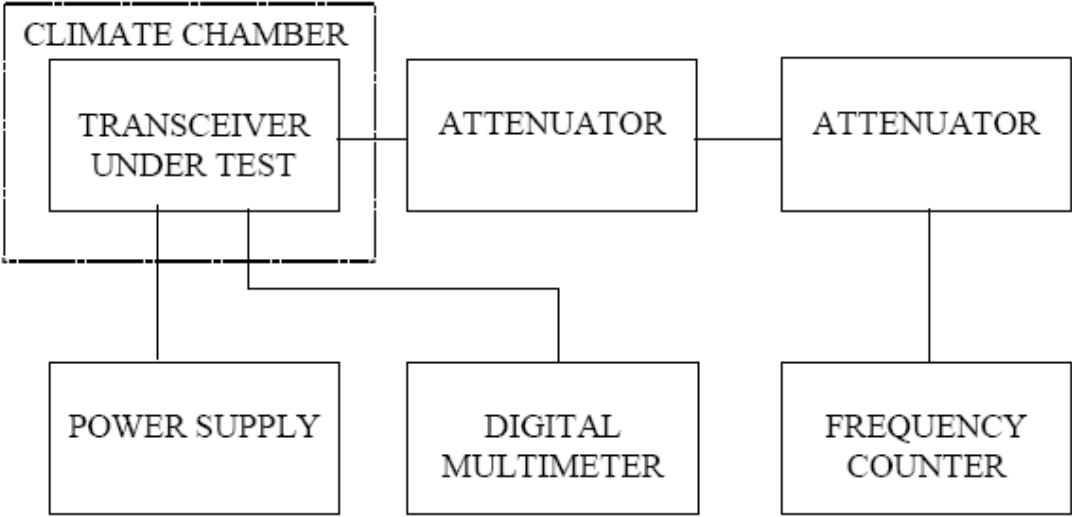
MINIMUM STANDARD: Shall not exceed 1.0 ppm from test frequency

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

TEST CONDITIONS: Standard Test Conditions

TEST EQUIPMENT: Frequency Counter, HP 8901B Modulation Analyzer
DC Power Supply, Hewlett Packard Model 6653A
Digital Voltmeter, HP 3478A DMM
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: 0.45			
Spec: < 1.0 ppm			
Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	220.000060	60	0.27
-20	220.000090	90	0.41
-10	220.000100	100	0.45
0	220.000060	60	0.27
10	220.000050	50	0.23
20	220.000090	90	0.41
30	220.000040	40	0.18
40	220.000030	30	0.14
50	220.000010	10	0.05
60	220.000010	10	0.05

Applicable to Part 90 (217-220 MHz)

Channel Frequency: 220 MHz			
Voltage & Power Level: 20 Volts @ 2 Watts			
Highest Variation: 0.45			
Spec: < 1.0 ppm			
Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	220.000060	30	0.14
-20	220.000090	90	0.41
-10	220.000100	100	0.45
0	220.000060	70	0.32
10	220.000050	70	0.32
20	220.000090	120	0.55
30	220.000040	80	0.36
40	220.000030	50	0.23
50	220.000010	40	0.18
60	220.000010	50	0.23

Channel Frequency: 220 MHz			
Voltage & Power Level: 20 Volts @ 1 Watts			
Highest Variation: 0.55			
Temperature (Deg C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)
-30	220.000020	20	0.09
-20	220.000080	80	0.36
-10	220.000100	100	0.45
0	220.000060	60	0.27
10	220.000060	60	0.27
20	220.000120	120	0.55
30	220.000070	70	0.32
40	220.000040	40	0.18
50	220.000030	30	0.14
60	220.000020	20	0.09

NAME OF TEST: Transmitter Occupied Bandwidth

RULE PART NUMBER: FCC: 2.201, 2.202, 2.1033 (c)(14), 2.1049 (h), 2.1041;90.203(j)(3); 80.211 (f)
 IC: RSS-Gen 4.4.1

Necessary Bandwidth Measurement

This radio modem uses digital modulation signals, passing through a Squared Root Raised Cosine $\alpha=0.2$ DSP implemented low-pass filter to an FM transceiver. The digital modulation is based on SRRC4FSK allows a SRRC2FSK subset to be used for lower bit rate with a better sensitivity reception. The necessary bandwidth calculation for this type of modulation 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	6.25 kHz	6.25 kHz	12.5 kHz	12.5 kHz	25 kHz	25 kHz
Emission Type	3K30 F1D	3K55 F1D	8K20 F1D	8K30 F1D	16K5 F1D	16K8 F1D
Data Rate	4 kbps	8 kbps	8 kbps	16 kbps	16 kbps	32 kbps
Baud Rate	4000	4000	8000	8000	16000	16000
Measured Peak Deviation	1.15 kHz	1.09 kHz	3.05 kHz	3.70 kHz	6.3 kHz	6.3 kHz
Measured 99% Occupied BW	3.3 kHz	3.55 kHz	8.20 kHz	8.30 kHz	16.5 kHz	16.8 kHz

MODEM SETUP:

For 2 FSK Modulation (3K30F1D, 8K20F1D, 16K5F1D) :
 200-dsp.par.setup.deviation= 01 c2 01 f4 05 dc 07 6c 0c 80 0f 3c
 200-dsp.par.setup.softSyncAmplitude= 32767 (0x7fff)

For 4 FSK Modulation (3K55F1D, 8K30F1D, 16K8F1D) :
 200-dsp.par.setup.deviation= 01 c2 01 f4 05 dc 07 6c 0c 80 0f 3c
 200-dsp.par.setup.softSyncAmplitude= 26200 (0x6658)

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.

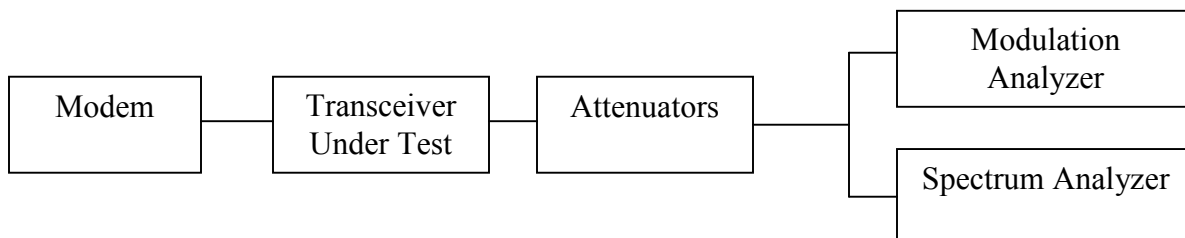
The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a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

TEST EQUIPMENT:

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

TEST SET-UP:

For the above requirements, the occupied bandwidth of a transmitter was measured using an HP8563E using the following settings:
 Occupied BW % Power: 99%
 Trace: Max Hold A
 RBW: 100 Hz (6.25 and 12.5 kHz channels)
 RBW: 300 Hz (25 kHz channels)
 VBW: 3 kHz
 SPAN: 100 kHz (6.25 and 12.5 kHz channels)
 SPAN: 150 kHz (25 kHz channels)



MODULATION SOURCE DESCRIPTION:

The 4-level signaling transmits two information bits per symbol (baud), which yields a bit rate of twice the on-air baud rate. Hence the 8, 16, or 32 kbps references in the Installation Guide correspond to a transmitter baud rate of 4000, 8000 or 16000 baud. That digital signal is digitally filtered (Square Root Raised Cosine pulse shaping with $\alpha=0.2$) by the DSP and converted to I&Q components, then fed to the digital to analog converter. This SRRC4FSK wave shape applied to the FM modulator will then produce a compact RF spectrum, when using proper frequency deviation, to fit inside the restrictive masks inherent to the intended channel bandwidth.

TX Data Test Pattern:

The transmit “test data” pattern command produces a 107,3741,823 bit pseudo- random pattern. This pattern is generated by the DSP. The 107,3741,823 bit sequence is repeated thereafter as long is necessary to complete the test duration, this sequence lasts 67,109 seconds at 16 kbps. Commonly this is longer than the test duration. This pattern is applied to the DSP modulator for mapping to 4-FSK and pulse shaping with SRRC $\alpha=0.2$. This data follows same modulation process as described in MODULATION SOURCE DESCRIPTION and the resulting base band signal feeds the modulator's input of the transceiver.

NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators
3K55F1D and **3K30F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(e), 2.1049 (c) (1); 80.211 (f)
IC: RSS-119 5.8.4
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 E**
Sidebands and Spurious [Rule 90.210 (e), 5.8.4, P = 12 Watts and P=1 Watt]
Authorized Bandwidth = 6 kHz [Rule 90.209(b) (5), 5.8.4]
From Fo to 3 kHz, down 0 dB.
Greater than 3 kHz to 4.6 kHz, down 30 +16.67(fd-3 kHz) dB or 55 +10 log(P) or 65 dB, whichever is the lesser attenuation.
Greater than 12.5 kHz, at least 50+10log₁₀(P) or 70 dB, whichever is the lesser attenuation.

Attenuation = 0 dB at Fo to 3 kHz
Attenuation = 30 dB at 3 kHz and 56.7 dB at 4.6 kHz @ 12 Watts
Attenuation = 65 dB at frequencies greater than 4.6 kHz @ 12 Watts
Attenuation = 30 dB at 3 kHz and 50 dB at 4.2 kHz and 55 dB at 4.6 kHz @ 1 Watt
Attenuation = 55 dB at frequencies greater than 4.6 kHz @ 1 Watt

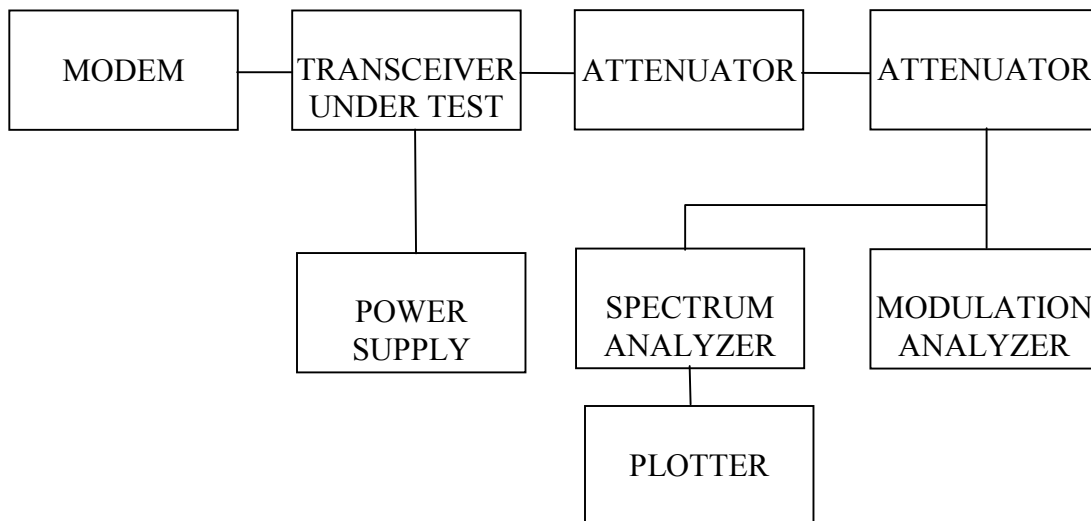
TEST RESULTS: Meets minimum standards (see data on following page)

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

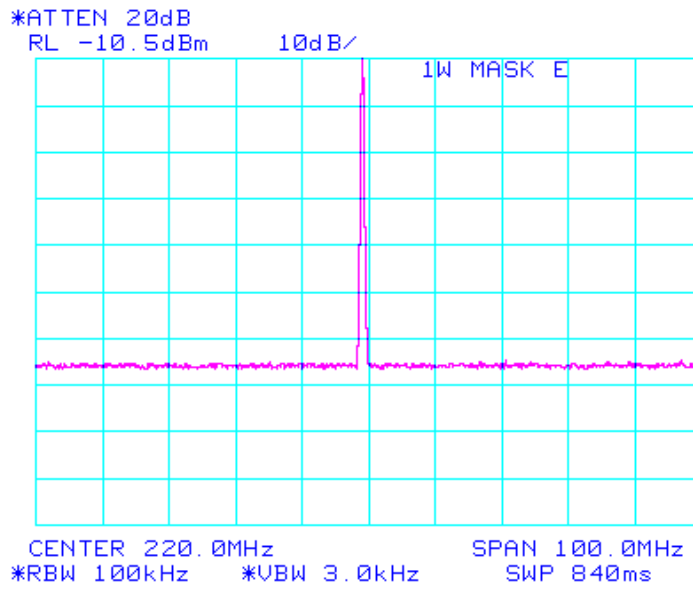
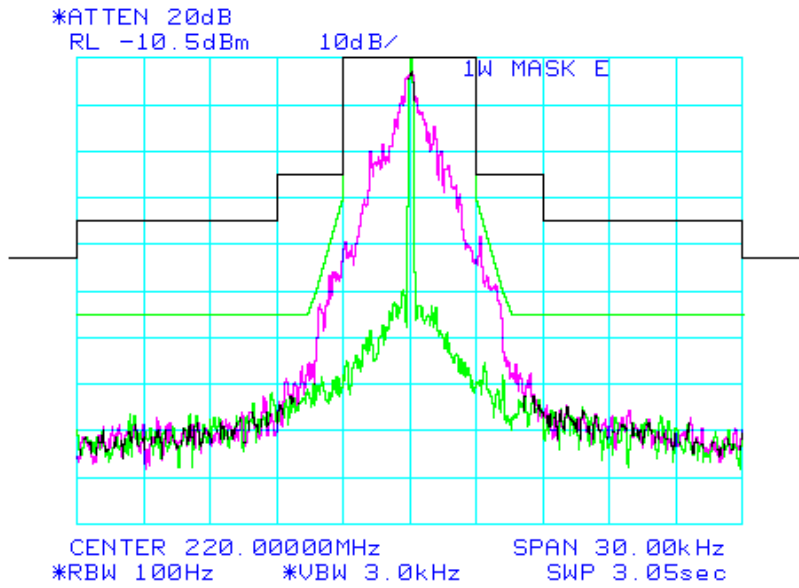
TEST SET-UP:



Mask: E, 1W
Output Power = 1 Watt

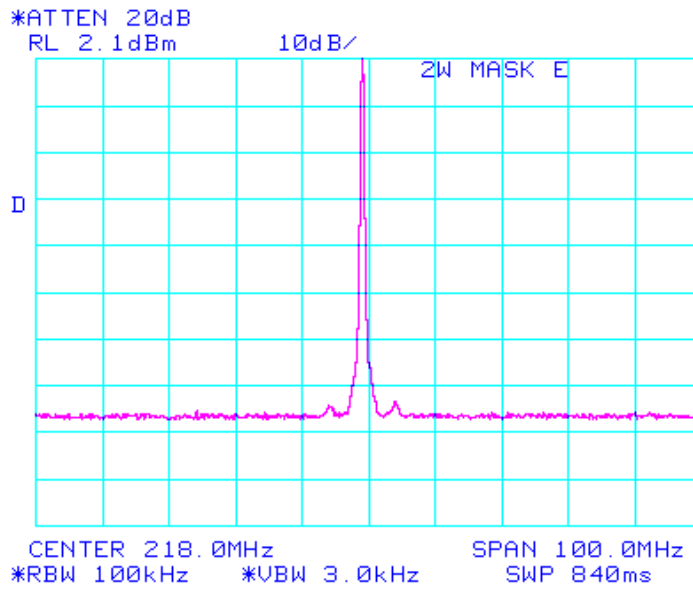
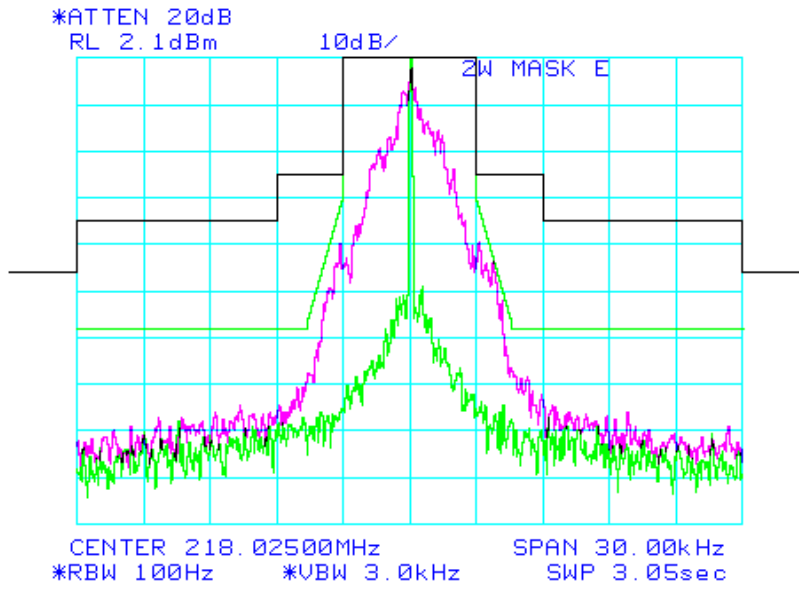
Spectrum for Emission: 3K30 F1D
Data Rate: 4 kbps Peak Deviation with Data: 1.15kHz

Mask B = Black Line
Mask E = Green Line



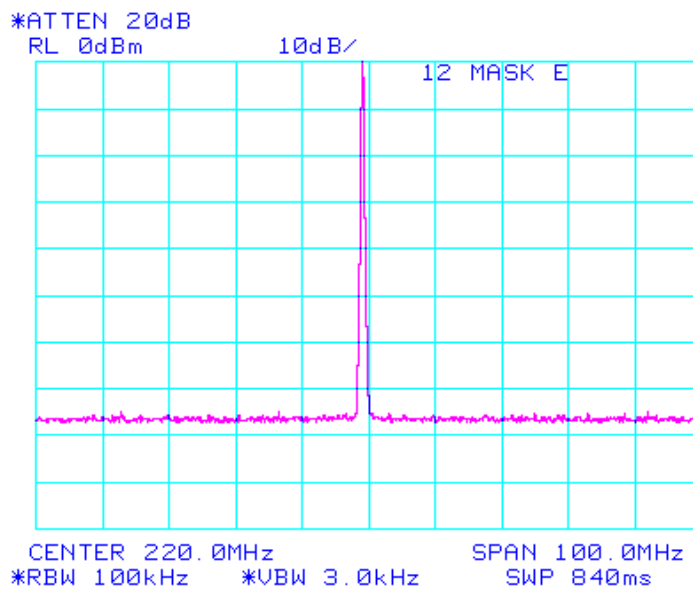
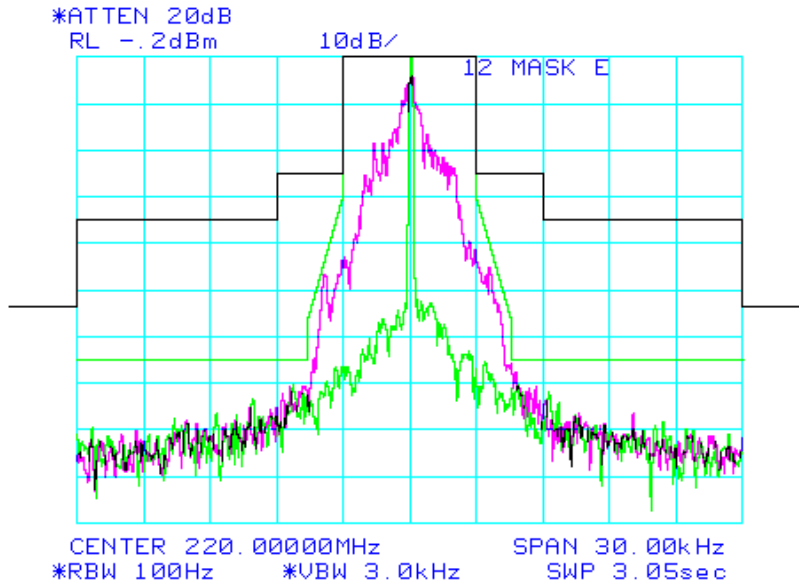
Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

Mask B = Black Line
Mask E = Green Line



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

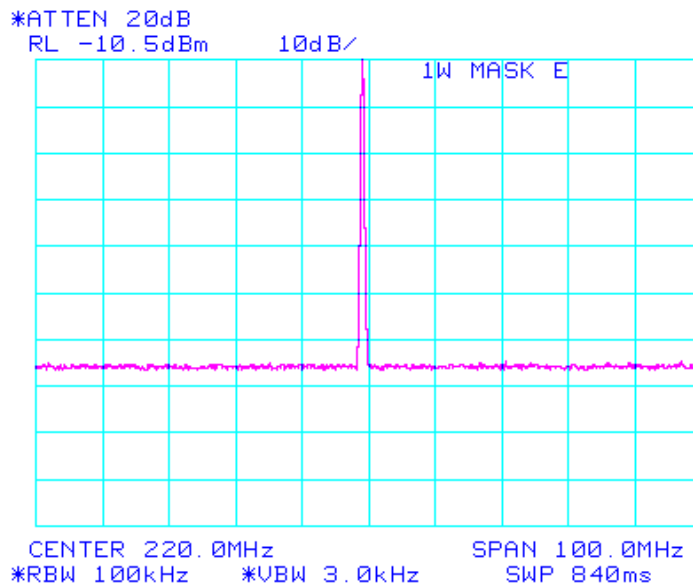
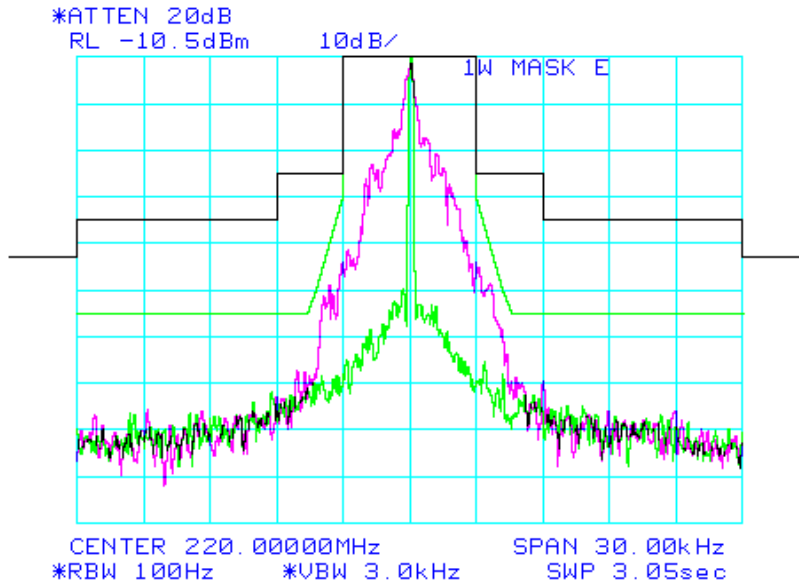
Mask B = Black Line
Mask E = Green Line



Mask: E, 1W
Output Power = 1 Watt

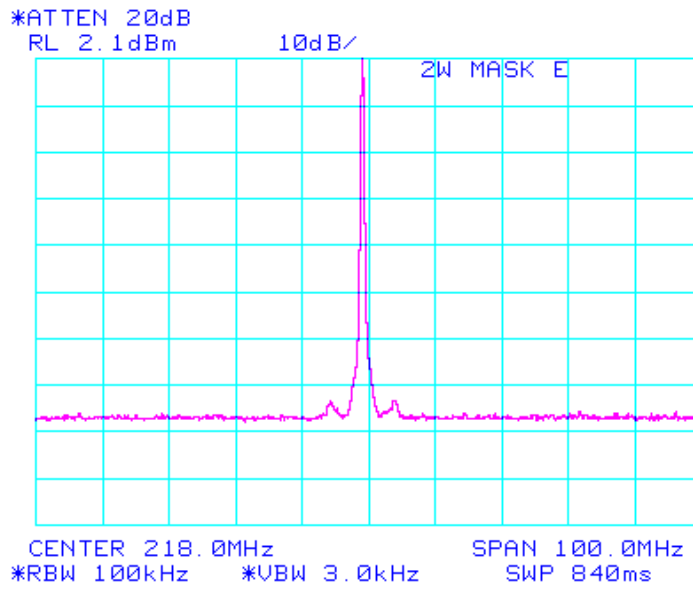
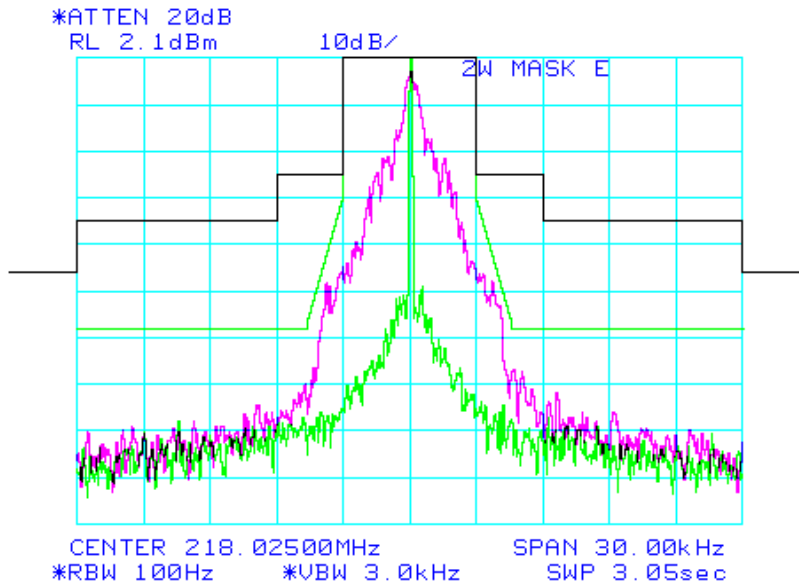
Spectrum for Emission: 3K55 F1D
Data Rate: 8 kbps Peak Deviation with Data: 1.09kHz

Mask B = Black Line
Mask E = Green Line



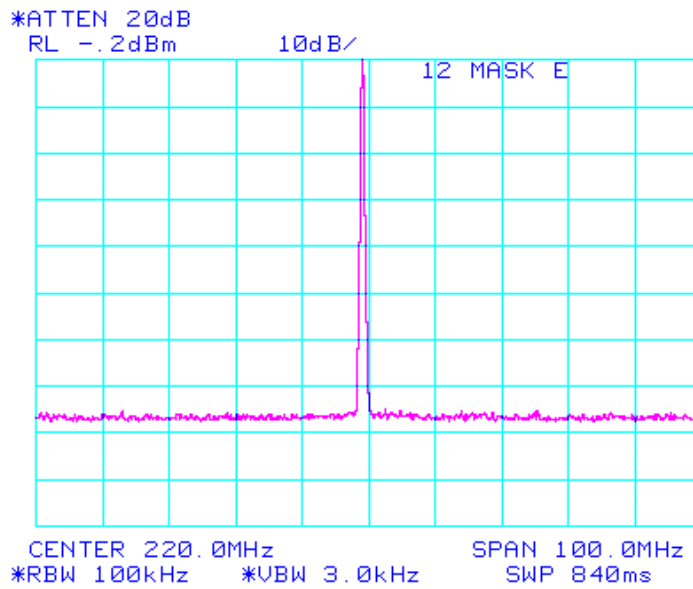
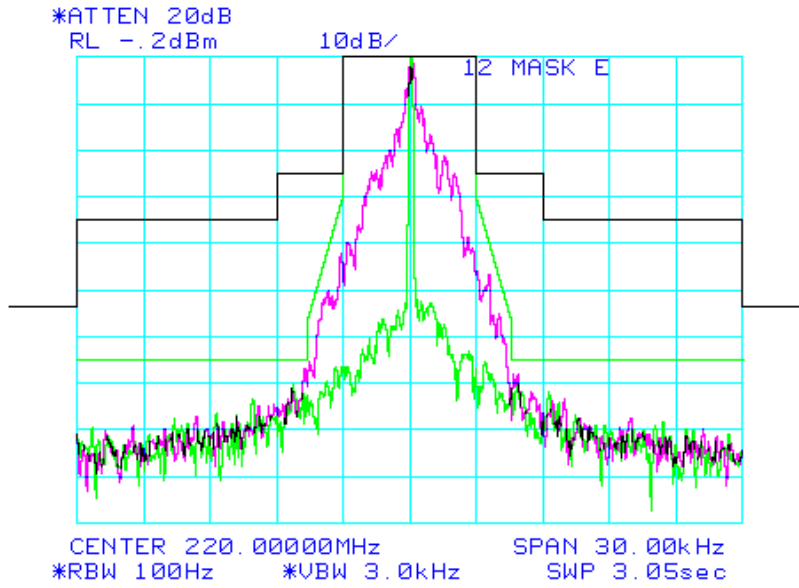
Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

