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FCC Certification Application

For The

Guardian 900
RADIO MODEM

FCC ID: NP4-5096-500

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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, 24.131, 101.109, 22.357;

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	Measured Peak Deviation	Measured 99% Occupied BW
12.5 kHz	10K2F3D	2.451 kHz	10.2 kHz
12.5 kHz	10K2F3E	2.451 kHz	10.2 kHz
25 kHz	15K3F3D	5.12 kHz	15.3 kHz
25 kHz	15K3F3E	5.12 kHz	15.3 kHz

THEORY OF MEASUREMENT

The way to define the Occupied Bandwidth is "The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth."

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.

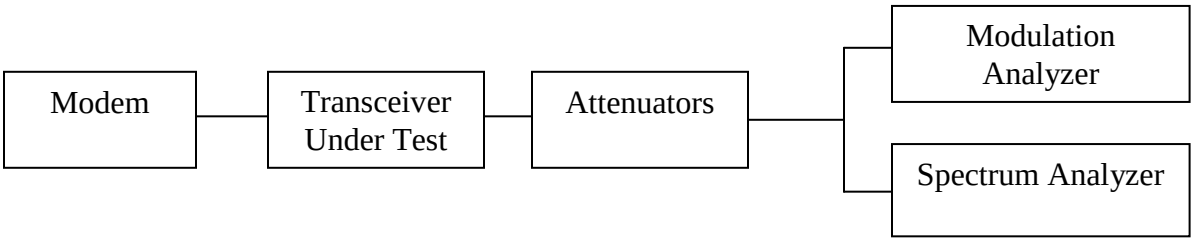
The Occupied Bandwidth measurement is in two parts relatively independent of each other. The first gives the RF spectrum profile, and the second calculates the frequency limits and they result in the Occupied bandwidth. While the first involves RF measurement instrumentation, the second is strictly a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

TEST EQUIPMENT:

50-Ohm Attenuator, Bird Electronics Model 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits Model ZFSC-3-4 (5.5dB IL at UHF)
DC Power Supply, Instek Model GPS-2303
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 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: same as RBW
SPAN: 50 kHz (12.5 kHz channels)
SPAN: 150 kHz (25 kHz channels)



NAME OF TEST: Transmitter Mask Emission Limits for Emission Designators **10K2F3D** and **10K2F3E**

RULE PART NUMBER: FCC: 2.202, 2.1049 (c) (1),22.359, 90.210 (i), 101.111 (a)(5);

MINIMUM STANDARDS:

Mask I
Sidebands and Spurious [P = 10 Watts and P=1 Watt]
Authorized Bandwidth = 12.5 kHz
From Fo to 6.8 kHz, down 0 dB.
Greater than 6.25 kHz to 9.0 kHz, down 25 dB
Greater than 9.0 kHz to 15 KHz, down 35 dB
Greater than 15 KHz, 43+10log(P) or 70 dB

Attenuation = 0 db at Fo to > 6.8 kHz
Attenuation = 25 dB at 6.8 kHz
Attenuation = 35 dB at 9.0 KHz
Attenuation = 53 dB at > 15 KHz @ 10W or 43 dB @ 1W

Mask 101.111(a)(5)
Sidebands and Spurious [P = 10 Watts and P=1 Watt]
Authorized Bandwidth = 12.5 kHz
From Fo to 2.5 kHz, down 0 dB.
Greater than 2.5 kHz to 6.25 kHz, down 53log(fd/2.5)
Greater than 6.25 kHz to 9.5 KHz, down 103log(fd/3.9)
Greater than 9.5 to 15 KHz, 157log(fd/5.3)
Greater than 15 KHz,, 50+10log(P) or 70 dB

Attenuation = 0 db at Fo to 6.25 kHz
Attenuation = 21.1dB at 6.25 kHz
Attenuation = 39.8 dB at 9.5 KHz
Attenuation = 70.9 dB at 15 kHz
Attenuation = 60 dB at > 15 KHz @ 10W or 50dB @ 1W

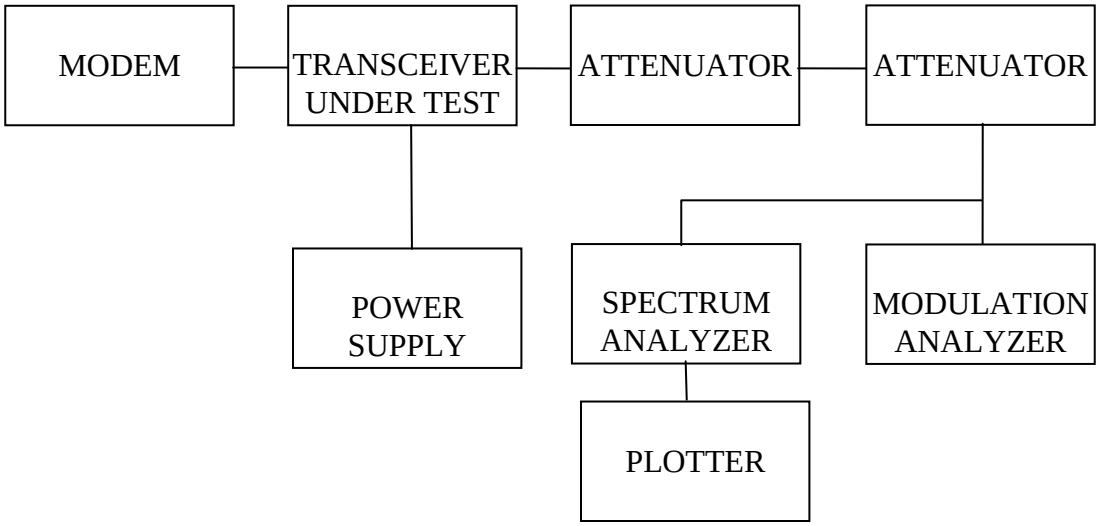
TEST RESULTS: Meets minimum standards (see data on following page)

TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 10 Watts
Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

