ENGINEERING TEST REPORT

914 MHz Transceiver Module
Model No.: 60068201

FCC ID: WB4-60068201

Applicant:

Atlas Polar Company Limited
60 Northline Road
Toronto, ON
Canada M4B 3E5

In Accordance With

Federal Communications Commission (FCC)
Part 15, Subpart C, Section 15.247
Frequency Hopping Spread Spectrum (FHSS)
Operating in 902 - 928 MHz Band

UltraTech's File No.: ATLP-003_F15C247

This Test report is Issued under the Authority of
Tri M. Luu, BASc,
Vice President of Engineering
UltraTech Group of Labs

Date: May 04, 2012

Report Prepared by: Dharmajit Solanki	Tested by: Mr. Wayne Wu, EMI/RFI Technician
Issued Date: May 04, 2012	Test Dates: March 21 to April 12, 2012

The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.
This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.

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FCC	VCCI	Industry Canada Approved Test Facility	NVLAP	BSMI	Korea KCC-RRL
91038	1309	46390-2049	NVLAP Lab Code 200093-0	SL2-IN-E-1119R	CA2049

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Part 15, Subpart C, Section 15.247
Title:	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15
Purpose of Test:	To gain FCC Equipment Authorization for Frequency Hopping Spread Spectrum Transceiver Operating in the Frequency Band 902 - 928 MHz.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.10-2009 - American National Standard for Testing Unlicensed Wireless Devices
Environmental Classification:	[x] Commercial, industrial or business environment [x] Residential environment

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None

1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 2 & 15	2011	Code of Federal Regulations – Telecommunication
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
CISPR 22 & EN 55022	2008 2006	Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement
CISPR 16-1-1	2003	Specification for Radio Disturbance and Immunity measuring apparatus and methods
996369 D01	2011	Module Certification Guide v01r03
FCC ET Docket No. 99-231	2002	Amendment to FCC Part 15 of the Commission's Rules Regarding to Spread Spectrum Devices

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Atlas Polar Company Limited
Address:	60 Northline Road Toronto, ON Canada M4B 3E5
Contact Person:	Mr. Sanjay Sood Phone #: 416 751-7744 Fax #: 416 751-2094 Email Address: sanjaysood@atlaspolar.com

MANUFACTURER	
Name:	Atlas Polar Company Limited
Address:	60 Northline Road Toronto, ON Canada M4B 3E5
Contact Person:	Mr. Sanjay Sood Phone #: 416 751-7744 Fax #: 416 751-2094 Email Address: sanjaysood@atlaspolar.com

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Atlas Polar Company Limited
Product Name:	914 MHz Transceiver Module
Model Name or Number:	60068201
Serial Number:	Test Sample
Type of Equipment:	Spread Spectrum Transmitter
Input Power Supply Type:	External Vehicle Battery
Primary User Functions of EUT:	Spread Spectrum OEM Transceiver Module

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Only Vehicular environments
Power Supply Requirement:	3.5V to 6.5V DC
RF Output Power Rating:	8.93 dBm Conducted / 12.88 dBm eirp
Operating Frequency Range:	902.805 – 924.855 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	450 kHz
Data Rates:	25.6 kbps
Duty Cycle:	Continuous
Modulation Type:	FHSS
Antenna Connector Type:	Permanently Soldered to Wire Antennas or RP-SMA connectors for two Di-pole type Antennas

2.4. ASSOCIATED ANTENNA DESCRIPTIONS

There are three antenna types:

1. Wire Antenna, Gain = 3.95 dBi (Max Gain)
2. ¼ Wave Di-Pole Antenna (ANT-916-CW-RCL), Gain = 0 dBi (Max Gain)
3. ¼ Wave Di-Pole Antenna (ANT-916-CW-QW), Gain = 2.72 dBi (Max Gain)

The Wire antenna and higher gain Di-pole antenna (ANT-916-CW-QW) were selected for testing to represents the worst-cases of emissions. Refer to antennas exhibit for detailed specifications.

2.5. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RF IN/OUT Port	1	RP-SMA or Soldering points on PCB	Direct connection
2	DC Supply & I/O Port	1	8 Pin Header	Non-shielded cable

2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Test Jig
Brand name:	Atlas Polar Company Limited
Connected to EUT's Port:	I/O Port

Ancillary Equipment # 2	
Description:	AC/DC Adaptor
Brand name:	CUI Inc
Model Name or Number:	3A-161WU15
Connected to EUT's Port:	Test jig of the EUT

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	20°C to 23C
Humidity:	30% to 55%
Pressure:	98 to 102 kPa
Power Input Source:	5.0 VDC Via Test Jig

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	▪ Each of lowest, middle and highest channel frequencies transmits continuously for emissions measurements. ▪ The EUT operates in normal Frequency Hopping mode for occupancy duration, and frequency separation.
Special Test Software & Hardware:	Special controls provided on the Test Jig to allow the EUT to operate in hopping mode or at each channel frequency continuously. For example, the transmitter will be operated at each of lowest, middle and highest frequencies individually continuously during testing.
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as non-integral antenna equipment as described with the test results.

Transmitter Test Signals	
Frequency Band(s):	902.805 – 924.855 MHz
Frequency(ies) Tested: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	902.805, 913.605 and 924.855 MHz
RF Power Output: (measured maximum output power at antenna terminals)	8.93 dBm
Normal Test Modulation:	FHSS
Modulating Signal Source:	Internal

EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada Site No.: 2049A-3, Expiry Date: April 14, 2014).

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Requirements	Compliance (Yes/No or N/A)
15.207(a)	Power Line Conducted Emissions Measurements*	N/A
15.247(a)(1)	Provisions for Frequency Hopping Systems	Yes
15.247(b)	Peak Output Power	Yes
15.247(b) (5), 1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class B Digital Devices. The engineering test report is available upon request.		

*- The module is designed to be exclusively used in mobile products manufactured by the applicant and derives power from these products run on the vehicle battery.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1. TEST PROCEDURES

ANSI C63.10-2009 and FCC Public Notice @ DA 00-705 (March 30, 2000) – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement. Refer to Exhibit 7 for Measurement Uncertainties.

5.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4, ANSI C63.10-2009 and CISPR 16-1-1.

5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

5.5. COMPLIANCE WITH FCC PART 15 – GENERAL TECHNICAL REQUIREMENTS

FCC Section	FCC Rules	Manufacturer's Clarification
15.31	The hoping function must be disabled for tests, which should be performed with the EUT transmitting on the number of frequencies specified in this Section. The measurements made at the upper and lower ends of the band of operation should be made with the EUT tuned to the highest and lowest available channels.	The hoping function was disabled for tests
15.203	Described how the EUT complies with the requirement that either its antenna is permanently attached, or that it employs a unique antenna connector, for every antenna proposed for use with the EUT. The exception is in those cases where EUT must be professionally installed. In order to demonstrate that professional installation is required, the following 3 points must be addressed: ➢ The application (or intended use) of the EUT ➢ The installation requirements of the EUT ➢ The method by which the EUT will be marketed	Antennas are either permanently soldered (Wire Antenna) or connected using unique RP-SMA connectors for two Di-pole Antennas, hence meet this requirement
15.204	Provided the information for every antenna proposed for use with the EUT: ➢ type (e.g. Yagi, patch, grid, dish, etc…), ➢ manufacturer and model number ➢ gain with reference to an isotropic radiator	Refer to sec 2.4 of this report
15.247(a)	Description of how the EUT meets the definition of a frequency hopping spread spectrum, found in Section 2.1. Based on the technical description.	See Operational Description
15.247(a)	Equal Hopping Frequency Use: Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g. that each new transmission event begins on the next channel in the hopping sequence after final channel used in the previous transmission events).	See Operational Description
15.247(g)	The EUT must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.	See Operational Description
15.247(h)	The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.	See Operational Description

5.6. PROVISIONS FOR FREQUENCY HOPPING SYSTEMS [§ 15.247(a)(1)]

5.6.1. Limit

§ 15.247(a)(1): Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo-randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

§ 15.247(a)(1)(iii): Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2. Method of Measurements

FCC Public Notice DA 00-705

Carrier Frequency Separation:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = wide enough to capture the peaks of two adjacent channels
- RBW = 1% of the span
- VBW ≥ RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Number of hopping frequency:

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = the frequency band of operation
- RBW = 1% of the span
- VBW ≥ RBW
- Sweep = Auto
- Detector = peak
- Trace = max hold