Mask B = Black Line
Mask E = Green Line



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

Mask B = Black Line
Mask E = Green Line



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators
8K20F1D and **8K30F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(d), 2.1049 (c) (1); 80.211 (f)
IC: RSS-119 5.8.3
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), 5.8.3, P = 12 Watts and P=1 Watt]
Authorized Bandwidth = 11.25 kHz [Rule 90.209(b) (5), 5.8.3]
From Fo to 5.625 kHz, down 0 dB.
Greater than 5.625 kHz to 12.5 kHz, down 7.27($f_i - 2.88\text{kHz}$) 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

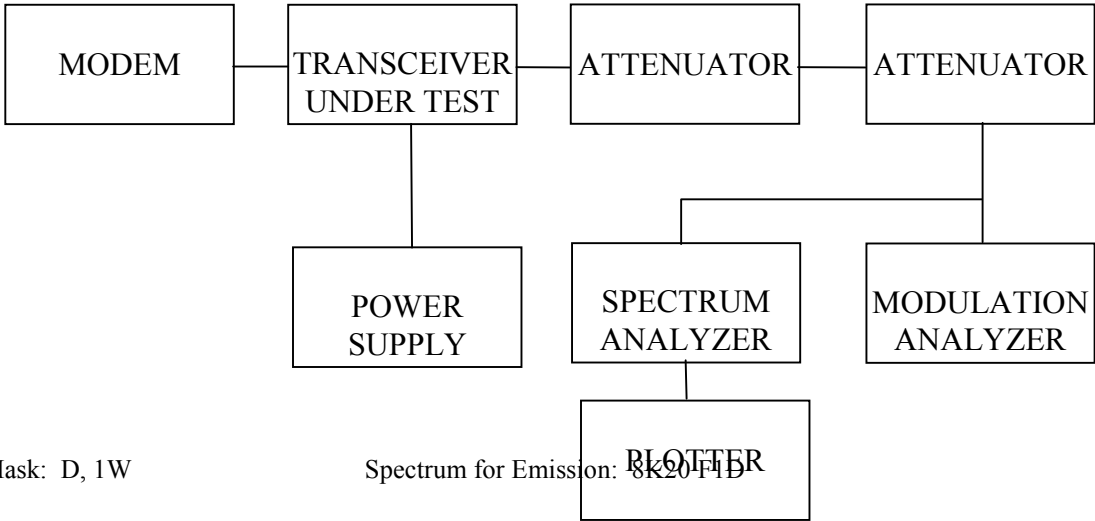
TEST RESULTS: Meets minimum standards (see data on following page)

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

TEST PROCEDURE: TIA/EIA – 603-C, 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:



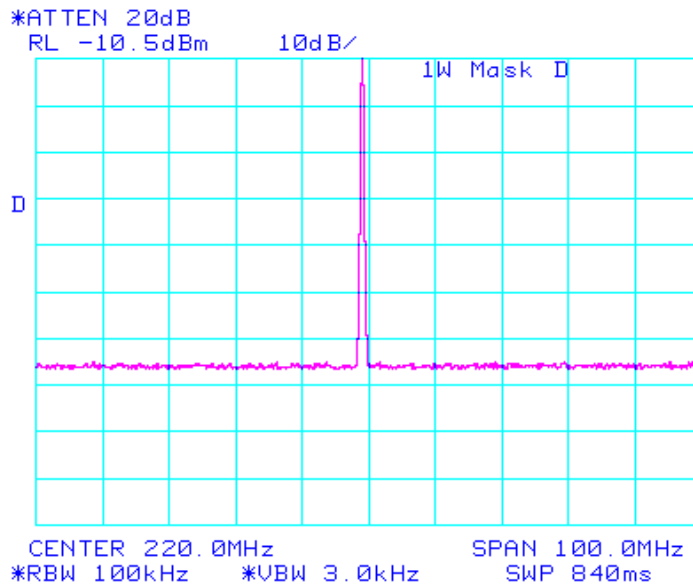
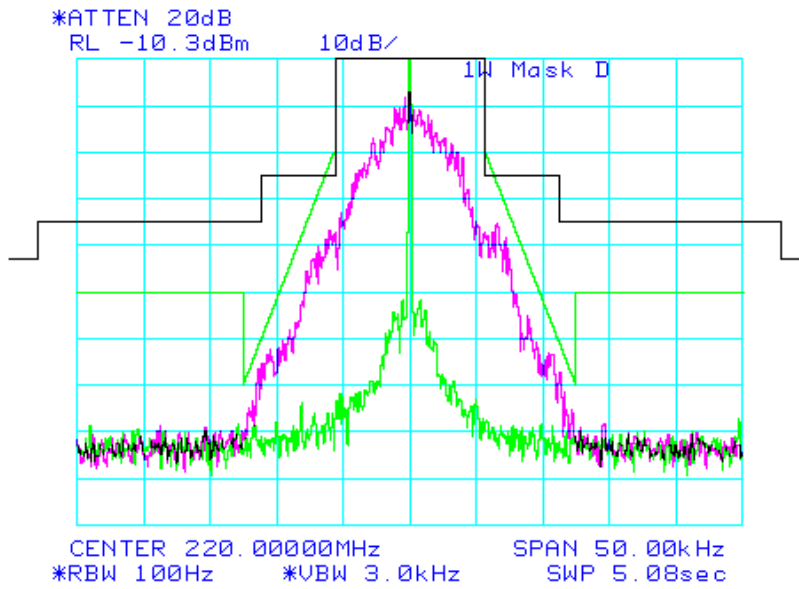
Output Power = 1 Watt

Data Rate: 8 kbps

Peak Deviation with Data: 3.05 kHz

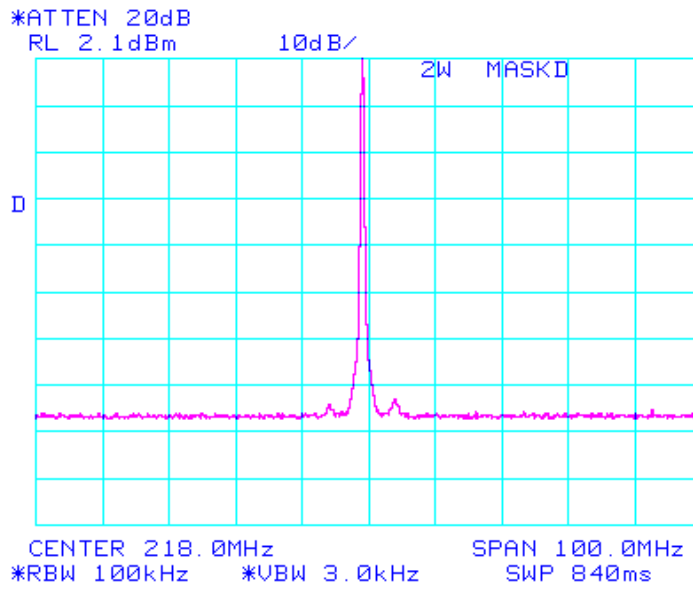
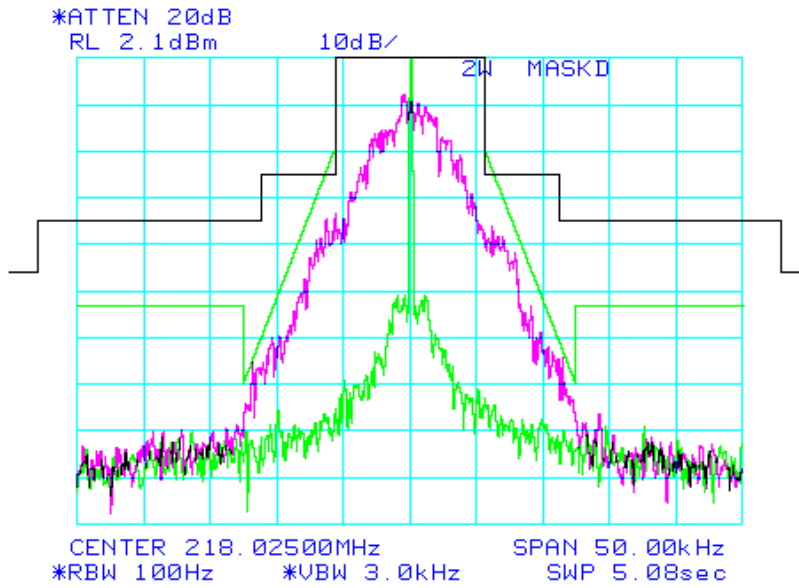
Mask B = Black Line

Mask D = Green Line



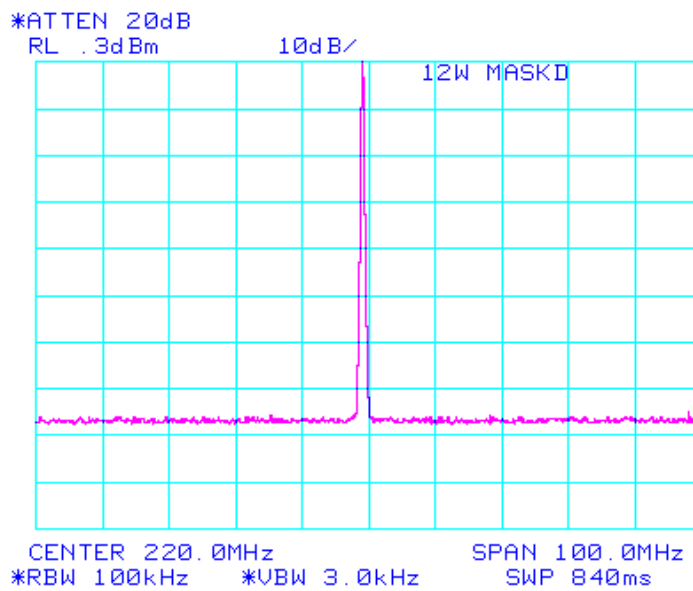
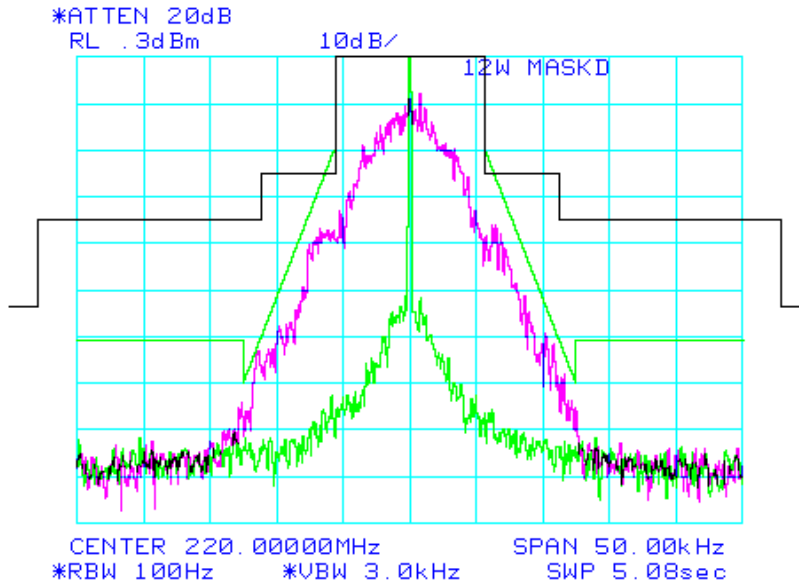
Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

