Calamp Wireless networks Corporation
Corporate Headquarters and Manufacturing Operations
299 Johnson Avenue, Suite 110
Waseca, MN 56093-0833 USA
Phone: 507-833-8819
Fax: 507-833-6748

FCC Part 90 Certification Application

IC RSS-119 Certification Application

For The

Guardian 400
VHF RADIO MODEM

FCC ID: NP4-5046-300

IC ID: 773B-5046300

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 4.6.1

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 outlined in FCC: (2.202(c)(4)) and IC: TRC 43 section 7.

The measurement explanations are provided below.

Necessary Bandwidth Measurement:

Channel Spacing	Emission Type	Data Rate	Baud Rate	Measured Peak Deviation	Measured 99% Occupied BW
12.5 kHz	10K2F3D	NA	NA	2.484 kHz	10.2 kHz
12.5 kHz	10K2F3E	NA	NA	2.484 kHz	10.2 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) (RSS-Gen 4.6.1), 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

$$TP=\int_{0}^{+\infty} PSD_{(f)}df=(1/t)\int_{-\infty}^{+\infty} |z_{(t)}|^2dt$$

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.

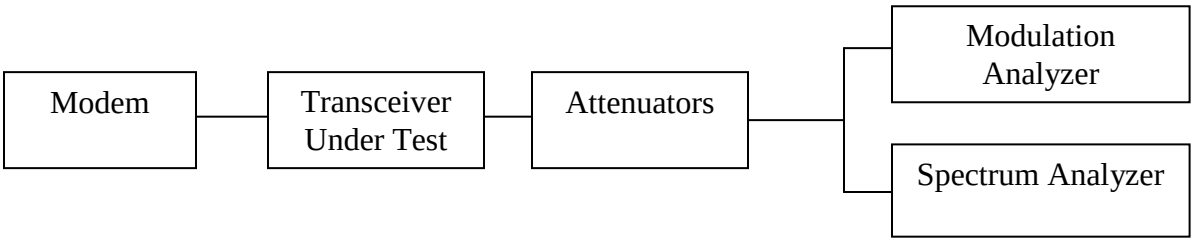
The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a 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 25-A-MFN-6 (6dB, 25W)
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 (12.5 kHz channels)
VBW: 3 kHz
SPAN: 50 kHz (12.5 kHz channels)



NAME OF TEST: Transmitter Occupied Bandwidth for Emission Designators **10K2F3D** and **10K2F3E**

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, P =2 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 $7.27(f_d\text{-}2.88\text{kHz})$ dB.
Greater than 12.5 kHz, at least $50+10\log_{10}(P)$ 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

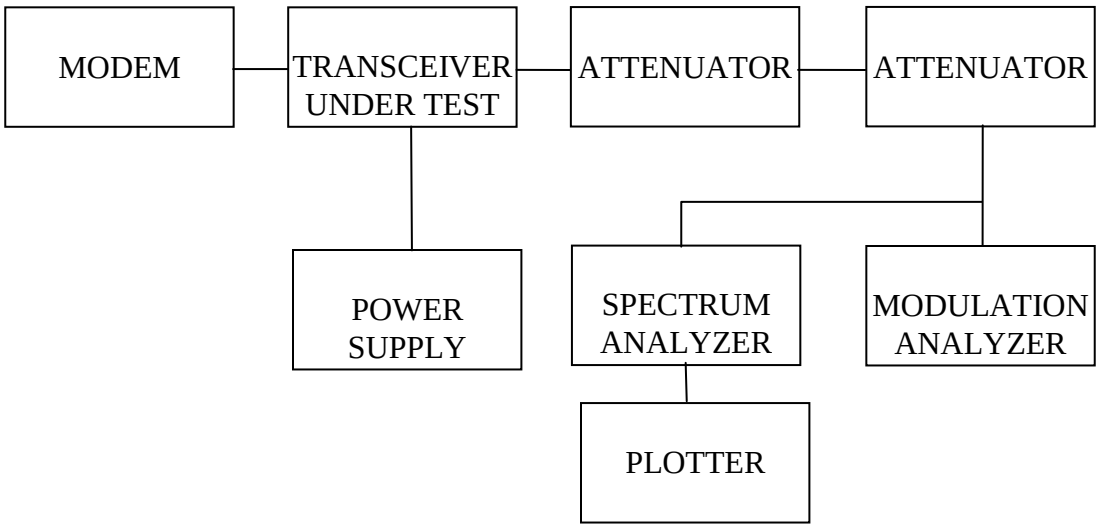
TEST RESULTS: Meets minimum standards (see data on following page)

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 25-A-MFN-6 (6dB, 25W)
DC Power Supply, Hewlett Packard Model 6653A
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901B

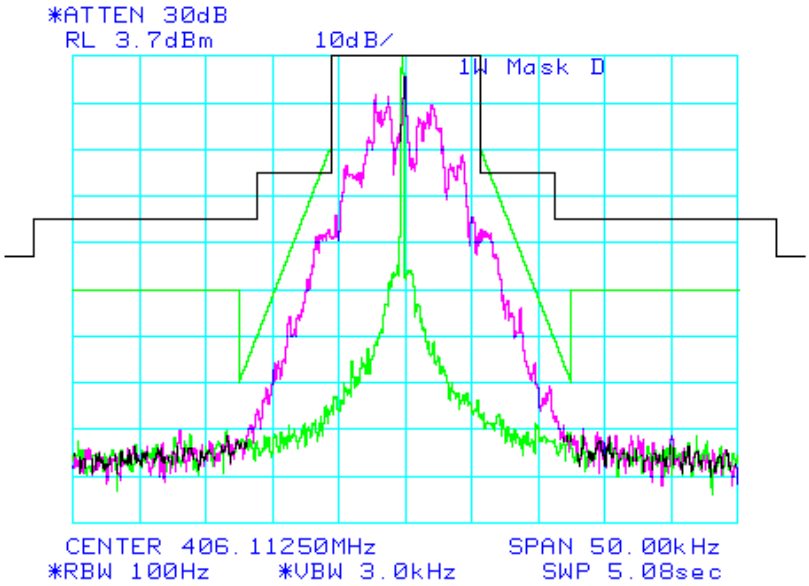
TEST SET-UP:

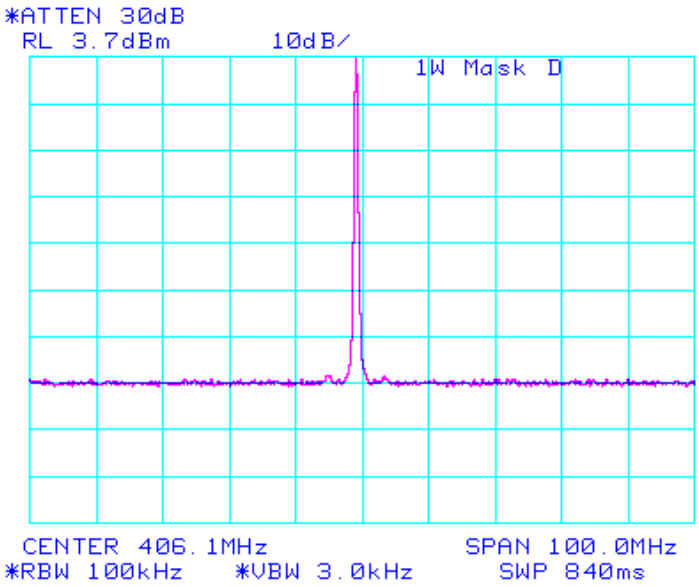


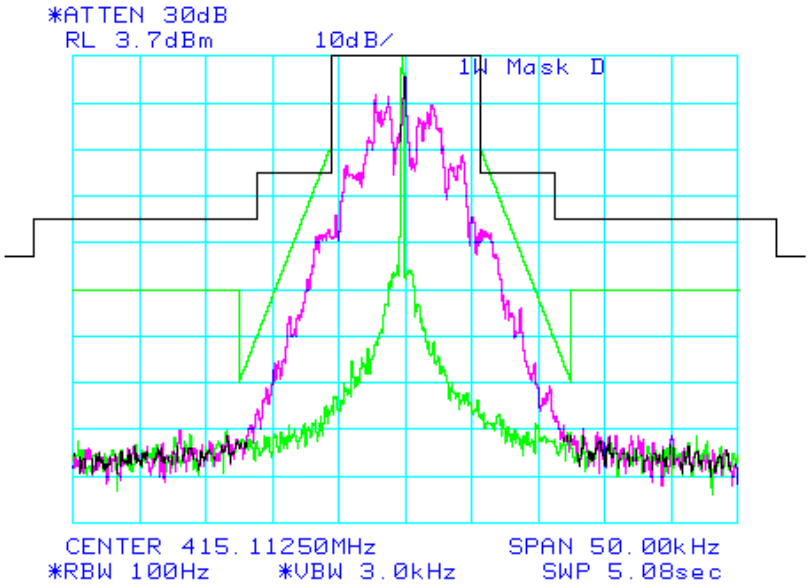
Mask: D, 1W
Output Power = 1 Watt

Spectrum for Emission: 10K2F3D
Peak Deviation with Data: 2.484 kHz

Mask B = Black Line
Mask D = Green Line



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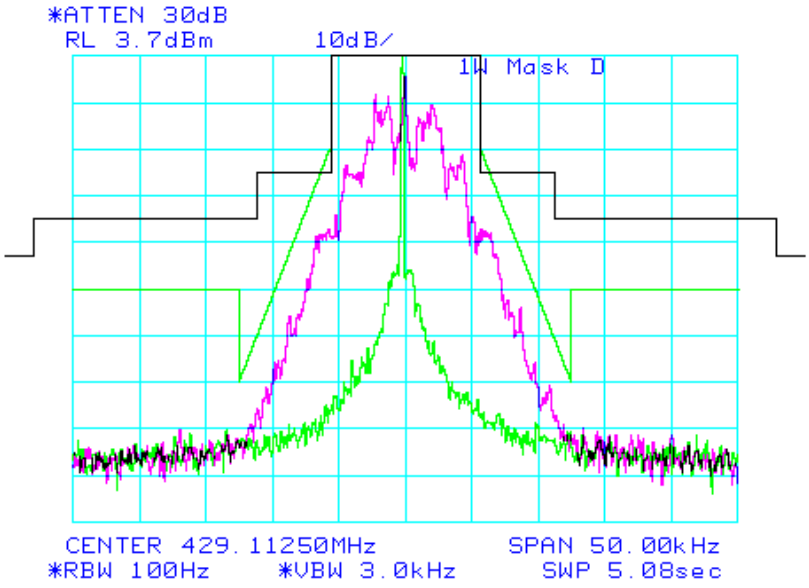
RL 3.7dBm
10dB/
1W Mask D
CENTER 415.11250MHz
SPAN 50.00kHz
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec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SPAN 50.00kHz
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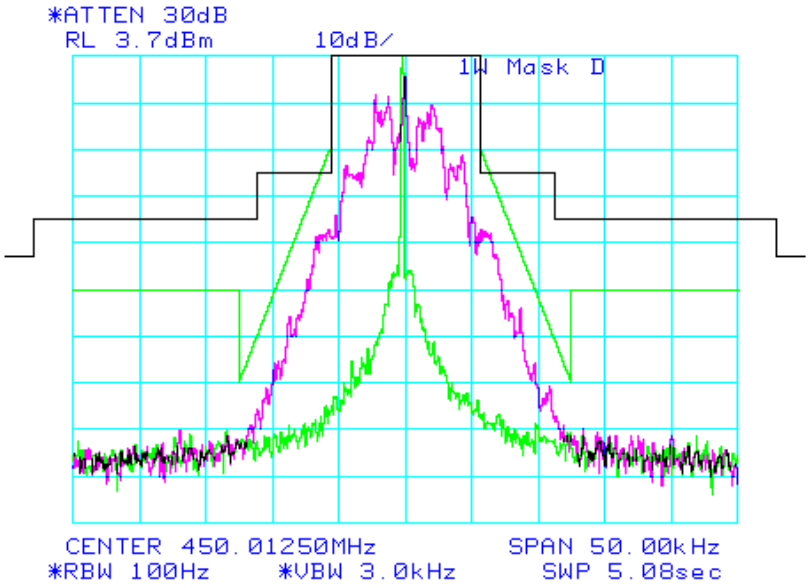
SWP 5.08sec