Time of Occupancy (Dwell Time):

The hopping function of the EUT is enabled. Use the spectrum analyzer setting as follows:

- Span = 0 Hz centered on a hopping channel
- RBW = 1 MHz
- VBW ≥ RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector = peak
- Trace = max hold

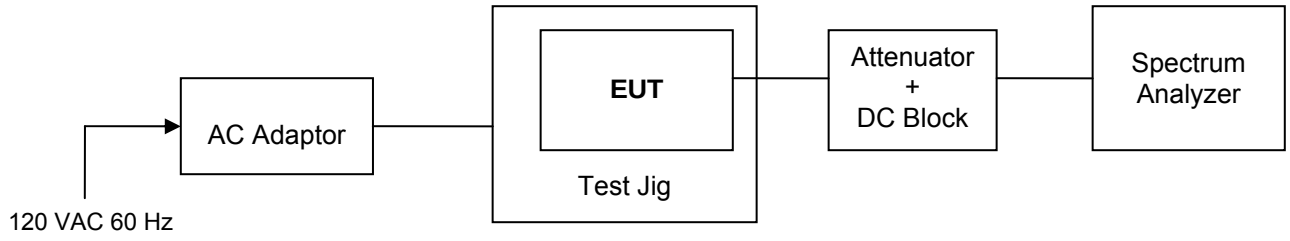
If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g. date rate modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.

20 dB Bandwidth:

Use the spectrum analyzer setting as follows:

- Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
- RBW = 1% of the 20 dB bandwidth
- VBW ≥ RBW
- Sweep = auto
- Detector = peak
- Trace = max hold
- The transmitter shall be transmitting at its maximum data rate.
- Allow the trace to stabilize.
- Use the marker-to-peak function to set the marker to the peak of the emission.
- Use the marker-delta function to measure 20 dB down on both sides of the emission.
- The 20 dB BW is the delta reading in frequency between two markers.

5.6.3. Test Arrangement



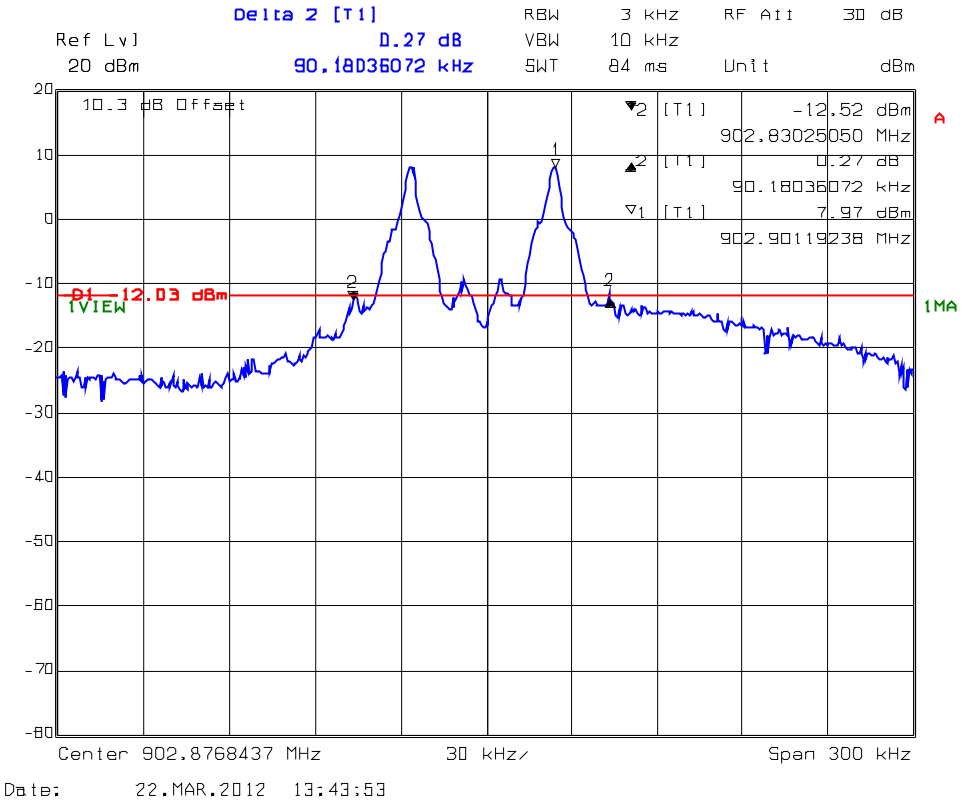
5.6.4. Test Data

Test Description	FCC Specification	Measured Values	Comments
Receiver Input Bandwidth and Hopping Capability	The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.	--	See Note 1
20 dB BW of the hopping channel	The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.	92 kHz	See Note 2
Channel Hopping Frequency Separation	Minimum of 25 kHz or 20dB BW whichever is greater.	450 kHz	See Note 2
Number hopping frequencies	If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.	50 hopping frequencies	See Note 2
Average Time of Occupancy	If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period	0.33 s within a 20 second period	See Note 2

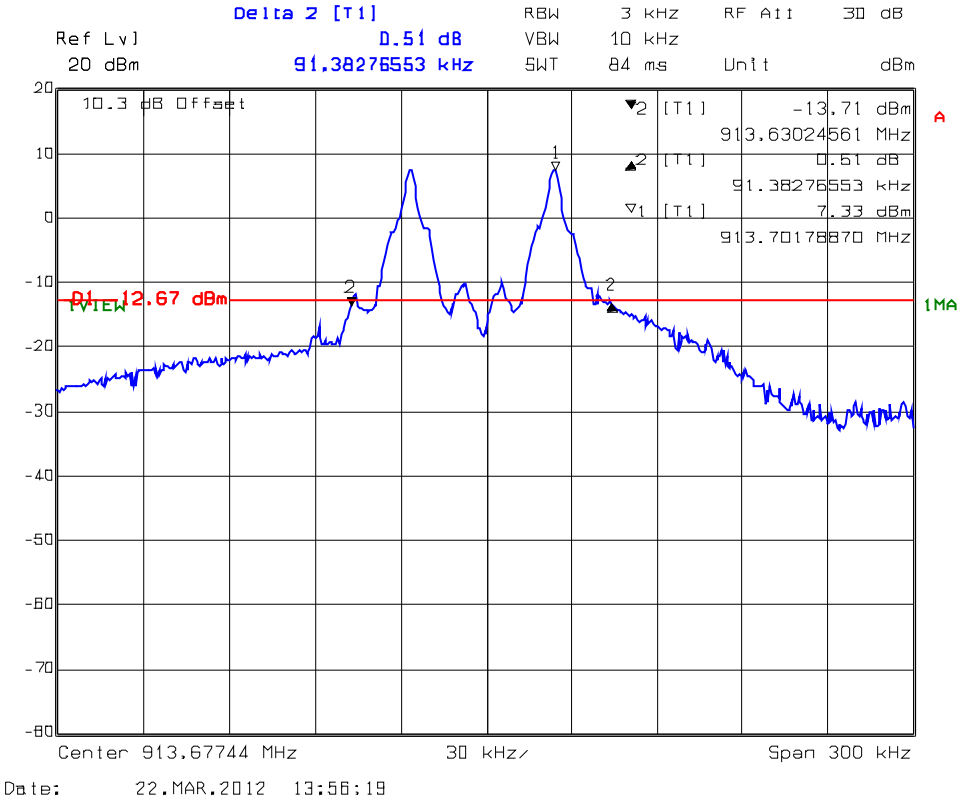
Note 1: See operational description exhibit for details.

Note 2: See the following plots for detail.