Mask B = Black Line
Mask D = Green Line



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

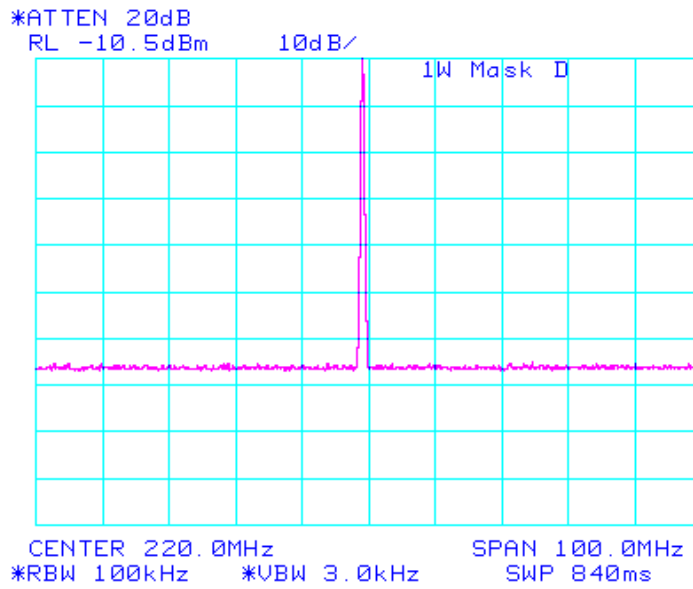
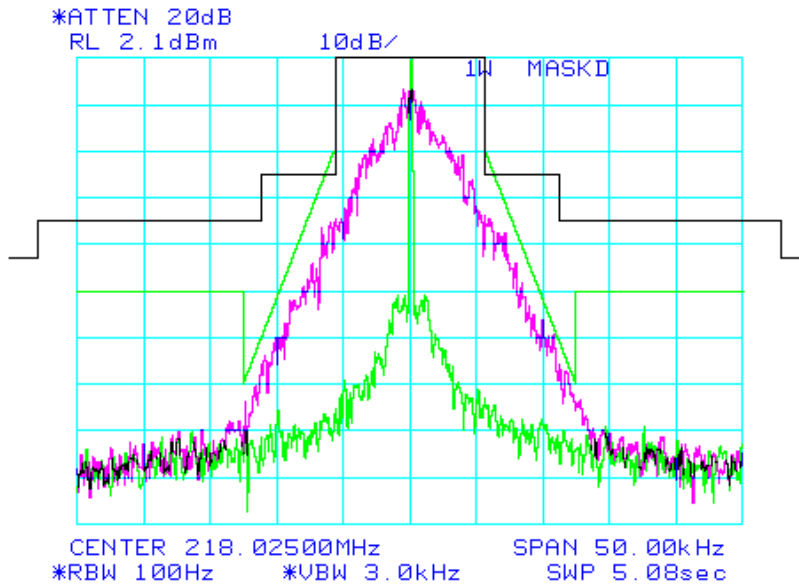
Mask B = Black Line
Mask D = Green Line



Mask: D, 1W
Output Power = 1 Watt

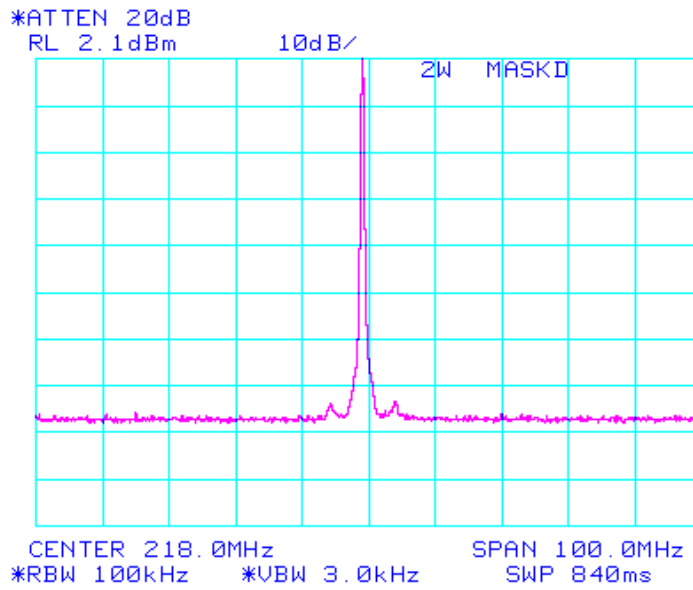
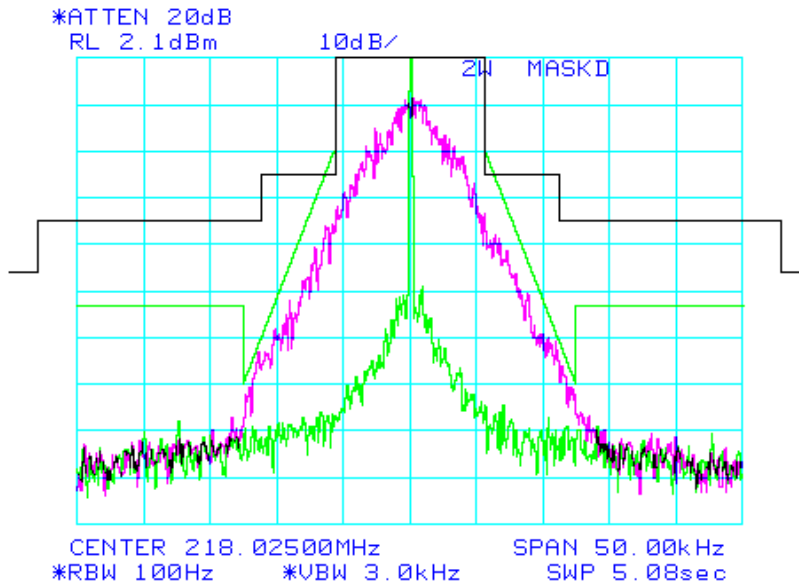
Spectrum for Emission: 8K30 F1D
Data Rate: 16 kbps Peak Deviation with Data: 3.70 kHz

Mask B = Black Line
Mask D = Green Line



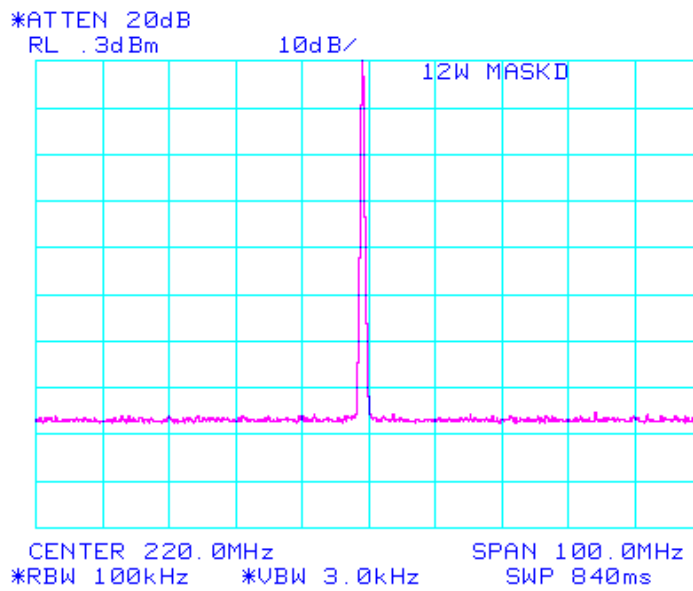
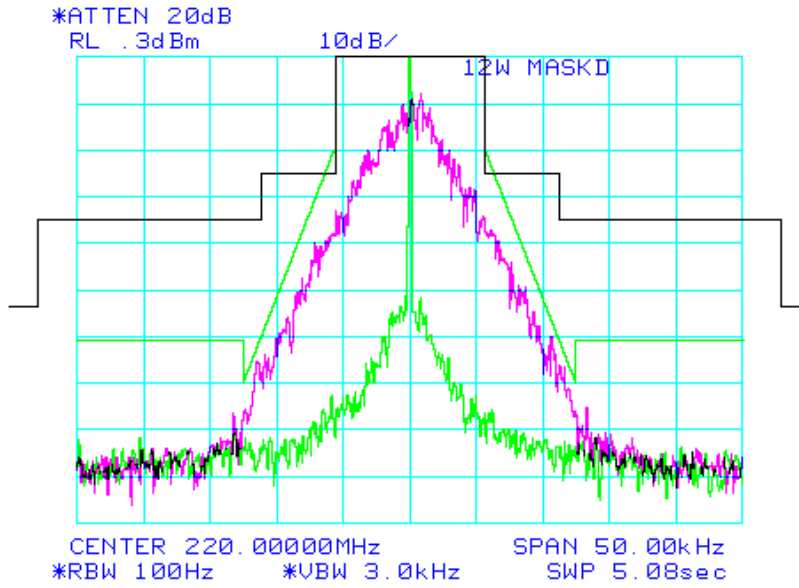
Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

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



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

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(c), 2.1049 (c) (1); 80.211 (f)
 IC: RSS-119 5.8.2
 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), 5.8.2, P = 12 Watts and P=1 Watt]
 Authorized Bandwidth = 20 kHz [Rule 90.209(b) (5), 5.8.2]
 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

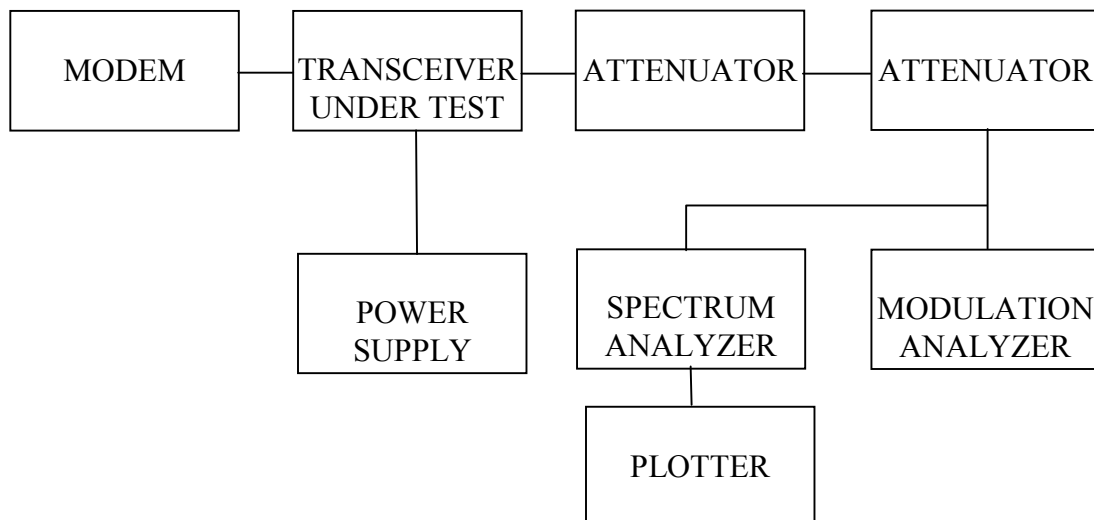
TEST RESULTS: Meets minimum standards (see data on following page)

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

TEST PROCEDURE: TIA/EIA – 603-C, 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

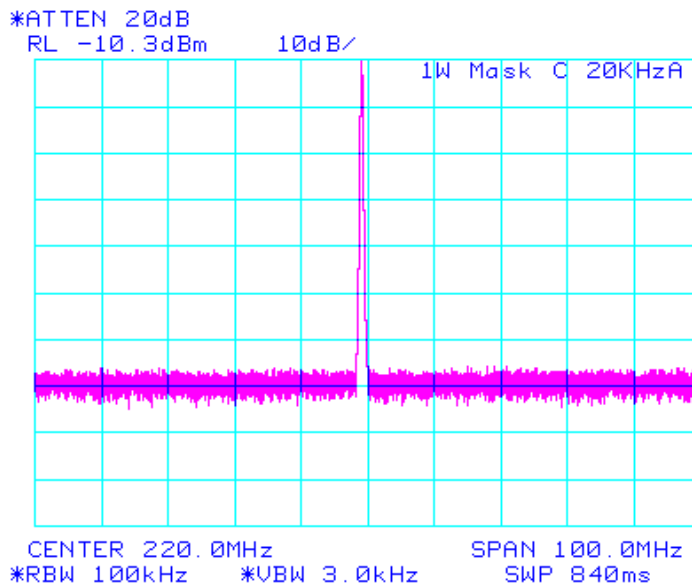
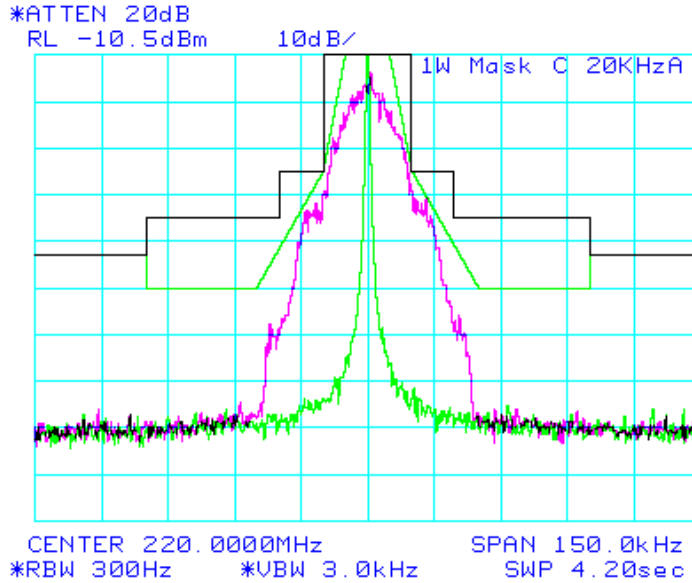
TEST SET-UP:



Mask: C, 1W
Output Power = 1 Watt

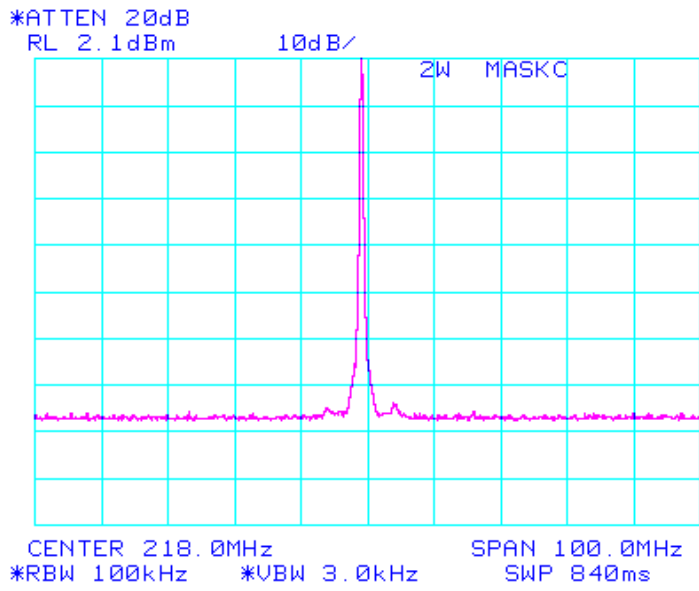
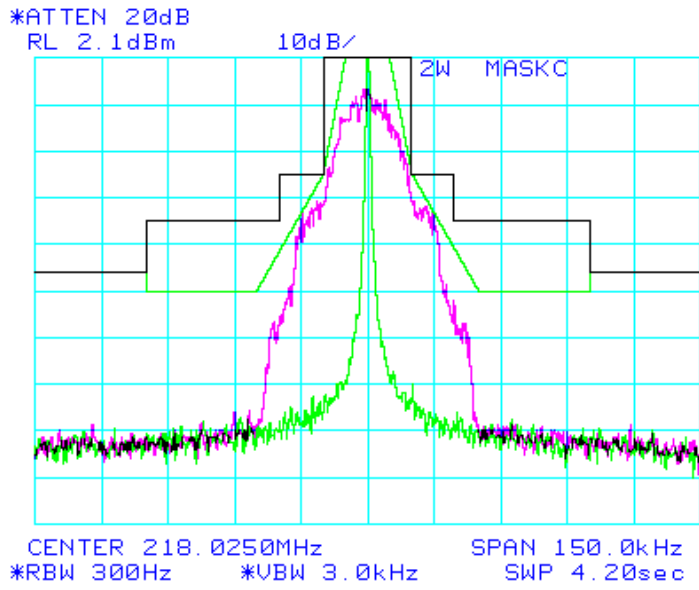
Spectrum for Emission: 16K5 F1D
Data Rate: 16 kbps Peak Deviation with Data: 6.30 kHz

Mask B = Black Line
Mask C = Green Line



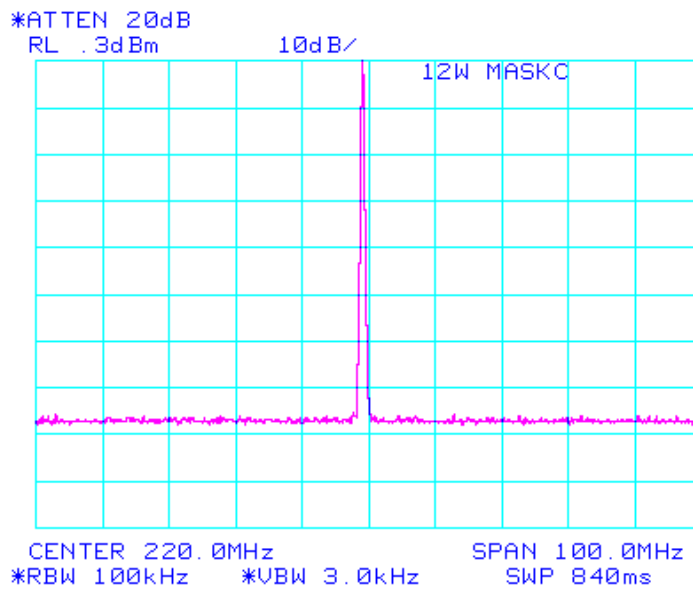
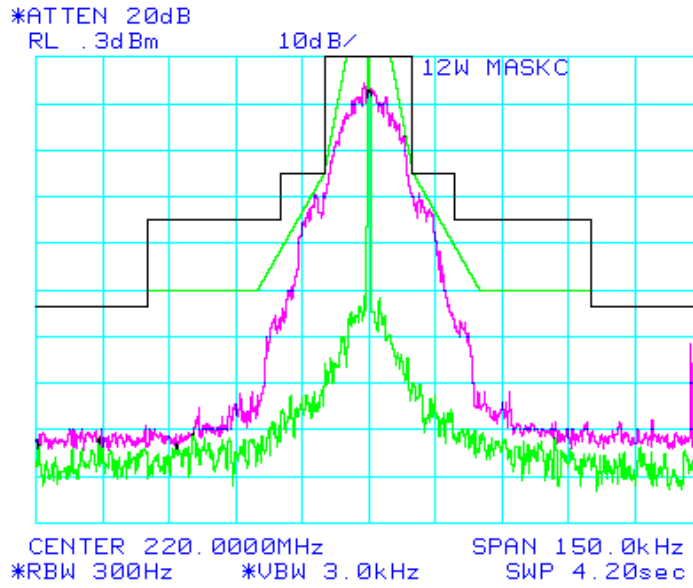
Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

Mask B = Black Line
Mask C = Green Line



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

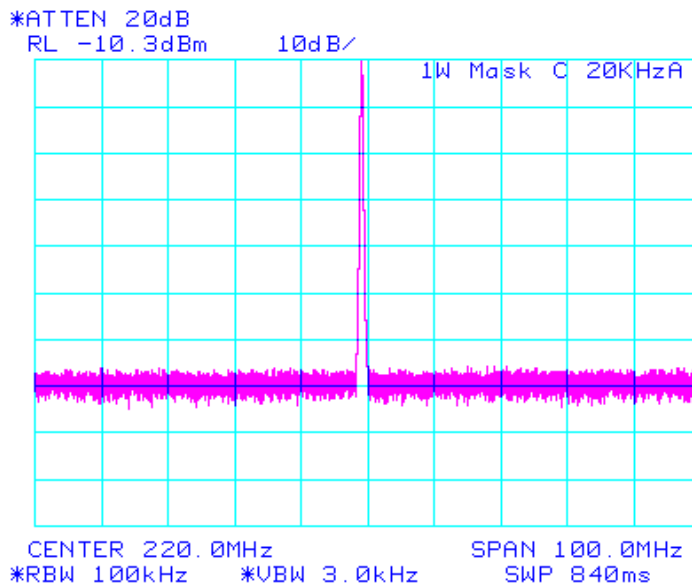
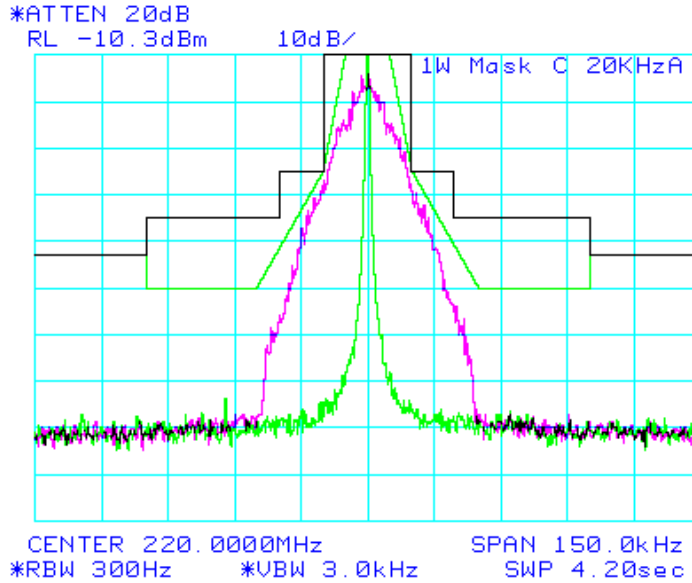
Mask B = Black Line
Mask C = Green Line



Mask: C, 1W
Output Power = 1 Watt

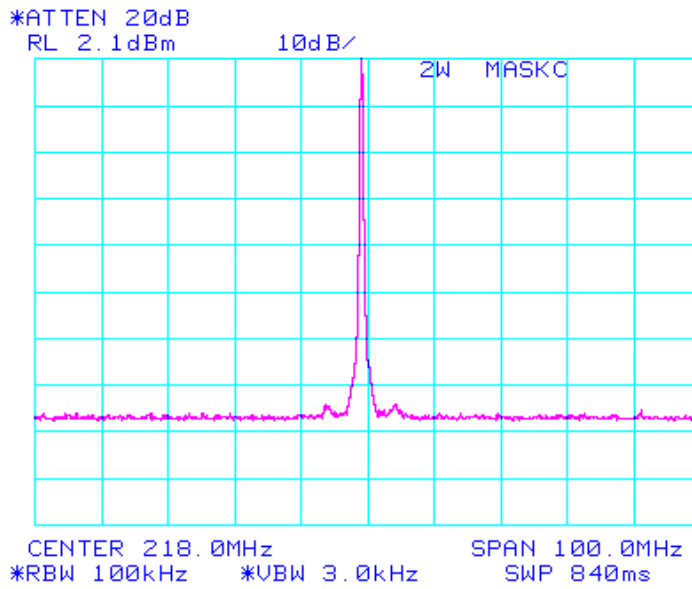
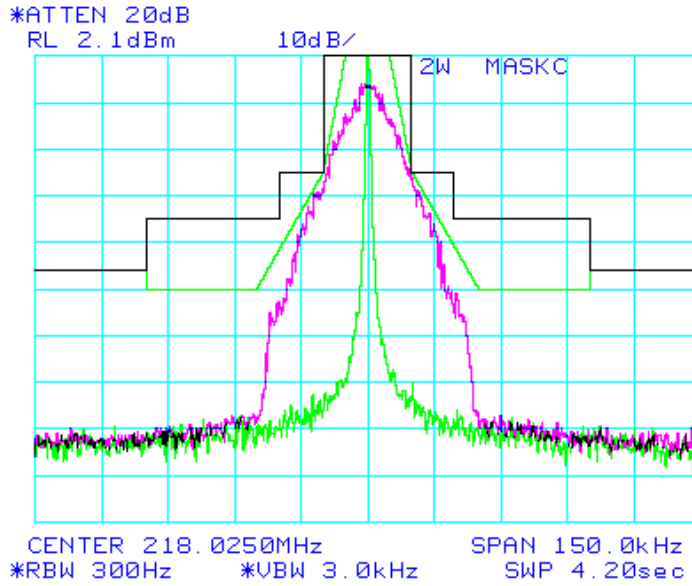
Spectrum for Emission: 16K8 F1D
Data Rate: 32 kbps Peak Deviation with Data: 6.3 kHz

Mask B = Black Line
Mask C = Green Line



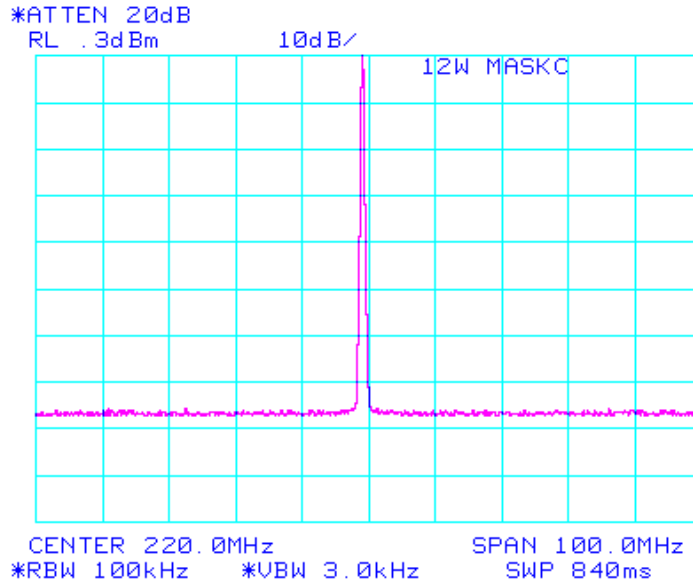
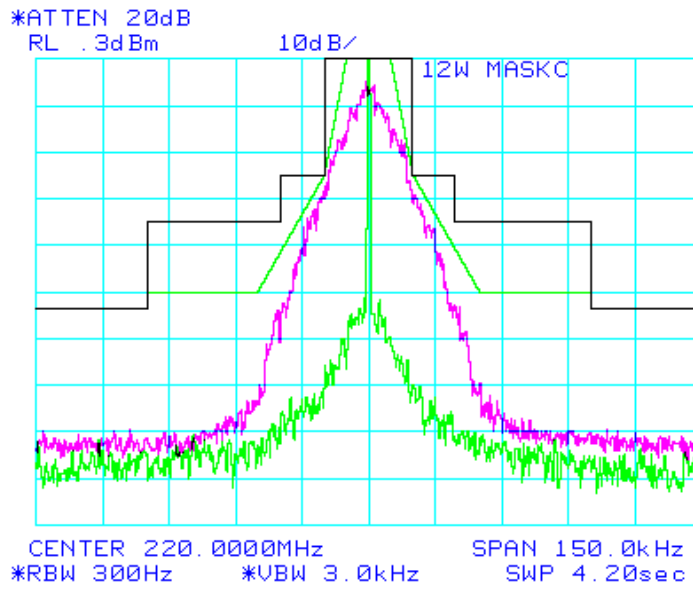
Output Power = 2 Watt
Applicable to Part 90 (217-220 MHz)

Mask B = Black Line
Mask C = Green Line



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

Mask B = Black Line
Mask C = Green Line



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **3K30F1D, 3K55F1D, 8K20F1D, 8K30F1D, 16K5F1D** and **16K8F1D**

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 F_o to 2 kHz, down 0 dB.
 Greater than 2 kHz to 3.75 kHz, down $30 + 20(f_d - 2)$ dB.
 On any frequency beyond 3.75 kHz removed from the center of the authorized bandwidth f_d : 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:

3K30F1D	2 contiguous channels
3K55F1D	2 contiguous channels
8K20F1D	5 contiguous channels
8K30F1D	5 contiguous channels
16K5F1D	10 contiguous channels
16K8F1D	10 contiguous channels

For emission designators 3K30F1D, 3K55F1D
 Attenuation = 0 dB at F_o to 4.5 kHz
 Attenuation = 30 dB at 4.5 kHz
 Attenuation = 55 dB at 5.25 kHz @ 1W
 Attenuation = 65 dB at 5.75 kHz @ 12W

For emission designators 8K20F1D,8K30F1D
 Attenuation = 0 dB at F_o 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 designators 16K5F1D, 16K8F1D
 Attenuation = 0 dB at F_o to 24.5 kHz
 Attenuation = 30 dB at 24.5 kHz
 Attenuation = 55 dB at 25.75 kHz @ 1W
 Attenuation = 65 dB at 26.25 kHz @ 12W

