Testing Tomorrow's Technology

Application
For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraph 15.247

and

IC Radio Standards Specification: RSS-210

Permissive Change

For the

RFM/Cirronet

Model(s): DNT90C and DNT90P

FCC ID: HSW-DNT90
IC: 4492A-DNT90

UST Project: 12-0237
Issue Date: May 3, 2012

Total Pages in This Report: 40

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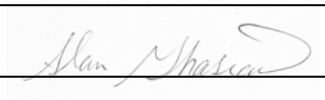
I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Consulting Engineer President

Date: May 3, 2012

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: RFM/Cirronet

MODEL(S): DNT90C and DNT90P

FCC ID: HSW-DNT90

IC ID: 4492A-DNT90

DATE: May 3, 2012

This report concerns (check one): Original grant
Class II change X

Equipment type: FHSS Transceiver Module

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: N/A
date

agrees to notify the Commission by N/A
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

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General Information

1.1 Purpose of this Report

The purpose of this report is to demonstrate compliance with Part 15 Subpart C of the FCC's Code of Federal Regulations and Industry Canada's Radio Standards Specification RSS-210 for a Class II Permissive Change to include the use of an integral chip antenna. The chip antenna information is as follows:

Manufacturer	Model	Peak Gain	Frequency
Johanson Technology	0915AT43A0026	-1.0	902-928 MHz

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on April 25, 2012 in good operating condition.

1.3 Product Description

The DNT90 is a frequency hopping spread spectrum (FHSS) transceiver operating in the 902-928 MHz frequency band which provides for wireless connectivity for point-to-point, point-to-multipoint and store-and-forward radio applications. The DNT90 comes in two models, the DNT90C and DNT90P. The models are electrically identical and differ only in the mounting options. The DNT90C is a castellated version and the DNT90P is a pin version for socket mounting. The DNT90P was tested as a representative sample and is referred to herein as DNT90.

Technical details:
Band of operation: 902-928 MHz
Number of hopping channels: 52
Channel spacing 480 KHz
Output power: 22 dBm
Over the air data rate: 100 Kbps
Modulation format: Gaussian filtered FSK
User interface rates: 9600 baud up to 230 Kbps
Receiver sensitivity: -100 dBm at 100 Kbps
Certification sub-type Frequency Hopper (>50 channels)
Emission Designator: F1D
Antennas: 5 dBi Omni(dipole), 6 dBi Yagi, -1 dBi chip antenna (pending)
RF connector: UFL

1.4 Duty Cycle Correction

For average radiated measurements, using a 10.4% duty cycle, the measured level was reduced by a factor 19.66dB. The duty cycle correction factor is determined using the formula: 20log (10.4/100) **= 19.66 dB**.

For details please the attached Annex Duty Cycle calculation.

1.5 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2003)* for FCC subpart B Digital equipment Verification requirements and per FCC Public Notice DA 00-705 released March 30, 2000 for Frequency Hopping Spread Spectrum Systems operating under section 15.247. Also, Marker-Delta Method was followed to measure the upper band-edge.

Digital RF conducted and radiated Verification emissions data (FCC 15.107 and 109) below 1 GHz were taken with the measuring receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1.0 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off throughout the evaluation process.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions are provided in separate Appendices.

1.6 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5117. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 2982A-1.

Table 1 - EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
(EUT) RFM / Cirronet	DNT90	None	HSW-DNT90	1m U USB
Switching Power Supply	--	None	None	6' U – P 120 VAC/ 60 Hz

2 Tests and Measurements

2.1 Test Equipment

Table 2 below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are included herewith.

Table 2 - Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	10/26/11
SPECTRUM ANALYZER	8566B	HEWLETT-PACKARD	2410A00109	11/04/11
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	2944A06291	10/06/11
BICONICAL ANTENNA 25 MHz to 200 MHz	3110B	EMCO	9307-1431	04/29/11
LOG PERIODIC 100 MHz to 1000 MHz	3146	EMCO	3110-3236	11/22/11
HORN ANTENNA 1 GHz to 18 GHz				08/10/11
PREAMP 1 GHz to 26.5 GHz	8449B	HEWLETT-PACKARD	3008A00480	11/15/11
CALCULATION PROGRAM	N/A	N/A	Ver. 6.0	N/A

Note: The calibration interval of the above test instruments is 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) Requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 as follows:

Table 3 - Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates over 902 MHz to 928 MHz, 3 test frequencies will be used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10^{th} harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above, whichever is the higher range of investigation.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

2.6 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. RFM / Cirronet Inc. will sell the RF Module with the following additional antenna to the original application:

Table 4 - Allowed Antenna(s)

MANUFACTURER	TYPE OF ANTENNA	MODEL	REPORT REFERENCE	GAIN dB_i
Johanson Technology	Integral Chip antenna	0915AT43A0026	Antenna 1	-1.0

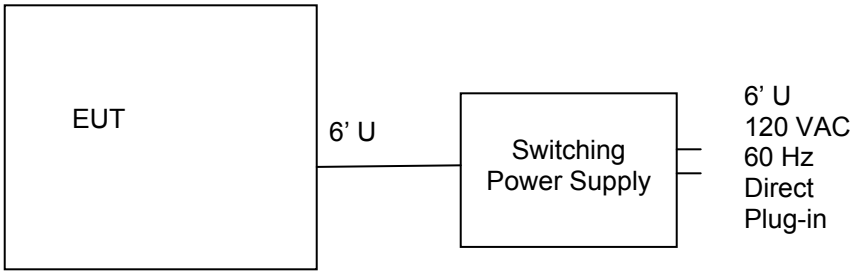


Figure 1 - Test Configuration

2.7 Intentional Radiator, Radiated Emissions (Antenna Conducted) (CFR 15.209, 15.247(d)) (IC RSS 210, A2.9 (a))

The EUT was put into a continuous-transmit mode of operation and tested per FCC Public Notice DA 00-705, for conducted out of band emissions emanating from the antenna port over the frequency range of 30 MHz to 12.5 GHz. A conducted scan was performed on the EUT to identify and record spurious signals that were related to the transmitter. Antenna Conducted Emissions of a significant magnitude that fell within restricted bands were then measured as radiated emissions on the OATS. The conducted emissions graphs are found in figures 4 through 10 below. The limit for antenna conducted power is 1 Watt (30 dBm) per 15.247 (b)(3) and b(4).

For radiated measurements, the EUT was set into a continuous transmission mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ RBW. The results of peak radiated spurious emissions falling within restricted bands are given in Table 5, 6 and 7 below.

For Average Voltage measurements above 1 GHz, the emissions were measured using RBW = 1 MHz and VBW = 10 Hz. For a pulse-modulated transmitter, the EUT's average emissions are further modified by adding to them the worst-case duty cycle, determined by adding the EUT's total pulse widths (on time) over a 100 ms period and dividing by 100 ms.

On the OATS, the EUT was mounted on top of a non-conductive table, 80 cm above the floor, by placing it in the X-Z plane along the Z axis with its bottom cover in parallel with the ground. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display (with channel A in the Clear-Write mode and channel B in the Max-Hold mode) for the largest signal visible. That exact antenna height where the signal was maximized was recorded for reproducibility purposes. Also, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied. Data is shown in Tables 5 through 7.

Radiated emissions above 3 GHz were measured at a distance of 3 meters. There were no test failures.

2 Test and Measurements (Cont'd)

2.8 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d)) (IC RSS 210, A2.9 (a)) (Cont'd).

