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FCC Part 90 Certification Application

FCC Form 731

For The

Viper
UHF RADIO MODEM

FCC ID: NP4-5048-300

For a Class II Permissive Change

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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);
IC: RSS-Gen 4.4.1

Necessary Bandwidth Measurement

This radio modem uses digital modulation signals, passing through a Squared Root Raised Cosine α=0.2 or α=0.5 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	Emission Type	Data Rate	Baud Rate	Measured Peak Deviation	Measured 99% Occupied BW
6.25 kHz	3K20 F1D	12 kbps	4000	1.15 kHz	3.20 kHz
6.25 kHz	3K45 F1D	16 kbps	4000	1.056 kHz	3.45 kHz
12.5 kHz	8K50 F1D	24 kbps	8000	3.725 kHz	8.50 kHz
12.5 kHz	8K08 F1D	32 kbps	8000	3.728 kHz	8.08 kHz
25 kHz	17K8 F1D	48 kbps	16000	7.590 kHz	17.8 kHz
25 kHz	17K0 F1D	64 kbps	16000	7.520 kHz	17.0 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

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

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.

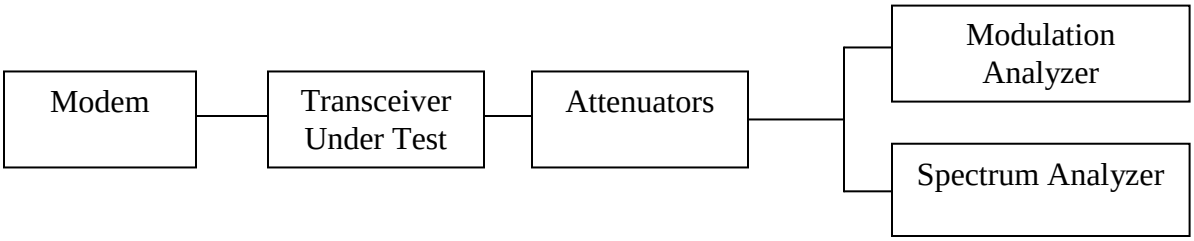
The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a 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 HP8901A

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 and 50 kHz channels)
VBW: 3 kHz
SPAN: 100 kHz (6.25 and 12.5 kHz channels)
SPAN: 150 kHz (25 kHz channels)
SPAN: 200 kHz (50 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 64 kbps references in the Installation Guide correspond to a transmitter baud rate of 32000 baud. The 8-level signaling transmits three information bits per symbol (baud), which yields a bit rate of three times the on-air baud rate. Hence the 12, 24, 48,or 96 kbps references in the Installation Guide correspond to a transmitter baud rate of 4000, 8000, 16000 or 32000 baud. The 16-level signaling transmits four information bits per symbol (baud), which yields a bit rate of four times the on-air baud rate. Hence the 16, 32, 64, or 128 kbps references in the Installation Guide correspond to a transmitter baud rate of 4000, 8000, 16000 or 32000baud. That digital signal is digitally filtered (Square Root Raised Cosine pulse shaping with α=0.2 or 0.5) by the DSP and converted to I&Q components, then fed to the digital to analog converter. This SRRC4FSK, SRRC8FSK, or SRRC16FSK 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, 8-FSK and 16-FSK and pulse shaping with SRRC α=0.2 or α=0.5 depending on the channel selection. 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 **3K20F1D** and **3K45F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(e), 2.1049 (c) (1);
IC: RSS-119 5.8.4

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 4.6 kHz, at least $55+10\log_{10}(P)$ or 65 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

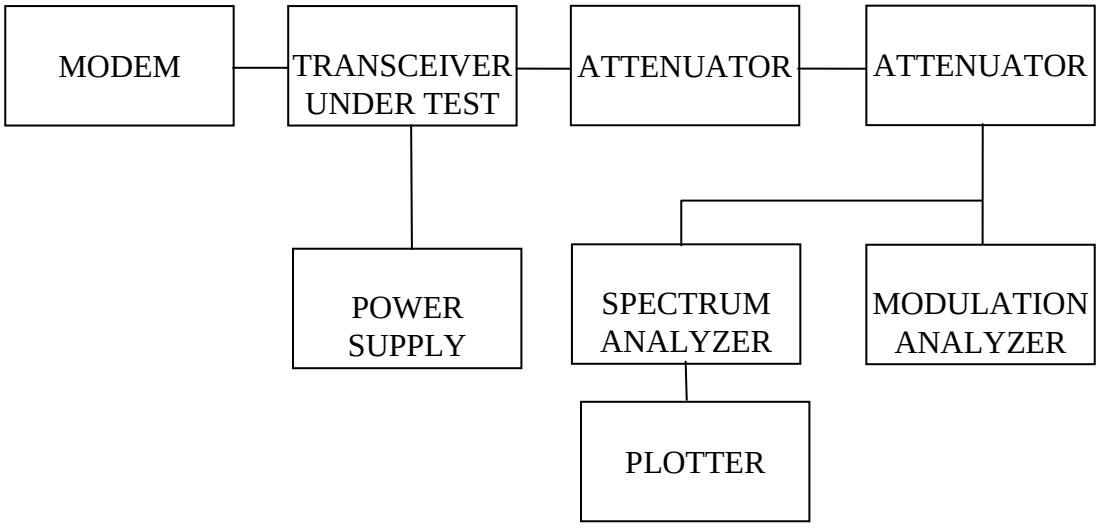
TEST RESULTS: Meets minimum standards (see data on following page)