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

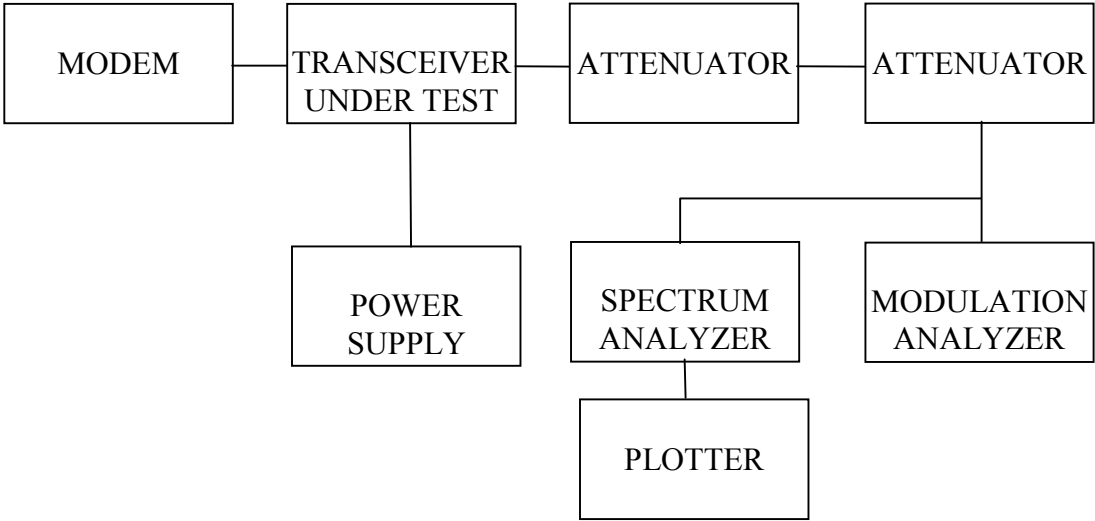
TEST CONDITIONS: Standard Test Conditions, 25 C
 RF Power Level = 1 Watt and 12 Watts
 Voltage = 20VDC

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

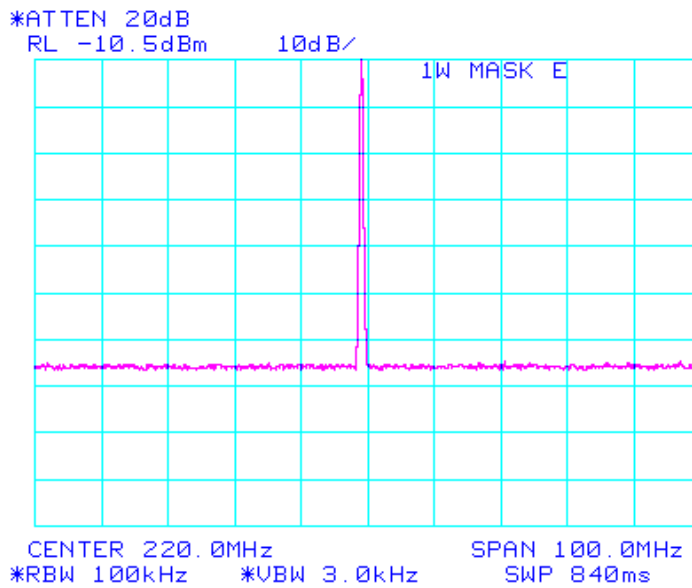
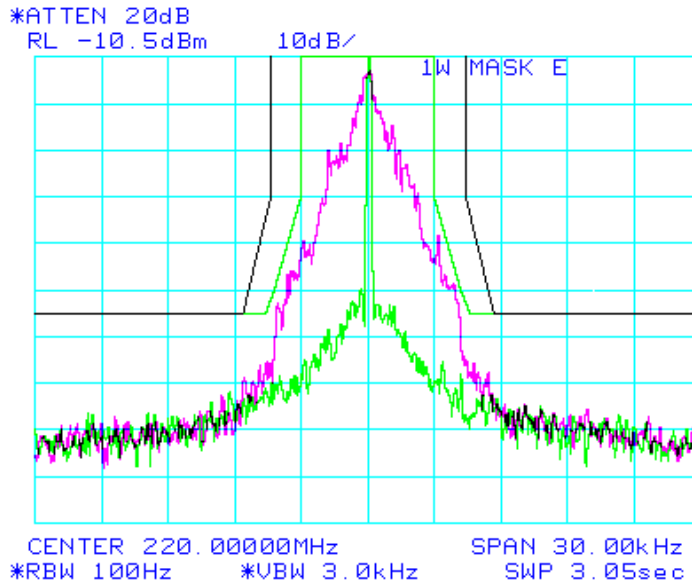
TEST SET-UP:



Mask: F(2 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 3K30F1D
Data Rate: 4 kbps Peak Deviation with Data: 1.15 kHz

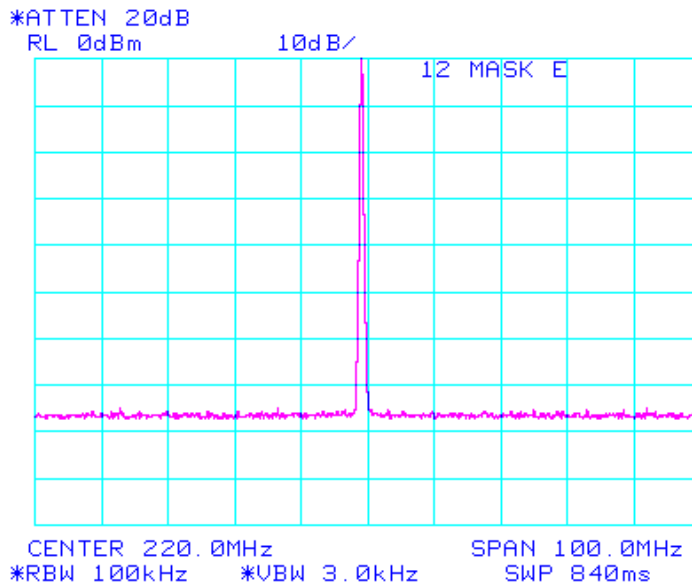
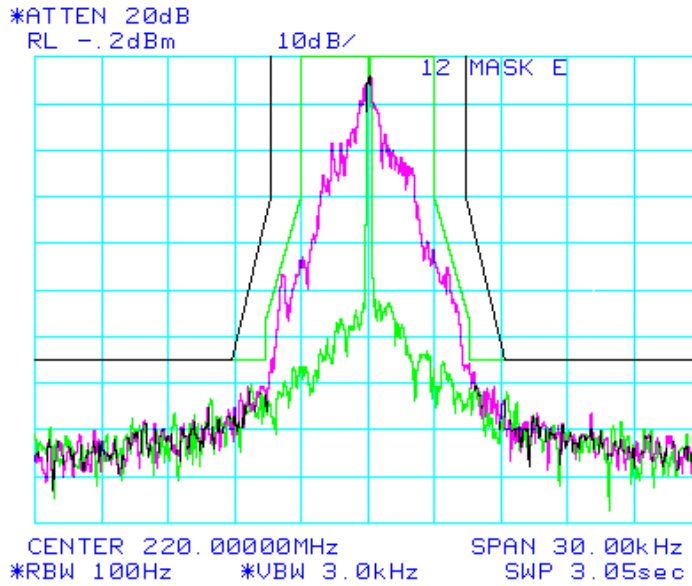
Mask F = Black Line



Mask: F(2 aggregate masks)
Output Power = 12 Watt

Spectrum for Emission: 3K30F1D
Data Rate: 4 kbps Peak Deviation with Data: 1.15 kHz

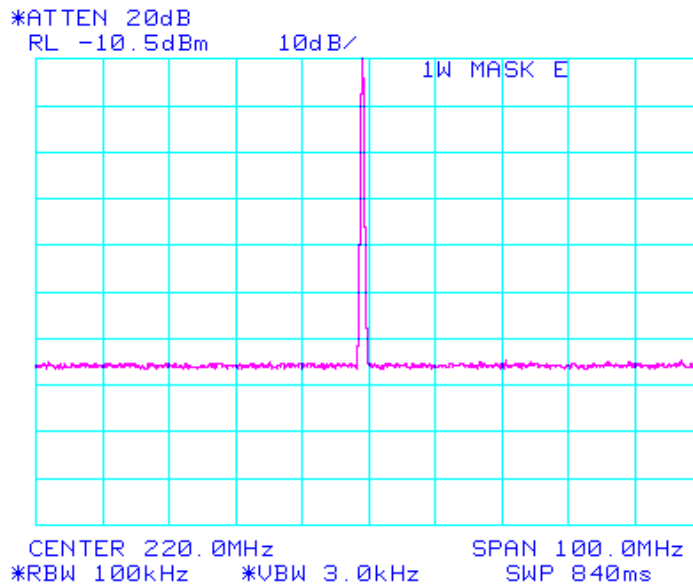
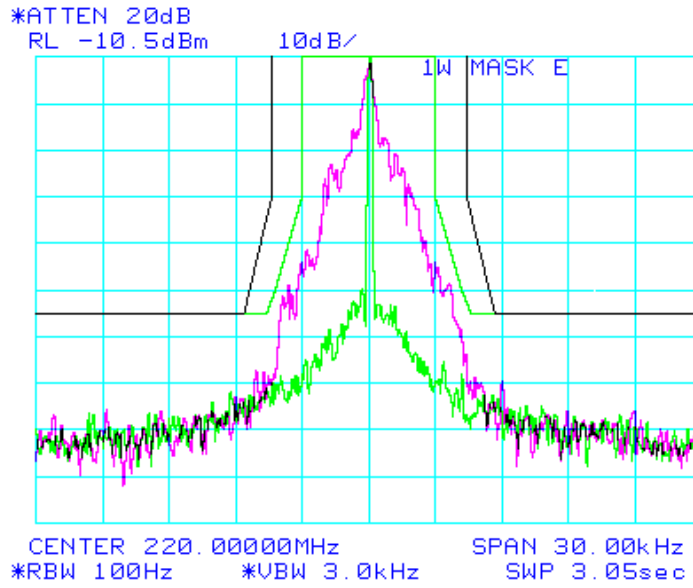
Mask F = Black Line



Mask: F(2 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 3K55 F1D
Data Rate: 8 kbps Peak Deviation with Data: 1.09 kHz

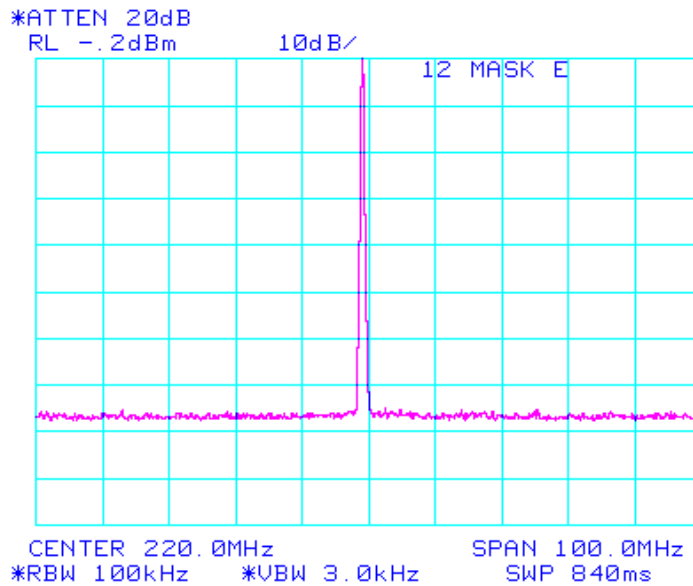
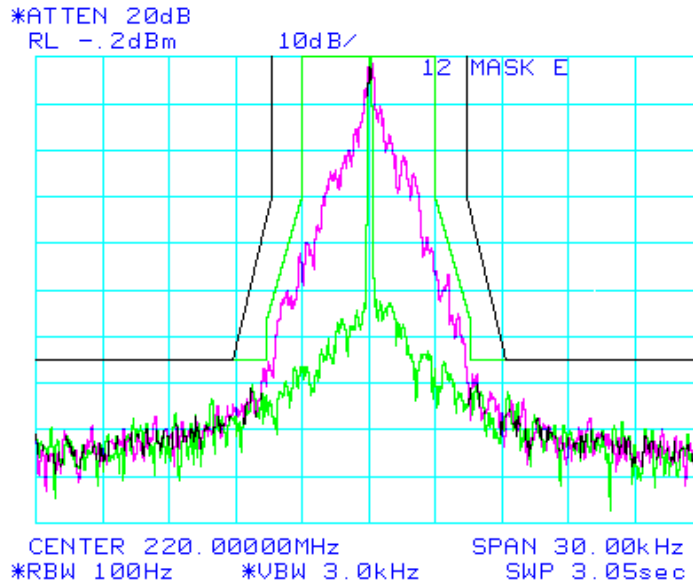
Mask F = Black Line



Mask: F(2 aggregate masks)
Output Power = 12 Watt

Spectrum for Emission: 3K55 F1D
Data Rate: 8 kbps Peak Deviation with Data: 1.09 kHz