Note: Large Signal shown is Fundamental Frequency

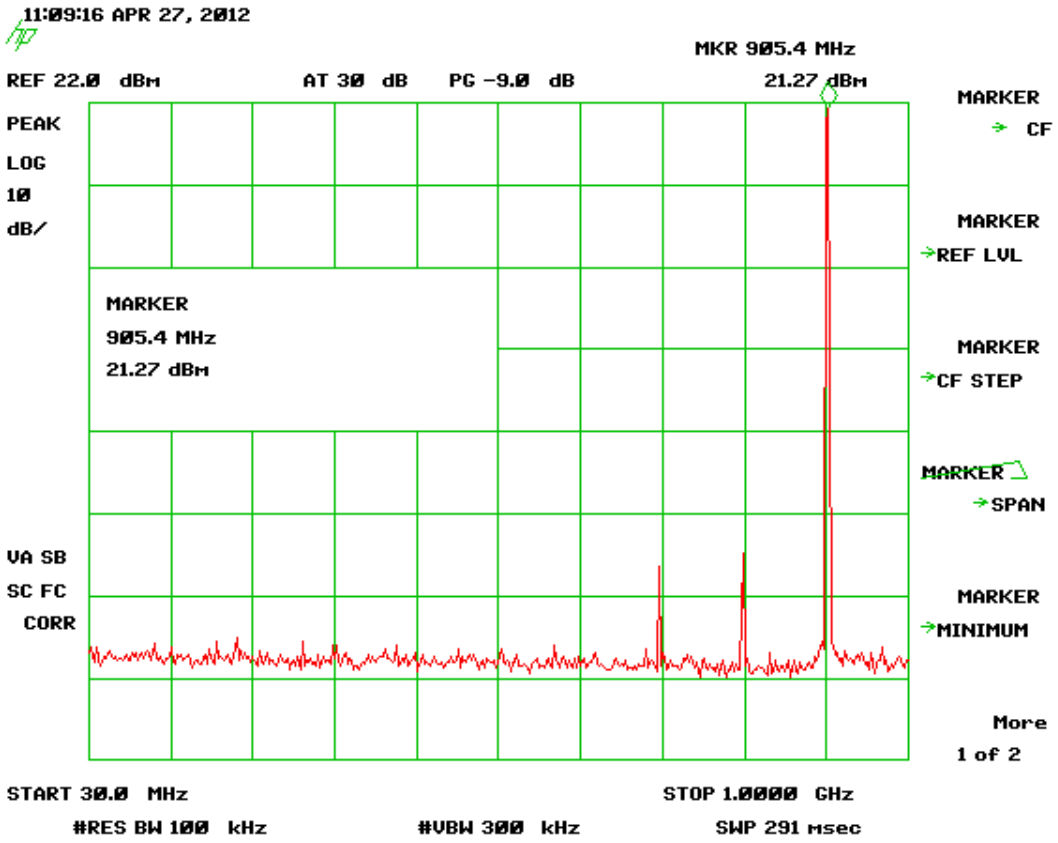


Figure 2 - Antenna Conducted Spurious Emissions – Low Channel, Part 1

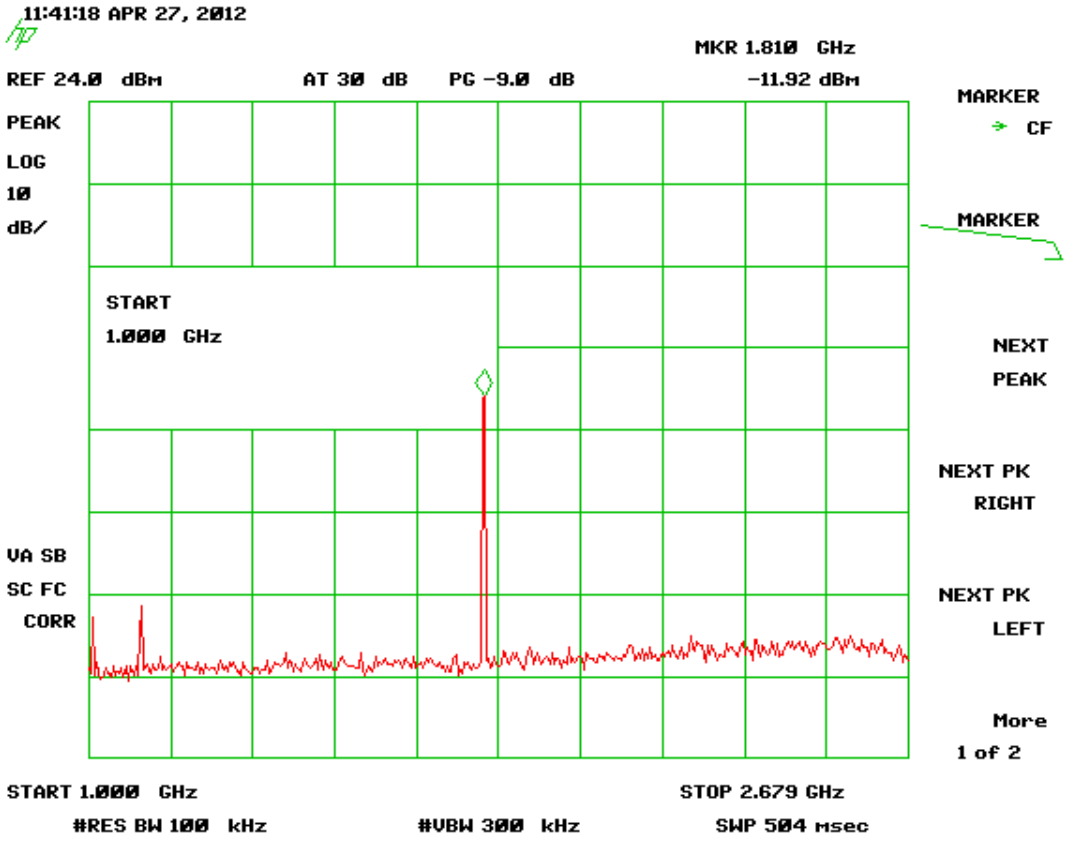


Figure 3 - Antenna Conducted Spurious Emissions – Low Channel, Part 2

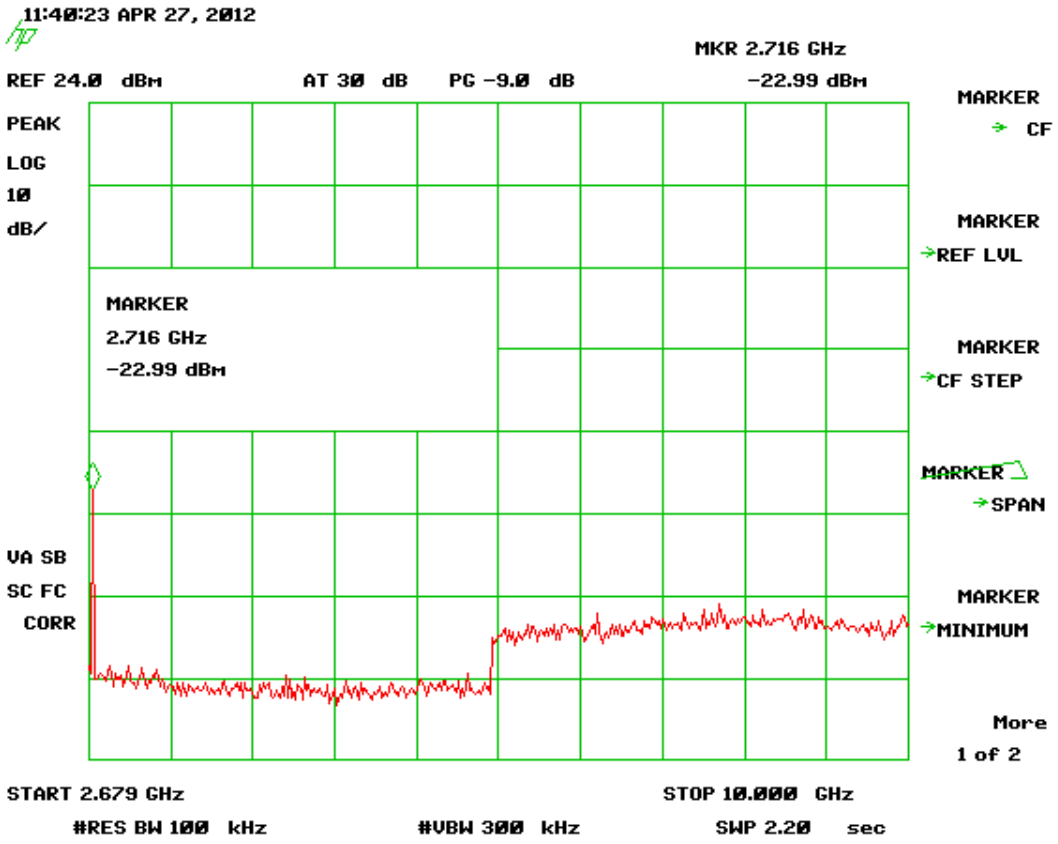


Figure 4 - Antenna Conducted Spurious Emissions – Low Channel, Part 3

Note: Signal shown represents Fundamental Frequency

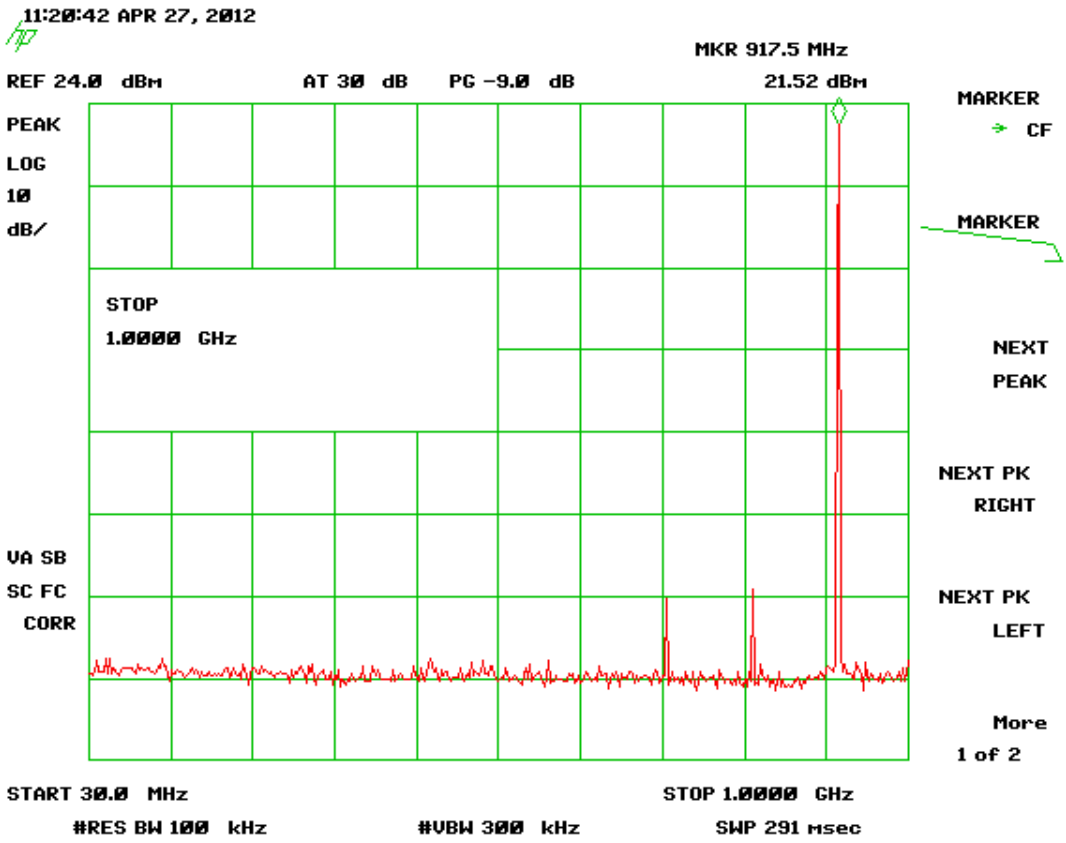


Figure 5 - Antenna Conducted Spurious Emissions - Mid Channel, Part 1

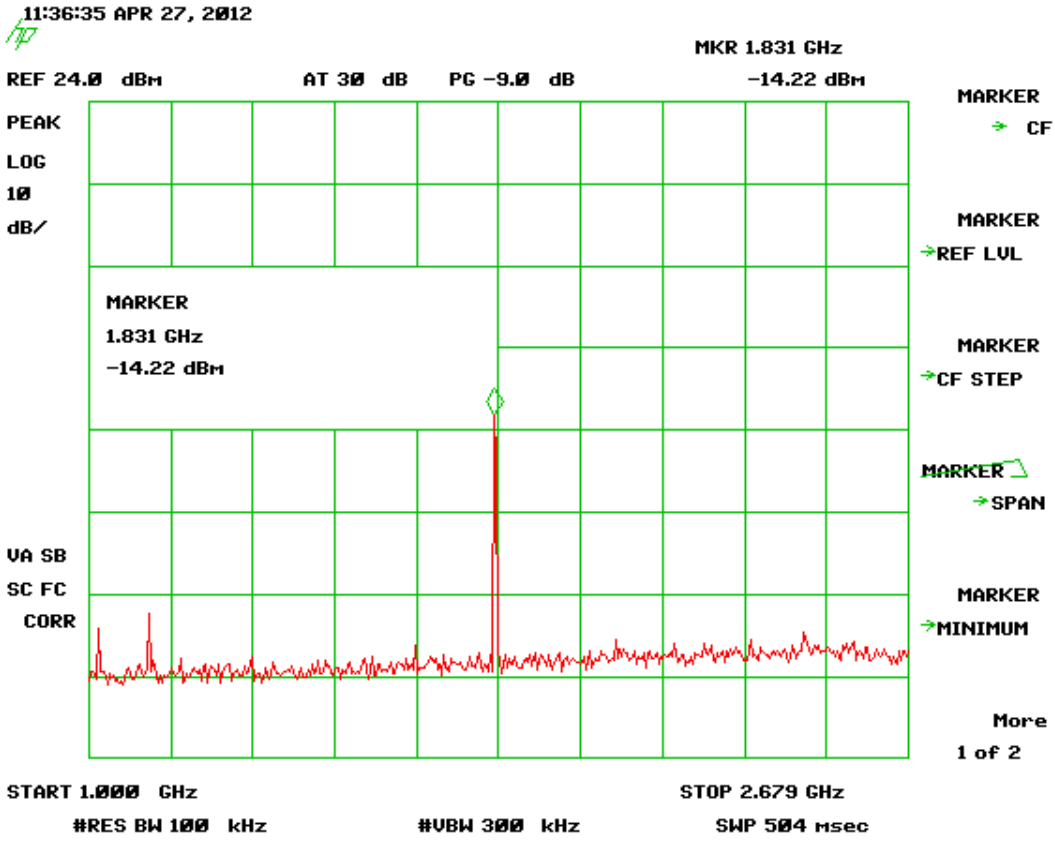


Figure 6 - Antenna Conducted Spurious Emissions – Mid Channel, Part 2

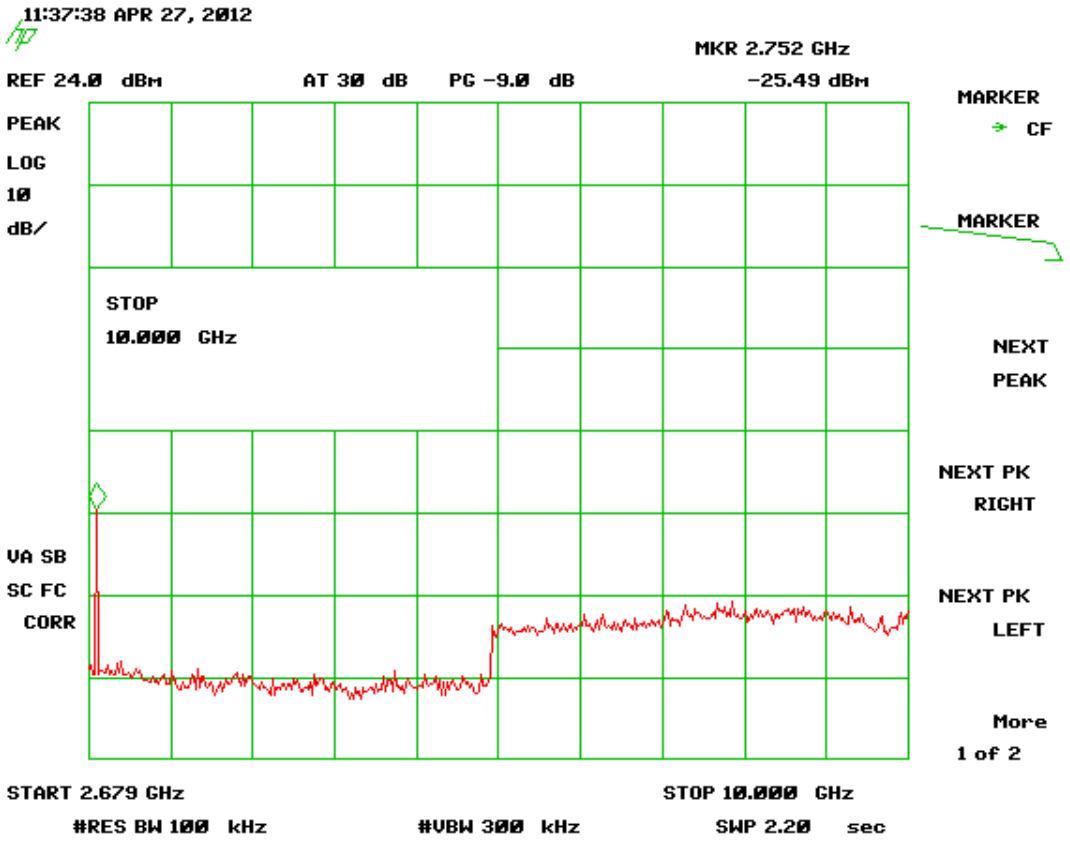


Figure 7 - Antenna Conducted Spurious Emissions – Mid Channel, Part 3

Note: Large Signal shown is Fundamental Frequency

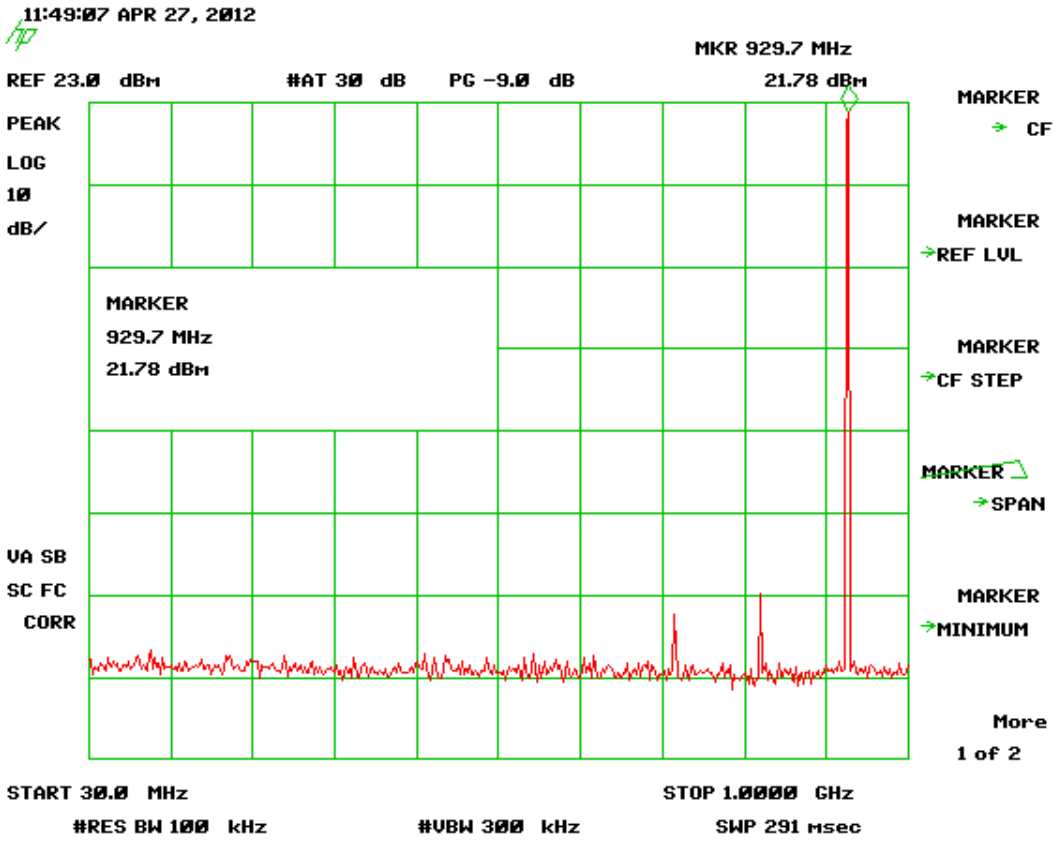


Figure 8 - Antenna Conducted Spurious Emissions – High Channel, Part 1

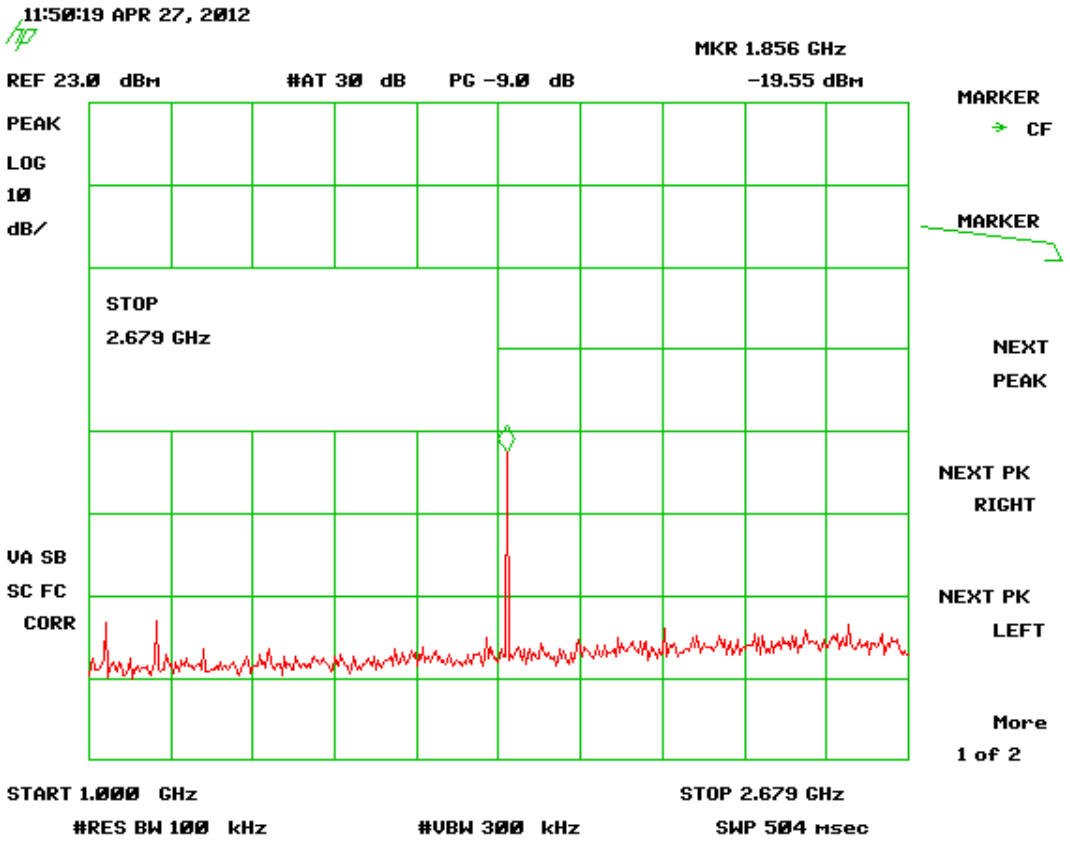


Figure 9 - Antenna Conducted Spurious Emissions - High Channel, Part 2

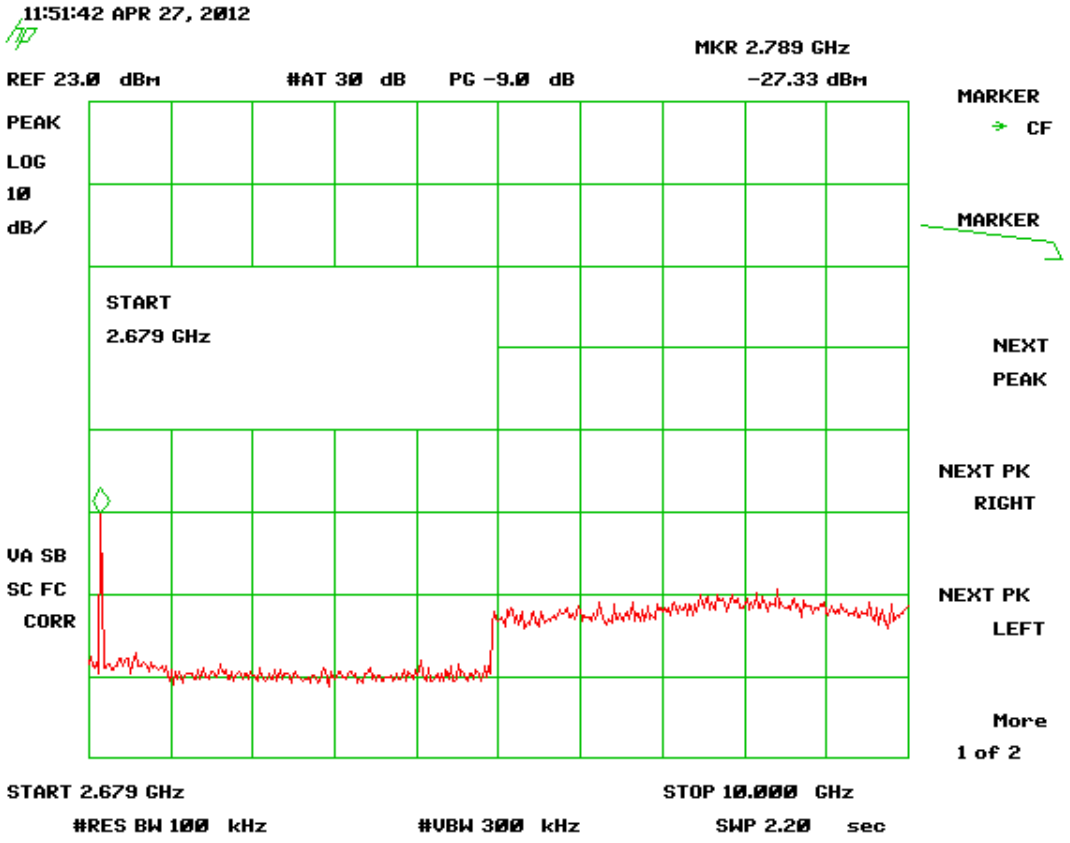


Figure 10 - Antenna Conducted Spurious Emissions - High Channel, Part 3

Table 5 - Peak Radiated Harmonic & Spurious Emissions-Antenna 1

Radiated Harmonic and Spurious Emissions								
Tested By: J.W.	Test: FCC Part 15, Para 15.247(d)				Client: RFM/Cirronet			