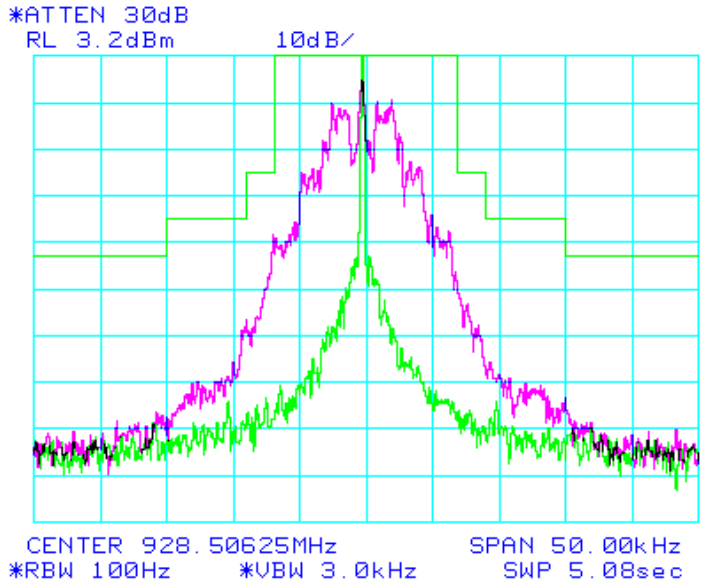
TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits Model ZFSC-3-4 (5.5dB IL at UHF)
DC Power Supply, Instek Model GPS-2303
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

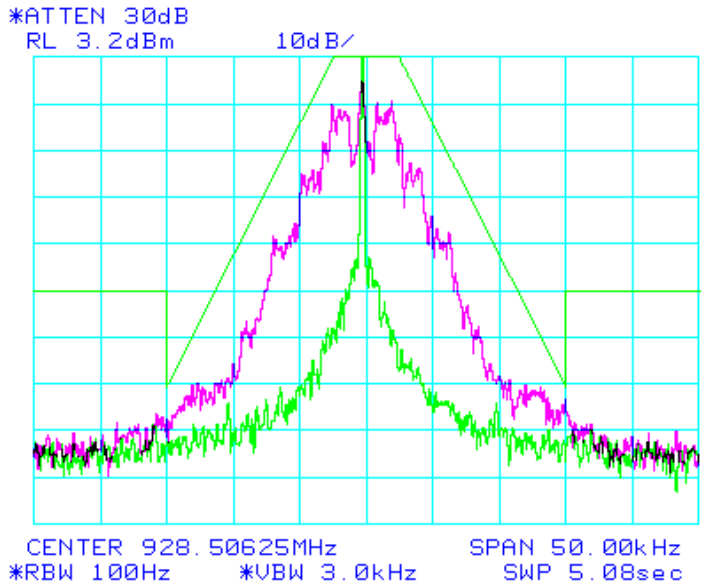

MODEM
TRANSCEIVER UNDER TEST
ATTENUATOR
ATTENUATOR
POWER SUPPLY
SPECTRUM ANALYZER
MODULATION ANALYZER
PLOTTER

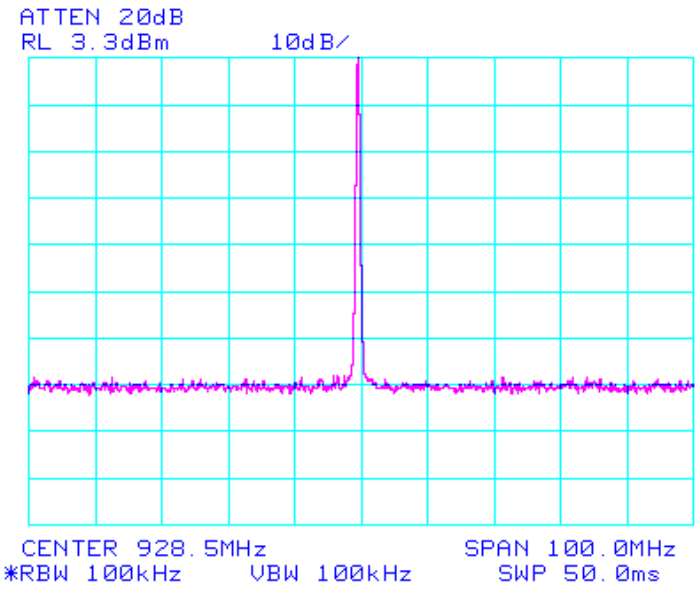
Spectrum for Emission: 10K2F3D
Peak Deviation with Data: 2.451 kHz
Output Power = 1 Watt

Mask: I



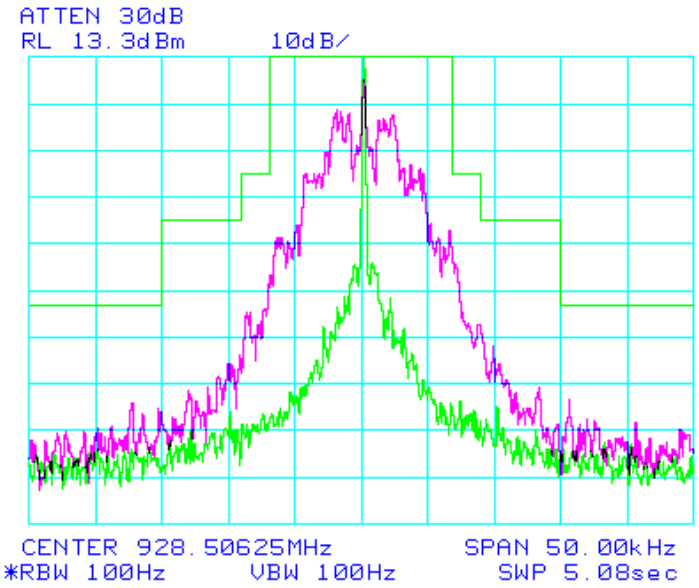
Mask: 101.111 (a)(5)




ATTEN 20dB
RL 3.3dBm
10dB/
CENTER 928.5MHz
SPAN 100.0MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms

Output Power = 10 Watts

Mask: I



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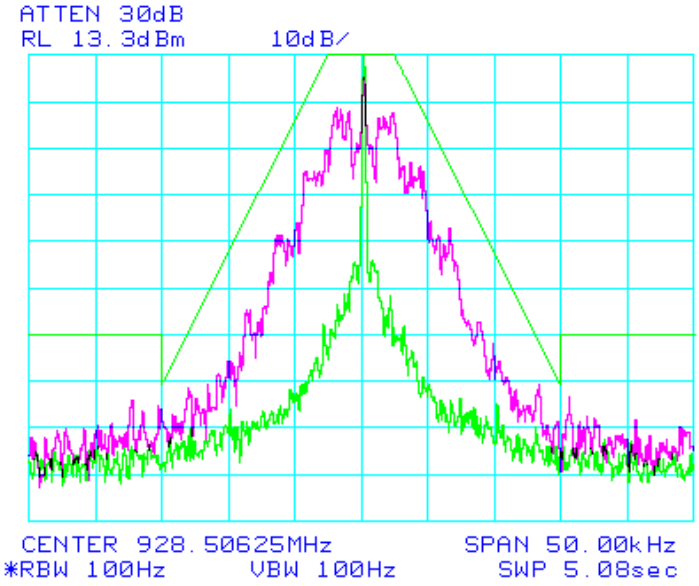
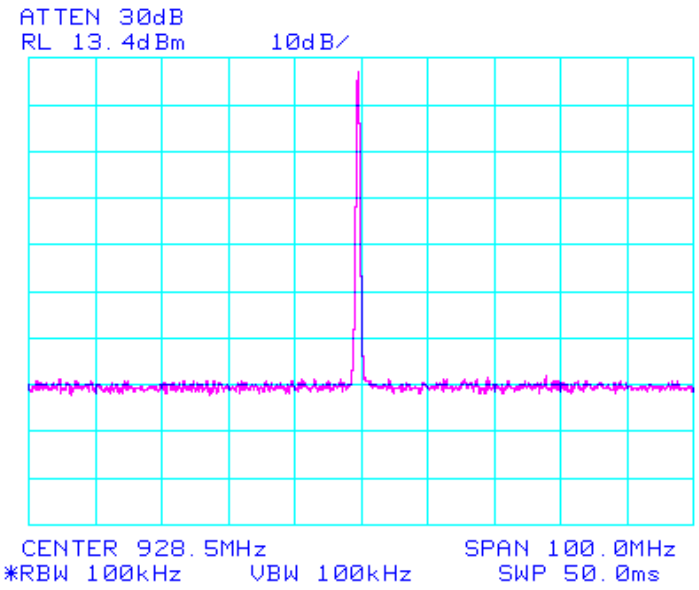
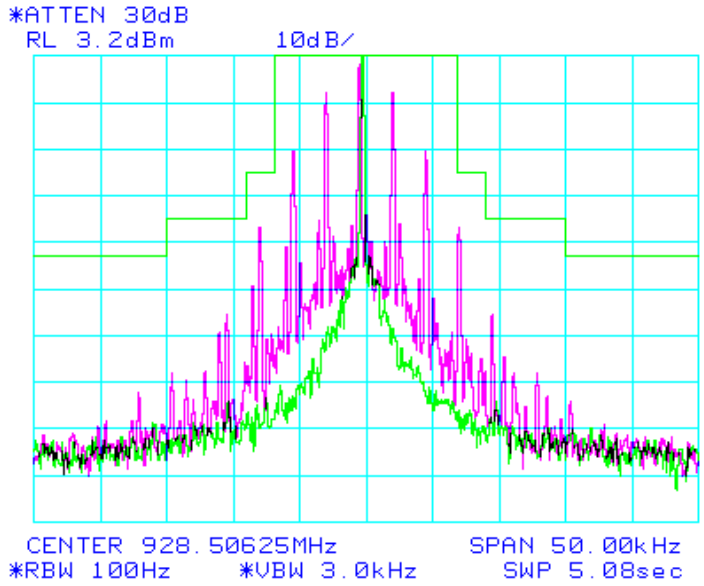



ATTEN 30dB
RL 13.4dBm
10dB/
CENTER 928.5MHz
SPAN 100.0MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms

Spectrum for Emission: 10K2F3E
Peak Deviation with Data: 2.451 kHz
Output Power = 1 Watt

Mask: I



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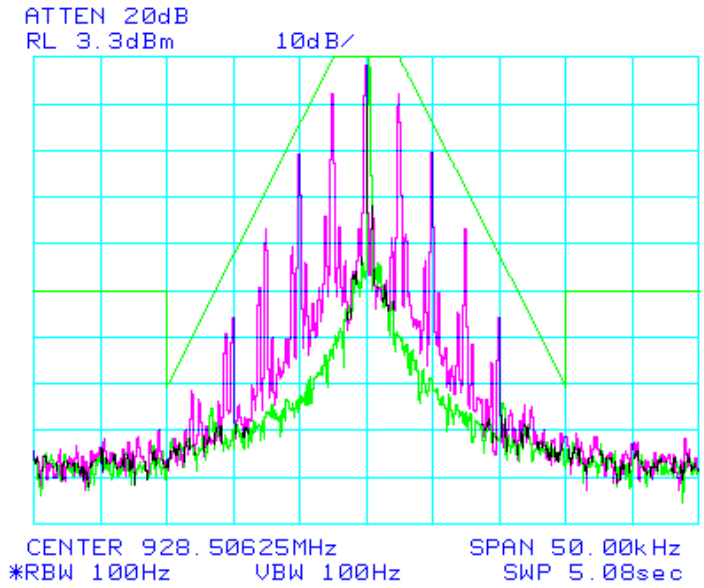
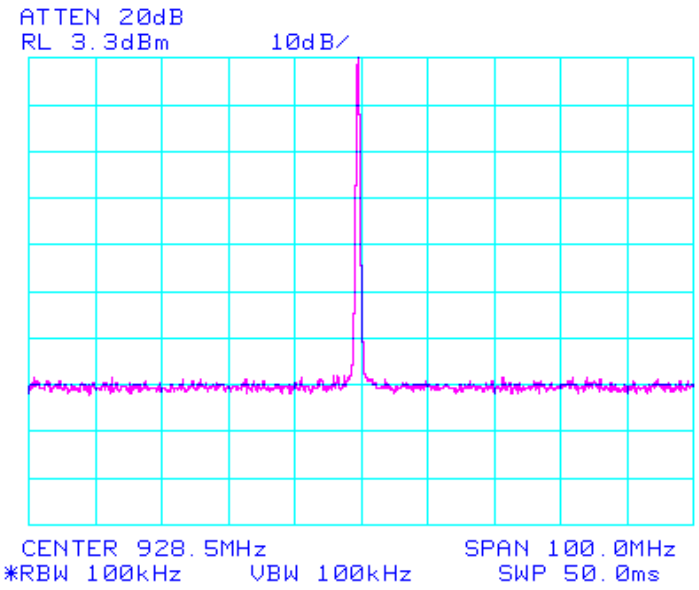
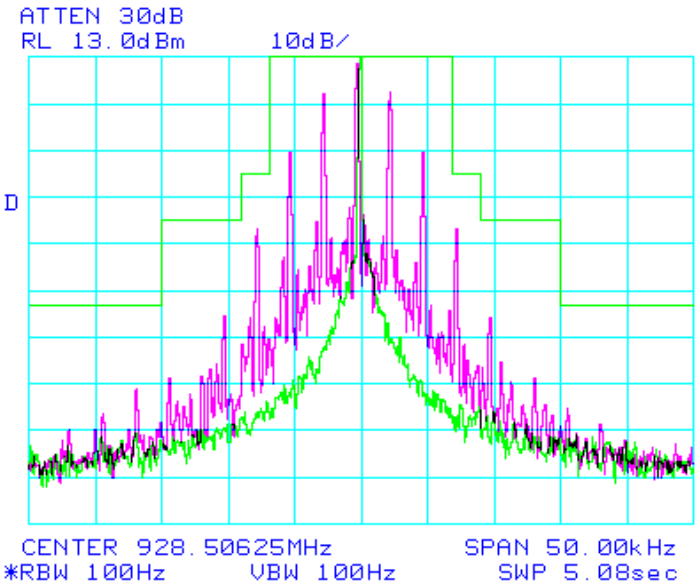