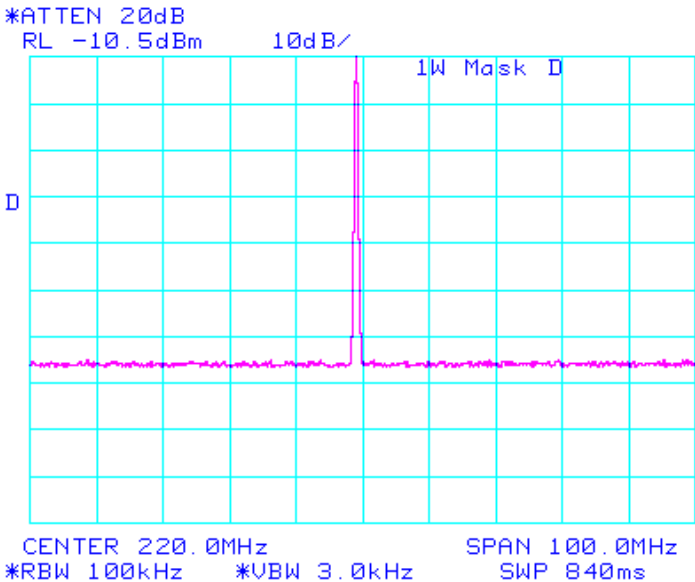
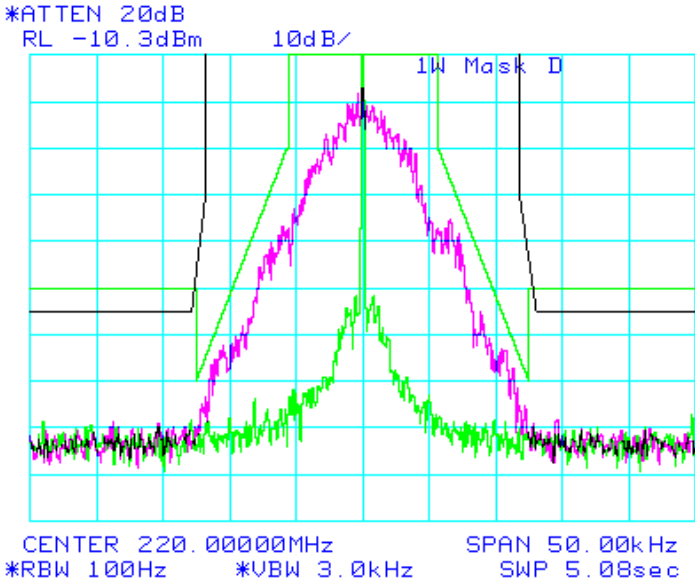
Mask F = Black Line



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

Spectrum for Emission: 8K20 F1D
Data Rate: 8 kbps Peak Deviation with Data: 3.05 kHz

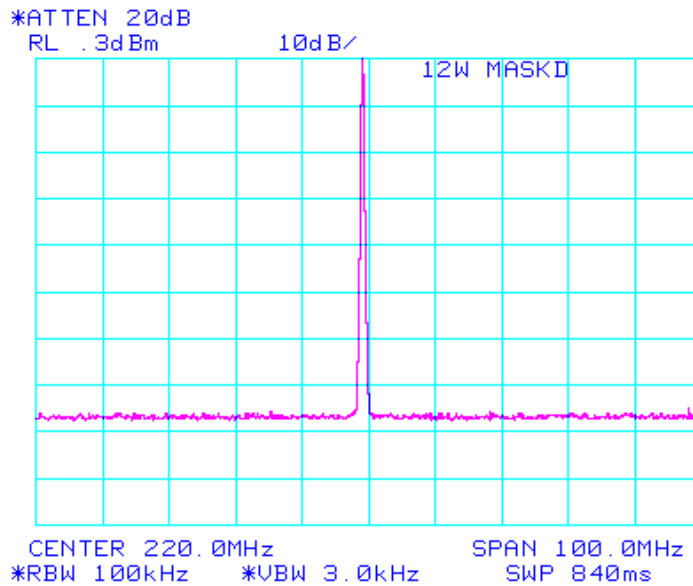
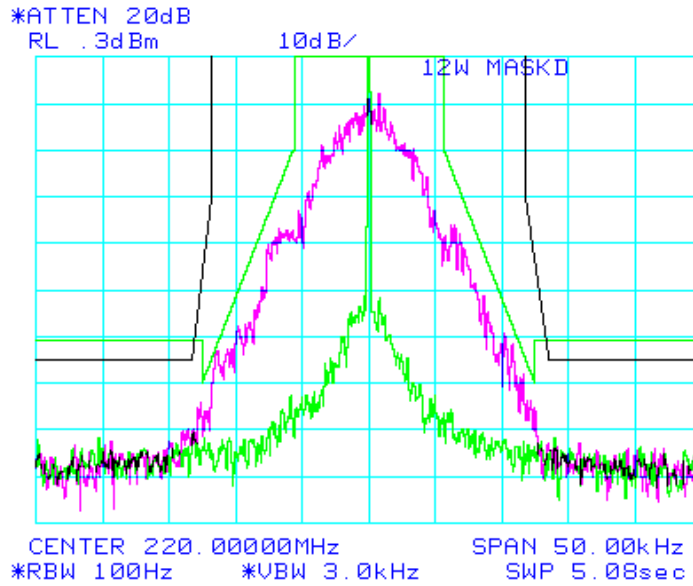
Mask F = Black Line



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

Spectrum for Emission: 8K20 F1D
Data Rate: 8 kbps Peak Deviation with Data: 3.05 kHz

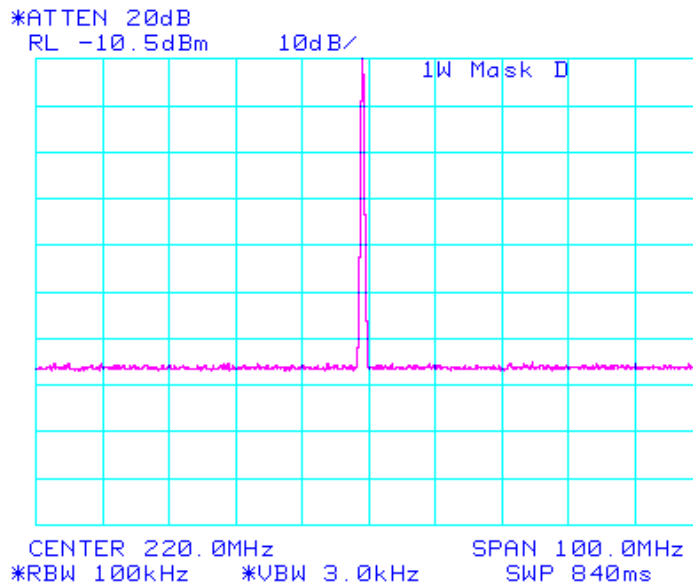
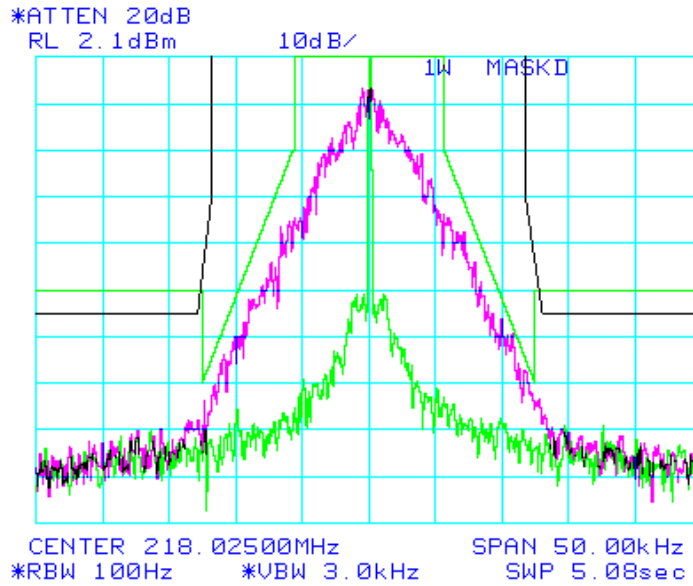
Mask F = Black Line



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

Spectrum for Emission: 8K30 F1D
Data Rate: 16 kbps Peak Deviation with Data: 3.70 kHz

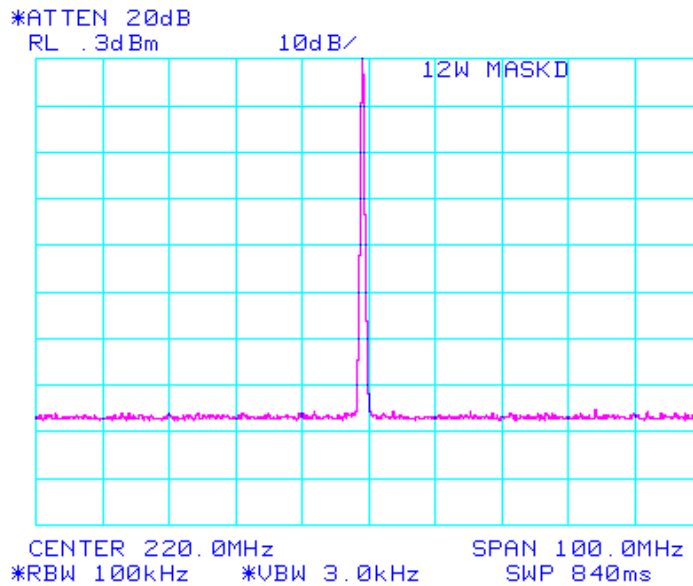
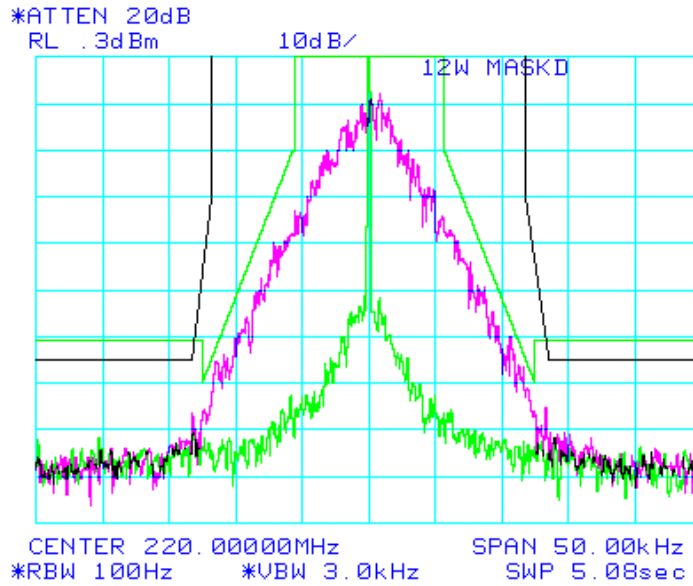
Mask F = Black Line



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

Spectrum for Emission: 8K30 F1D
Data Rate: 16 kbps Peak Deviation with Data: 3.70 kHz

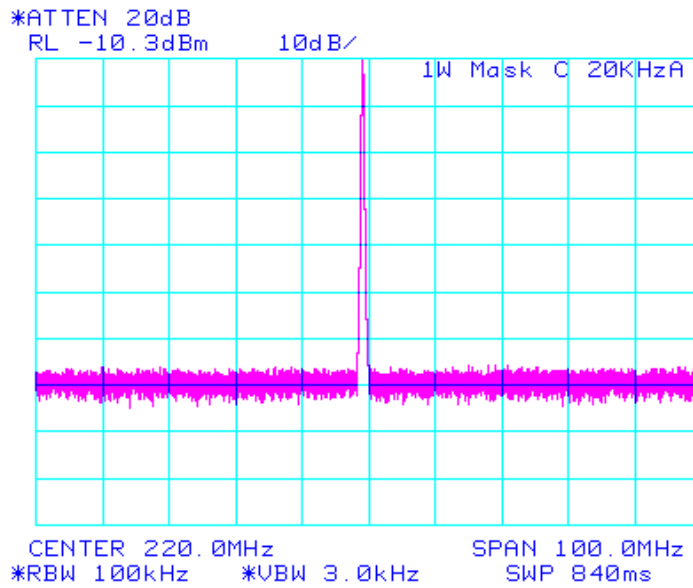
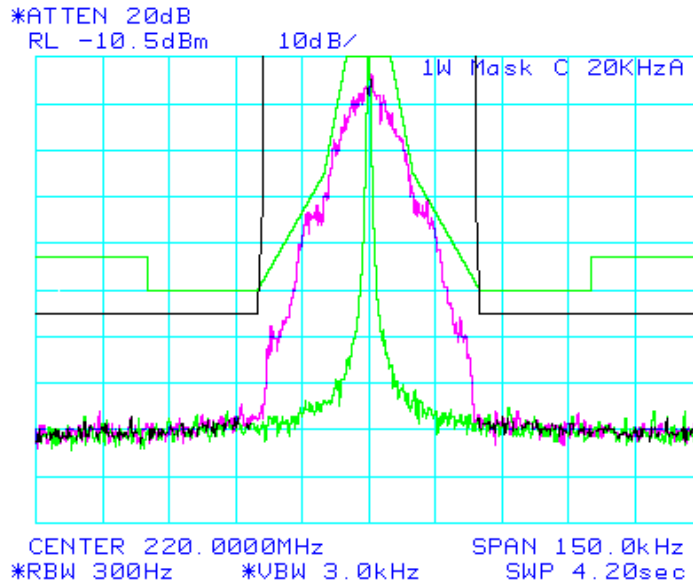
Mask F = Black Line



Mask: F(10 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 16K5 F1D
Data Rate: 16 kbps Peak Deviation with Data: 6.3 kHz