	Project: 12-0237				Model: DNT90P			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**PEAK Limits (dBuV/m)**	**Distance / Polarization**	**Pass Margin (dB)**	**Detector PK / AVG**
LOW BAND - PEAK								
902.61	84.01		28.96	112.97		3.0m./		
2707.82	70.24	1.50	-2.93	68.81	74.0	3.0m./	5.2	**PK**
3601.53	64.65	1.50	1.28	67.43	74.0	3.0m./	6.6	**PK**
4514.43	62.98	1.50	2.41	66.89	74.0	3.0m./	7.1	**PK**
5414.82	55.13	1.50	4.77	61.40	74.0	3.0m./	12.6	**PK**
MID BAND- PEAK								
915.09	86.29		28.86	115.15		3.0m./		**PK**
2745.25	74.45	1.50	-2.91	73.04	74.0	3.0m./	1.0	**PK**
3660.38	61.14	1.50	1.34	63.98	74.0	3.0m./	10.0	**PK**
4575.43	68.30	1.50	2.43	72.23	74.0	3.0m./	1.8	**PK**
HIGH BAND- PEAK								
927.09	84.29		28.97	113.26		3.0m./		**PK**
2781.25	74.26	1.50	-2.74	73.02	74.0	3.0m./	1.0	**PK**
3708.36	64.66	1.50	1.72	67.88	74.0	3.0m./	6.1	**PK**
4635.46	67.48	1.50	2.62	71.60	74.0	3.0m./	2.4	**PK**

- - Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation of CFR 15.35.

SAMPLE CALCULATION:
RESULTS: At 2707.82 MHz: = 70.24 dBuV + additional factor (-2.93) dB/m = 68.81 dBuV/m @ 3m
Margin = (74.0 – 68.81) = 5.2 dB

Test Date: April 25, 2012
Tested By
Signature:  Name: **John Wynn**

Table 6 - AVG Radiated Harmonic & Spurious Emissions-Antenna 1

Radiated Harmonic and Spurious Emissions								