*ATTEN 30dB
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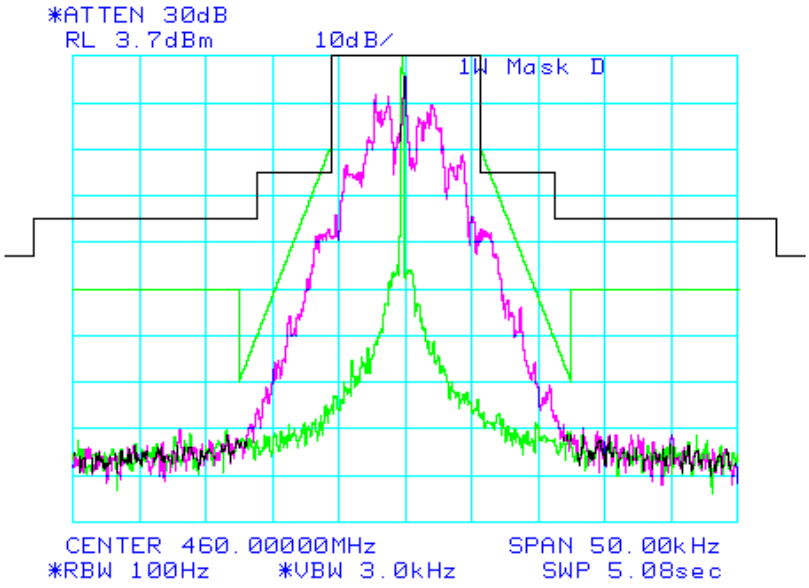
CENTER 450.01250MHz
SPAN 50.00kHz
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec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SPAN 50.00kHz
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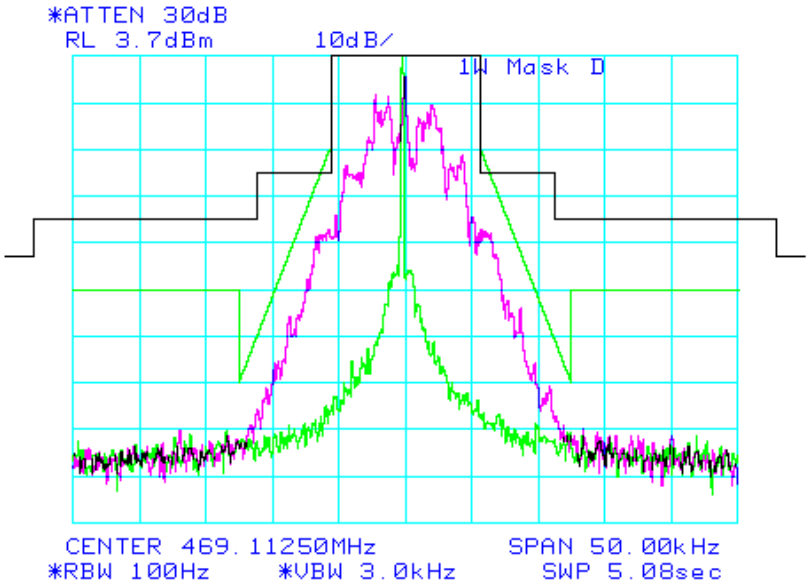
SWP 5.08sec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10dB/
1W Mask D
CENTER 469.11250MHz
SPAN 50.00kHz
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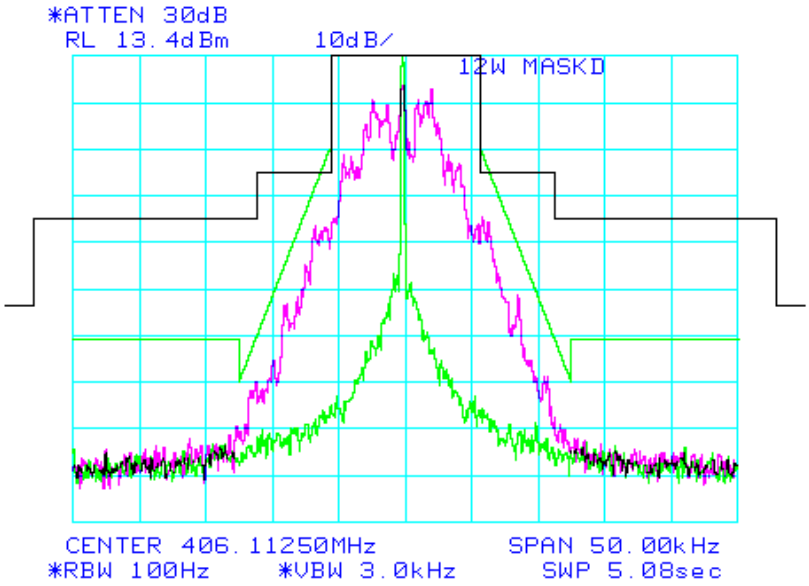
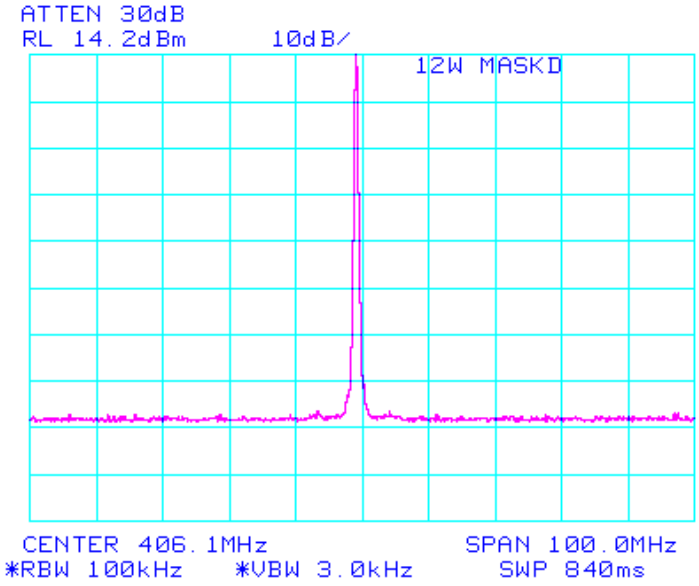
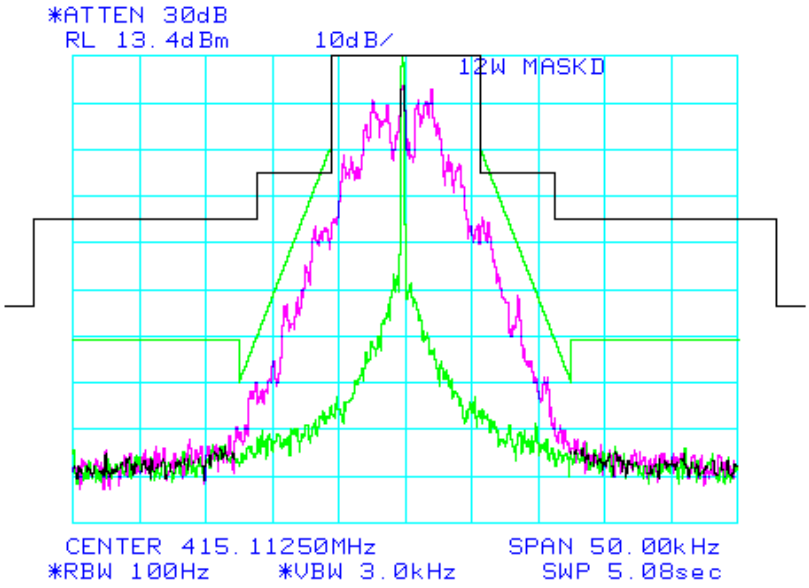
SWP 5.08sec