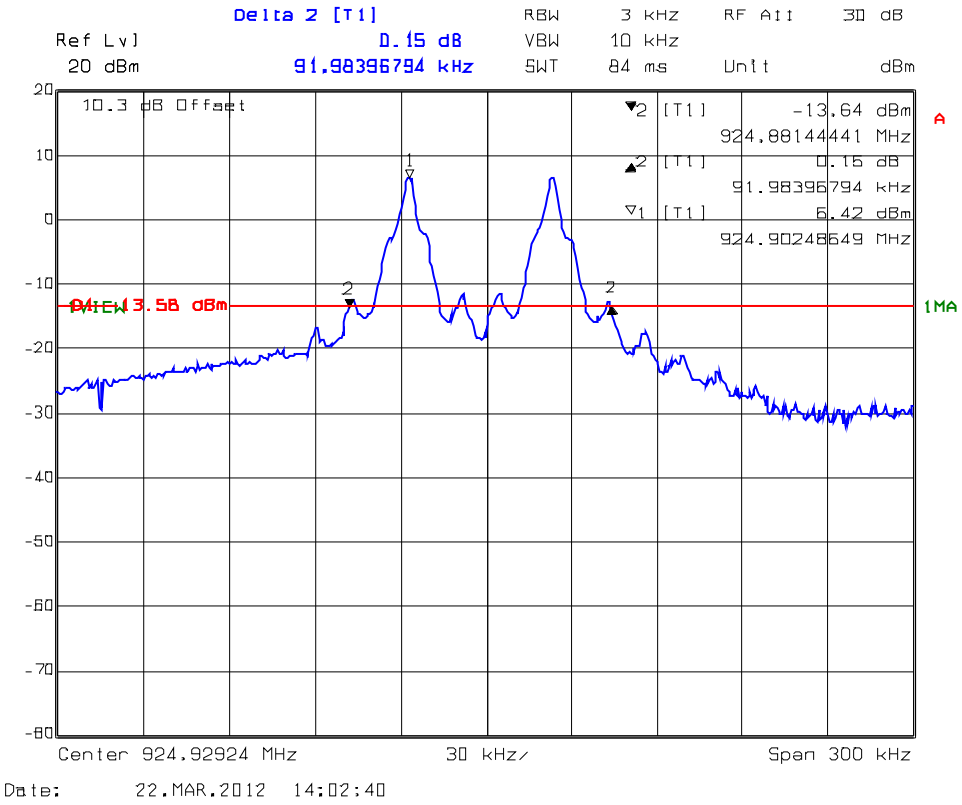
Plot 5.6.4.1 20 dB Bandwidth
Test Frequency: 902.805 MHz



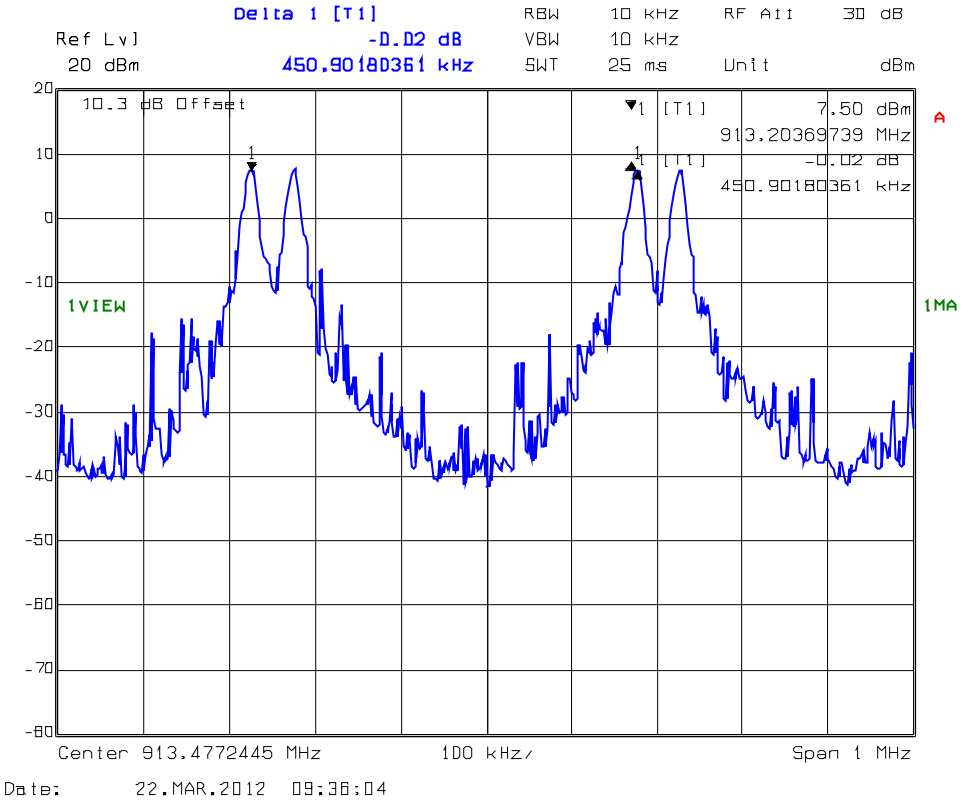
Plot 5.6.4.2 20 dB Bandwidth
Test Frequency: 913.605 MHz



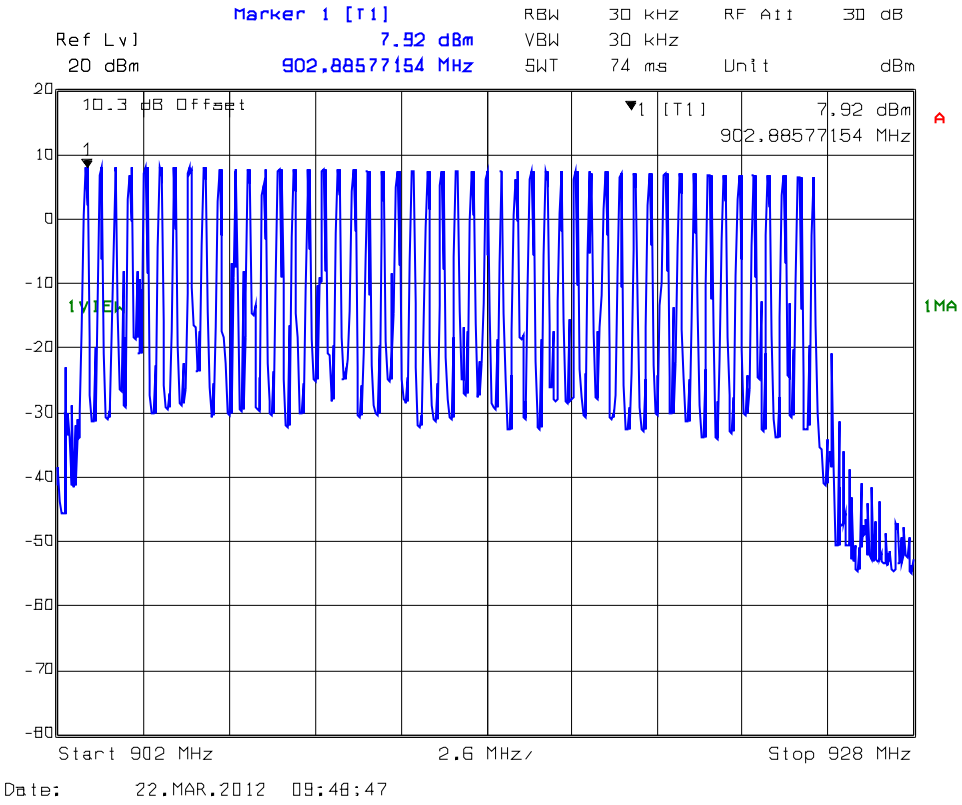
Plot 5.6.4.3 20 dB Bandwidth
Test Frequency: 924.855 MHz



Plot 5.6.4.4 Carrier Frequency Separation

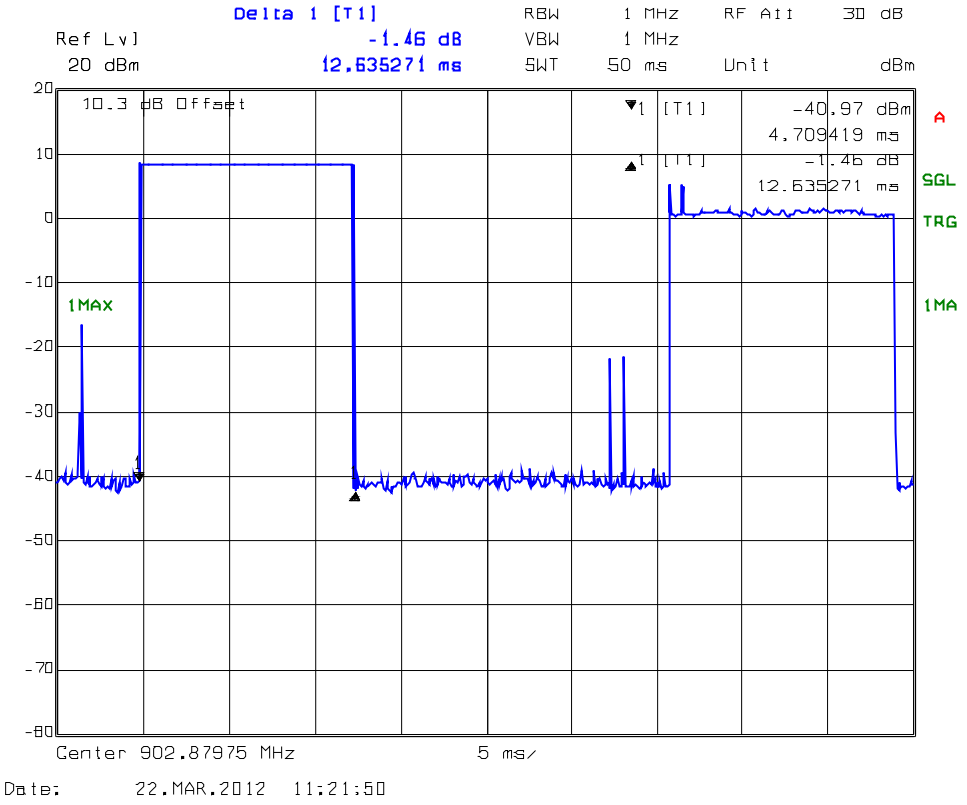


Plot 5.6.4.5 Number of Hopping Frequencies
Total 50 Hopping Channels from 902.805-924.855 MHz