Tested By: J.W.	Test: FCC Part 15, Para 15.247(d)				Client: Cirronet Inc.			
	Project: 12-0237				Model: DNT90P			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Distance / Polarization**	**Pass Margin (dB)**	**Detector PK / AVG**
LOW BAND - PEAK								
902.61	84.01	-20.00	28.96	92.97		3.0m./		
2707.82	70.24	-18.10	-2.93	49.21	54.0	3.0m./	4.8	**PK**
3601.53	64.65	-18.10	1.28	47.83	54.0	3.0m./	6.2	**PK**
4514.43	62.98	-18.10	2.41	47.29	54.0	3.0m./	6.7	**PK**
5414.82	55.13	-18.10	4.77	41.80	54.0	3.0m./	12.2	**PK**
MID BAND- PEAK								
915.09	86.29	-20.00	28.86	95.15		3.0m./		**PK**
2745.25	74.45	-18.10	-2.91	53.44	54.0	3.0m./	0.6	**PK**
3660.38	61.14	-18.10	1.34	44.38	54.0	3.0m./	9.6	**PK**
4575.43	68.30	-18.10	2.43	52.63	54.0	3.0m./	1.4	**PK**
HIGH BAND- PEAK								
927.09	84.29	-20.00	28.97	93.26		3.0m./		**PK**
2781.25	74.26	-18.10	-2.74	53.42	54.0	3.0m./	0.6	**PK**
3708.36	64.66	-18.10	1.72	48.28	54.0	3.0m./	5.7	**PK**
4635.46	67.48	-18.10	2.62	52.00	54.0	3.0m./	2.0	**PK**

- - Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation of CFR 15.35.
- Additional factor due to the use of filter and the application of the DC 19.6 dB.

SAMPLE CALCULATION:
RESULTS: At 2707.82 MHz: = 70.24 dBuV+ (-18.10) + (-2.93) dB/m = 49.21 dBuV/m @ 3m
Margin = (54.0 – 49.21) = 4.8 dB

Test Date: April 25, 2012
Tested By
Signature:  Name: **John Wynn**