Output Power = 12 Watts

Mask B = Black Line
Mask D = Green Line



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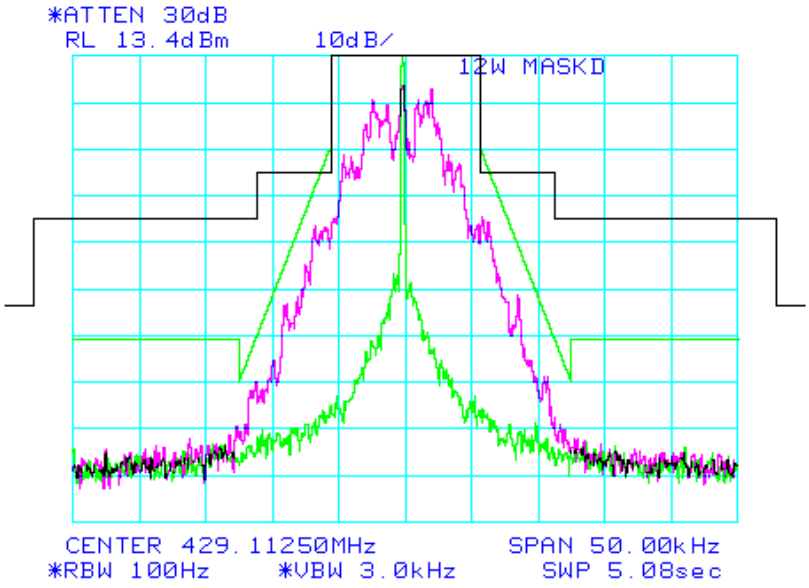
*VBW 3.0kHz
SWP 5.08sec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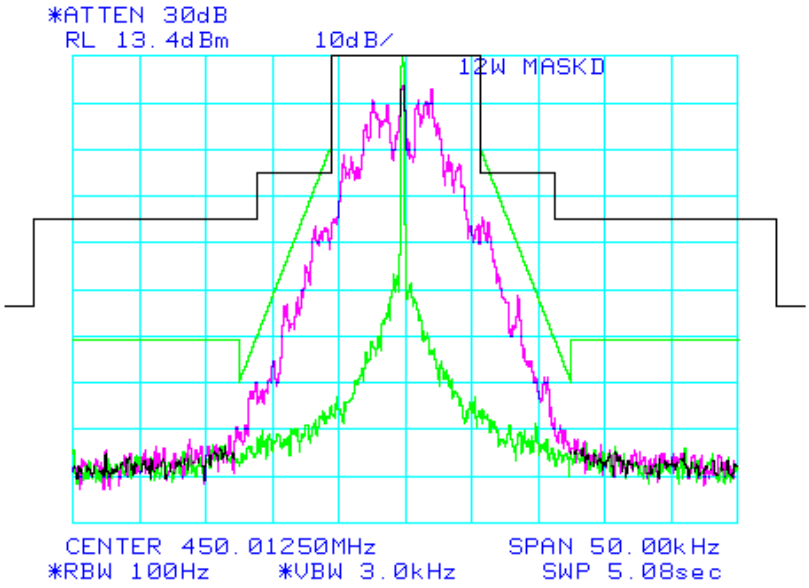
*VBW 3.0kHz
SWP 5.08sec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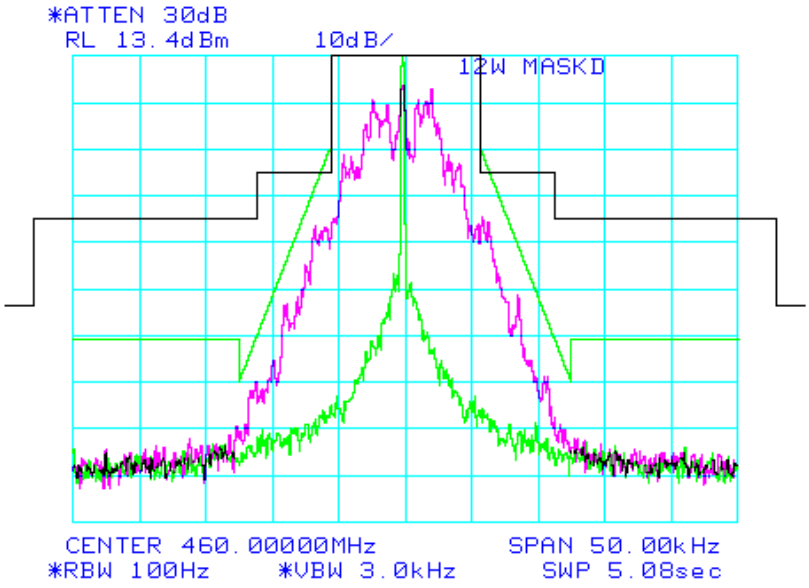