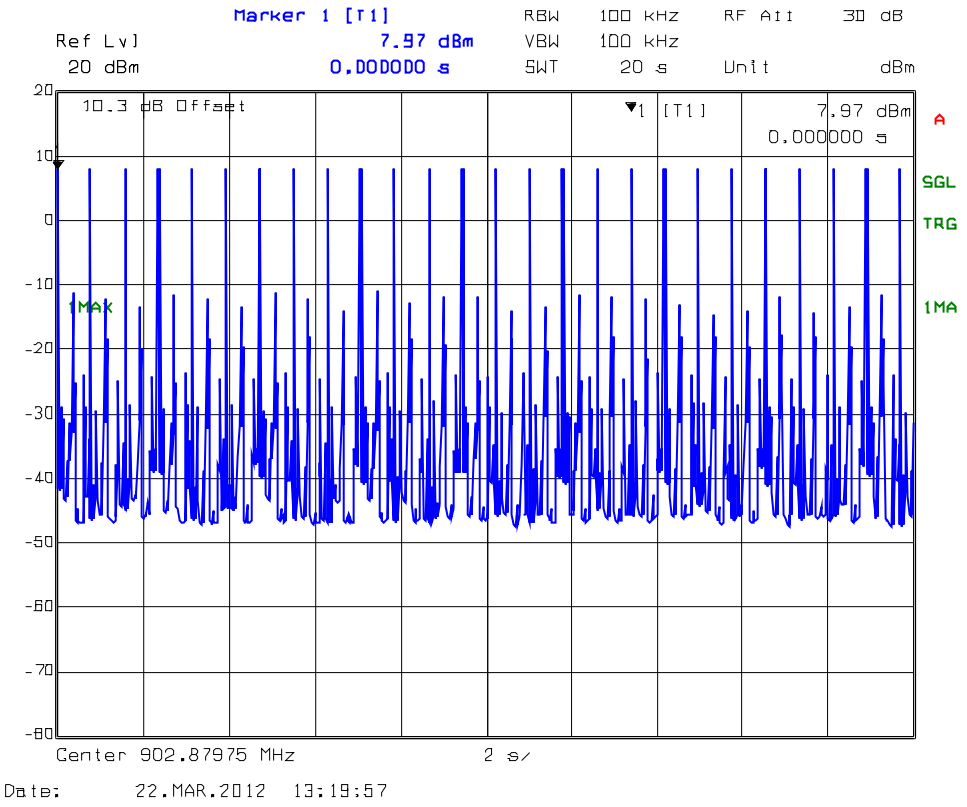
Plot 5.6.4.6 Dwell Time per Hope
Test Frequency: 902.805 MHz

Hope Dwell Time = 12.635271ms



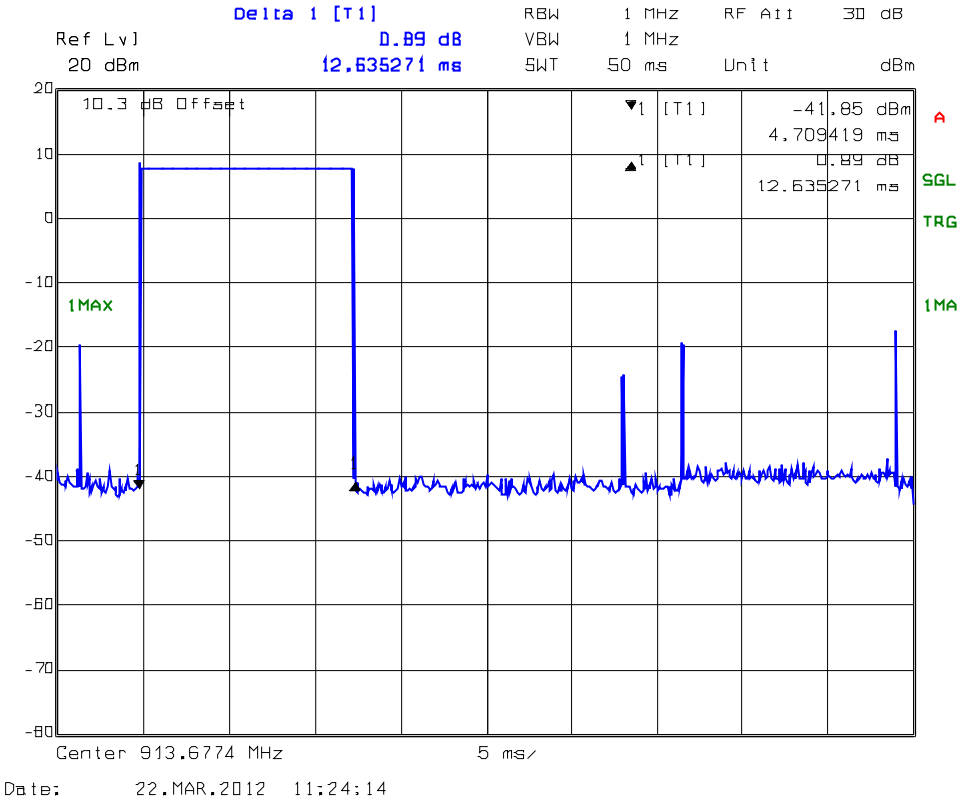
Plot 5.6.4.7 Time of Occupancy
Test Frequency: 902.805 MHz

Time of Occupancy in 20 Seconds = 12.635271ms x 26 hopes = 328.517046 ms



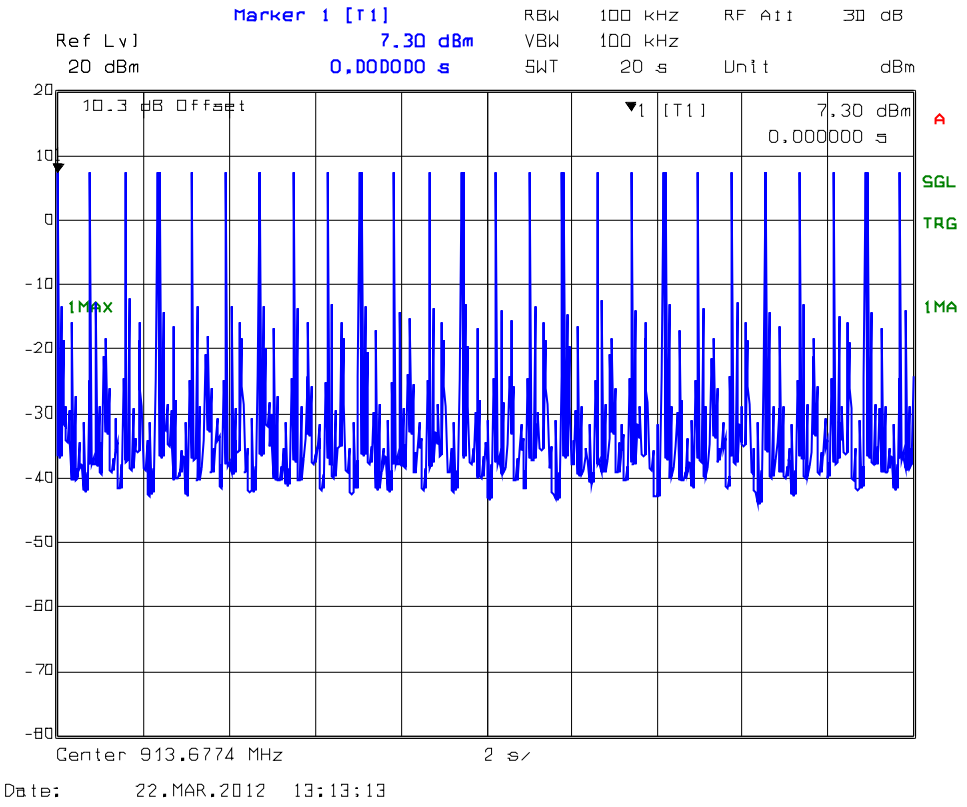
Plot 5.6.4.8 Dwell Time per Hope
Test Frequency: 913.605 MHz

