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Test Report

Client: Hetronic International
3905 NW 36th St.
Oklahoma City, OK 73112

Contact: Dave Cameron

EUT: ASA-3-460M
FCC ID: LWP-ASA3460M
IC: 2119B-ASA3460M

Test Report No.: R040511-01C

Approved By: Nic Johnson, NCE
Test Engineer, iNARTE Certification, EMC-003337-NE

A handwritten signature in black ink, appearing to read "Nic Johnson", is written over a horizontal line. The signature is fluid and cursive.

Date: 13 October 2011

Total Pages: 24

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Revision Page

Rev. No.	Date	Description
Original	11 May 2011	Original - NJohnson
A	5 Oct 2011	Revision after TCB comments - NJohnson
B	10 Oct 2011	Changed calculations in Table 5 - NJohnson
C	13 Oct 2011	Changed calculations in Table 5, added additional description to Section 2.4.1 and Figure 10 and 11 in section 2.4. Modulation type was added to Table 2 in Section 1.2. - NJohnson

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1 Summary of Test Results

1.1 Emissions Test Results

The EUT was tested for compliance to the following standards:

- (1) The US Code of Federal Regulations, Title 47, Part 90:2010
- (2) TIA-603-C:2004
- (3) Industry Canada RSS-131 Issue 2:2003

Below is a summary of the test results. Complete results of testing can be found in Section 3.

Table 1 - Emissions Test Results

Emissions Tests	Test Method and Limits	Result
Conducted Carrier Output Rating	CFR Title 47, Part 90.217 TIA-603-C, Section 2.2.1 Industry Canada RSS-131 Issue 2:2003, Section 6.2	Complies
Spurious Emissions at Antenna Terminals	CFR Title 47, Part 90.217 TIA-603-C, Section 2.2.13 Industry Canada RSS-131 Issue 2:2003, Section 4.4	Complies
Passband Gain and Bandwidth	Industry Canada RSS-131 Issue 2:2003, Section 4.1	Complies
Unwanted Emissions: Radiated Spurious	CFR Title 47, Part 90; TIA-603-C Section 2.2.12	Complies
Intermodulation Attenuation	TIA-603-C, Section 2.2.16 Device does NOT allow for multiple inputs. Test was not performed	NA

EUT Description

The Equipment Under Test (EUT) was an ASA-3 module from Hetronic International. It is a switched preamplifier and variable power amplifier. This version of the amplifier is intended to work with Hetronic RF modules from 450MHz to 470MHz. It offers between 10 and 14dB of small signal gain.

1.2 Equipment under Test (EUT)

Table 2 – Equipment under Test (EUT)

Identification	ASA-3-460M
Manufacturer	Hetronic International
Serial Number	NCEE Test 1 (assigned)
EUT Received Date	21 April 2011
EUT Tested Date	25 – 28 April 2011
Input modulation type	F1D (Frequency Shift Keying)

1.3 Testing Location

All testing was performed at the NCEE Lincoln facility, which is an A2LA accredited EMC test laboratory accredited per scope 1953.01.

1.4 EUT Setup

The EUT was powered by 3 AA batteries and the signal was supplied with a signal generator at the maximum signal strength as allowed in the user's manual, which was 11dBm.

2 Test Results

2.1 Output Power

Test: CFR Title 47, Part 90.217
Industry Canada RSS-131 Issue 2:2003, Section 6.2

Test Specifications: ANSI TIA -603-C, clause 2.2.1

Test Result: Complies Date: 5/11/2011

2.1.1 Test Description

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable. The resolution bandwidth was set to 10MHz (maximum) and the video bandwidth was set to 10MHz to capture the maximum amount of signal. The analyzer used a peak detector in max hold mode. This represented the maximum output power.

2.1.2 Test Results

No power measurements were found to exceed the 120mW limit as specified in FCC Part 90.217. No power measurements at harmonic frequencies were within 20dB of the output power at the fundamental.

2.1.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $45 \pm 5\%$
Temperature of $20 \pm 2^\circ \text{C}$

2.1.4 Test Setup

See Section 2.3 for further details.

2.1.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
100037	Rhode & Schwarz	ES126	EMI Test Receiver	9/2/2010

2.1.6 Test Pictures and/or Figures

Table 3 - Output Power

The signal generator output power was 11dBm (max output per user's manual)

Signal Generator Input Frequency:	450MHz	460MHz	470MHz	
	Power	Power	Power	Cable Loss
	dBm	dBm	dBm	dB
Fundamental	20.71	20.59	20.49	-0.12

$\Delta = \text{Fundamental} - \text{Harmonic Output Power}$

$120\text{mW} = 20.79\text{dBm}$

All measurements include cable loss. Cable loss is listed in last column.

2.2 Spurious Emissions at Antenna Terminals

Test: CFR Title 47, Part 90.217; TIA-603-C Section 2.2.13
Industry Canada RSS-131 Issue 2:2003, Section 4.4

Test Specifications: TIA 603-C

Test Result: Complies Date: 6/10/2011

2.2.1 Test Description

On any frequency removed from the center of the assigned channel by more than 250 percent at least: $43 + 10 \log (P)$ dB attenuated.

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to the 10th harmonic.

2.2.2 Test Results

No power measurements were found to exceed the 120mW limit as specified in FCC Part 90.217. No power measurements at harmonic frequencies were within 20dB of the output power at the fundamental.

2.2.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $45 \pm 5\%$
Temperature of $20 \pm 2^\circ \text{C}$

2.2.4 Test Setup

See Section 2.3 for further details.