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

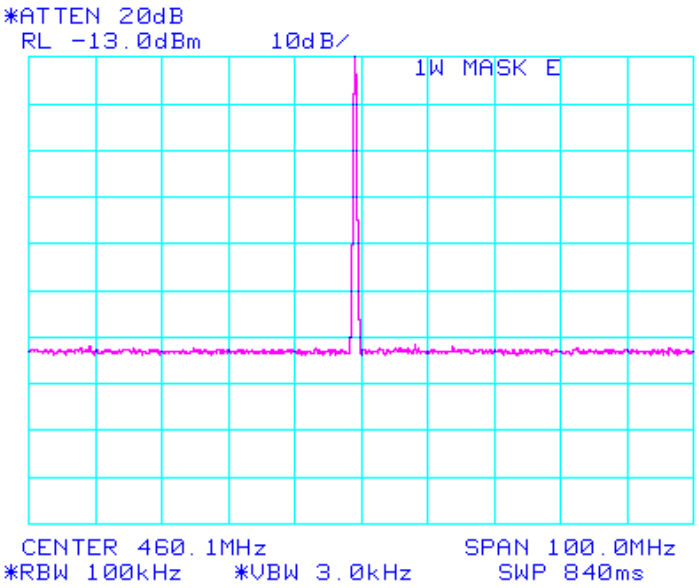
TEST PROCEDURE: TIA/EIA – 603-C

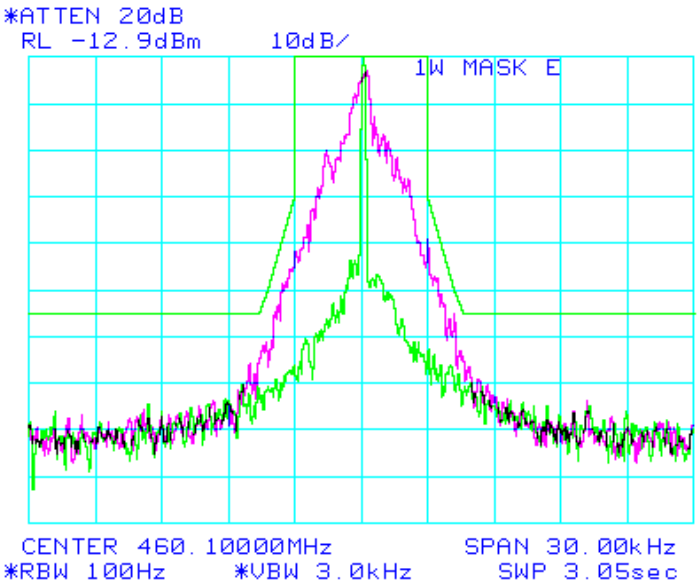
TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
50-Ohm Attenuator, Pasternack Model PE7002-10 (10dB)
DC Power Supply, Hewlett Packard Model 6653A
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

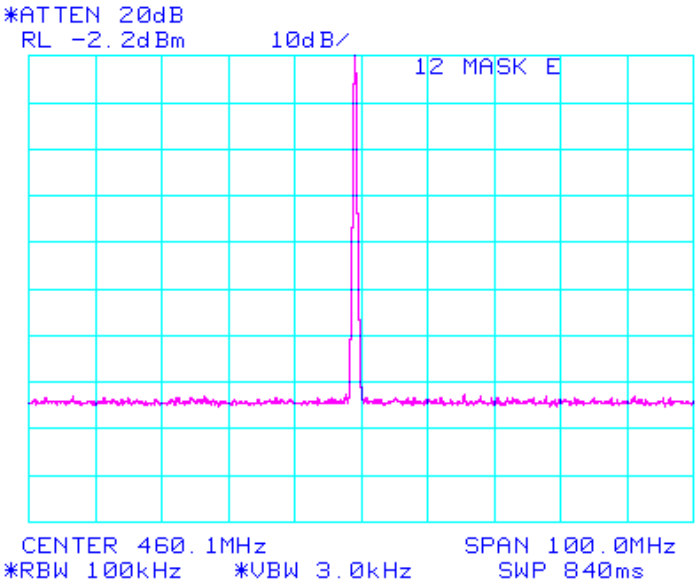


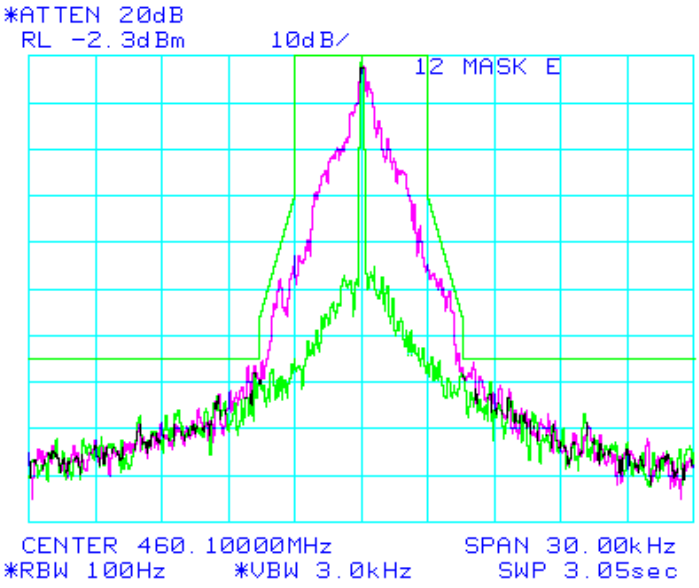
Mask: E, 1W Spectrum for Emission: 3K20 F1D
Output Power = 1 Watt Data Rate: 12 kbps Peak Deviation with Data: 1.15kHz