Hope Dwell Time = 12.635271ms



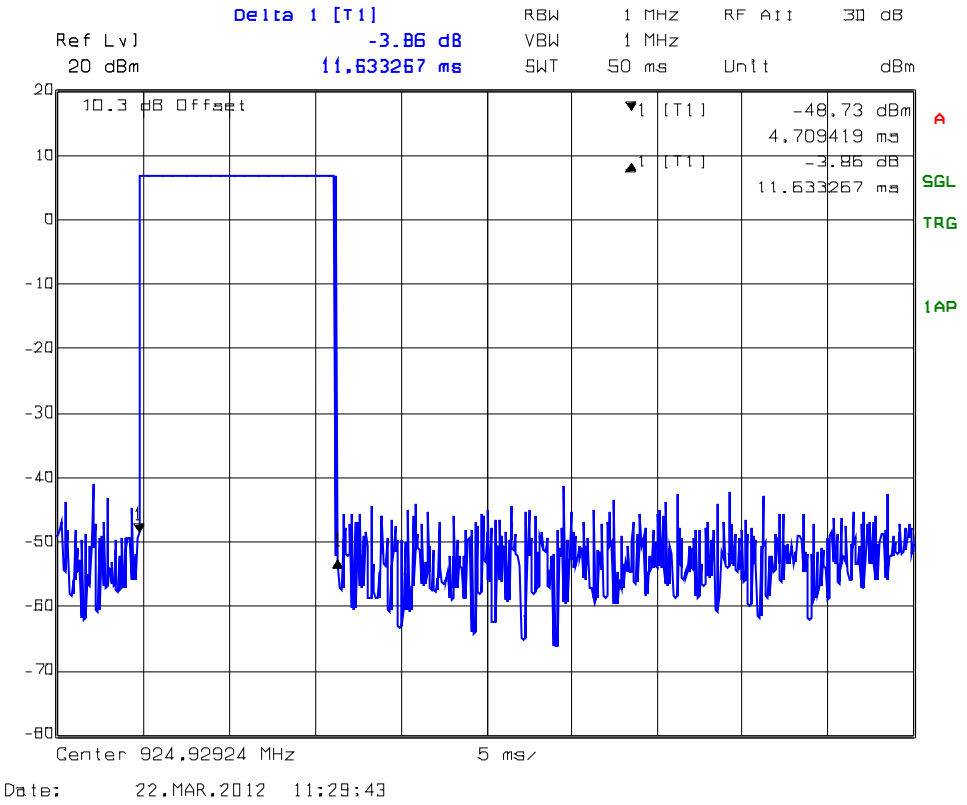
Plot 5.6.4.9 Time of Occupancy
Test Frequency: 913.605 MHz

Time of Occupancy in 20 Seconds = 12.635271ms x 26 hopes = 328.517046 ms



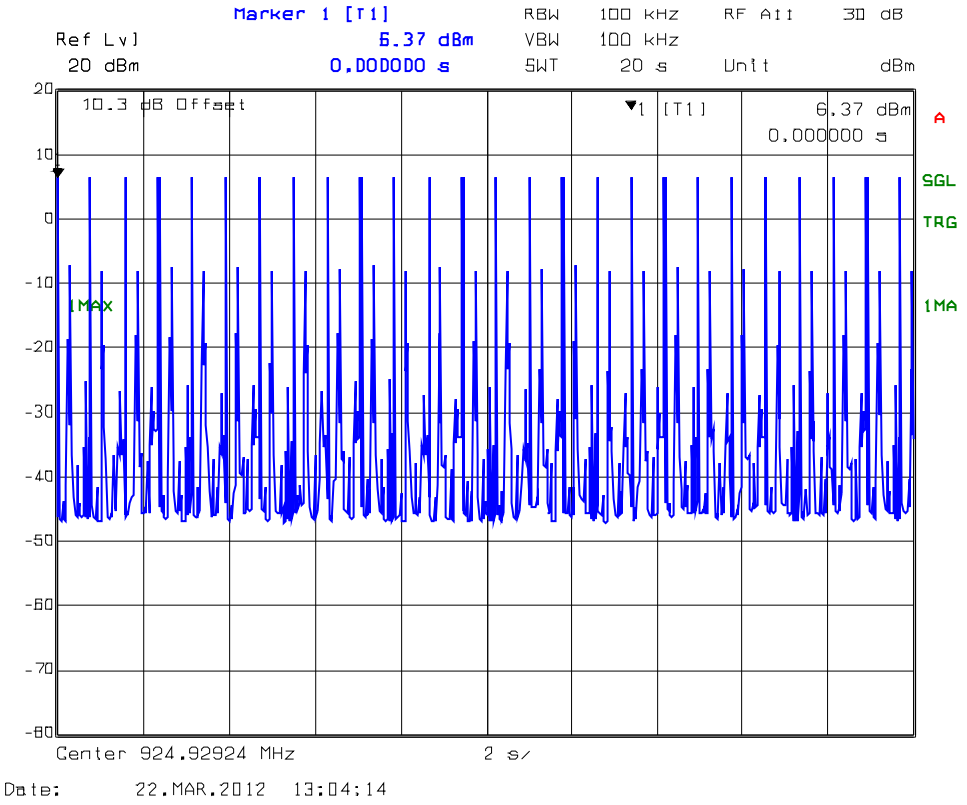
Plot 5.6.4.10 Dwell Time per Hope
Test Frequency: 924.855 MHz

Hope Dwell Time = 11.633267 ms



Plot 5.6.4.11 Time of Occupancy
Test Frequency: 924.855 MHz

Time of Occupancy in 20 Seconds = 11.633267 ms x 26 hopes = 302.464942 ms



5.7. PEAK OUTPUT POWER & EQUIVALENT ISOTROPIC RADIATED POWER (EIRP) [§ 15.247(b)]

5.7.1. Limit

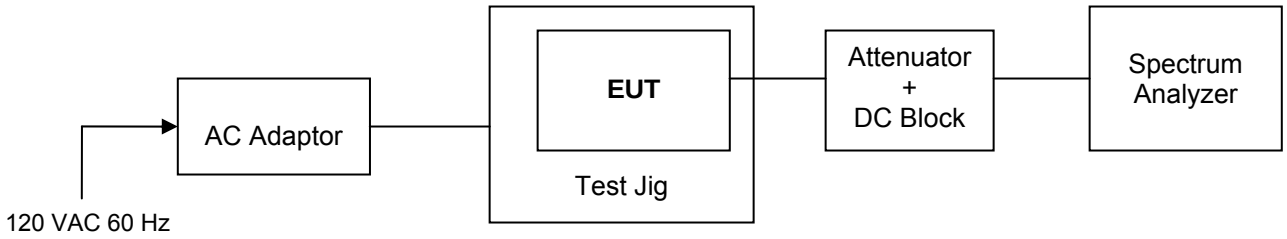
§15.247(b)(2): For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels.

§15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.7.2. Method of Measurements

FCC Public Notice DA 00-705 and ANSI C63.10-2009.