2.2.5 Test Equipment Used

Test Setup

Test Equipment Used

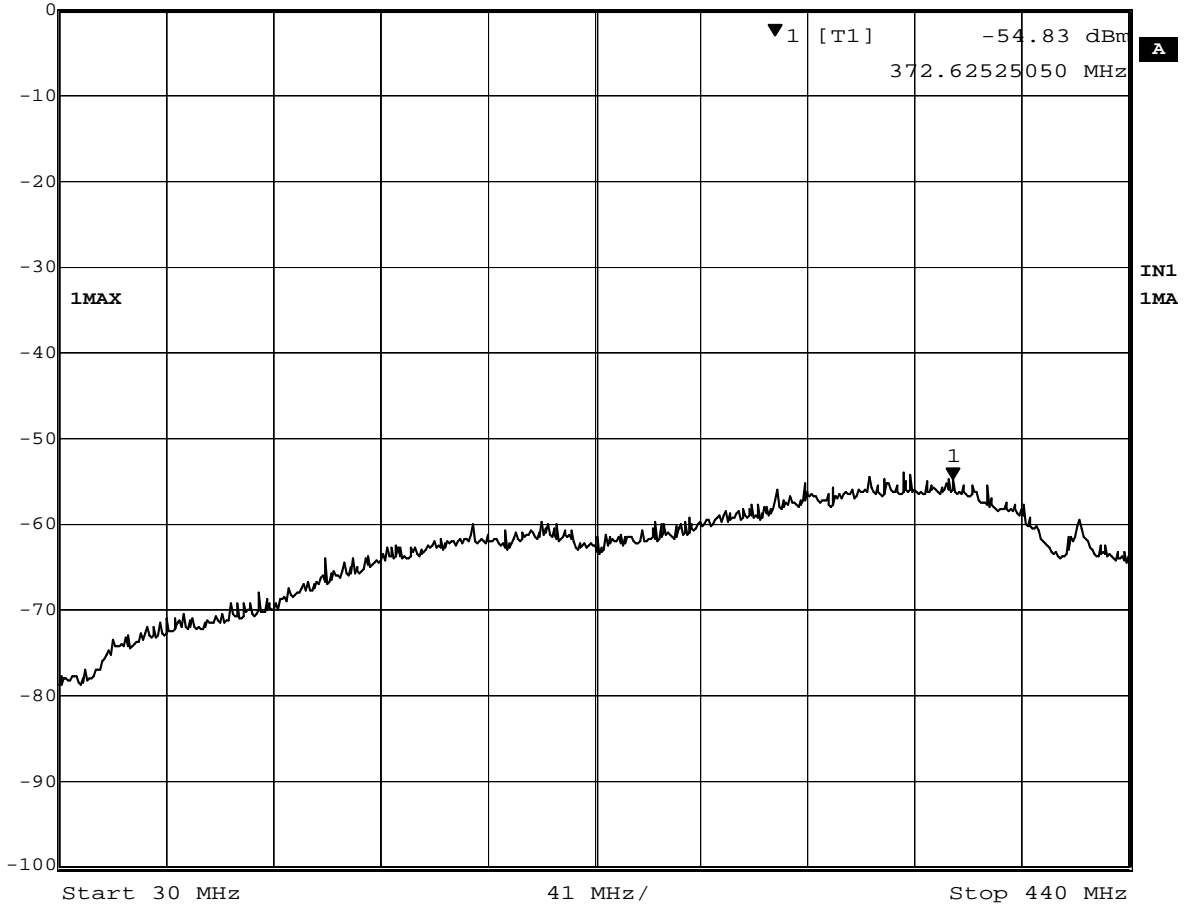
Serial No.	Manufacturer	Model	Description	Last Cal.
100037	Rhode & Schwarz	ES126	EMI Test Receiver	9/2/2010

Table 4 - Conducted Measurements of Harmonics and Fundamental

Signal Generator Input Frequency:	450MHz		460MHz		470MHz		Cable Loss dB
	Power	Delta	Power	Delta	Power	Delta	
	dBm	dB	dBm	dB	dBm	dB	
Fundamental	20.71	NA	20.59	NA	20.49	NA	-0.12
2nd harmonic	-17.59	38.30	-18.49	39.08	-24.83	45.32	-0.18
3rd harmonic	-34.60	55.31	-36.72	57.31	-37.92	58.41	-0.25
4th harmonic	-42.05	62.76	-44.17	64.76	-48.16	68.65	-0.25
5th harmonic	-41.35	62.06	-44.31	64.90	-44.87	65.36	-0.31
6th harmonic	-41.48	62.19	-45.15	65.74	-47.51	68.00	-0.37
7th harmonic	-49.83	70.54	-53.82	74.41	-52.71	73.20	-0.38
8th harmonic	-53.53	74.24	-54.39	74.98	-54.79	75.28	-0.42
9th harmonic	-55.18	75.89	-56.62	77.21	-56.37	76.86	-0.47
10th harmonic	-56.75	77.46	-56.10	76.69	-57.26	77.75	-0.45



OVLD Marker 1 [T1] RBW 100 kHz RF Att 10 dB
Ref Lvl -54.83 dBm VBW 100 kHz
0 dBm 372.62525050 MHz SWT 105 ms Unit dBm

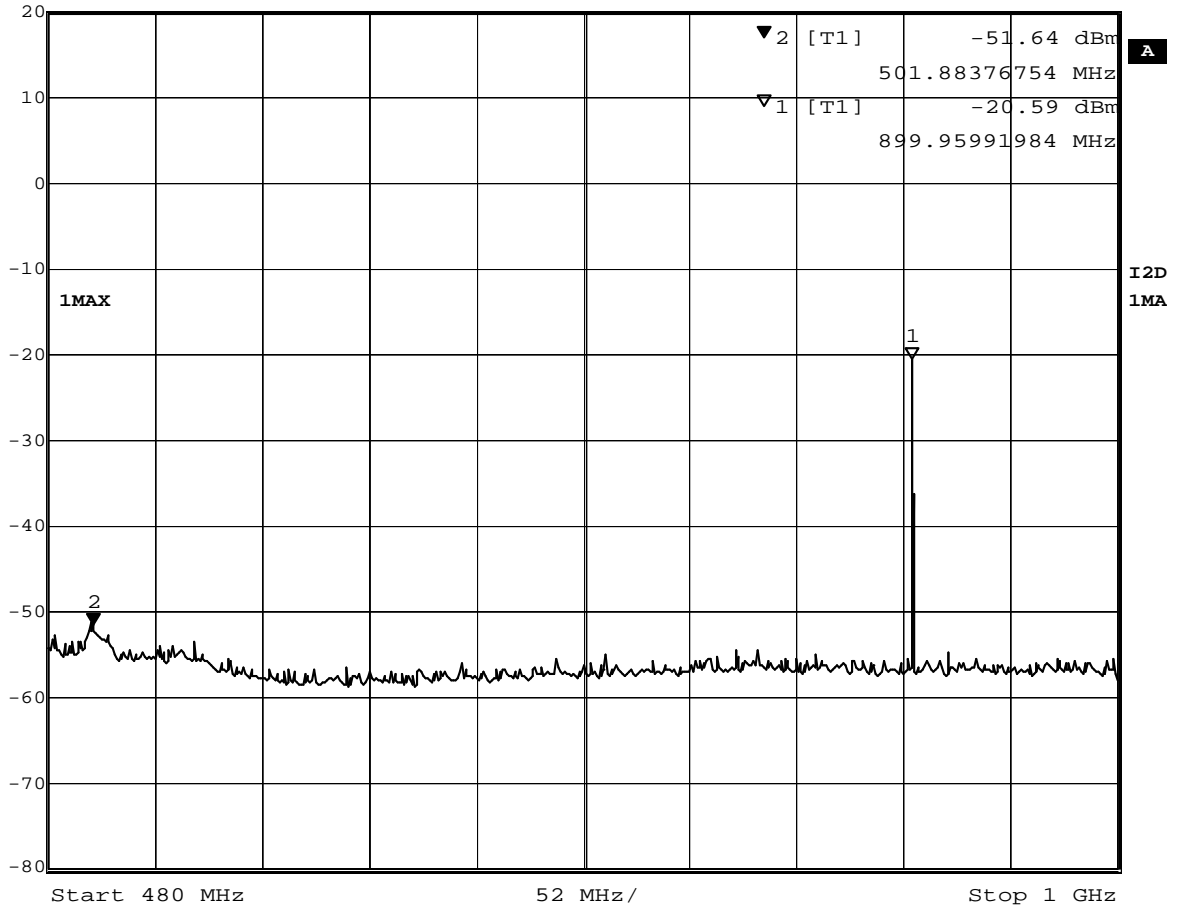


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Figure 1 - Conducted Spurious Emissions, 30MHz - 440MHz