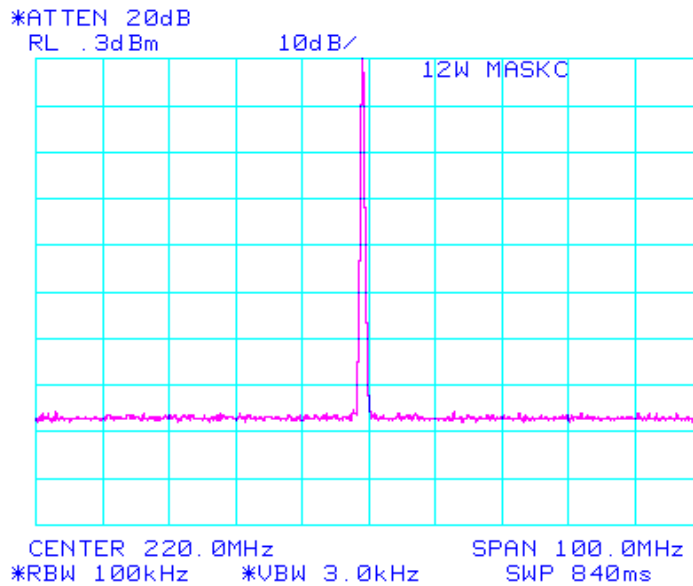
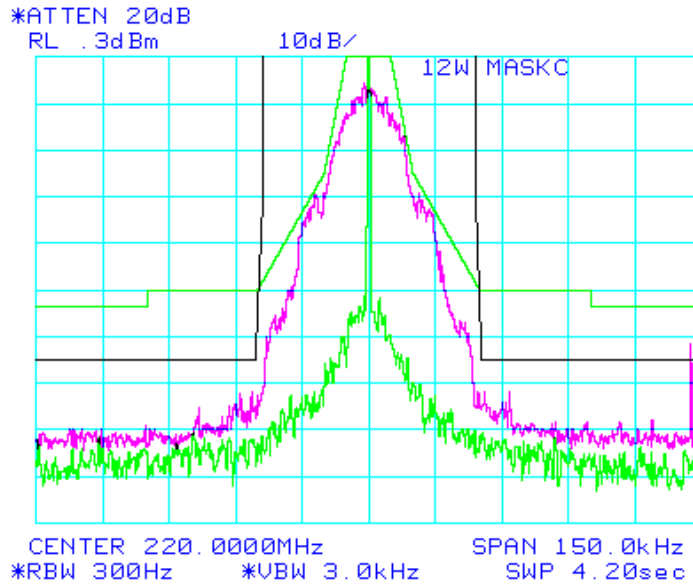
Mask F = Black Line



Mask: F(10 aggregate masks)
Output Power = 12 Watt

Spectrum for Emission: 16K5 F1D
Data Rate: 16 kbps Peak Deviation with Data: 6.3 kHz

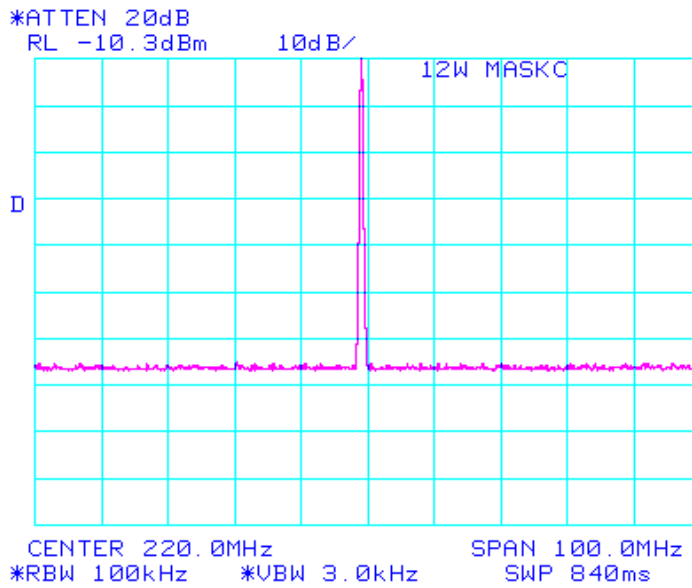
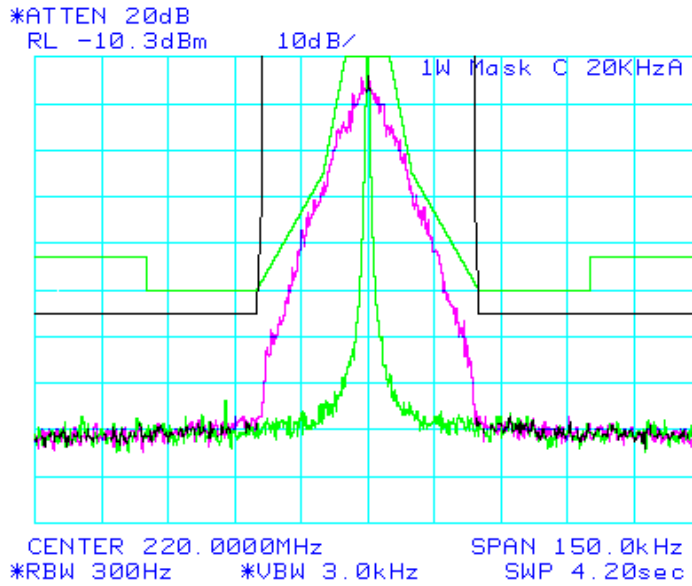
Mask F = Black Line



Mask: F(10 aggregate masks)
Output Power = 1 Watt

Spectrum for Emission: 16K8 F1D
Data Rate: 32 kbps Peak Deviation with Data: 6.3 kHz

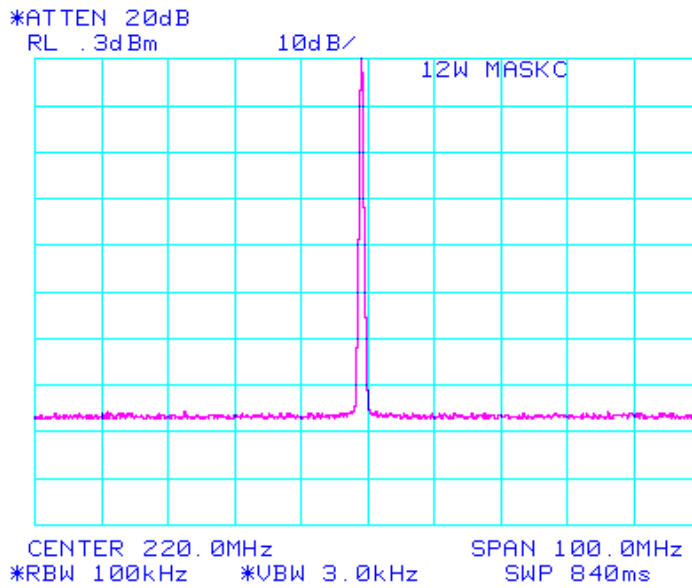
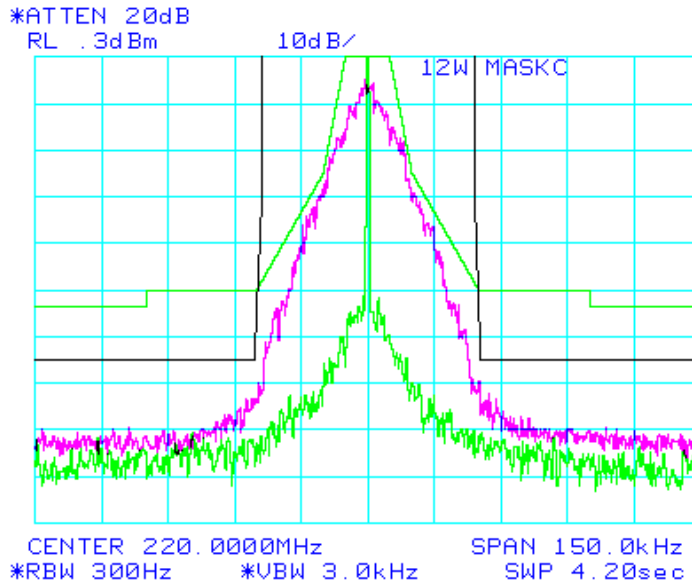
Mask F = Black Line



Mask: F(10 aggregate masks)
Output Power = 12 Watt

Spectrum for Emission: 16K8 F1D
Data Rate: 32 kbps Peak Deviation with Data: 6.3 kHz

Mask F = Black Line



NAME OF TEST: Field Strength of Spurious Radiation

RULE PART NUMBER: FCC: 2.1053, 90.210 (c,3)(d,3)(e,3), 80.211 (f)
 IC: RSS-119 5.8.2, 5.8.3, 5.8.4
 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 -65dBc , whichever is the lesser attenuation.

For 1 Watt: $55+10\text{Log}_{10}(1 \text{ Watt}) = -55 \text{ dBc}$
 or -65dBc , whichever is the lesser attenuation.

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

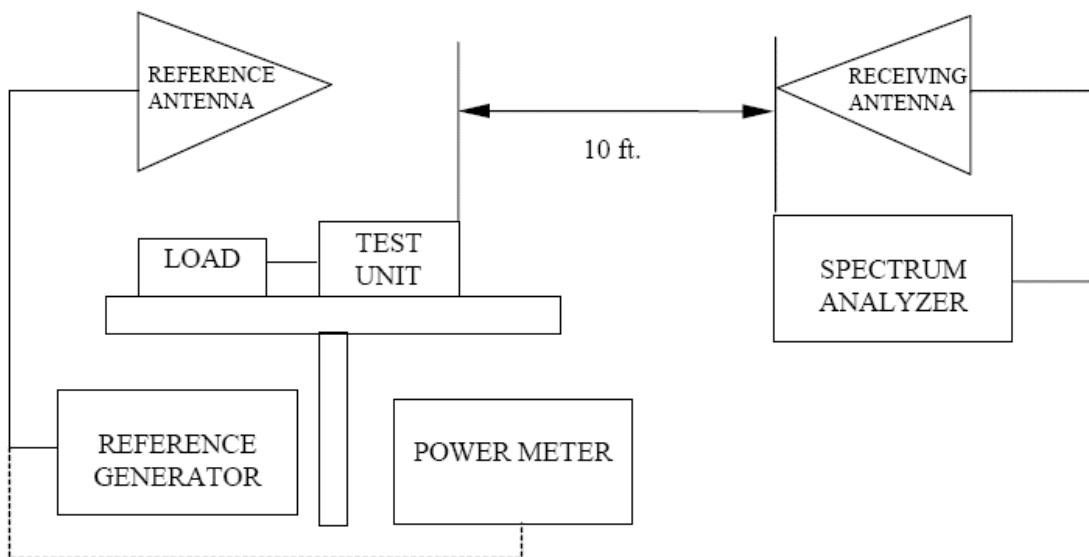
TEST CONDITIONS: Standard Test Conditions, 25 C
 RF Power Level = 1 Watt and 12 Watts
 Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C, 2.2.12

TEST EQUIPMENT: Waveguide Horn Antenna, EMCO Model 3115
 Log Periodic Linear Polarization Antenna, AILTECH Model 94612-1
 Bilog Antenna, Chase Model CBL6111B
 Dipole Antenna, Electro-Metrics Model EM-6924
 Power Supply, Hewlett Packard Model 6653A
 Spectrum Analyzer, Hewlett Packard Model HP8563E
 Reference Generator, Agilent Model E82570
 Power Meter, Model HP437B
 50-Ohm Load, Bird 25-T-MN

MEASUREMENT PROCEDURE: Radiated spurious attenuation was measured according to TIA/EIA Standard 603-C Section 2.2.12

TEST SET-UP:



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

Frequency: 218.025 MHz Spec = -60.8 dBc
Power: 12 Watts Highest Spur = -86.6 dBc
40.8 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
436.05	H	-96.8	-70.7	-1.67	-0.53	-110.3
	V	-93.3	-59.3	-1.67	-0.53	-99.0
654.075	H	-96.3	-66.0	-1.83	-0.54	-105.5
	V	-101.7	-64.4	-1.83	-0.54	-103.9
872.1	H	-97.7	-61.0	-2.50	1.70	-97.6
	V	-99.5	-61.5	-2.50	1.70	-98.1
1090.125	H	-97.2	-61.4	-2.67	3.11	-96.4
	V	-101.4	-65.4	-2.67	3.11	-100.4
1308.15	H	-99.7	-63.2	-3.00	3.98	-97.0
	V	-101.4	-61.4	-3.00	3.98	-95.2
1526.175	H	-96.2	-56.7	-3.17	4.76	-89.6
	V	-101.4	-60.4	-3.17	4.76	-93.3
1744.2	H	-99.7	-58.4	-3.33	4.85	-91.0
	V	-98.9	-58.0	-3.33	4.85	-90.7
1962.225	H	-96.9	-54.5	-3.83	4.93	-86.6
	V	-99.0	-57.5	-3.83	4.93	-89.6
2180.25	H	-99.9	-56.2	-4.50	5.17	-87.3
	V	-100.0	-56.2	-4.50	5.17	-87.3

Frequency: 218.025 MHz Spec = -50.0 dBc
Power: 1 Watts Highest Spur = -74.4 dBc
30.0 dBm

Spurious Frequency (MHz)	Polarization (Horz/Vert)	Spurious Level (dBm)	Substitution Generator (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Spurious Attenuation dBc
436.05	H	-97.8	-71.7	-1.67	-0.53	-100.5
	V	-97.3	-63.3	-1.67	-0.53	-92.2
654.075	H	-101.3	-71.0	-1.83	-0.54	-99.7
	V	-102.8	-65.5	-1.83	-0.54	-94.2
872.1	H	-97.0	-60.3	-2.50	1.70	-86.1
	V	-101.7	-63.7	-2.50	1.70	-89.5
1090.125	H	-99.0	-63.2	-2.67	3.11	-87.4
	V	-99.4	-63.4	-2.67	3.11	-87.6
1308.15	H	-99.0	-62.5	-3.00	3.98	-85.6
	V	-100.1	-60.1	-3.00	3.98	-83.1
1526.175	H	-98.4	-58.9	-3.17	4.76	-80.9
	V	-100.0	-59.0	-3.17	4.76	-81.1

Equipment Calibration Information

Equipment	Serial Number	Cal Date	Cal Due
HP 8563E Spectrum Analyzer	3221A00149	3/23/2008	3/23/2010
Agilent E8257D Signal Generator	MY44320507	3/23/2008	3/23/2010
HP 8901B Modulation Analyzer	3019A02779	3/21/2008	3/21/2010
HP 437B Power Meter	3125U12364	4/19/2008	4/19/2010

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