2.12 Maximum Peak Conducted Output Power (CFR 15.247 (b) (3))

The DNT90 module, the transmitter, was programmed to operate at a maximum of +22 dBm across the bandwidth.

Peak power within the band 902 MHz to 928 MHz was measured per FCC KDB Publication DA 00-705 as an Antenna Conducted test with a spectrum analyzer by connecting the spectrum analyzer directly, via a short RF cable, to the antenna output terminals on the EUT. The spectrum analyzer was set for an impedance of 50 Ω with the RBW set greater than the 6 dB bandwidth of the EUT, and the VBW ≥ RBW. The loss of the short cable is <1.0 dB, and a 8.0 dB attenuator was also used. The final corrected measurements were determined by adding 9.0 dB to the raw data measured values of Figures 11, 12 & 13. Peak antenna conducted output power is tabulated in Table 9 below.

Antenna Conducted Output Power was measured at Low Channel, Mid Channel and High Channel frequencies. See Figures 3 to 8 above. The 9.0 dB loss for the RF wire is taken into consideration here (Corrected Measurement column).

Table 9 - Peak Antenna Conducted Output Power per Part 15.247 (b) (3) (Same as EIRP)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Corrected Measurement (dBm)	(mW)	FCC Limit (mW Maximum)
Low Band (902.61 MHz)	12.52	21.52	141.91	1000
Mid Band (915.19 MHz)	12.77	21.77	150.31	1000
High Band (9267.4 MHZ)	13.10	22.1	162.18	1000