Marker 2 [T1] RBW 100 kHz RF Att 30 dB
Ref Lvl -51.64 dBm VBW 100 kHz
20 dBm 501.88376754 MHz SWT 130 ms Unit dBm

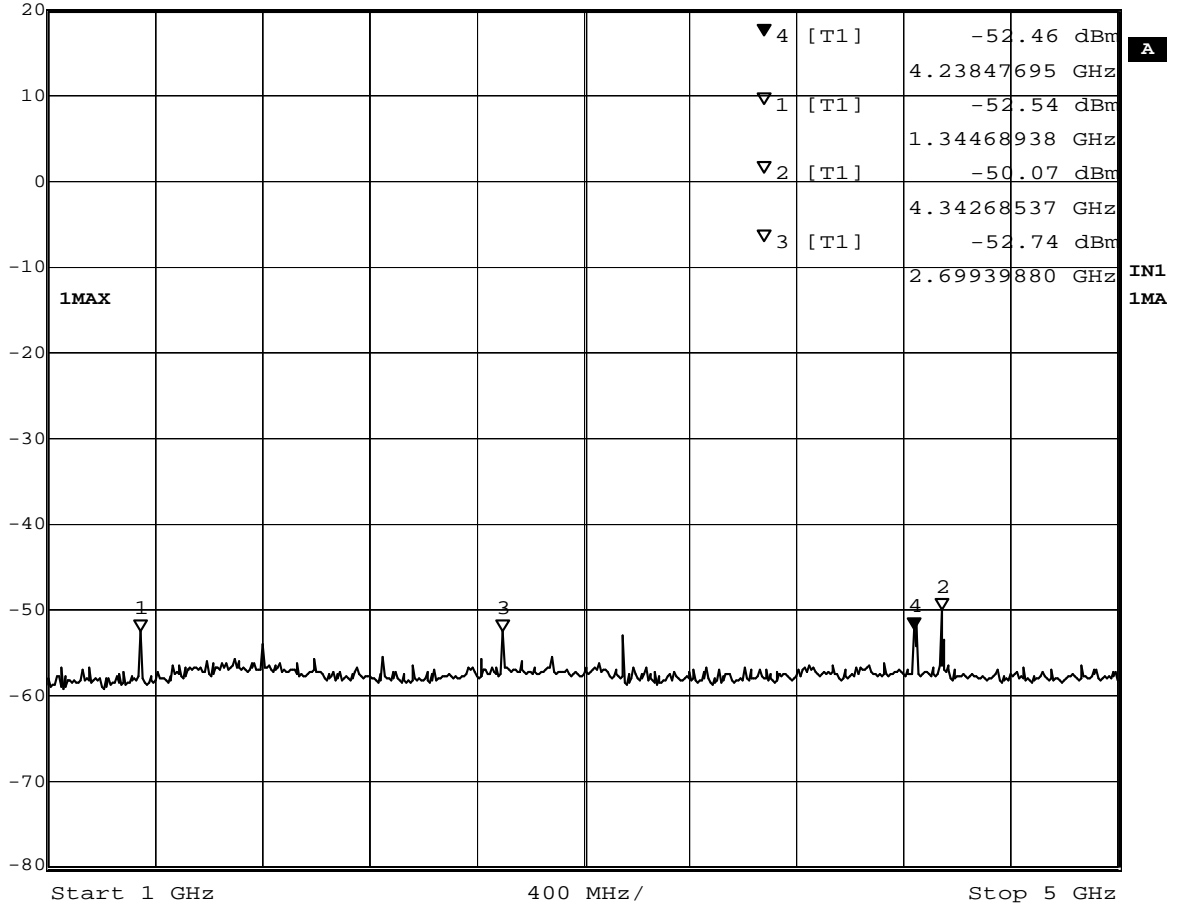


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Figure 2 - Conducted Spurious Emissions, 30MHz - 440MHz



Marker 4 [T1] RBW 100 kHz RF Att 30 dB
 Ref Lvl -52.46 dBm VBW 100 kHz
 20 dBm 4.23847695 GHz SWT 1 s Unit dBm