SWP 5.08sec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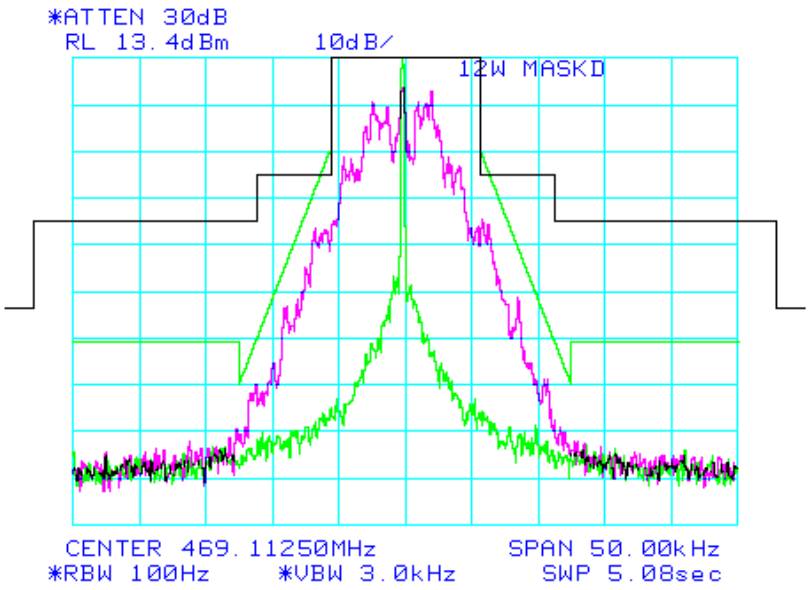
SWP 5.08sec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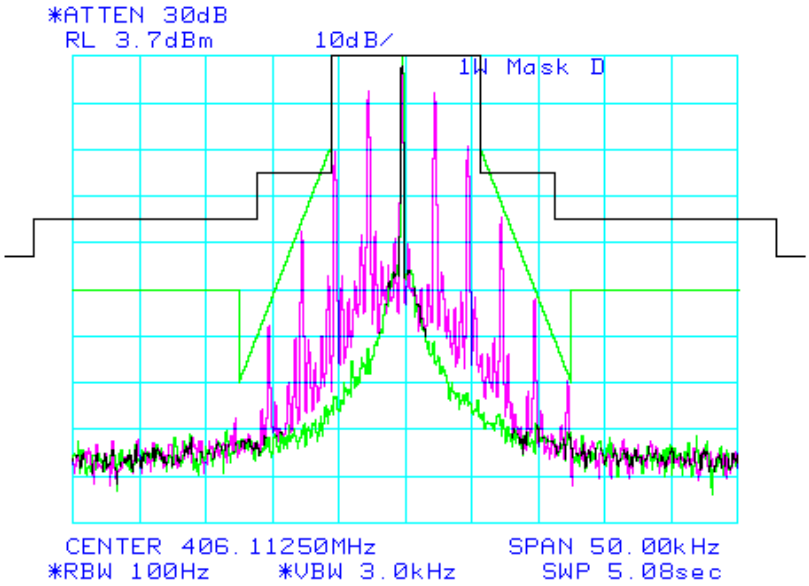
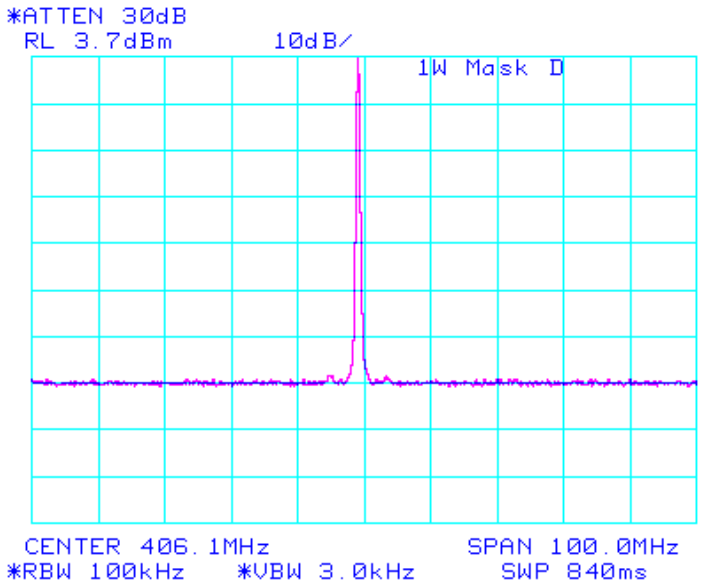
10dB/
12W MASKD
CENTER 469.11250MHz
SPAN 50.00kHz
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec

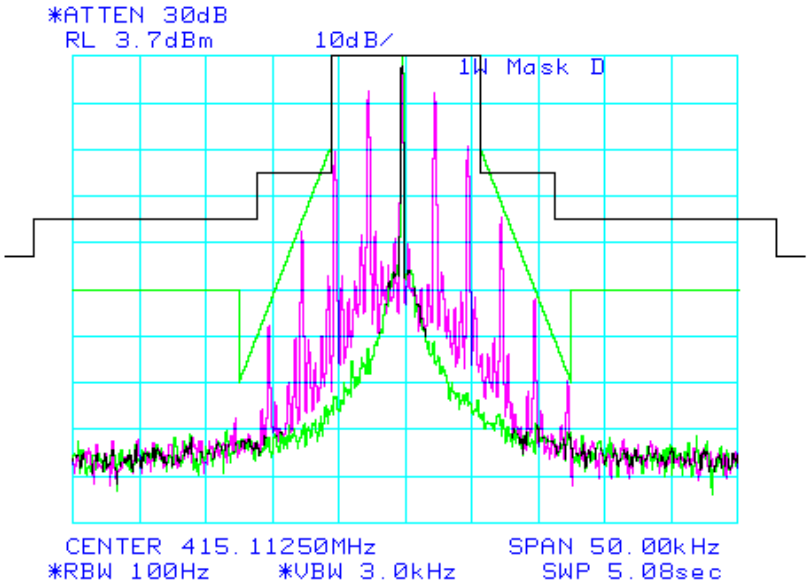
Mask: D, 1W
Output Power = 1 Watt

Spectrum for Emission: 10K2F3E
Peak Deviation with Data: 2.484 kHz

Mask B = Black Line
Mask D = Green Line






*ATTEN 30dB
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10dB/
1W Mask D
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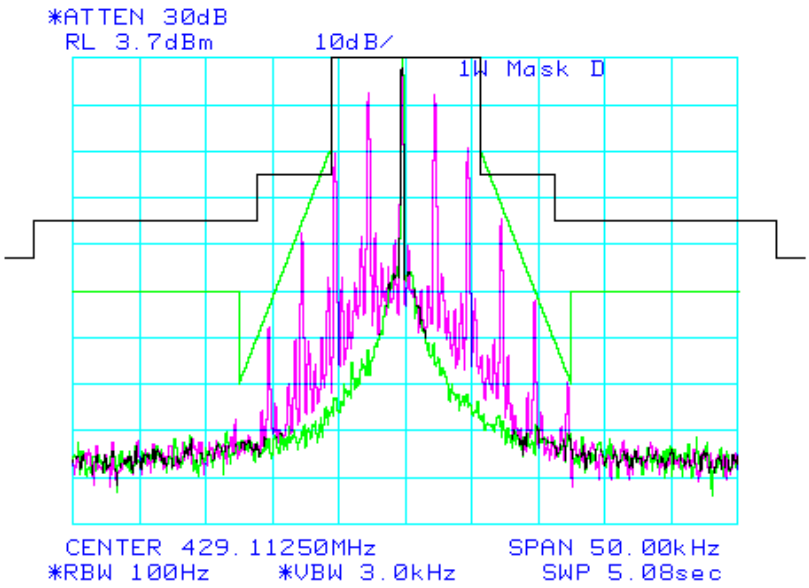
SPAN 50.00kHz
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec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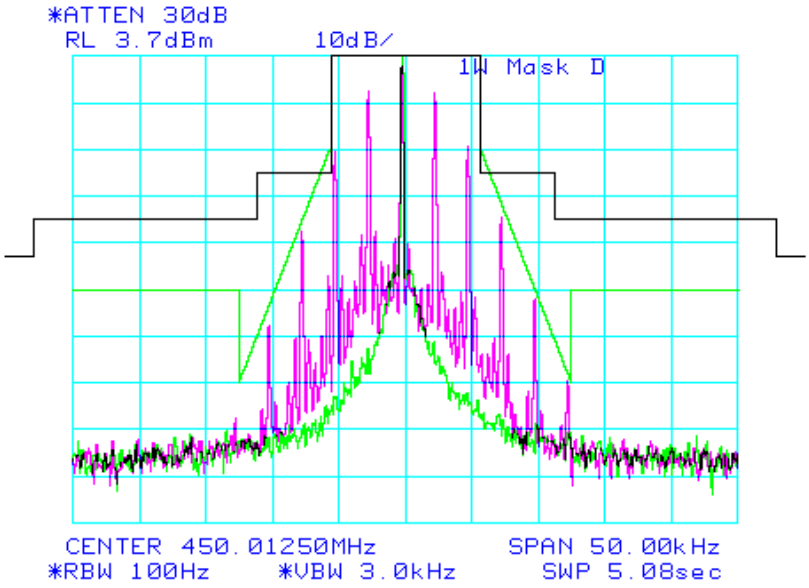
*VBW 3.0kHz