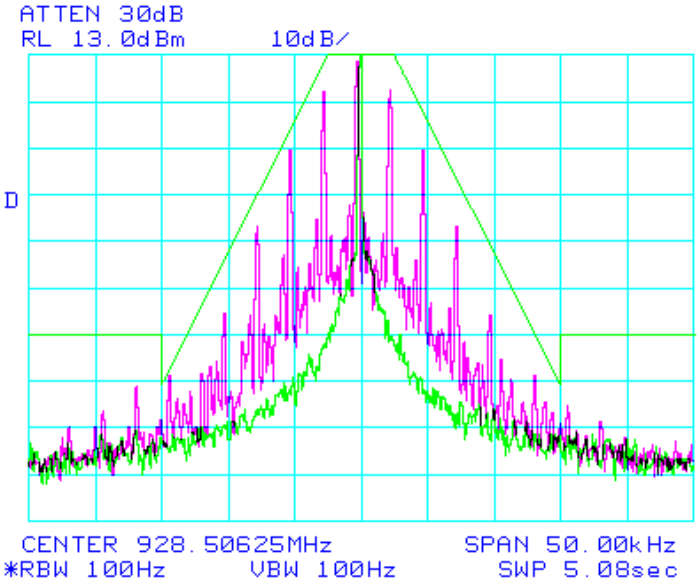

ATTEN 20dB
RL 3.3dBm
10dB/
CENTER 928.5MHz
SPAN 100.0MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms

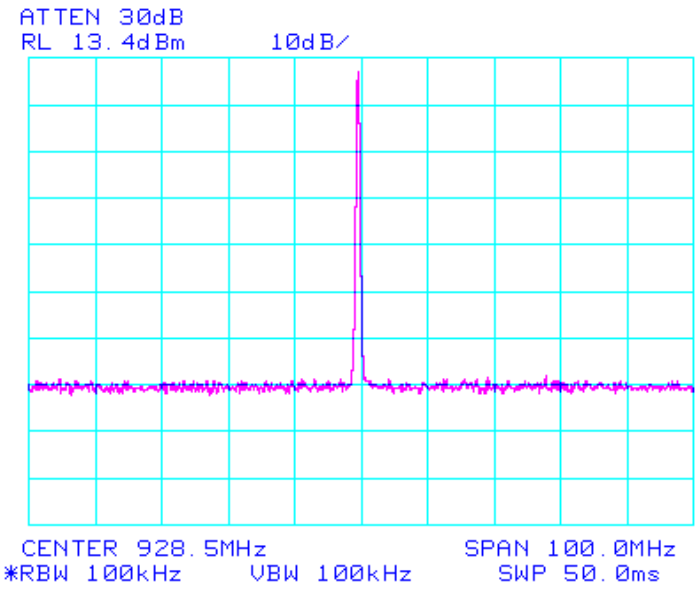
Output Power = 10 Watts

Mask: I



Mask: 101.111 (a)(5)




ATTEN 30dB
RL 13.4dBm
10dB/
CENTER 928.5MHz
SPAN 100.0MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms

NAME OF TEST: Transmitter Mask Emission Limits for Emission Designators **15K3F3D** and **15K3F3E**

RULE PART NUMBER: FCC: 2.202, 90.209 (b)(5), 90.210(b), 2.1049 (c) (1), 101.111 (a)(6) 24.133 (a)(1), 22.359;

MINIMUM STANDARDS:

Mask B
Sidebands and Spurious [P = 10 Watts and P=1 Watt]
Authorized Bandwidth = 20 kHz
From Fo to 50% of authorized bandwidth, down 0 dB.
From 50% to 100% of the authorized bandwidth, down 25dB
From 100% to 250% of the authorized bandwidth, down 35 dB
Greater than 250% of authorized BW, 43 + $10\log_{10}(P)$

Attenuation = 0 dB at Fo to 10 kHz
Attenuation = 25 dB at 10 kHz
Attenuation = 35 dB at 20 kHz
Attenuation = 53.0 dB at frequencies greater than 50 kHz @ 10 W
Attenuation = 43 dB at frequencies greater than 50 kHz @ 1 W

Mask 101.111(a)(6)
Sidebands and Spurious [P = 10 Watts and P=1 Watt]
Authorized Bandwidth = 25 kHz
From Fo to 5.0 kHz, down 0 dB.
From 5 kHz to 10 kHz, down 83 * $\log_{10}(f_d / 5)$ dB
Greater than 10.0 kHz to 250% auth BW, down 116log(fd/6.1)
or 50+10log(P) or 70 dB.
Greater then 250% auth BW, 43+$10\log_{10}(P)$ or 80 dB.

Attenuation = 0 db at Fo to 5 kHz
Attenuation = 25 dB at 10 kHz
Attenuation = 60 dB at 20.1 kHz @ 10W
Attenuation = 50 dB at 16.5 kHz @ 1W
Attenuation = 53 dB at > 62.5 kHz @ 10W or 43 dB @ 1W

Mask 24.133(a)(1) 25 kHz
Sidebands and Spurious [P = 10 Watts and P=1 Watt]
Authorized Bandwidth = 20 kHz
From Fo to 10 kHz, down 0 dB.
From 10 kHz to 50 kHz, down 116 * $\log_{10}(f_d + 10 / 6.1)$ dB,
50+10log(P) or 70 dB.
Greater than 50 kHz, 43+$10\log_{10}(P)$ or 80 dB.