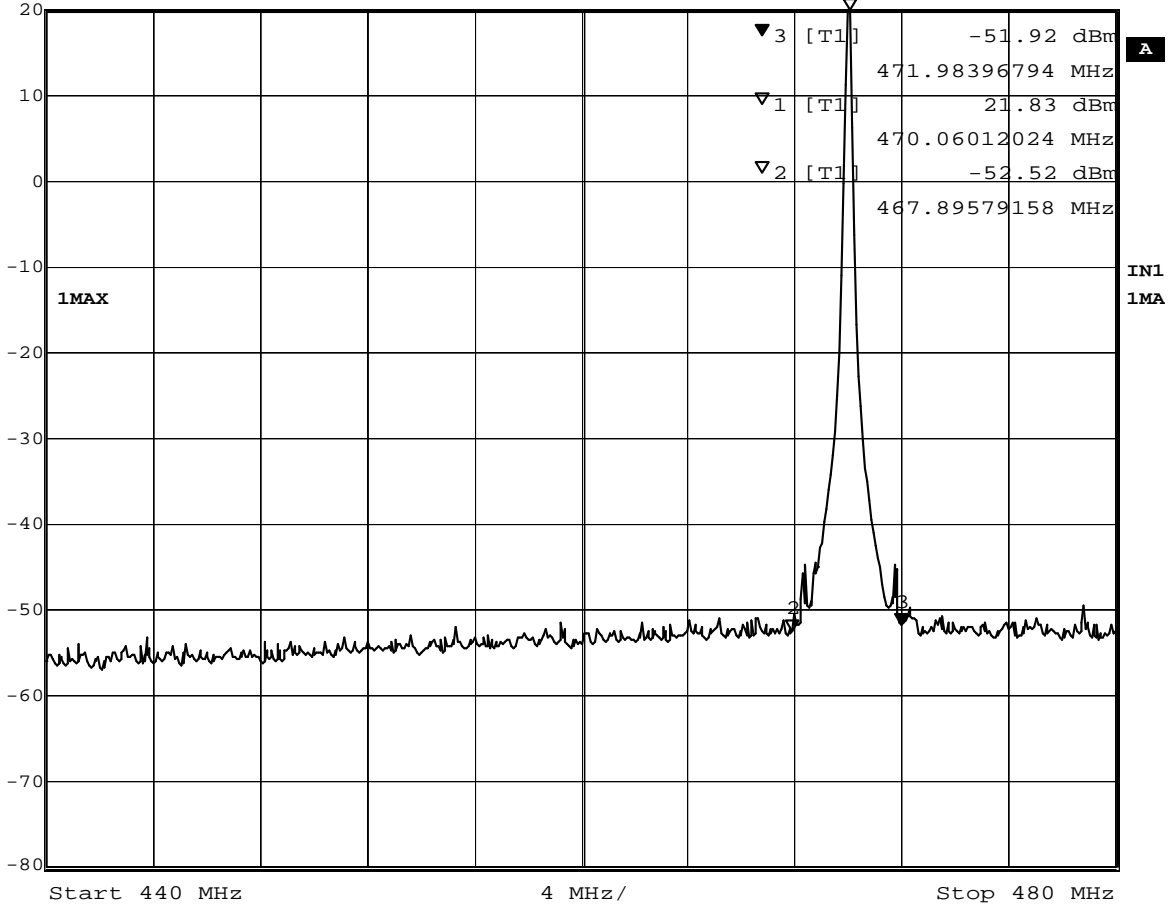


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Figure 3 - Conducted Spurious Emissions, 1GHz – 5GHz

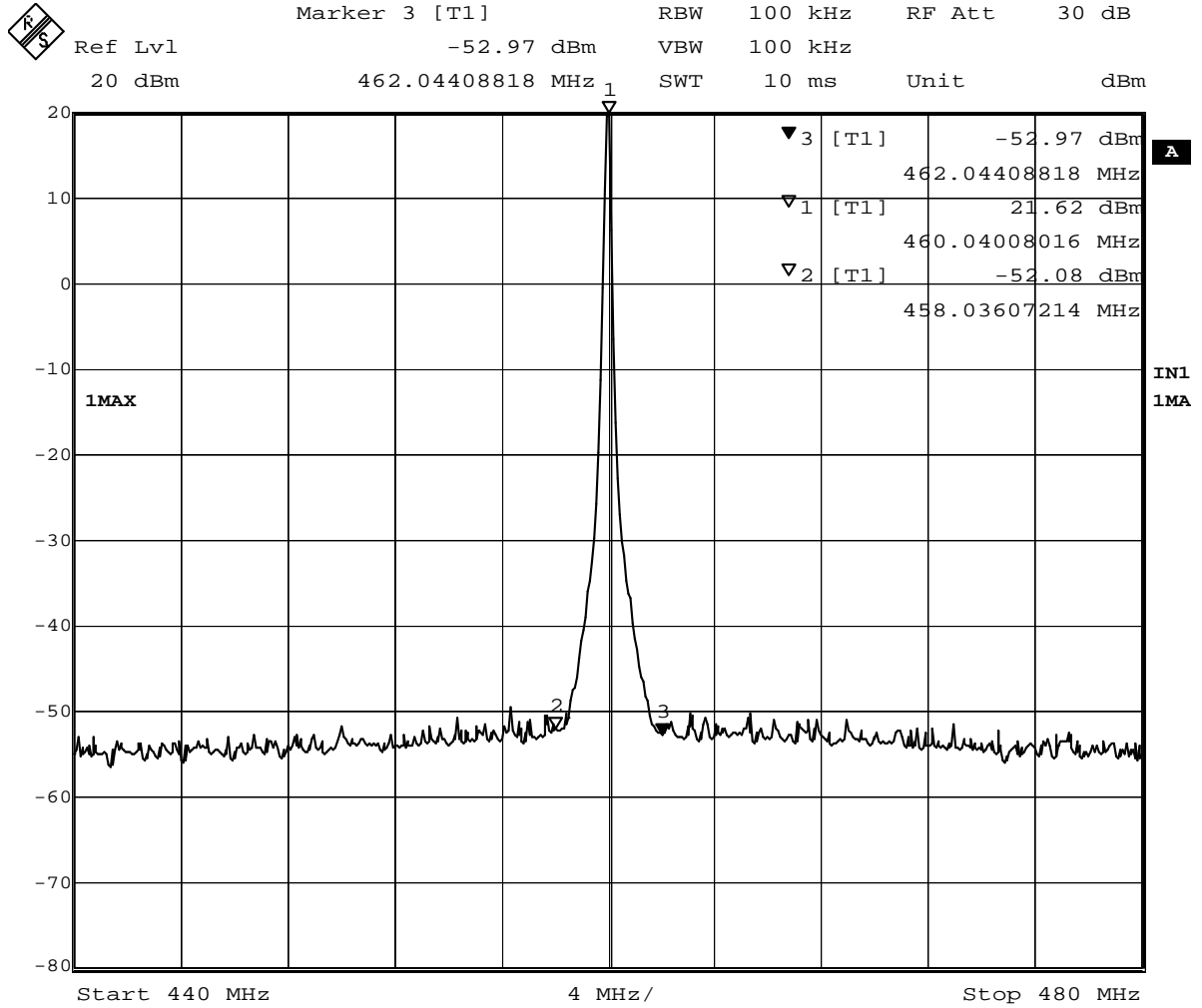


Marker 3 [T1] RBW 100 kHz RF Att 30 dB
 Ref Lvl -51.92 dBm VBW 100 kHz
 20 dBm 471.98396794 MHz SWT 10 ms Unit dBm