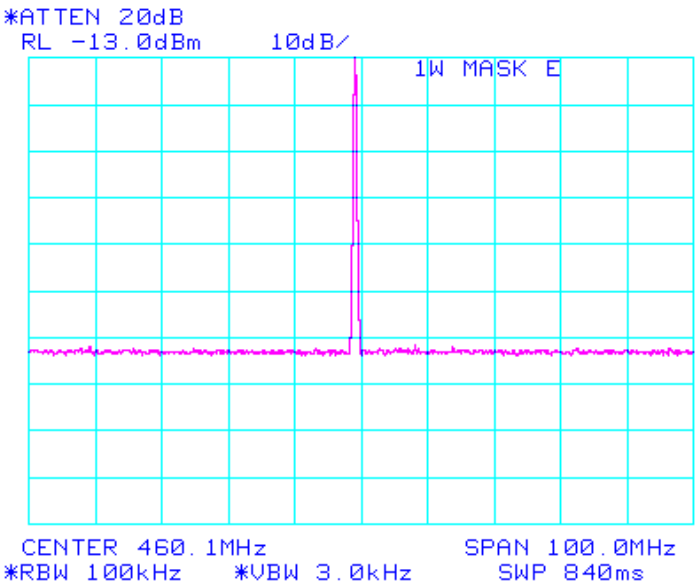
Output Power = 12 Watt

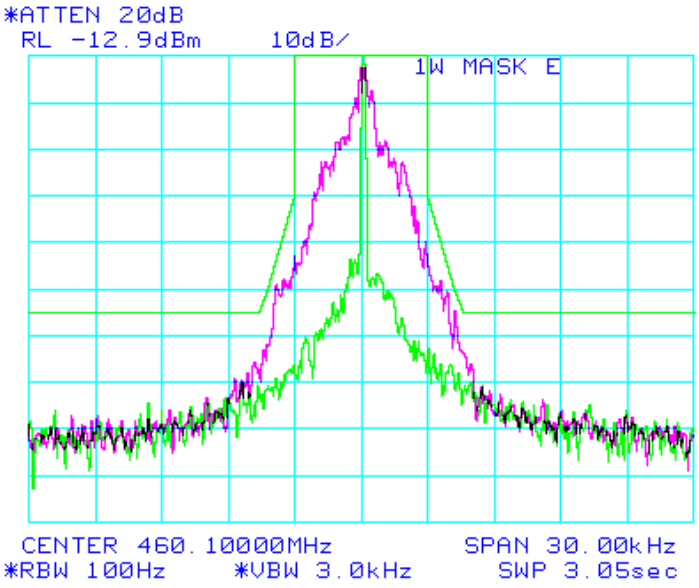




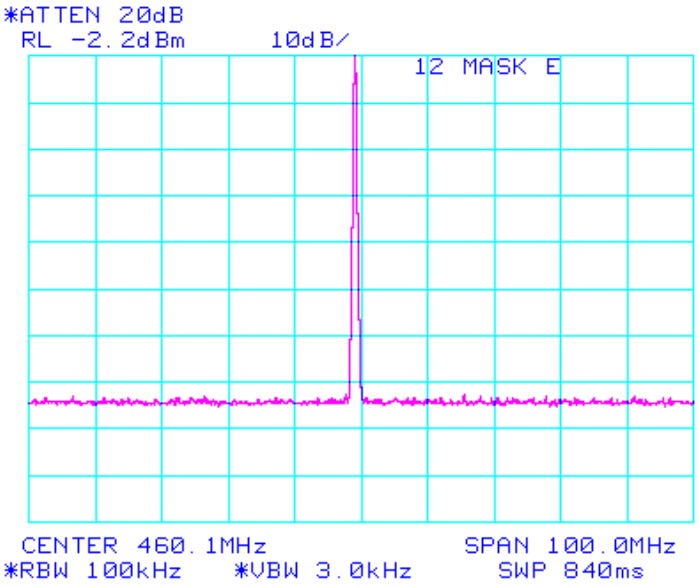
Mask: E, 1W
Output Power = 1 Watt

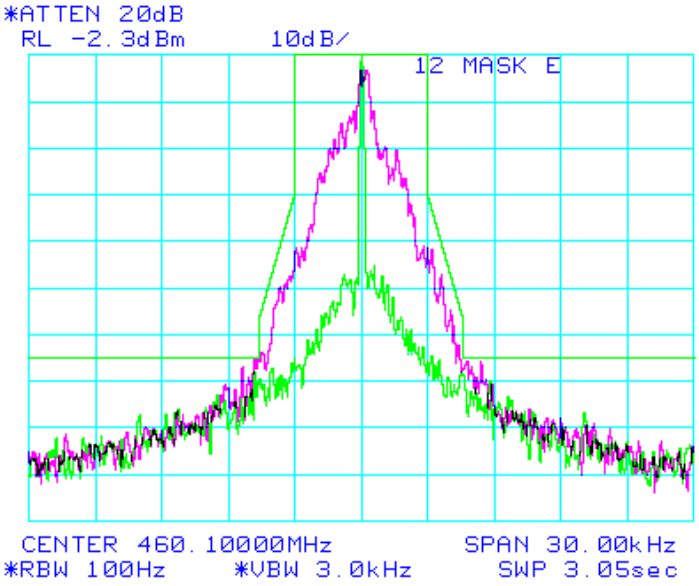
Spectrum for Emission: 3K45 F1D
Data Rate: 16 kbps
Peak Deviation with Data: 1.056 kHz