Attenuation = 0 db at Fo to 10 kHz
Attenuation = 25 dB at 10 kHz
Attenuation = 60 dB at 20 kHz @ 10W
Attenuation = 50 dB at 16.45 kHz @ 1W
Attenuation = 53 dB at 50 kHz @ 10W
Attenuation = 43 dB at 50 kHz @ 1W

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

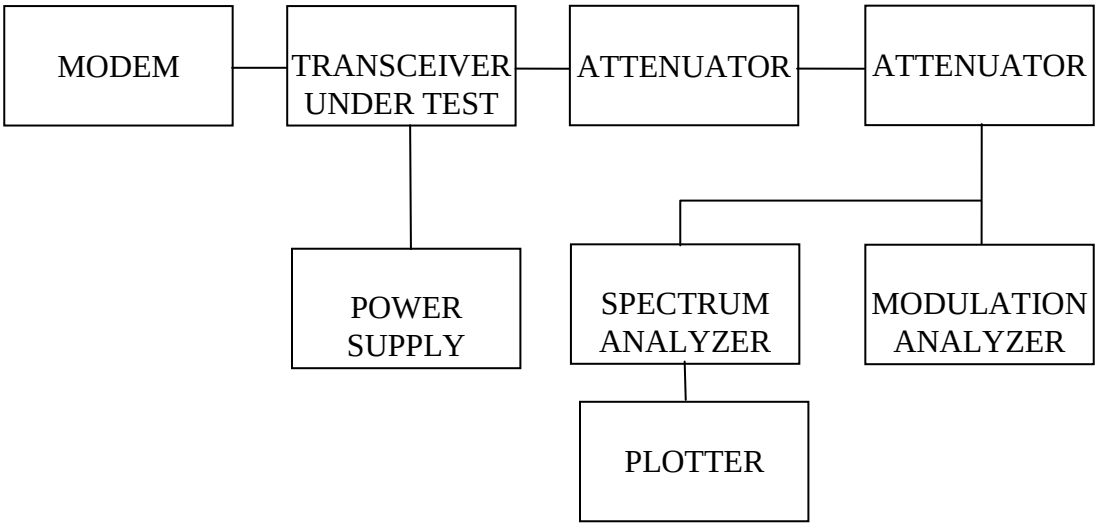
TEST CONDITIONS: Standard Test Conditions, 25 C
RF Power Level = 1 Watt and 12 Watts

Voltage = 20VDC

TEST PROCEDURE: TIA/EIA – 603-C

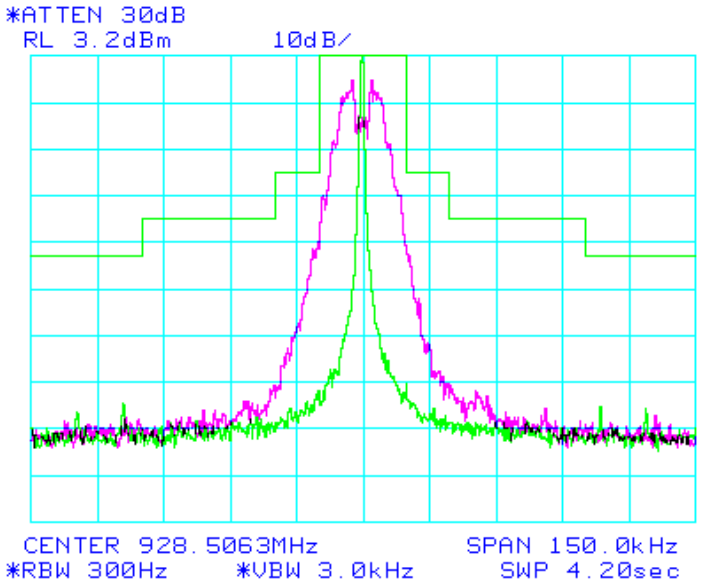
TEST EQUIPMENT: 50-Ohm Attenuator, Bird Electronics Model 25-A-MFN-20 (20dB, 25W)
50-Ohm Power Splitter, Mini Circuits Model ZFSC-3-4 (5.5dB IL at UHF)
DC Power Supply, Instek Model GPS-2303
Spectrum Analyzer, Hewlett Packard Model HP8563E
Modulation Analyzer, Hewlett Packard Model HP8901A

TEST SET-UP:

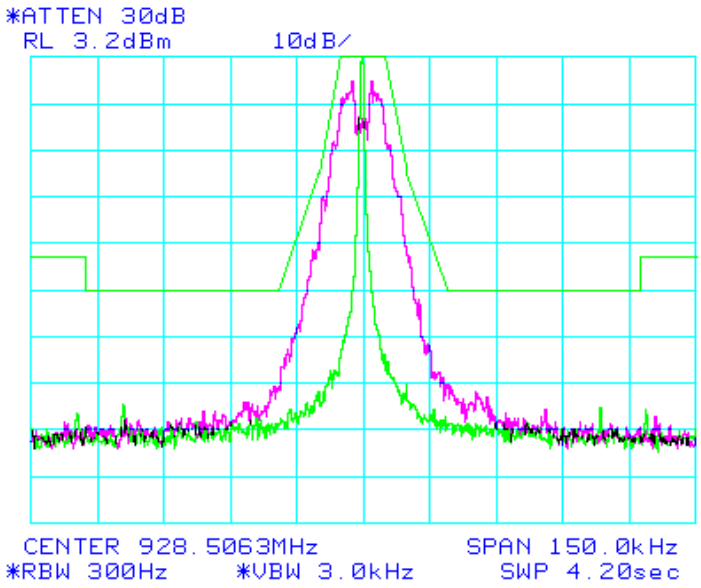


Spectrum for Emission: 15K3F3D
Peak Deviation with Data: 5.12 kHz

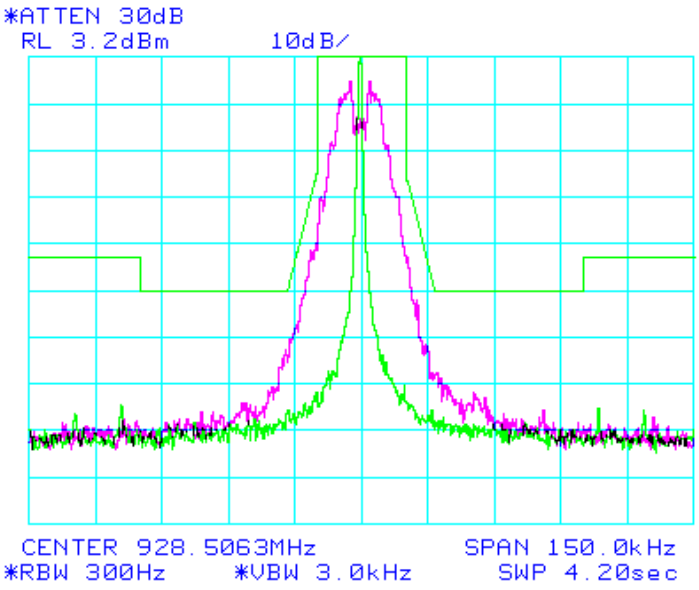
Output Power = 1 Watt
Mask: B

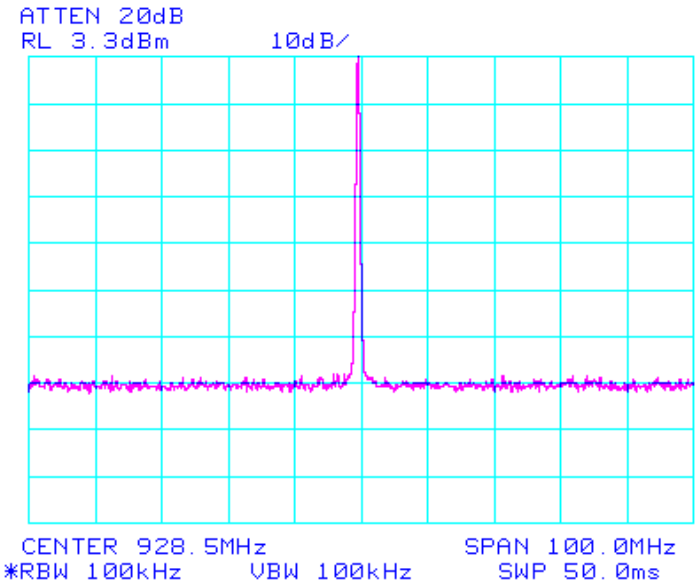


Mask: 101.111 (a)(6)

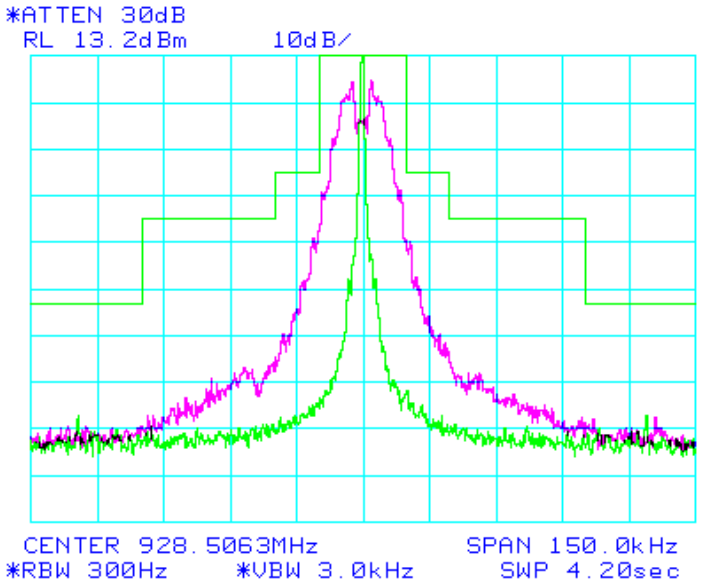


Mask: 24.133 (a)(1)





Output Power =10 Watts
Mask: B



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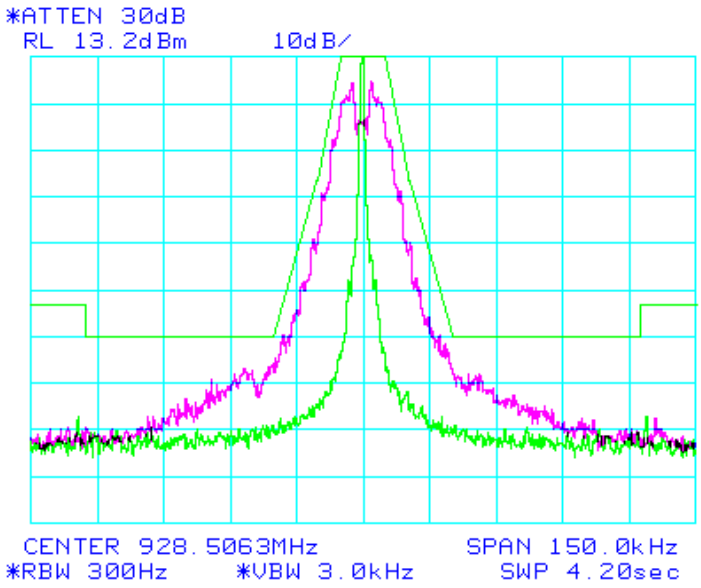