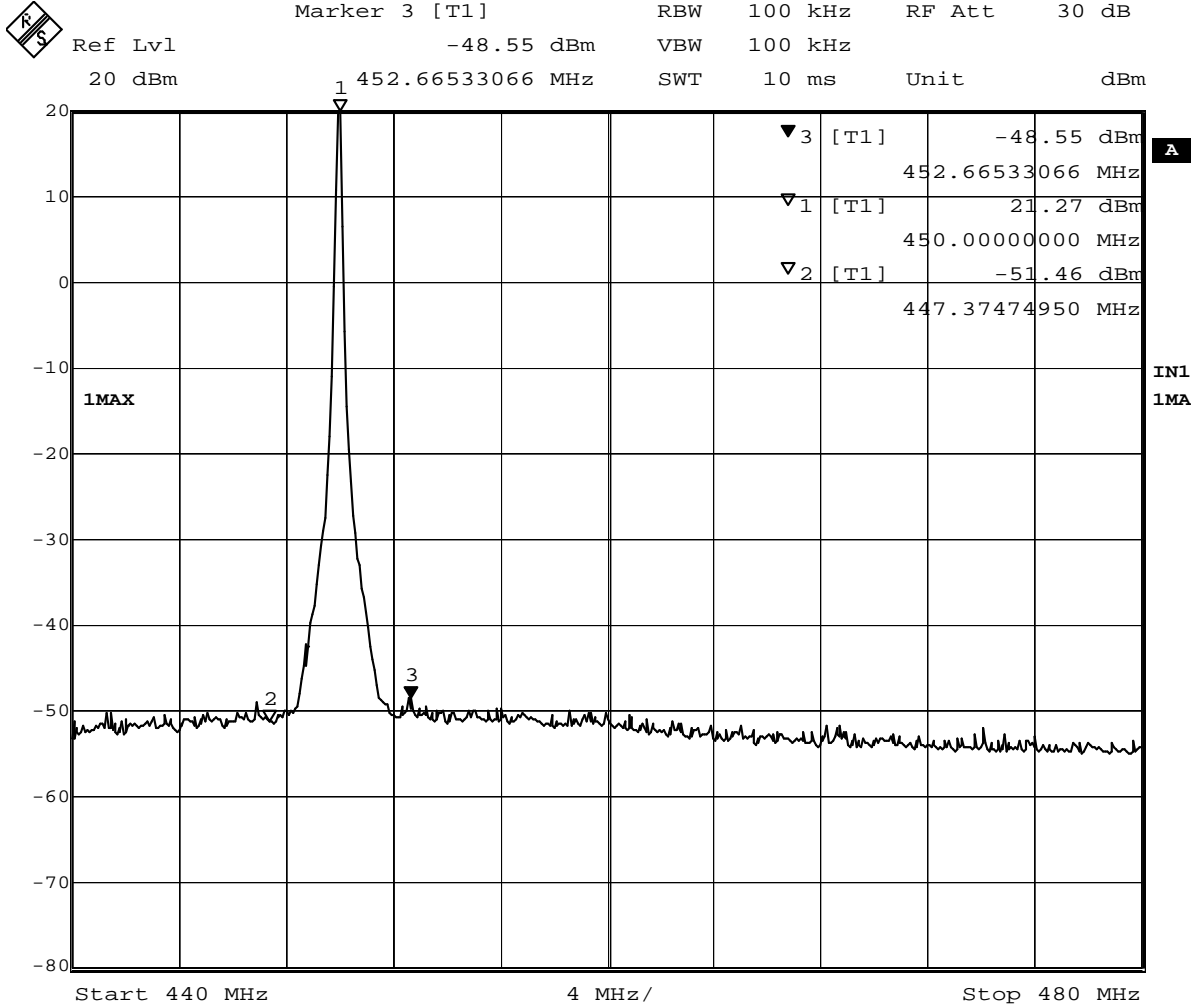
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Figure 4 - Conducted Spurious Emissions, 440MHz – 480MHz, Transmitting at 470MHz



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Figure 5 - Conducted Spurious Emissions, 440MHz – 480MHz, Transmitting at 460MHz



Date: 5.OCT.2011 19:22:07

Figure 6 - Conducted Spurious Emissions, 440MHz – 480MHz, Transmitting at 450MHz

2.3 Unwanted Emissions: Radiated Spurious

Test: CFR Title 47, Part 90; TIA-603-C Section 2.2.12
Industry Canada RSS-131 Issue 2:2003, Section 4.4

Test Specifications: TIA 603-C

Test Result: Complies Date: 5/11/2011

2.3.1 Test Description

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed with the EUT laying flat and standing up on its side. By rotating the turntable to maximize emissions, all three orthogonal axis were tested. The frequency range up to tenth harmonic of the fundamental frequency was investigated.

The EUT was then removed and the replaced with a substitution antenna of the same model as the receiving antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution. Spurious emissions in dB = 10 log (TXpwr in Watts/0.001) which is the absolute level.

2.3.2 Test Results

No radiated emissions measurements were found in excess of the limits. Test result data can be seen below.

2.3.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of 45 ± 5%

Temperature of 20 ± 2° C

2.3.4 Test Setup

See Section 2.3 for details.

2.3.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
1654	EMCO	3142B	Bicon Antenna	1/14/2011
1647	EMCO	3142B	Bicon Antenna	1/14/2011
6415	EMCO	3115	DRG Horn	1/12/2011
6416	EMCO	3115	DRG Horn	9/29/2011**
100037	Rhode & Schwarz	ES126	EMI Test Receiver	9/2/2010
2575	Rohde & Schwarz	ES-K1	Software v.1.60	NA
3545.7008.03	Rohde & Schwarz	TS	Preamplifier	12/15/2010*
1104.0002.290	Rohde & Schwarz	SMR 20	Signal Generator	1/14/2011
NCEE A (assigned)	Decibel	DB4303B	100 Watt RF Load	4/26/2011*

*Internal characterization

**Antenna factors were entered for most recent calibration. Testing was completed before the calibration date. These factors were used for the receive antenna from 1 – 5GHz in Table 5.