Test Date: April 26, 2012
Tested By
Signature: _____ Name: John Wynn

2 Test and Measurements (Cont'd)

2.12 Peak Power Output (CFR 15.247 (b)(3))

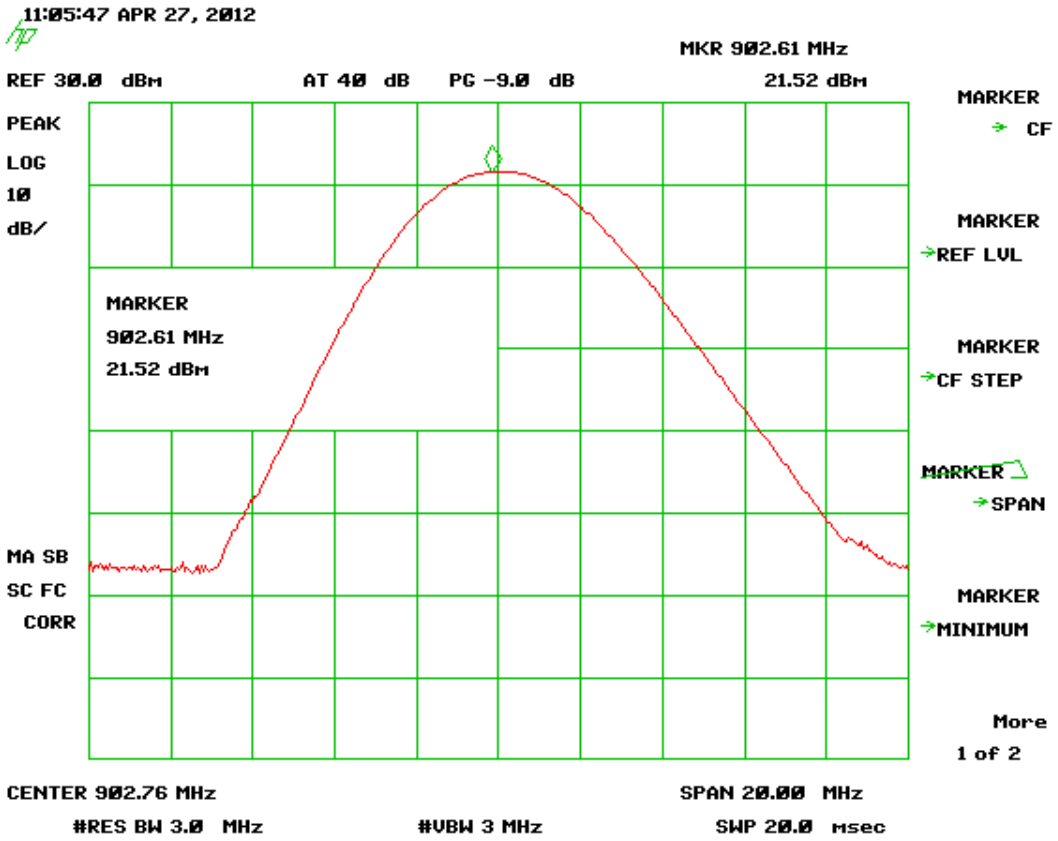


Figure 11 - Peak Antenna Conducted Output Power, Low Channel

2 Test and Measurements (Cont'd)

2.12 Peak Power Output (CFR 15.247 (b)(3))

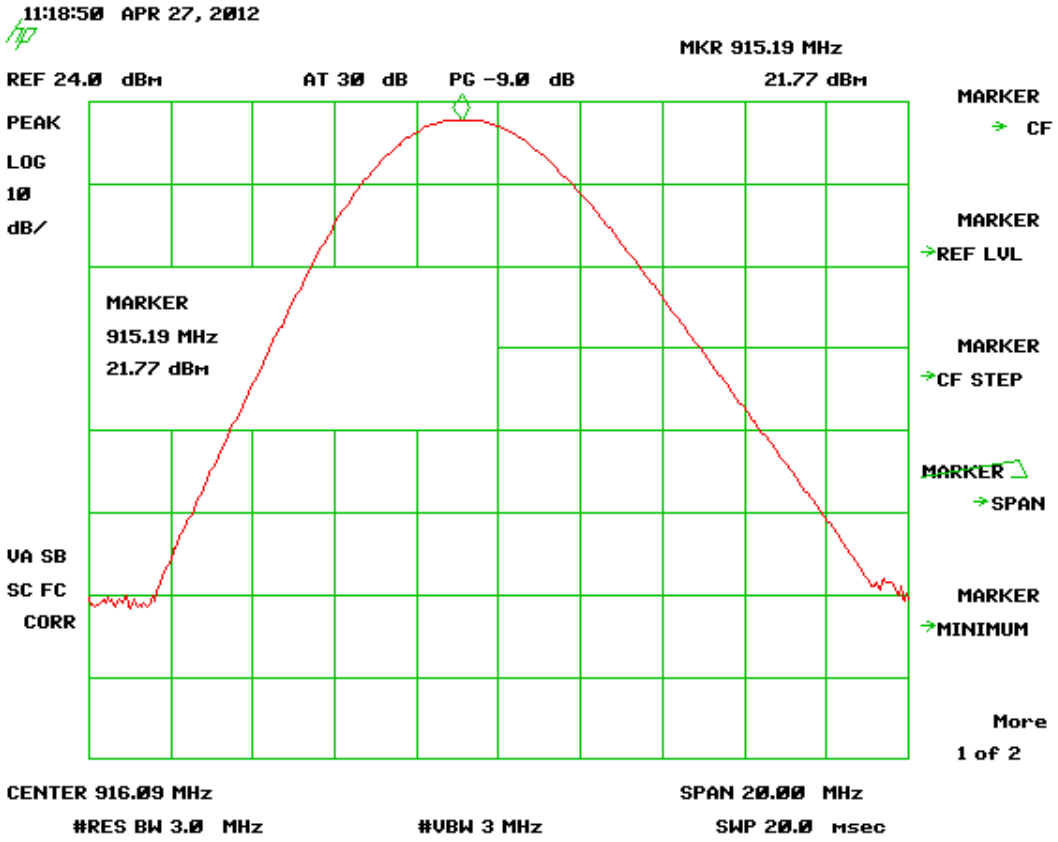


Figure 12 - Peak Antenna Conducted Output Power, Mid Channel

2 Test and Measurements (Cont'd)

2.12 Peak Power Output (CFR 15.247 (b)(3))

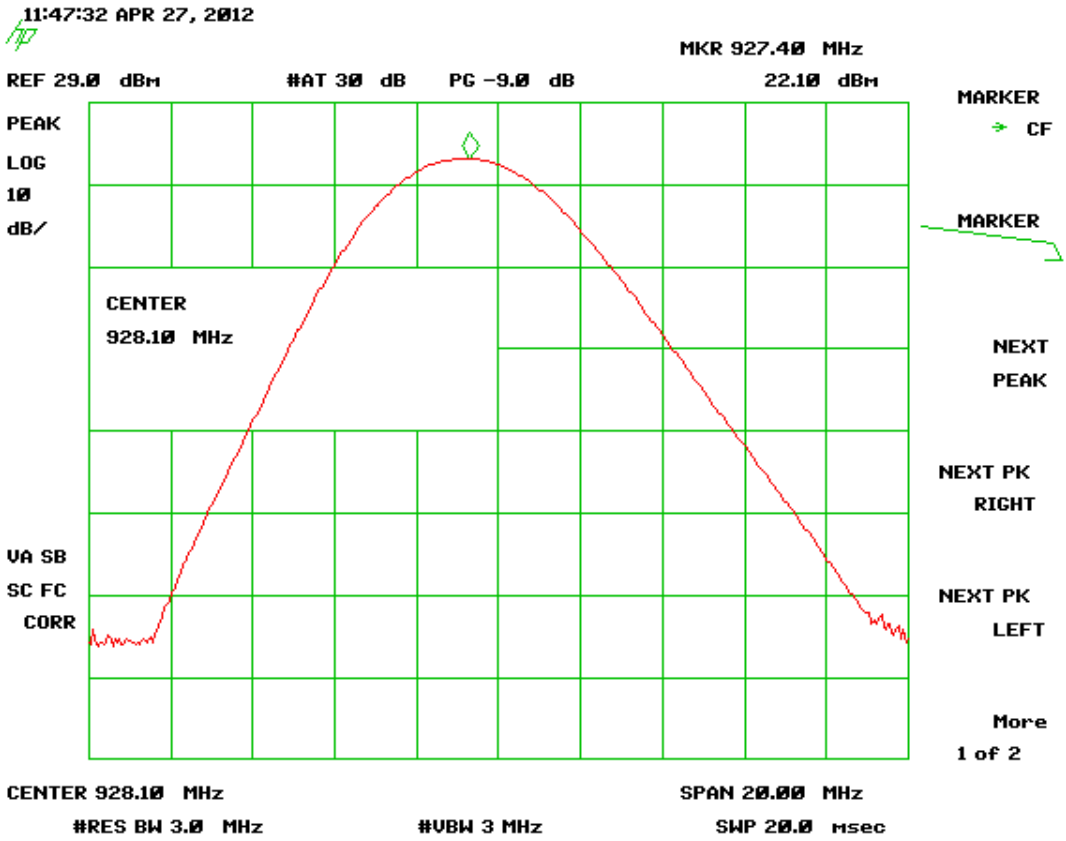


Figure 13 - Peak Antenna Conducted Output Power, High Channel

2.9 Band Edge Measurements – (CFR 15.247 (d))

Band Edge measurements are made with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Antenna port conducted measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in-band value (contained in a 100 kHz band). Because these frequencies occur above 1000 MHz they have both a peak and average requirement.

The measurement was conducted in the following manner: set the spectrum analyzer frequency span large enough (usually around 10 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Conducted measurements are performed with RBW ≥1% of the frequency span. In all cases, the VBW is set ≥ RBW. This procedure is similar to FCC Docket # DA 00-705.