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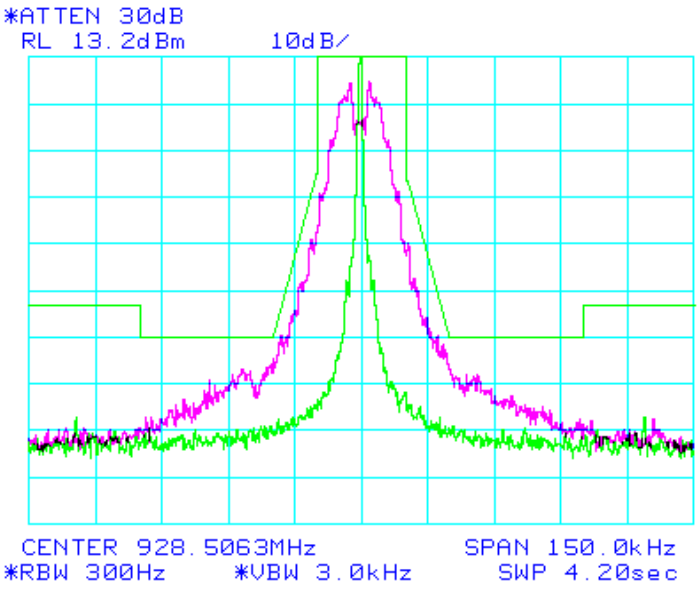
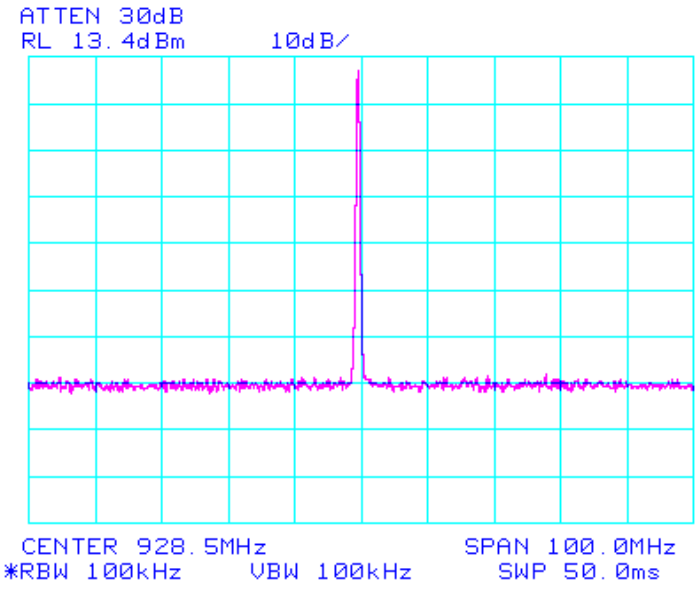
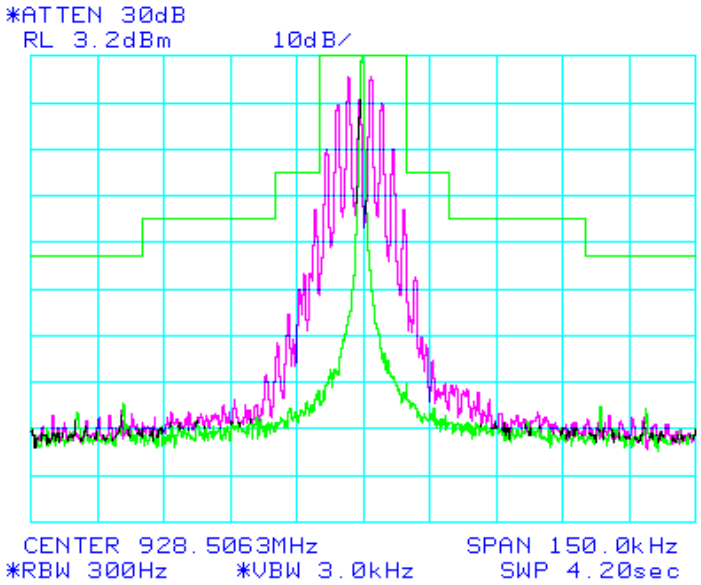




Spectrum for Emission: 15K3F3E
Peak Deviation with Data: 5.12 kHz
Output Power = 1 Watt
Mask: B



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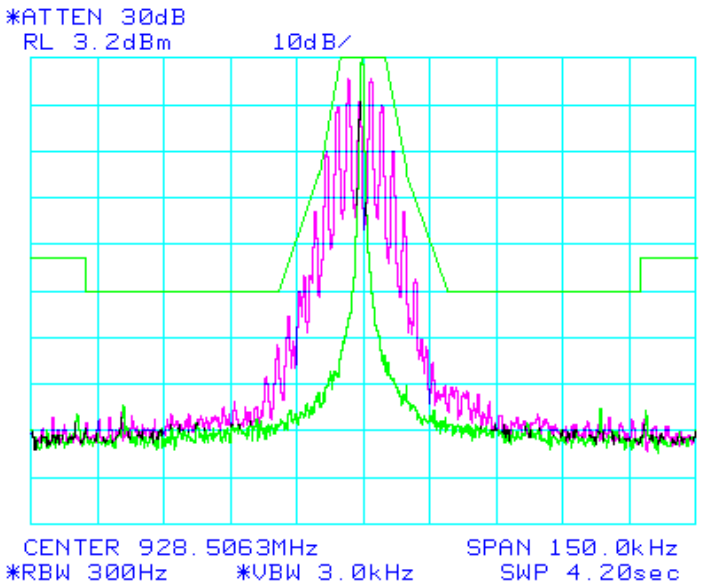