2.3.6 Test Pictures and/or Figures

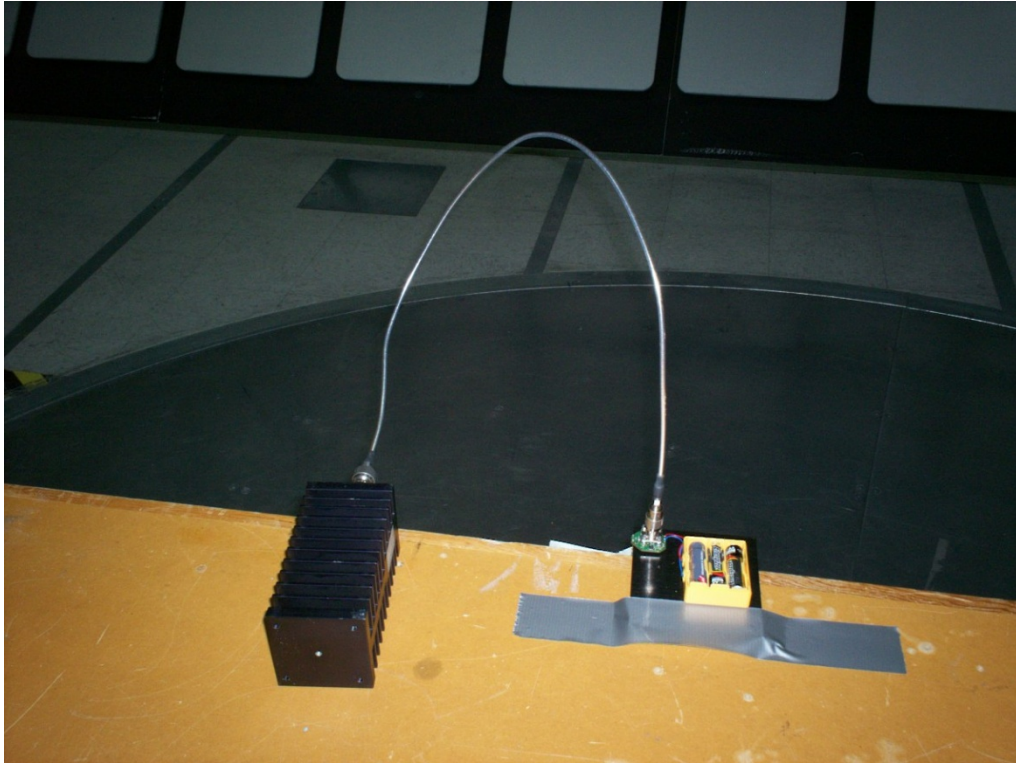


Figure 7 - Radiated Emissions Test Setup, 30MHz - 1GHz

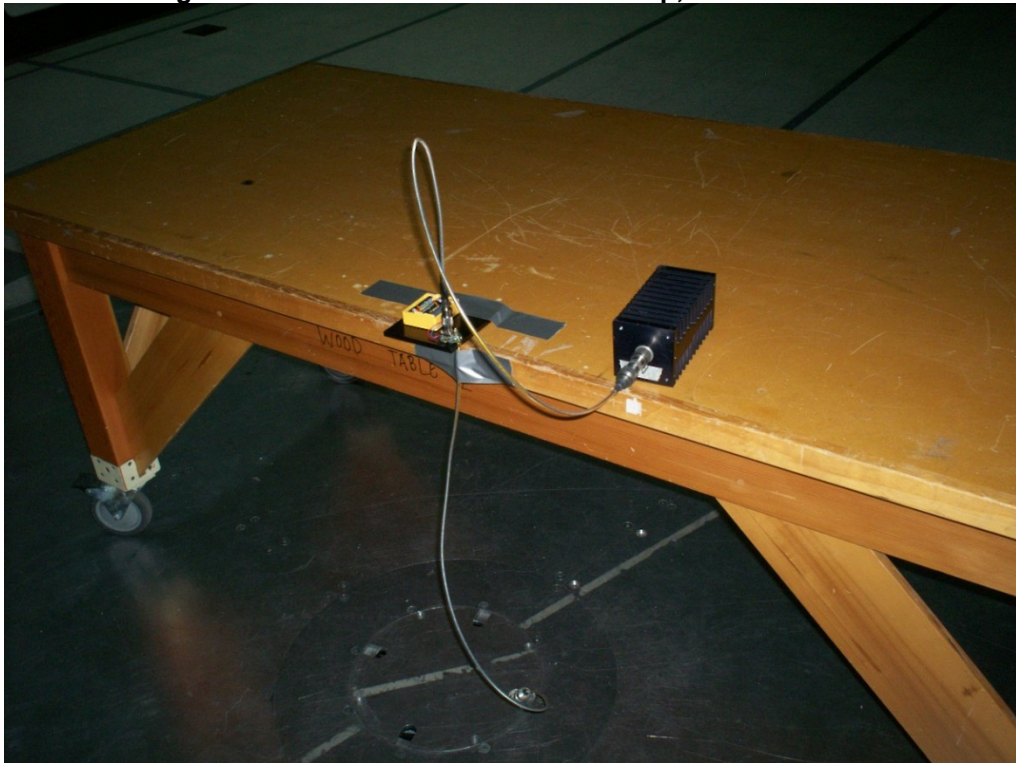


Figure 8 - Radiated Emissions Test Setup, 30MHz - 1GHz

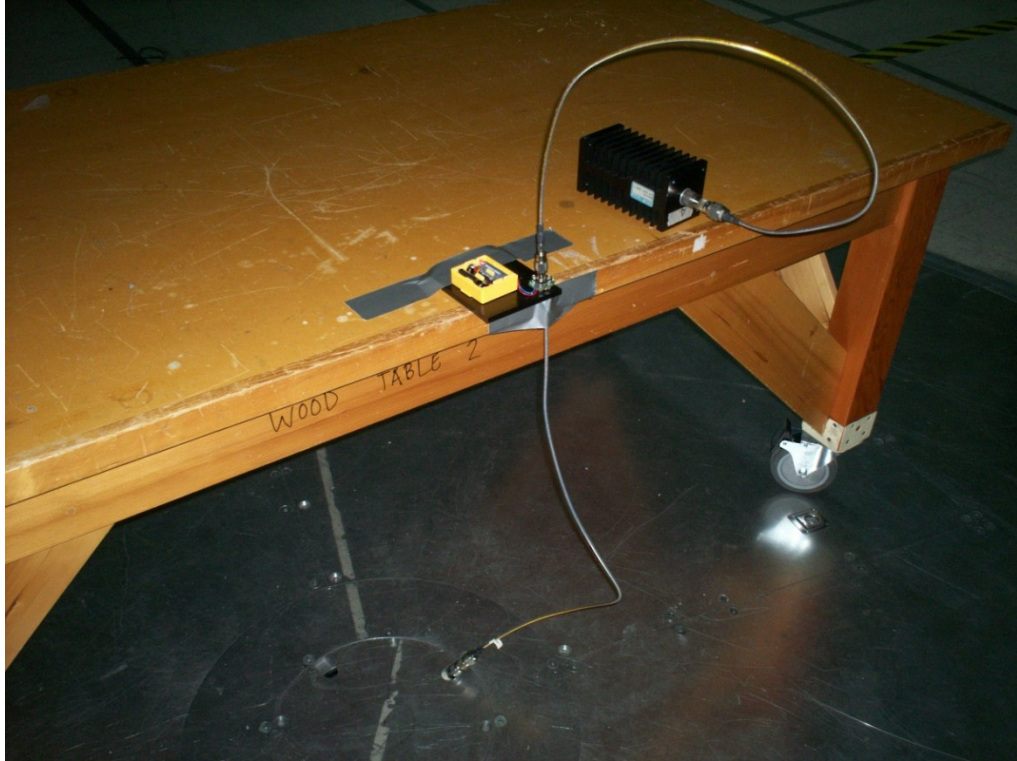


Figure 9 - Radiated Emissions Test Setup, 30MHz - 1GHz

Table 5 – Spurious Emissions Measurements

Frequency	Field Strength Level	Antenna Height	Angle	Pol.	Signal Generator Level	Transmit Antenna Gain	Transmit Cable loss	Level	Limit	Margin
MHz	dBµV/m	cm	deg.		dBm	dB	dB	dBm	dBm	dB
450MHz Fundamental										
30.3600	19.74	299	109	H	-71.65	0.14	0.90	-72.41	-13	59.41
106.2600	11.13	362	324	H	-82	1.24	1.80	-82.56	-13	69.56
449.9800	36.95	100	182	V	-61.26	3.68	3.70	-61.28	-13	48.28
897.0400	28.00	99	99	V	-75.65	3.13	5.20	-77.72	-13	64.72
1349.9400	53.99	143	221	V	-62.54	7.10	4.60	-60.04	-13	47.04
1800.5000	41.41	100	109	V	-66.81	8.32	5.50	-63.99	-13	50.99
2250.0000	47.74	100	249	V	-60.31	9.23	6.40	-57.48	-13	44.48
2700.0000	54.14	115	187	V	-66.98	9.78	7.10	-64.30	-13	51.30
460MHz Fundamental										
125.2800	12.16	397	323	V	-78.67	2.73	2.00	-77.94	-13	64.94
460.0000	37.50	100	6	V	-60.34	3.58	3.70	-60.46	-13	47.46
919.9600	67.51	197	6	V	-73.21	3.75	5.20	-74.66	-13	61.66
920.0200	47.95	180	269	V	-73.44	3.44	5.20	-75.20	-13	62.20
1380.0000	29.55	171	167	V	-60.32	7.40	4.70	-57.62	-13	44.62
1840.0000	49.84	139	195	V	-64.4	8.24	5.60	-61.76	-13	48.76
2300.0000	46.68	100	248	V	-61.02	9.21	6.40	-58.21	-13	45.21
2760.0000	56.82	129	194	V	-67.87	9.82	7.10	-65.15	-13	52.15
470MHz Fundamental										
31.4500	19.74	299	109	H	-71.039	0.15	0.90	-71.79	-13	58.79
100.1000	11.13	362	324	H	-78.99	1.03	1.80	-79.76	-13	66.76