Output Power = 12 Watt





NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **8K50F1D** and **8K08F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(d), 2.1049 (c) (1)
IC: RSS-119 5.8.3

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_d-2.88kHz) dB.
Greater than 12.5 kHz, at least 50+10log$_{10}$(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

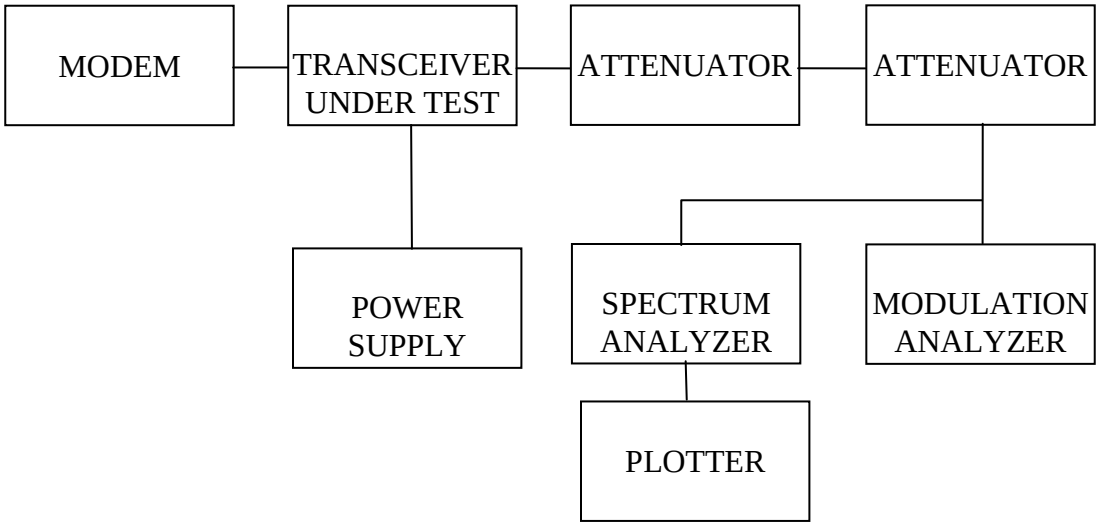
TEST RESULTS: Meets minimum standards (see data on following page)

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

TEST PROCEDURE: TIA/EIA – 603-C

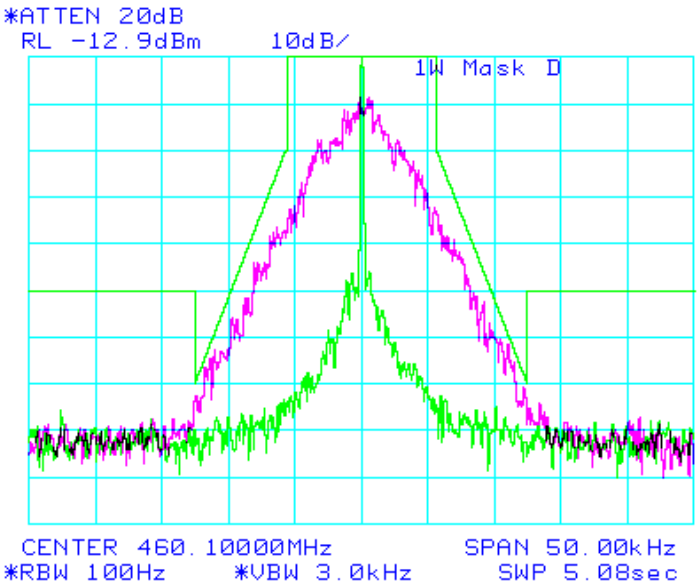
TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
50-Ohm Attenuator, Pasternack Model PE7002-10 (10dB)
DC Power Supply, Hewlett Packard Model 6653A
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

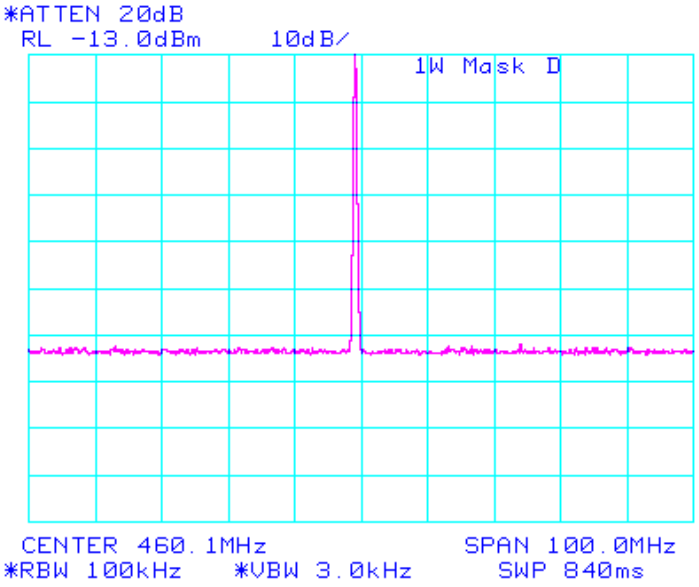
TEST SET-UP:



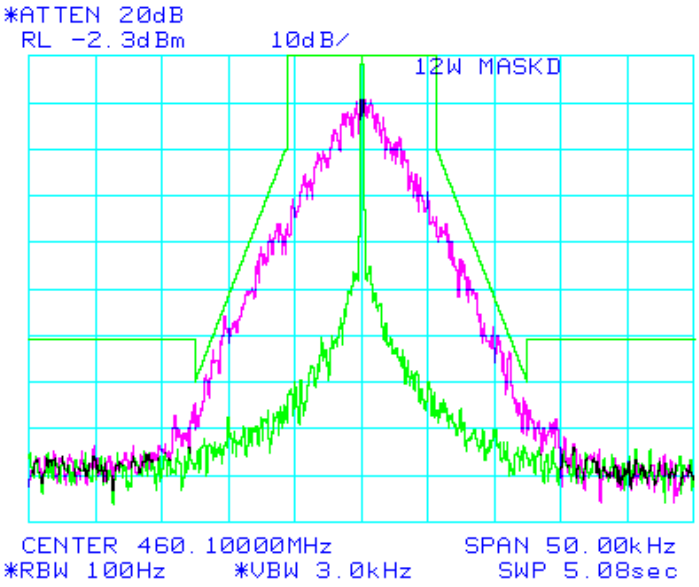
Mask: D, 1W
Output Power = 1 Watt

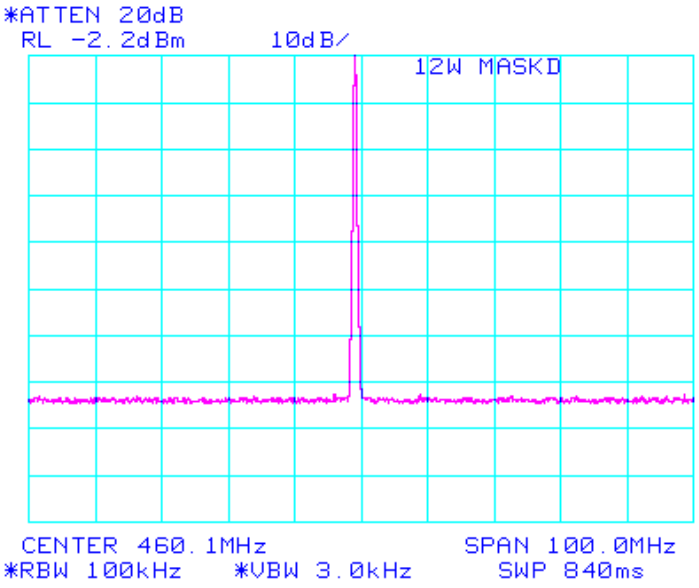
Spectrum for Emission: 8K50 F1D
Data Rate: 24 kbps
Peak Deviation with Data: 3.725 kHz