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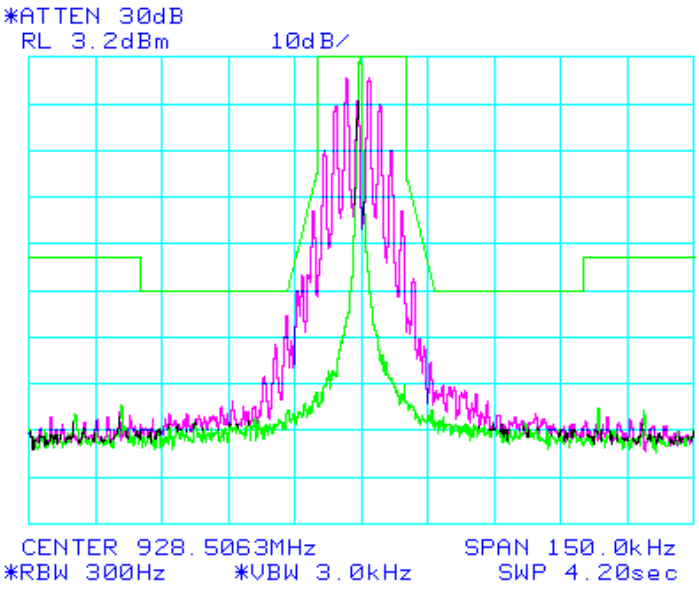
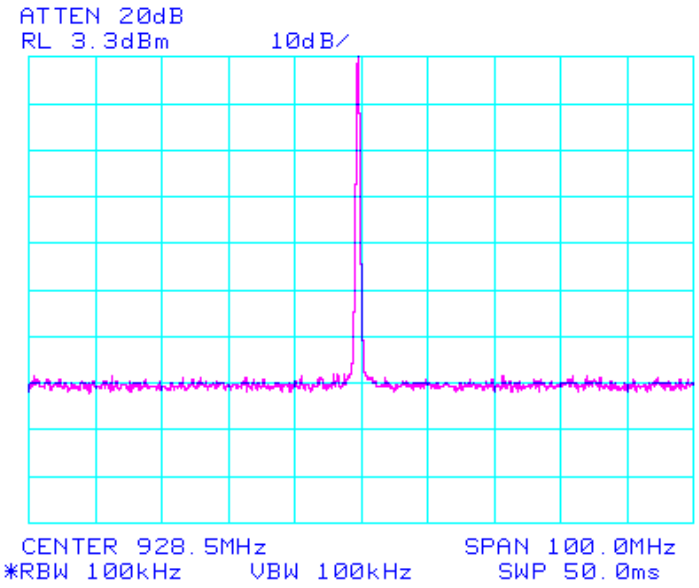
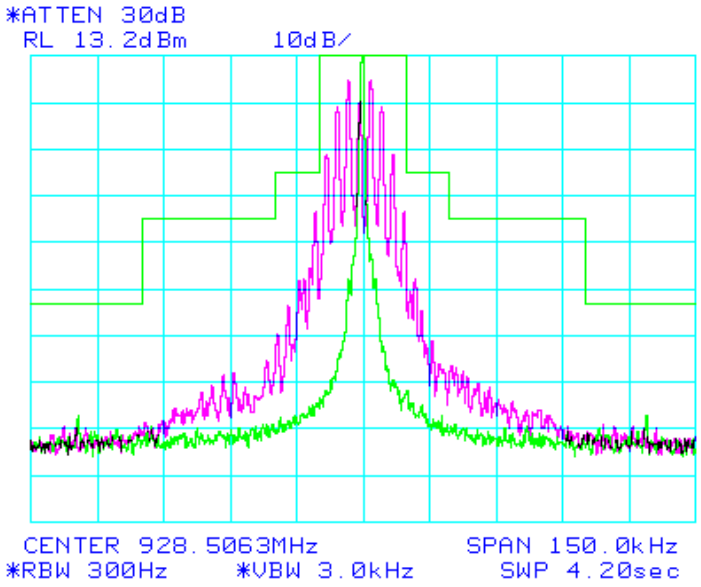
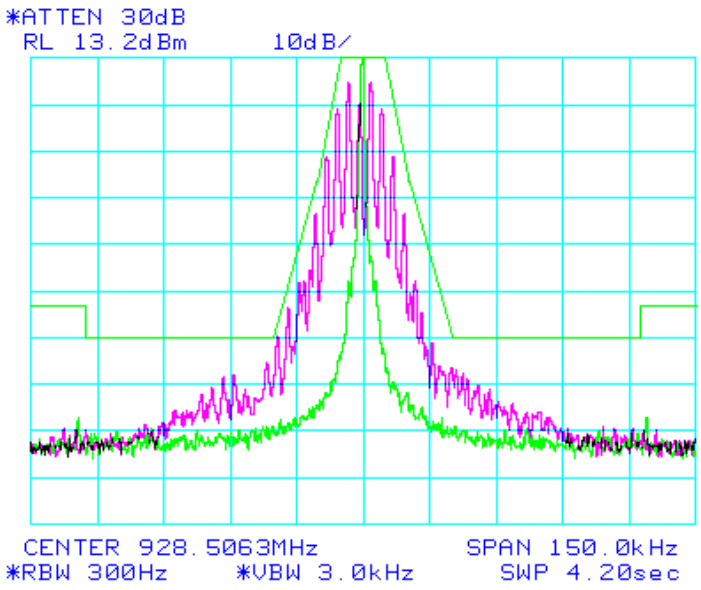




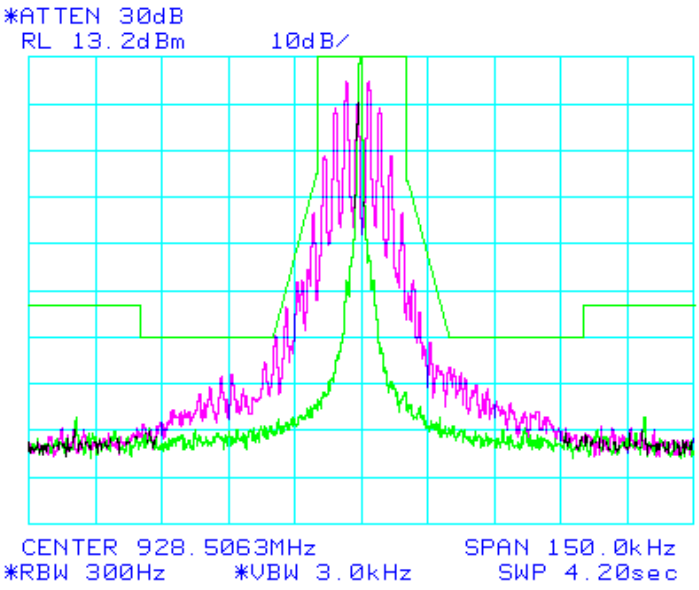
Output Power =10 Watts
Mask: B

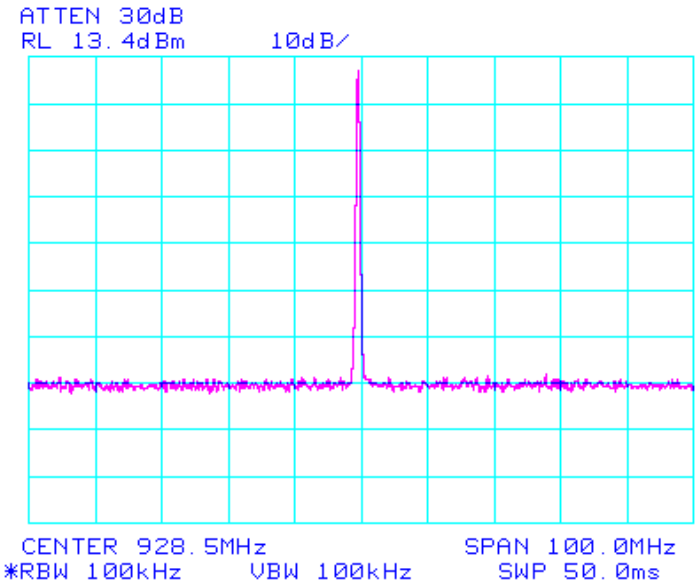


Mask: 101.111 (a)(6)



Mask: 24.133 (a)(1)





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.