470.0000	36.95	100	182	V	-59.54	3.43	3.70	-59.81	-13	46.81
940.0400	28.00	99	99	V	-73.21	3.56	5.20	-74.85	-13	61.85
1410.0000	46.47	130	208	V	-61.62	7.75	4.80	-58.67	-13	45.67
1880.0000	52.40	100	203	V	-69.54	8.32	5.60	-66.82	-13	53.82
Standby										
30.0000	14.02	397	305	V	-76.22	0.14	0.90	-76.98	-13	63.98
35.9400	11.09	392	121	V	-79.97	0.39	1.00	-80.58	-13	67.58
75.1800	10.95	136	114	H	-79.7	0.90	1.60	-80.40	-13	67.40
971.0200	28.49	100	158	H	-74.89	4.22	5.40	-76.07	-13	63.07
2030.5000	18.81	106	124	V	-77.43	8.87	24.40	-92.96	-13	79.96

2.4 Passband Gain and Bandwidth

Test: Industry Canada RSS-131 Issue 2:2003

Test Specifications: Section 6.2

Test Result: Complies Date: 6/10/2011

2.4.1 Test Description

The EUT was connected to the spectrum analyzer directly with a low-loss shielded coaxial cable. The resolution bandwidth was set to 100kHz and the 20dB bandwidth of the amplified signal was measured.

The gain-vs-frequency response of the amplifier is to be measured at least $\pm 250\%$ of the 20dB bandwidth from the passband. The amplifier was supplied with an FSK signal of 17dBm at 467.9MHz.

2.4.2 Test Results

See Data below.

2.4.3 Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $45 \pm 5\%$

Temperature of $20 \pm 2^\circ \text{C}$

2.4.4 Test Setup

See Section 2.3 for further details.

2.4.5 Test Equipment Used

Serial No.	Manufacturer	Model	Description	Last Cal.
100037	Rhode & Schwarz	ES126	EMI Test Receiver	9/2/2010



Marker 2 [T3] RBW 100 kHz RF Att 55 dB
Ref Lvl 124.84 dB μ V VBW 100 kHz
137 dB μ V 467.84569138 MHz SWT 5 ms Unit dB μ V

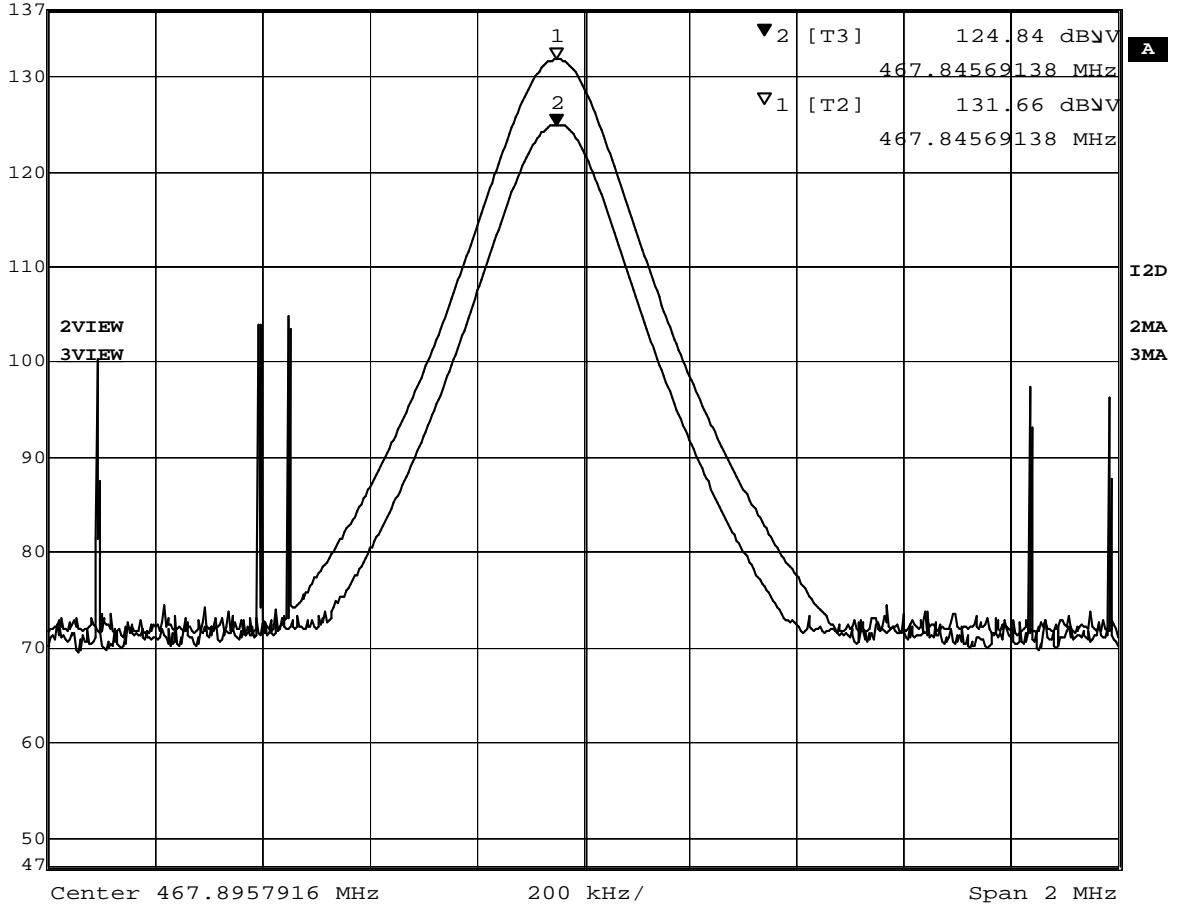
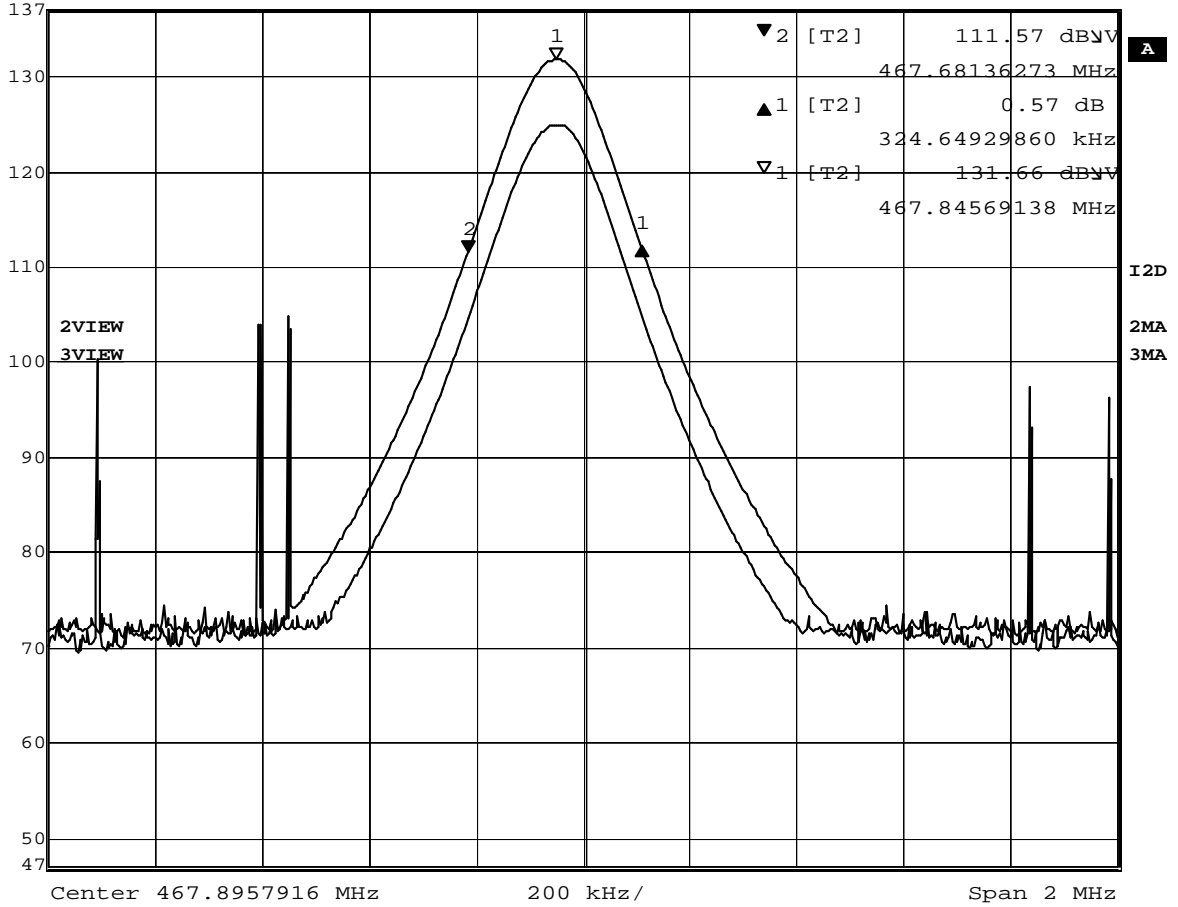