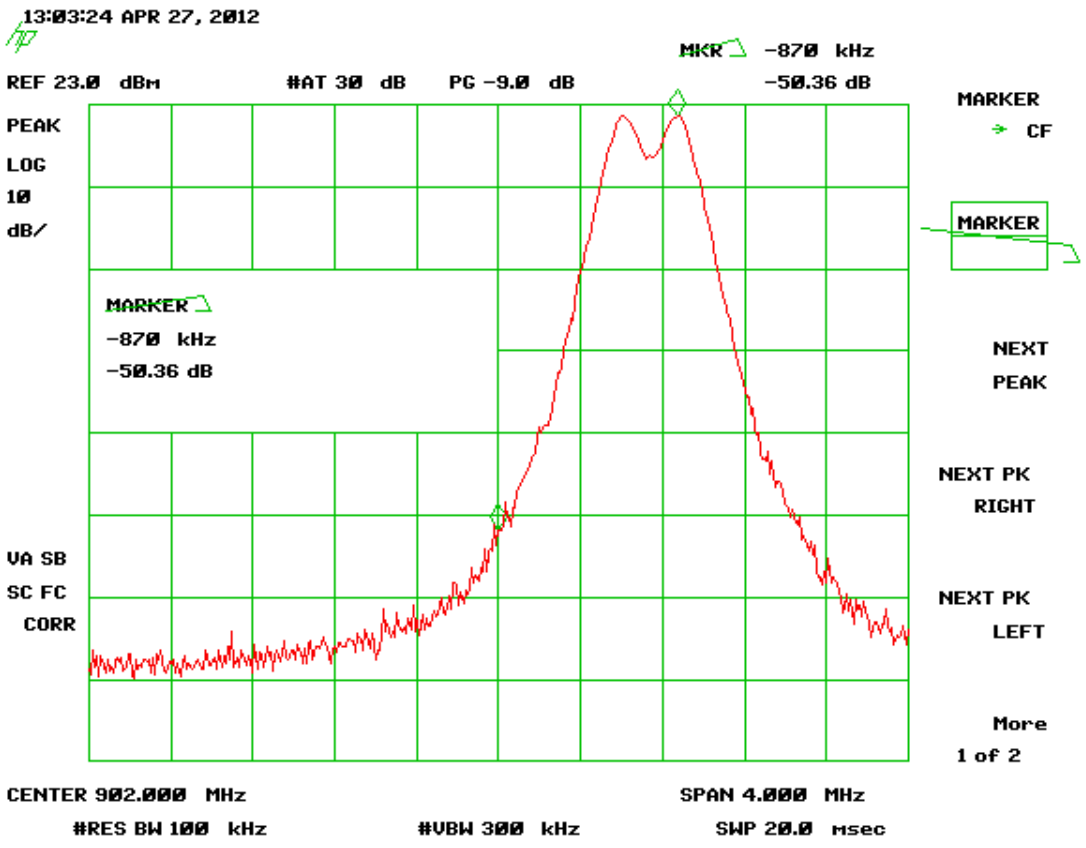


Figure 14 - Radiated Band Edge Compliance – Low Channel

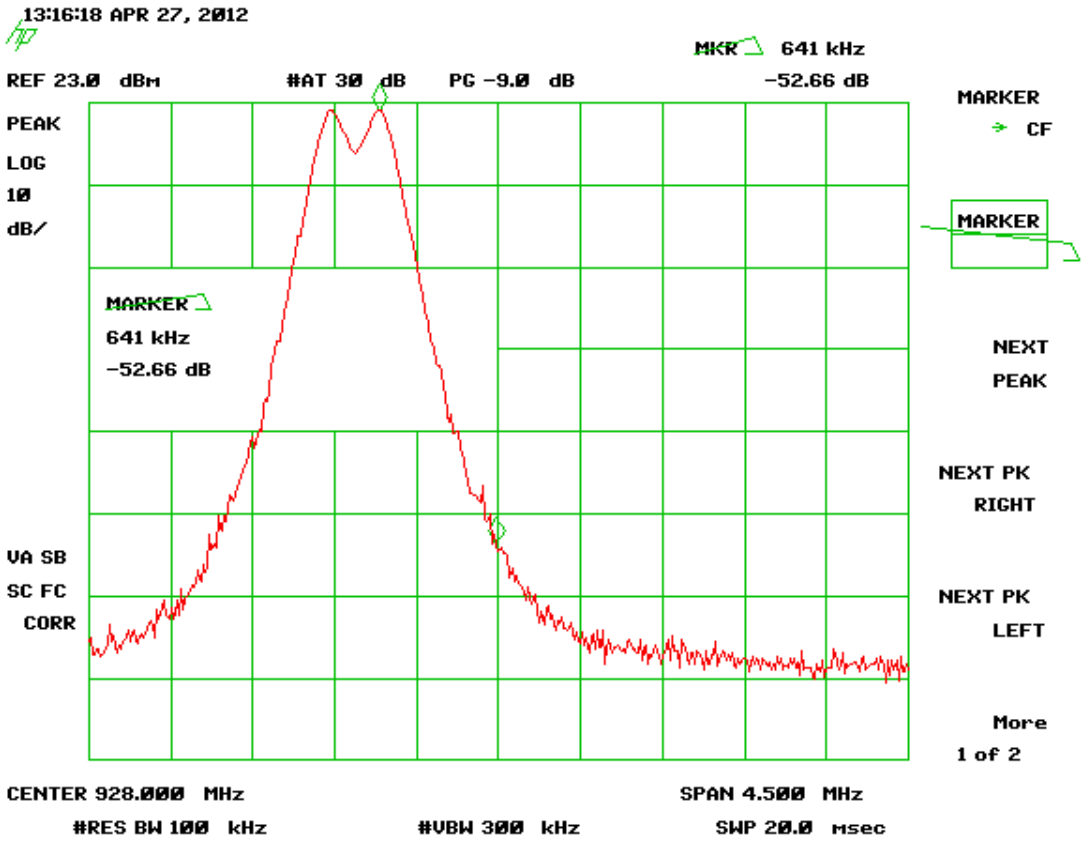


Figure 15 - Radiated Band Edge Compliance – High Channel

2.10 Unintentional Radiator, Radiated Emissions (CFR 15.109 (a))

The test data is provided herein to support the Verification requirement for digital devices. Radiated emissions coming from the EUT in a non-transmit state were evaluated from 30 MHz to 12.5 GHz per ANSI C63.4, Paragraph 8.

Measurements were made with the analyzer's resolution bandwidth set to 120 kHz for measurements made below 1 GHz and 1 MHz for measurements made above 1 GHz. The video bandwidth was set to three times the resolution bandwidth; 1 MHz RBW and 3 MHz VBW. The test data was maximized for magnitude by rotating the turn-table through 360 degrees and raising and lowering the receiving antenna between 1 to 4 meters in height as a part of the measurement procedure.

All measured signals were at least 6.5 dB below the specification limit. The results are shown in Table 7 below.

Table 7 – Unintentional Radiator, Radiated Emissions.

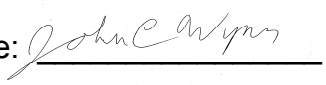
Unintentional Radiator, Radiated Emissions							
Test By: J.W.	Test: FCC Part 15.109, 15.209			Client: RFM/Cirronet			
	Project: 12-0237 Class: B			Model: DNT90P			
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
Tested from 30 MHz to 12.5 GHz							
373.3850	47.95	-8.43	39.52	46.0	2LP3mH	6.5	**PK**
762.7100	35.17	-0.92	34.25	46.0	2LP3mH	11.8	**PK**
995.5210	32.83	4.09	36.92	54.0	2LP3mH	17.1	**PK**
221.4960	41.45	-12.89	28.56	46.0	2LP3mV	17.4	**PK**
431.8470	46.02	-7.93	38.09	46.0	2LP3mV	7.9	**PK**
3847.3000	40.83	1.54	42.37	54.0	1HN3mV	11.6	**PK**
3934.7000	39.63	1.46	41.09	54.0	1HN3mH	12.9	**PK**

No other emissions detected within 20 dB of the FCC Part 15.109 limits

AF is antenna factor. CL is cable loss. PA is preamplifier gain

SAMPLE CALCULATION:
RESULTS: At 373.3850 MHz: = 47.95 + (-8.43) = 39.52 dBuV/m @ 3m
Margin = (46.0- 39.52) = 6.5 dB

Test Date: April 26, 2012

Tested By Signature:  Name: John Wynn

2.11 Measurement Uncertainty

2.11.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ±2.8 dB.

Conducted emissions were not re-tested for the permissive change as it was deemed not required due to the nature of the change.

2.11.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ±5.3 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ±5.1 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ±5.1 dB.

The data listed in this test report has sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.

2.12 20 dB Bandwidth Measurement per CFR 15.247, (IC RSS 210, A8.1)

The EUT antenna port was connected to a spectrum analyzer having a 50 Ω input impedance. Measurements were performed similar to the method of FCC DA 00-705 for a bandwidth of 20 dB. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in Table 9 and Figures 16 through 18.