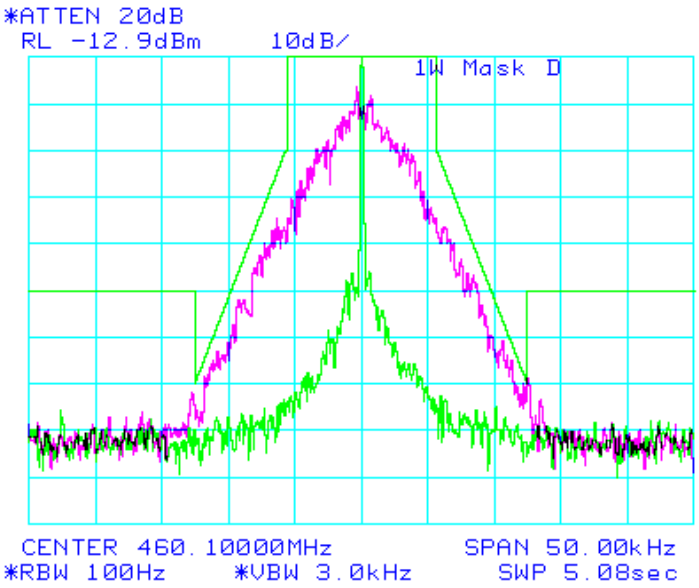
Output Power = 12 Watts

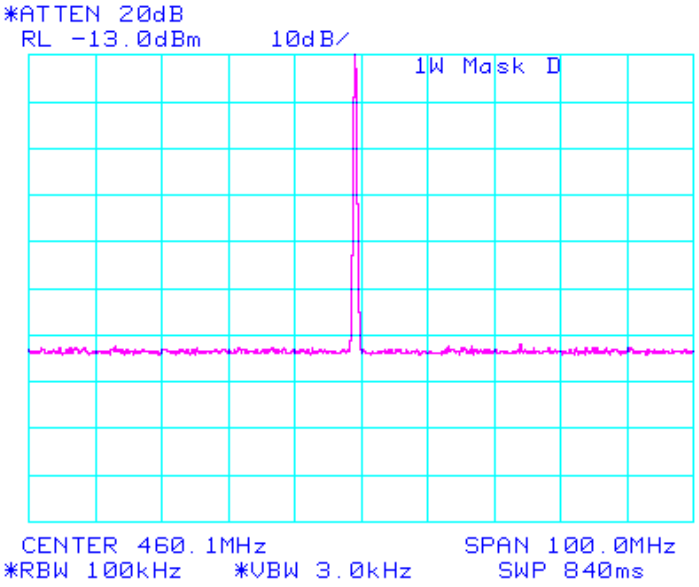




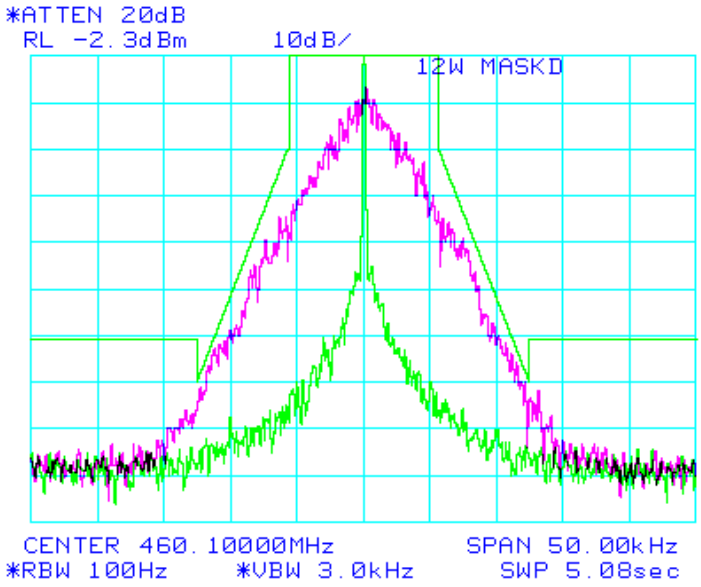
Mask: D, 1W
Output Power = 1 Watt

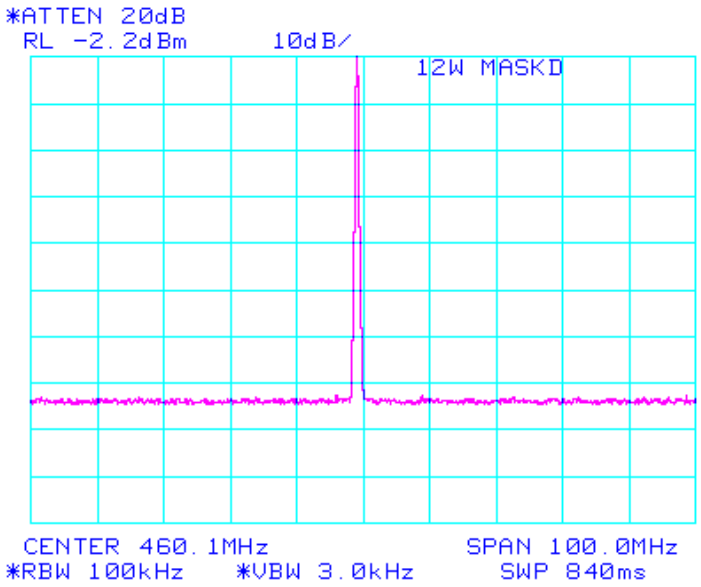
Spectrum for Emission: 8K08 F1D
Data Rate: 32 kbps
Peak Deviation with Data: 3.728 kHz





Output Power = 12 Watts





NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **17K8F1D** and **17K0F1D**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(c), 2.1049 (c) (1)
IC: RSS-119 5.8.2

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

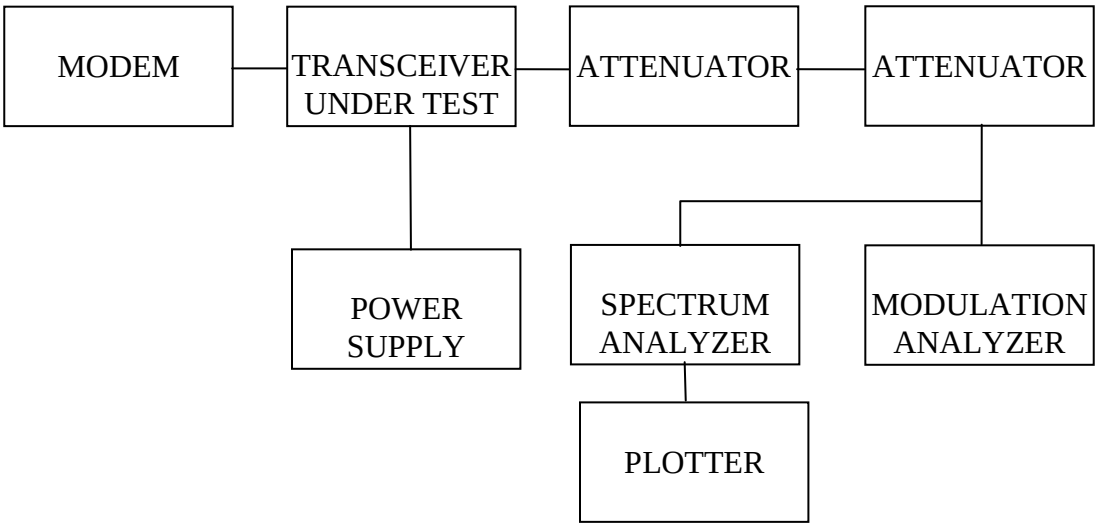
TEST RESULTS: Meets minimum standards (see data on following page)