5.7.3. Test Arrangement



5.7.4. Test Data

Transmitter Channel	Frequency (MHz)	Peak Output Power at Antenna Terminal (dBm)	Calculated EIRP Note 2 (dBm)	Peak Output Power Limit (dBm)	EIRP Limit (dBm)
Power at Standard Data Rate					
Lowest	902.805	8.93	12.88	30.0	36.0
Middle	913.605	8.51	12.46	30.0	36.0
Highest	924.855	7.90	11.85	30.0	36.0

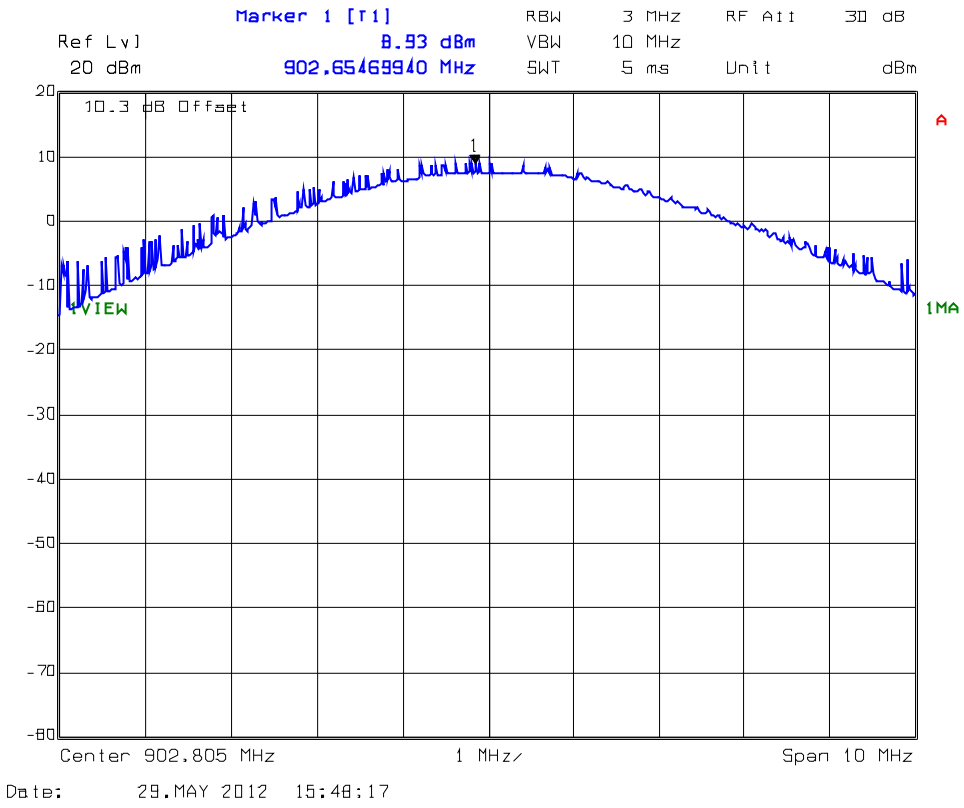
Note 1: The EIRP shall be calculated based on the transmitter antenna gain (G_{dBi}), cable loss (CL_{dB}) and peak output power at antenna terminal (P_{dBm}). Calculated EIRP = $P_{dBm} + G_{dBi} - CL_{dB}$

Note 2: Max Transmitter antenna gain is 3.95 dBi and cable loss is zero as no cable used to connect antenna.

Plot 5.7.4.1. Peak Output Power

Test Frequency: 902.805 MHz

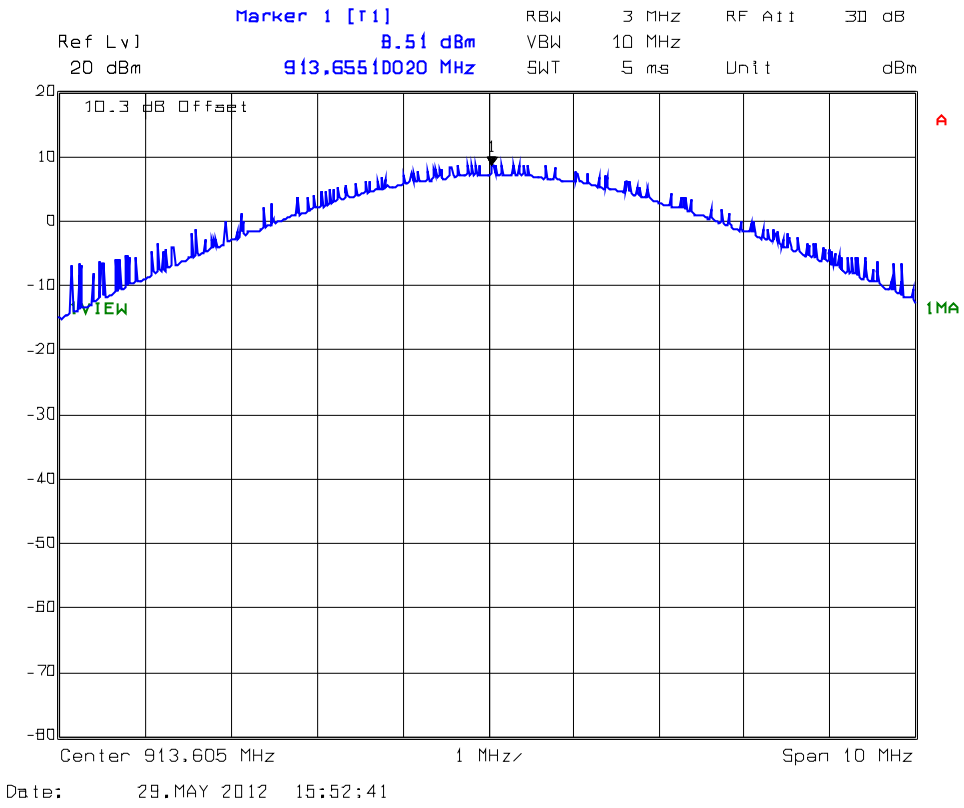
Measured Peak Power: 8.93 dBm



Plot 5.7.4.2. Peak Output Power

Test Frequency: 913.605 MHz

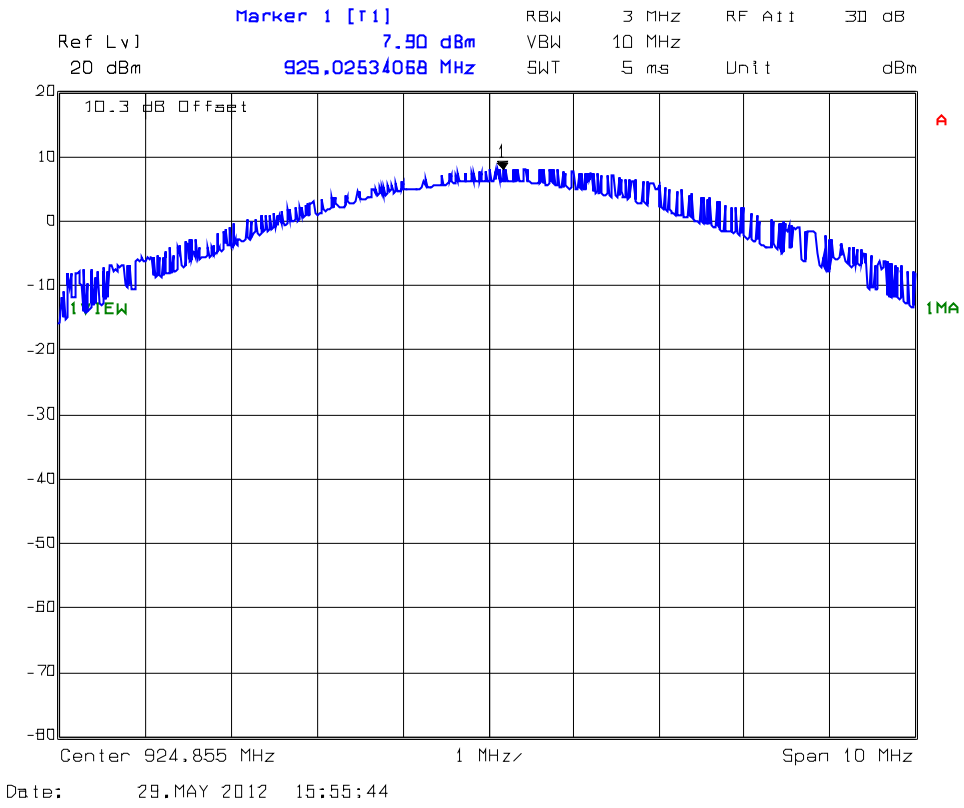
Measured Peak Power: 8.51 dBm



Plot 5.7.4.3. Peak Output Power

Test Frequency: 924.855 MHz

Measured Peak Power: 7.90 dBm



5.8. RF EXPOSURE REQUIRMENTS [§§ 15.247(b)(5), 1.1310 & 2.1091]

5.8.1. Limit

§ 15.247(b)(5): Systems operating under provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1).