Figure 10 – Amplified vs. Unamplified FSK Signal

The above plot is of an unamplified FSK signal and the same signal passed through the amplifier. Both traces are shown on the same plot. Marker 1 is on the amplified signal trace. Marker 2 is on the unamplified signal trace.



Ref Lvl	Delta 1 [T2]	RBW	100 kHz	RF Att	55 dB
137 dBmV	0.57 dB	VBW	100 kHz		
	324.64929860 kHz	SWT	5 ms	Unit	dBmV



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Figure 11 - 20dB Bandwidth, 324.65kHz

The lower trace on the plot is the unamplified FSK signal. This is shown for reference only.

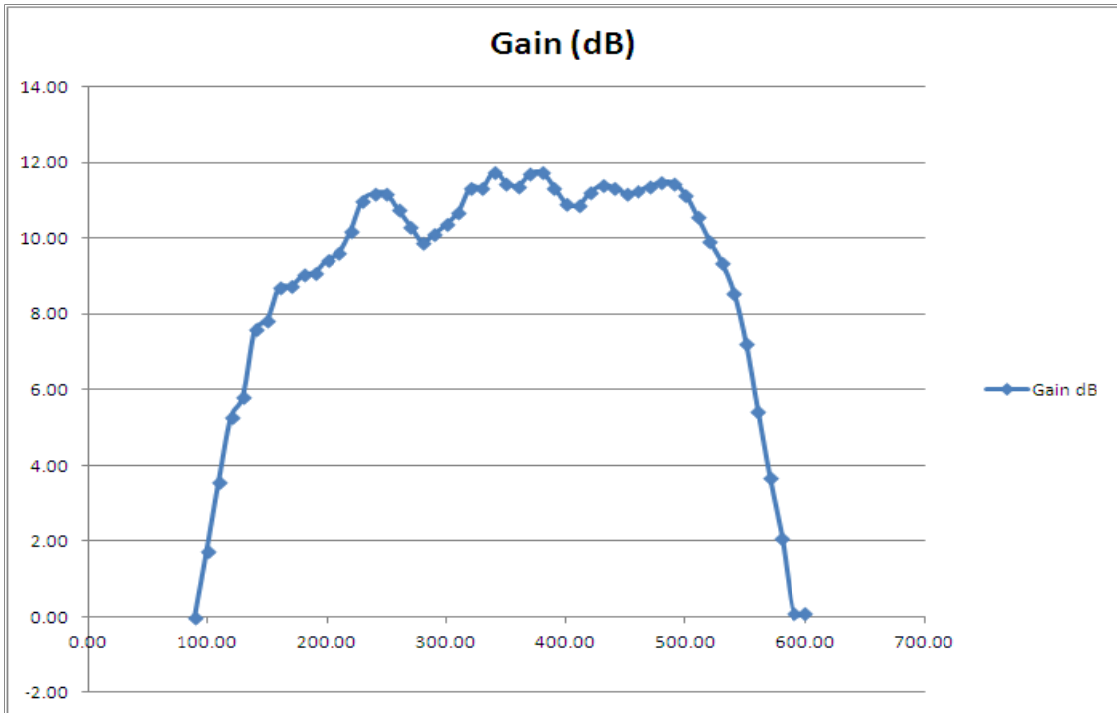


Figure 12 – Pass Band Gain

Table 6 – Gain vs. Frequency from 410 to 500MHz

Frequency MHz	Gain dB	Reference Power dBm	Cable Loss dB	Reading dBm	Gain dB
410.00	10.88	9.00	0.35	19.53	10.88
420.00	11.22	9.00	0.35	19.87	11.22
430.00	11.41	9.00	0.35	20.06	11.41
440.00	11.34	9.00	0.35	19.99	11.34
450.00	11.19	9.00	0.35	19.84	11.19
460.00	11.25	9.00	0.35	19.90	11.25
470.00	11.38	9.00	0.35	20.03	11.38
480.00	11.48	9.00	0.35	20.13	11.48
490.00	11.47	9.00	0.35	20.12	11.47
500.00	11.15	9.00	0.35	19.80	11.15