Table 9 – 20dB Bandwidth Measurement

Frequency (MHz)	20 dB Bandwidth (KHz)
902.75	420
915.24	415
927.23	420

Test Date: April 26, 2012

Tested By
Signature: John C Wynn Name: John Wynn

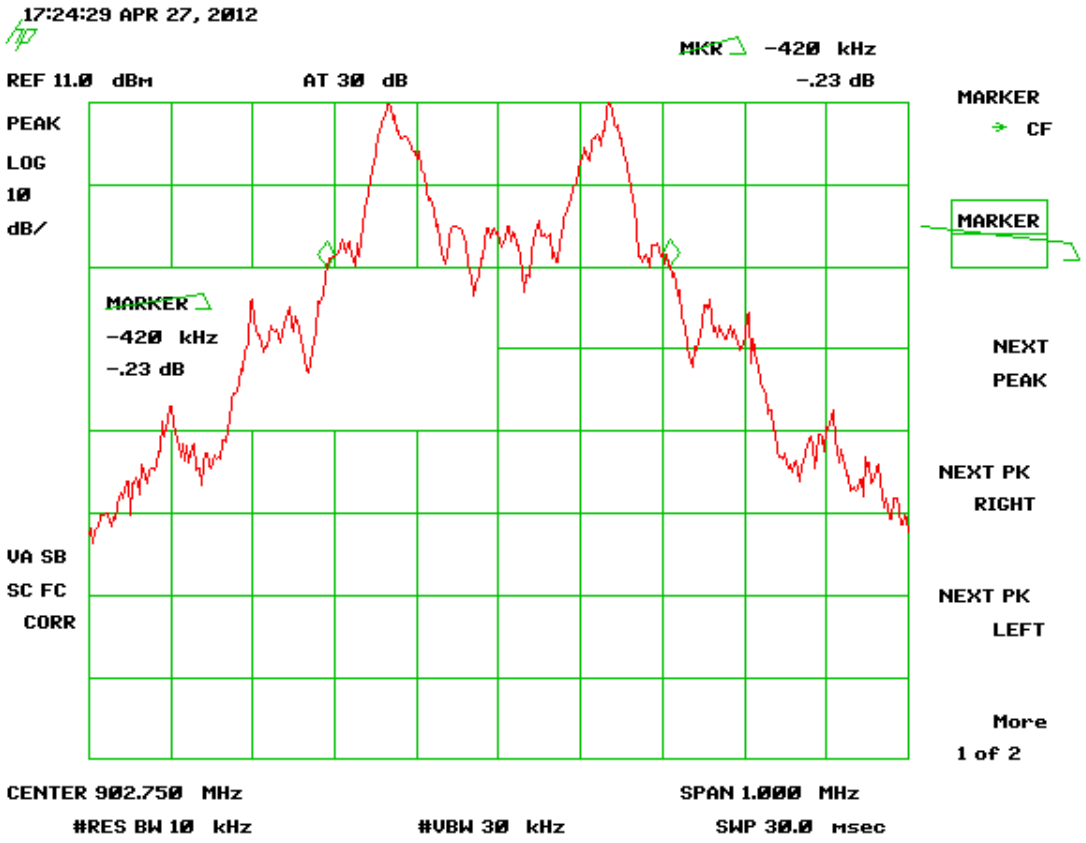


Figure 16 – Low Channel

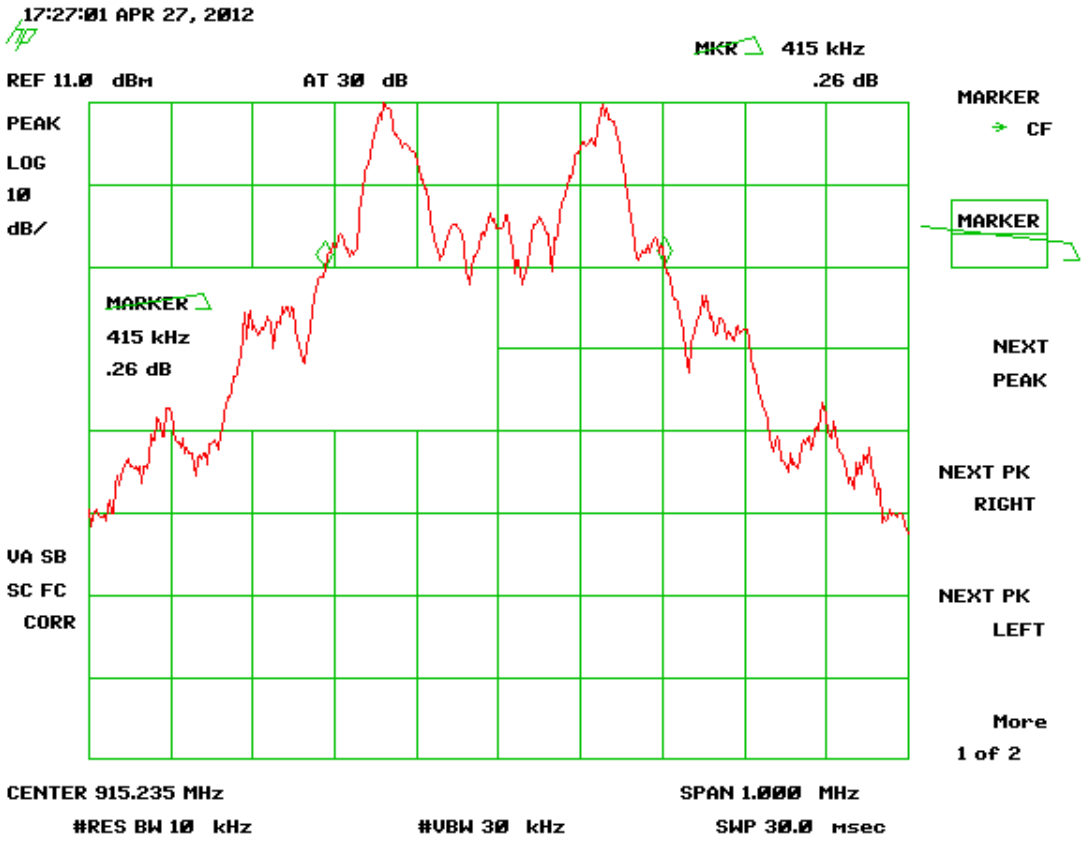


Figure 17 – Mid Channel

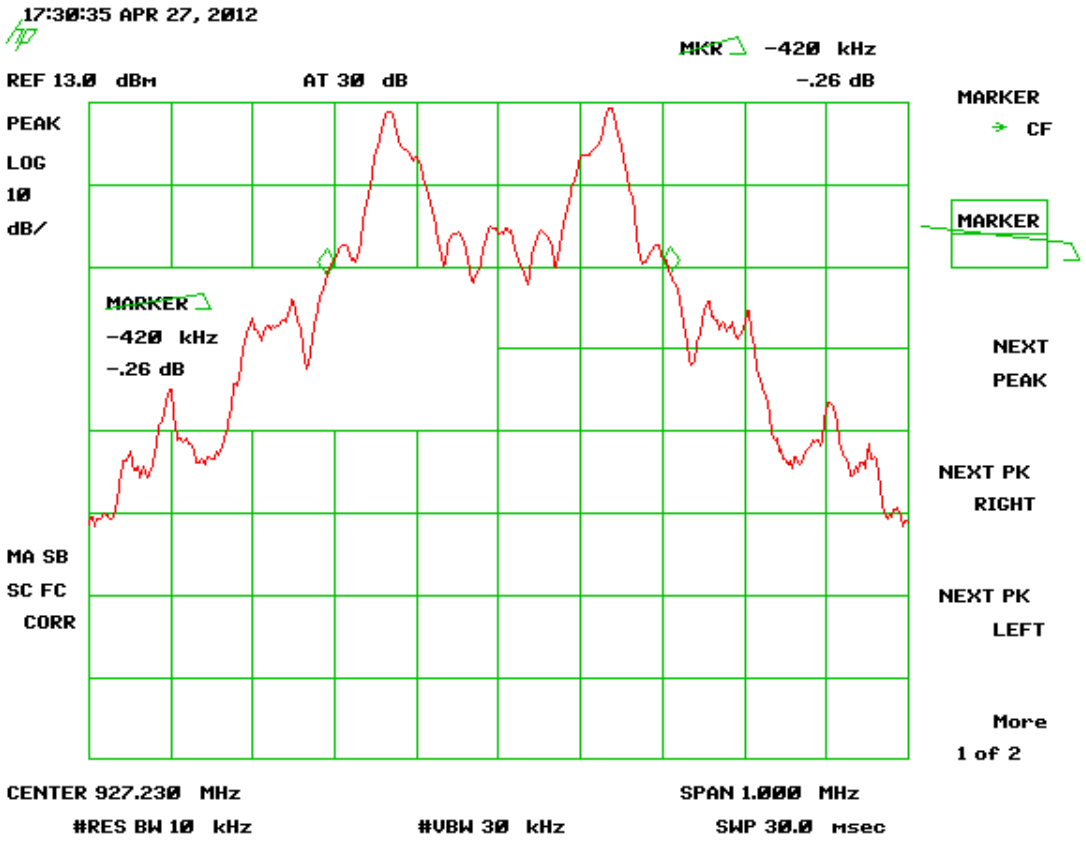


Figure 18 – High Channel

Figure 19 - Antenna 1 Front View

Figure 20 - Antenna 1 Back View