§ 1.1310:- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*($900/f^2$)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density
NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

5.8.2. Method of Measurements

Refer to Sections 1.1310, 2.1091 and Public Notice DA 00-705 (March 30, 2000)

Spread spectrum transmitters operating under section 15.247 are categorically from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.

In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement

(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
(4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

$S = PG/4\Pi r^2 = EIRP/4\Pi r^2$

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

$r = \sqrt{EIRP/4\Pi S}$

For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones, SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d)

5.8.3. Test Data

This device is categorically excluded form routine environmental evaluation for RF Exposure requirement as per section 2.1093.

This device may be used as stand-alone portable exposure conditions with no restrictions on host platforms when the source-based time-averaged output power is ≤ $60/f_{(GHz)}$ mW as specified in sec 2(a)(1) of FCC KDB 447498 v04.

Measured Maximum Peak Conducted Power = 6.57 mW

SAR evaluation is not required as Peak Conducted Power (6.57 mW) is well below the threshold value of 64 mW for 927 MHz band as calculated below.

Threshold Value = [60/f(GHz)] mW
= (60/0.927) mW
= 64 mW

5.9. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)]

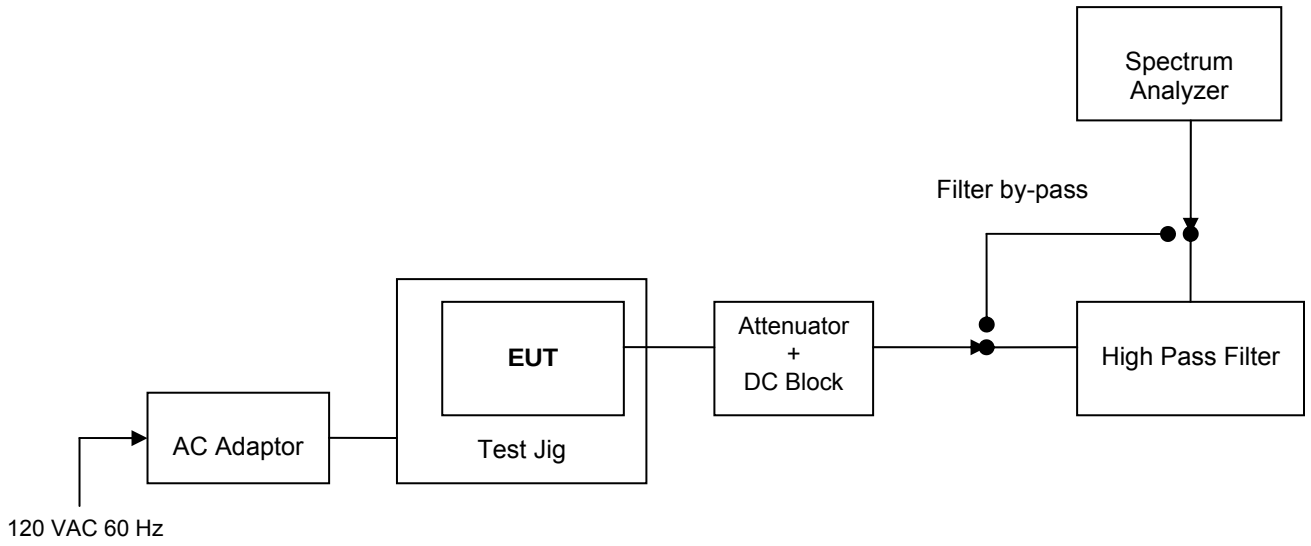
5.9.1. Limit

§ 15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

5.9.2. Method of Measurements

FCC Public Notice DA 00-705.

5.9.3. Test Arrangement

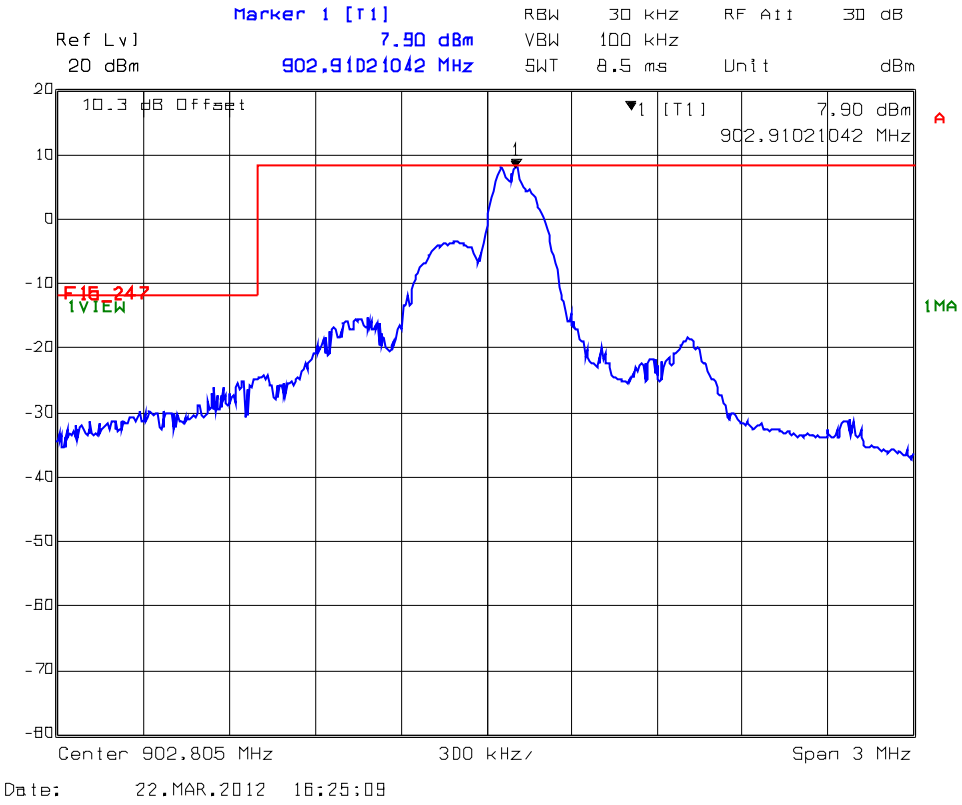


5.9.4. Test Data

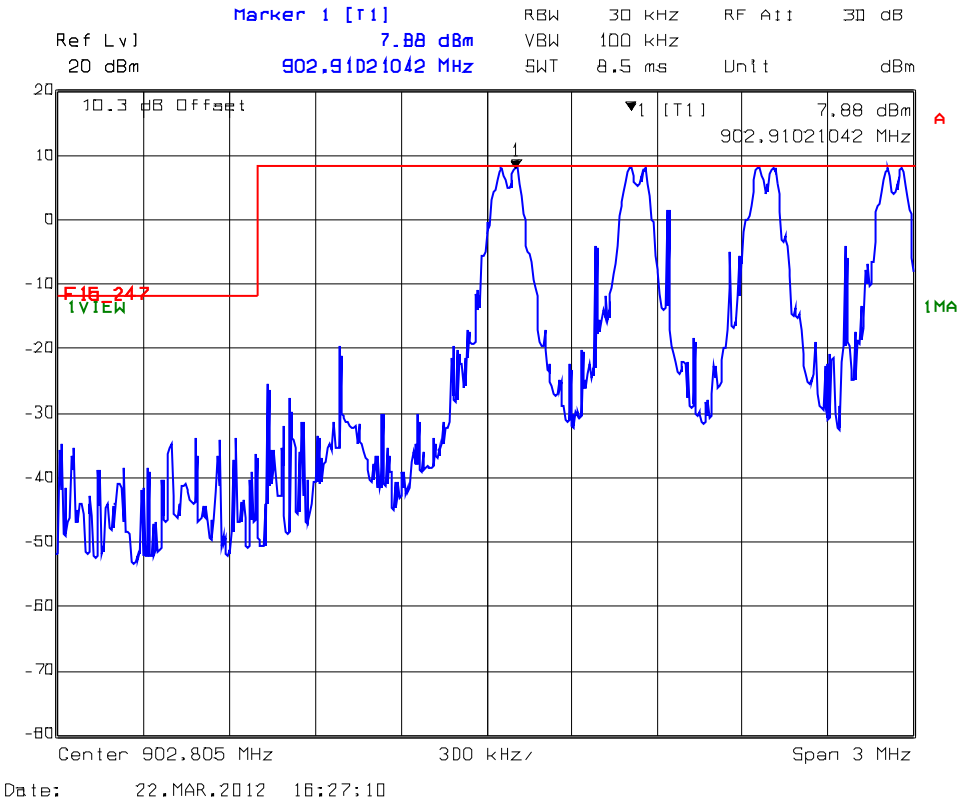
5.9.4.1. Band-Edge RF Conducted Emissions