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

TEST PROCEDURE: TIA/EIA – 603-C

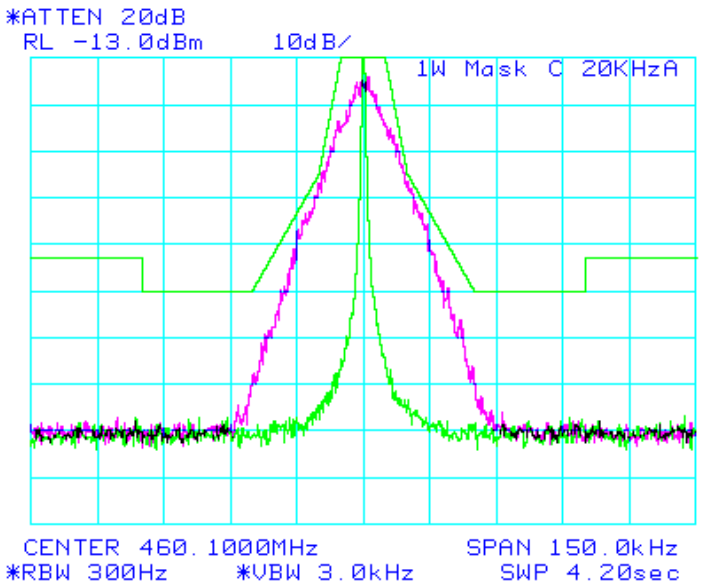
TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 50-A-FFN-20 (20dB, 50W)
50-Ohm Attenuator, Bird Electronics Model 10-A-MFN-10 (10dB, 10W)
50-Ohm Attenuator, Pasternack Model PE7002-10 (10dB)
DC Power Supply, Hewlett Packard Model 6653A
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

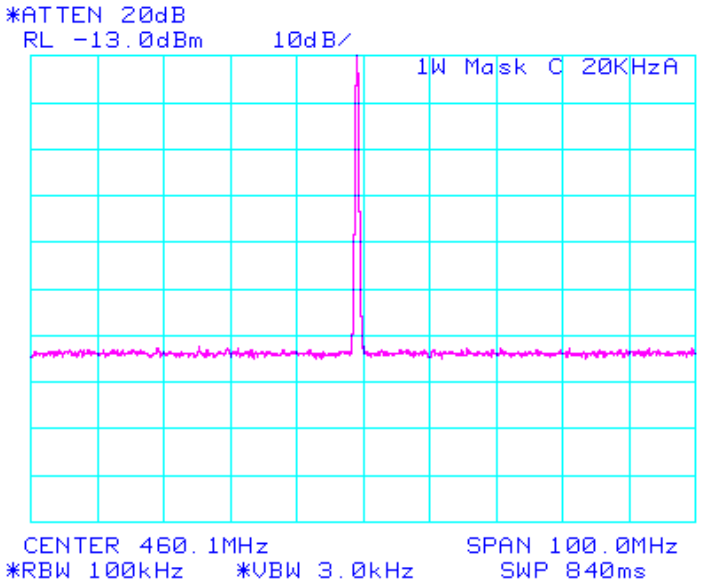
TEST SET-UP:



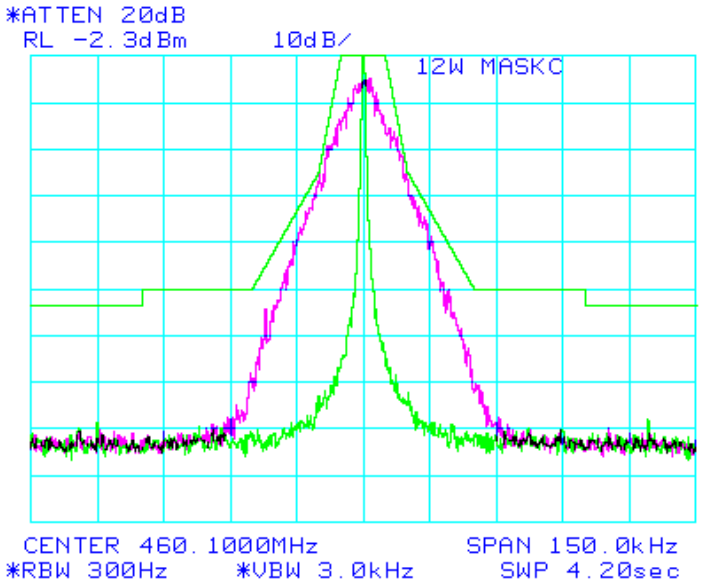
Mask: C, 1W
Output Power = 1 Watt

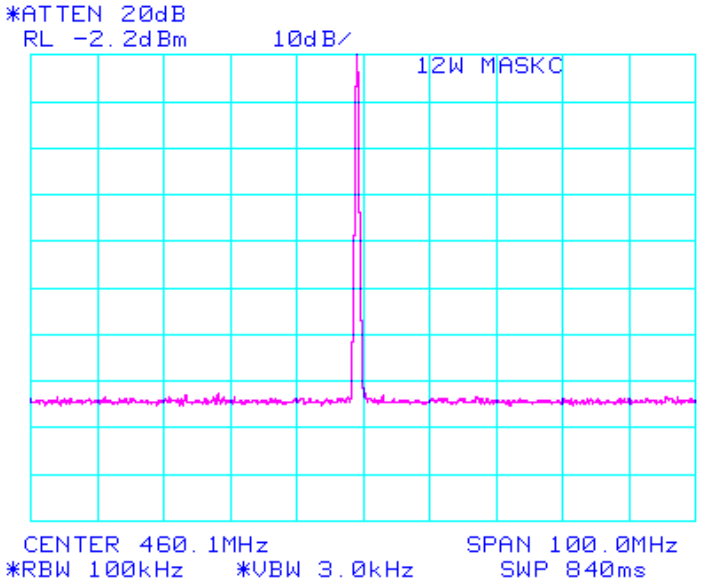
Spectrum for Emission: 17K8 F1D
Data Rate: 48 kbps
Peak Deviation with Data: 7.59 kHz