SWP 5.08sec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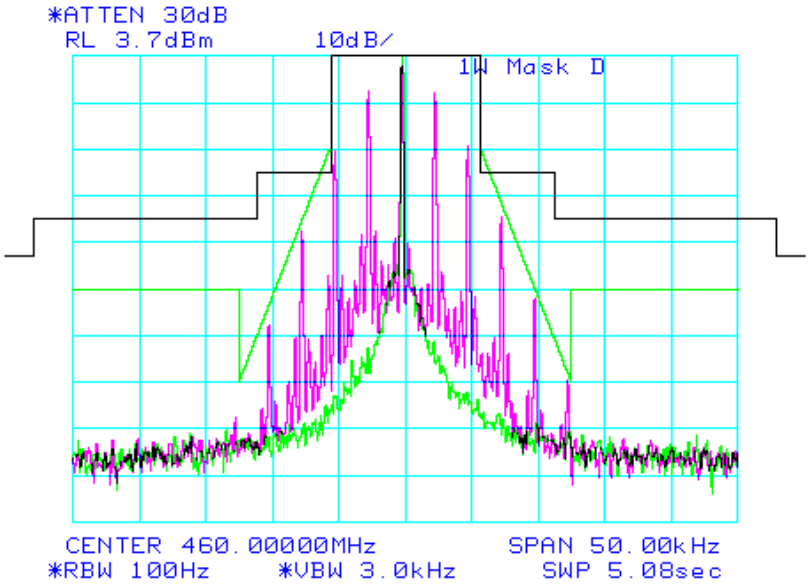
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec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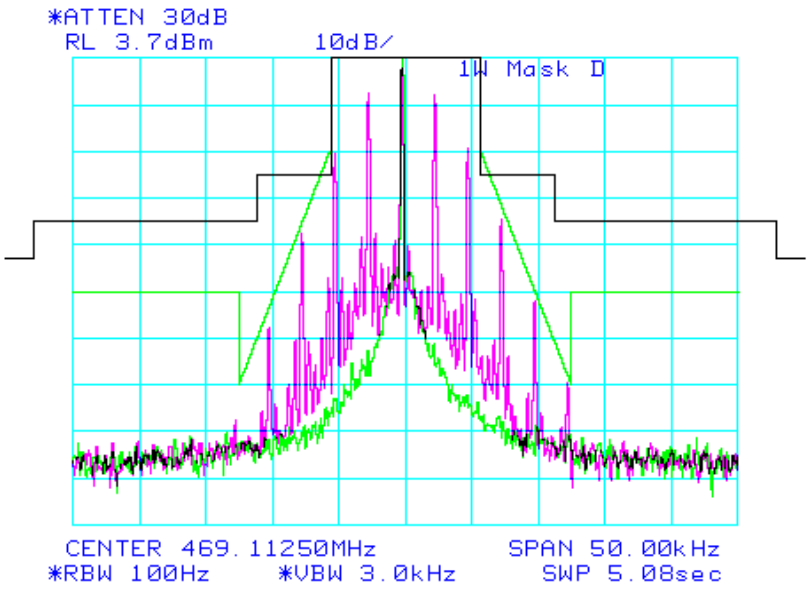
SWP 5.08sec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CENTER 469.11250MHz
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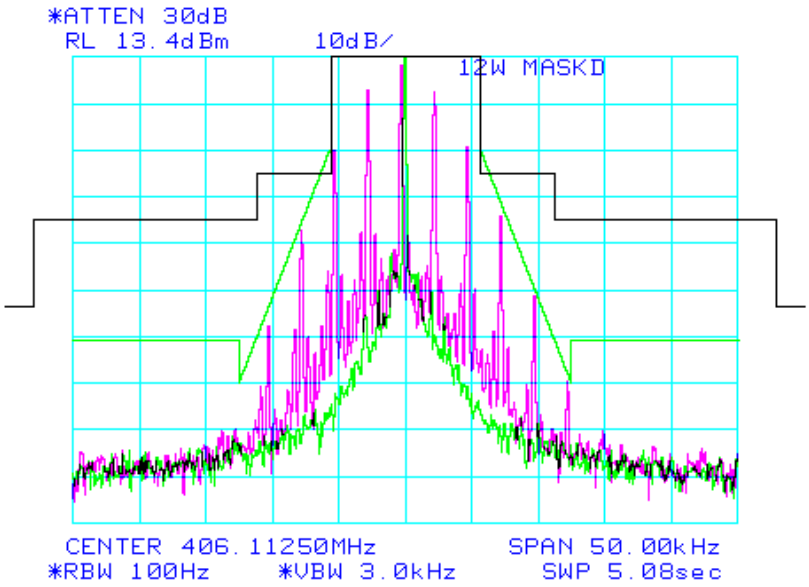
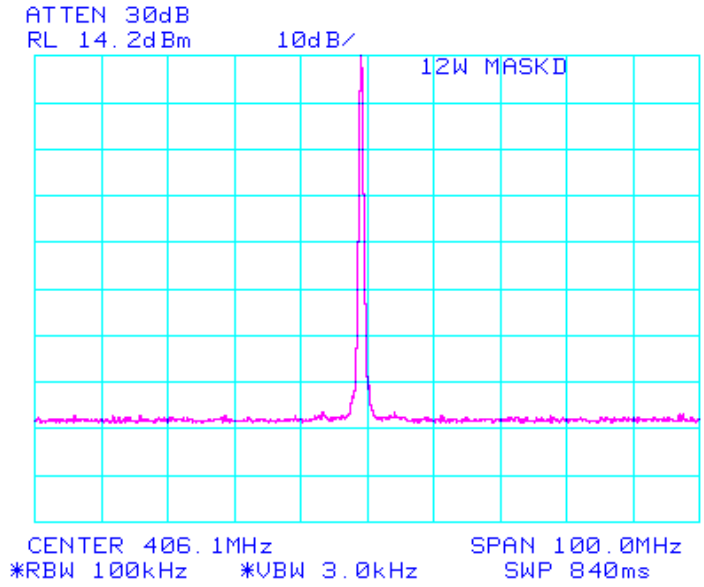
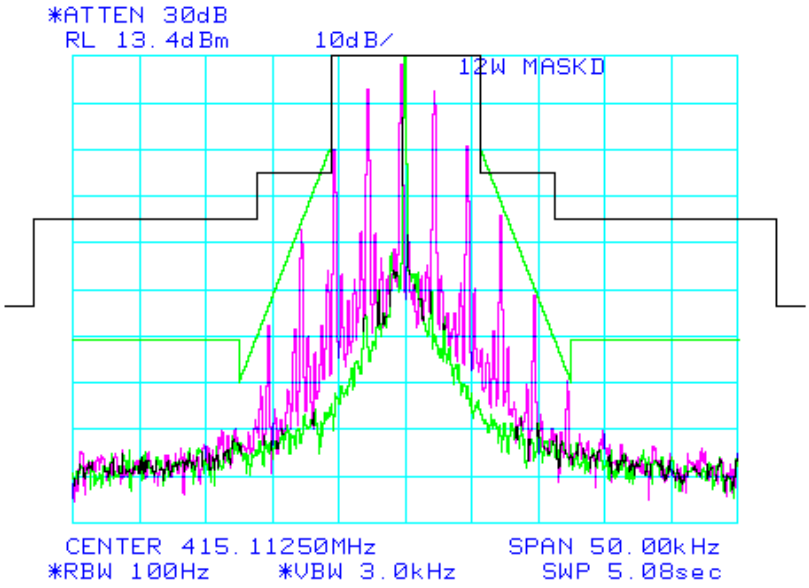
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec

Output Power = 12 Watts

Mask B = Black Line
Mask D = Green Line



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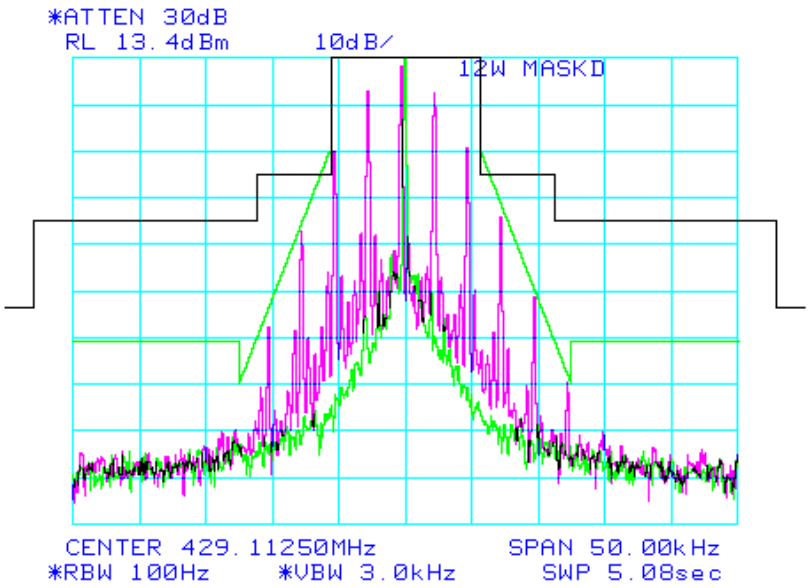
SPAN 50.00kHz
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec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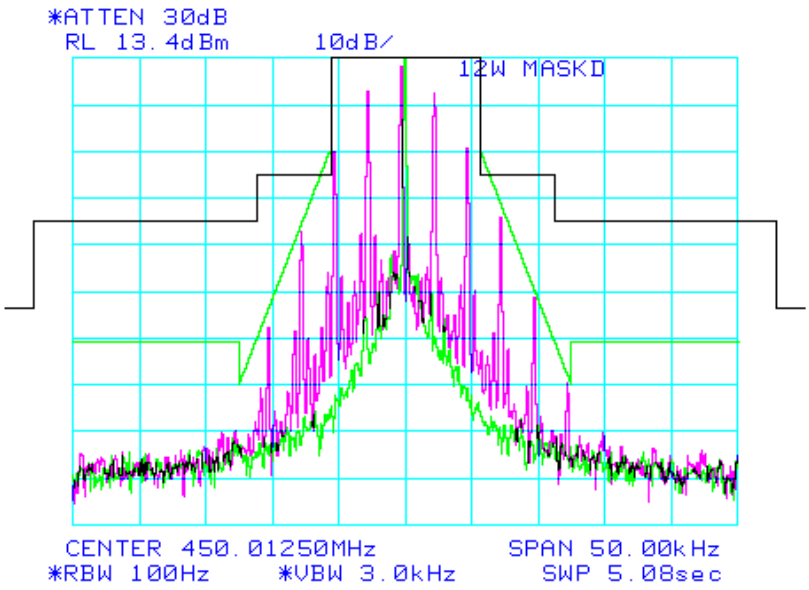
SWP 5.08sec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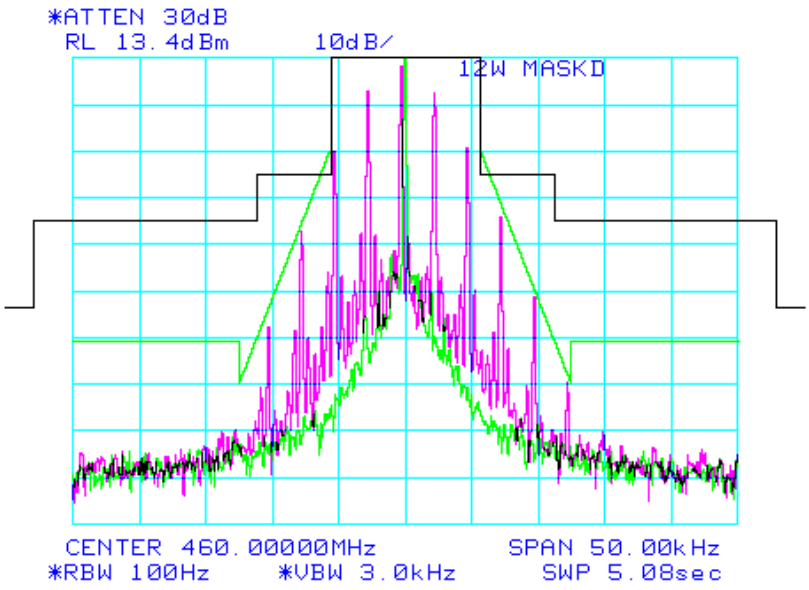
SWP 5.08sec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SPAN 50.00kHz
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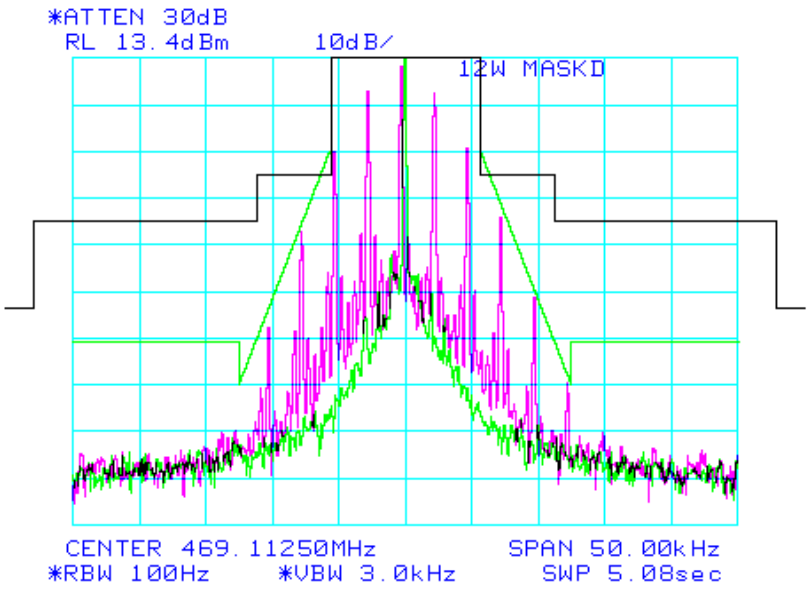
SWP 5.08sec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10dB/
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SPAN 50.00kHz
*RBW 100Hz
*VBW 3.0kHz
SWP 5.08sec

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.