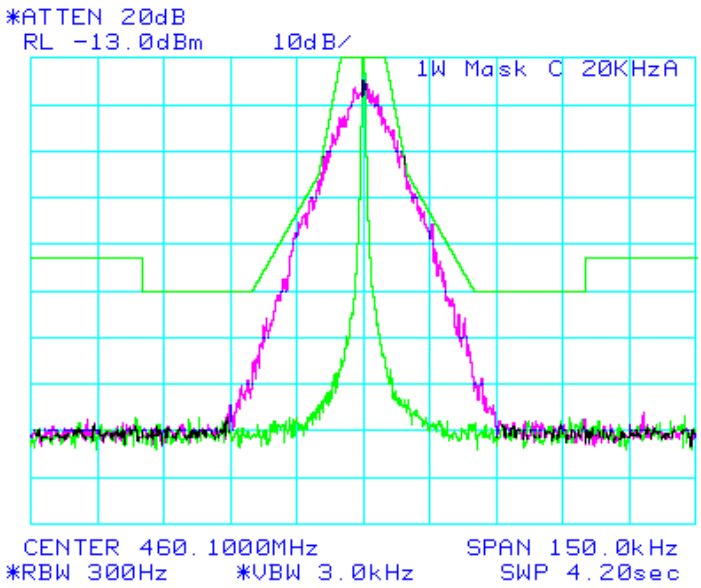
Output Power = 12 Watt

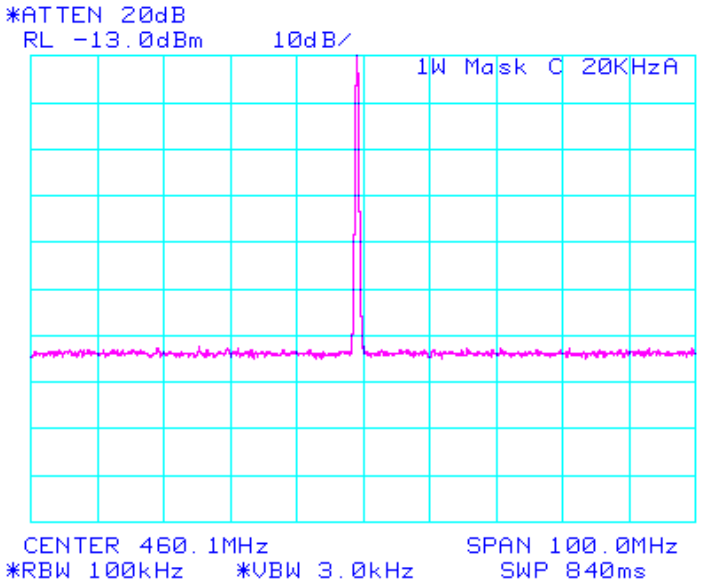




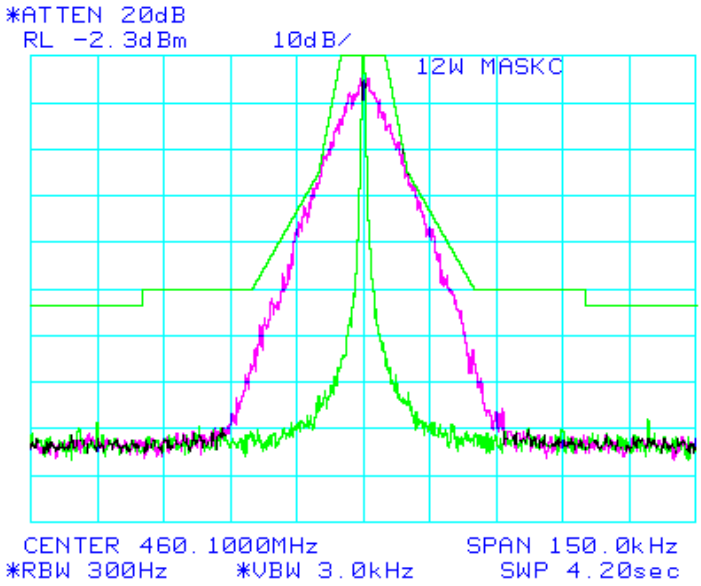
Mask: C, 1W
Output Power = 1 Watt

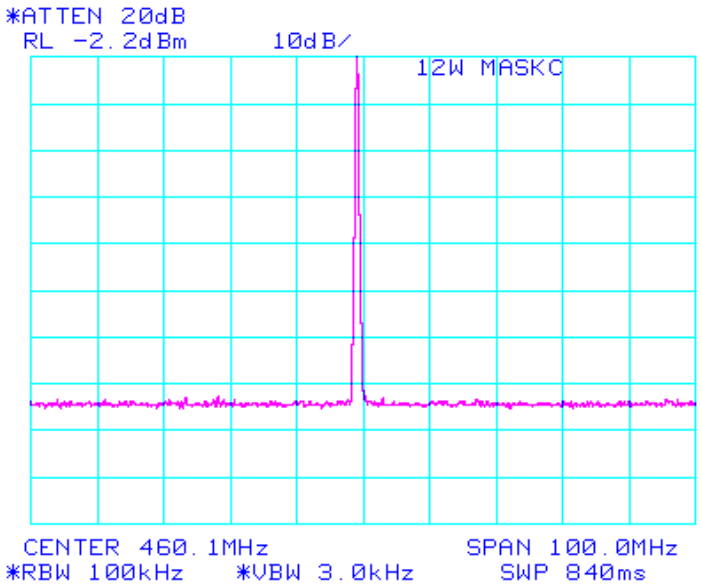
Spectrum for Emission: 17K0 F1D
Data Rate: 64 kbps
Peak Deviation with Data: 7.52 kHz





Output Power = 12 WattS





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
HP 437B Power Meter	3125U13882	4/12/2010	4/12/2012

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