See the following test data plots for measurement results:

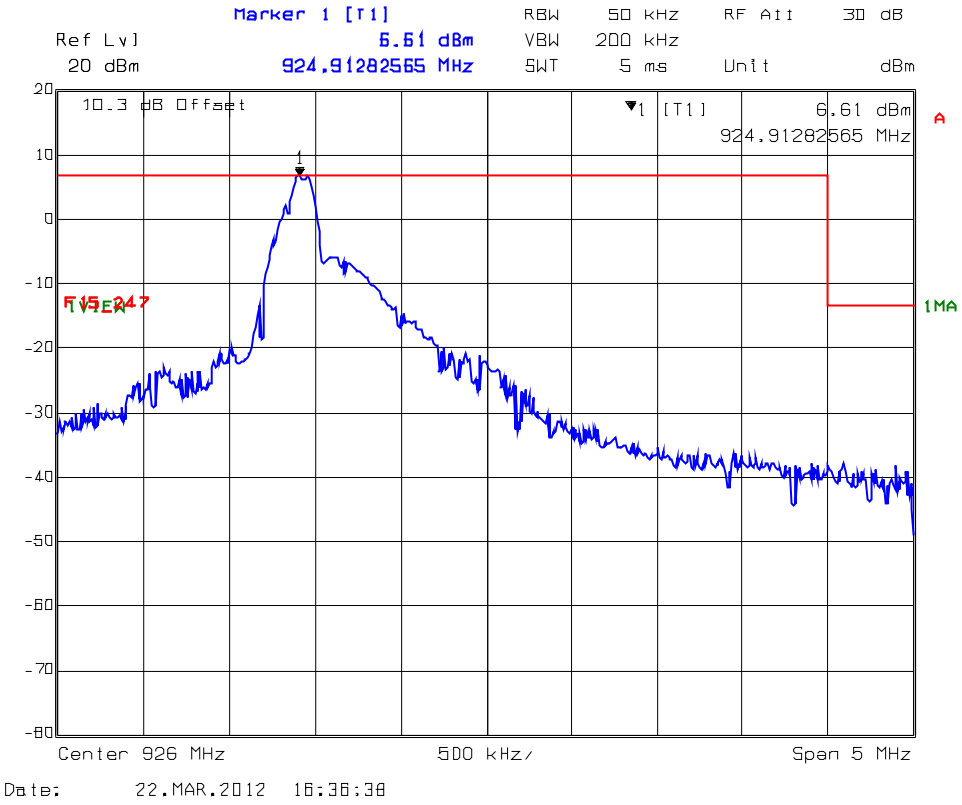
Plot 5.9.4.1.1 Band-Edge RF Conducted Emissions
Low End of Frequency Band, Single Frequency Mode



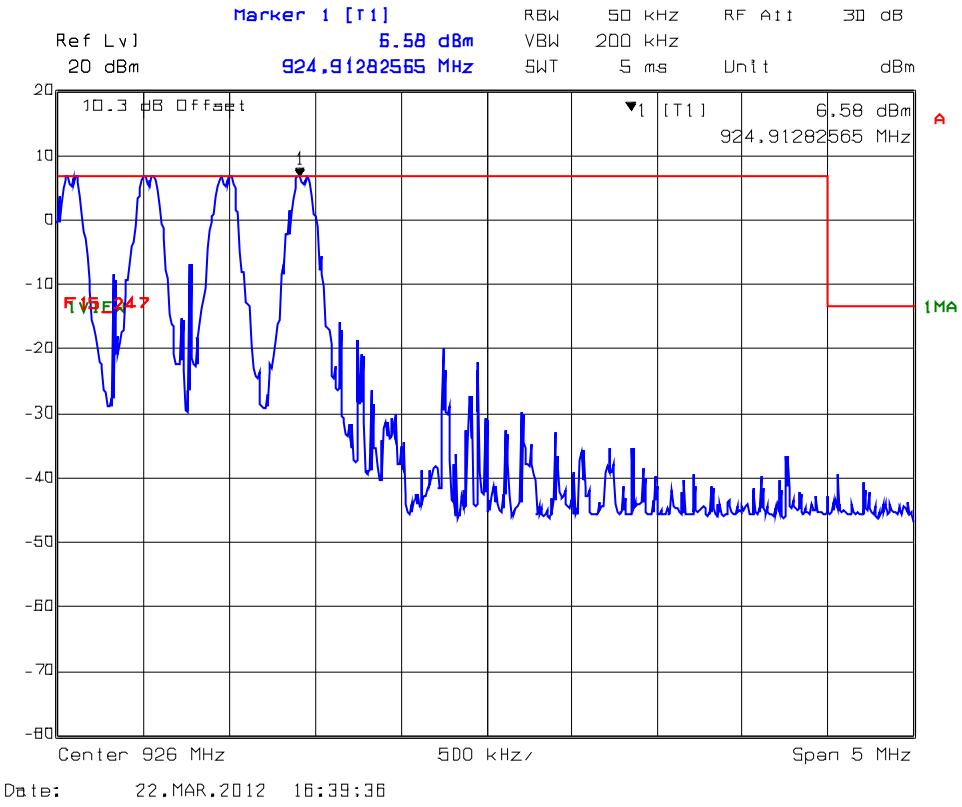
Plot 5.9.4.1.2 Band-Edge RF Conducted Emissions
Low End of Frequency Band, Pseudorandom Channel Hopping Mode



Plot 5.9.4.1.3 Band-Edge RF Conducted Emissions
High End of Frequency Band, Single Frequency Mode



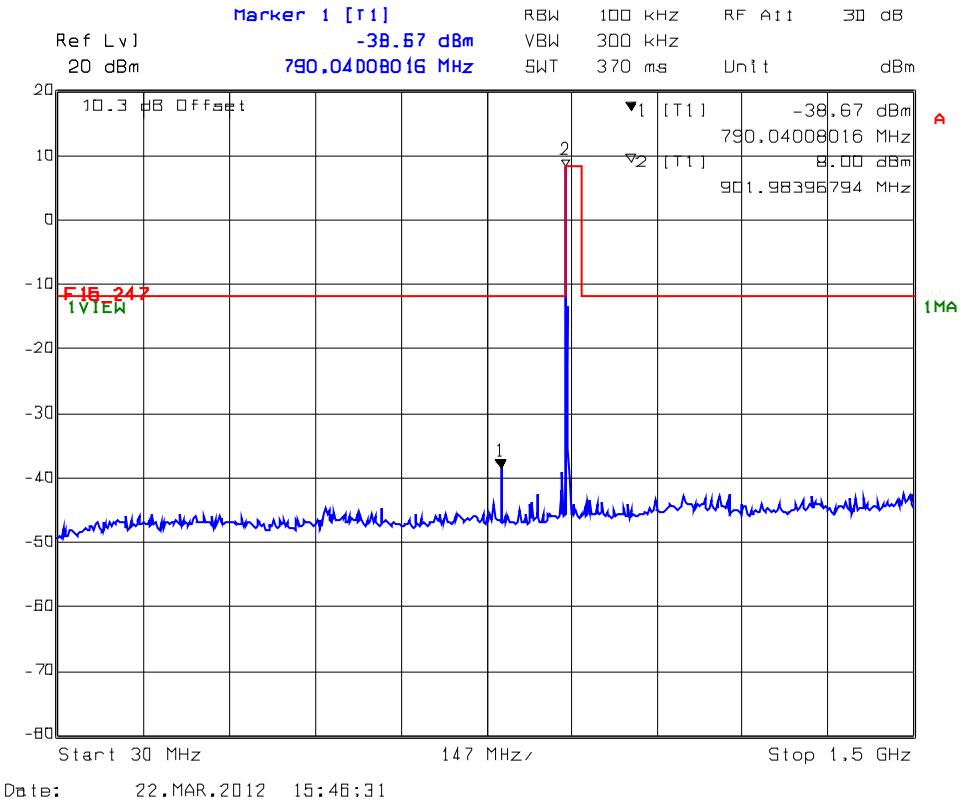
Plot 5.9.4.1.4 Band-Edge RF Conducted Emissions
High End of Frequency Band, Pseudorandom Channel Hopping Mode



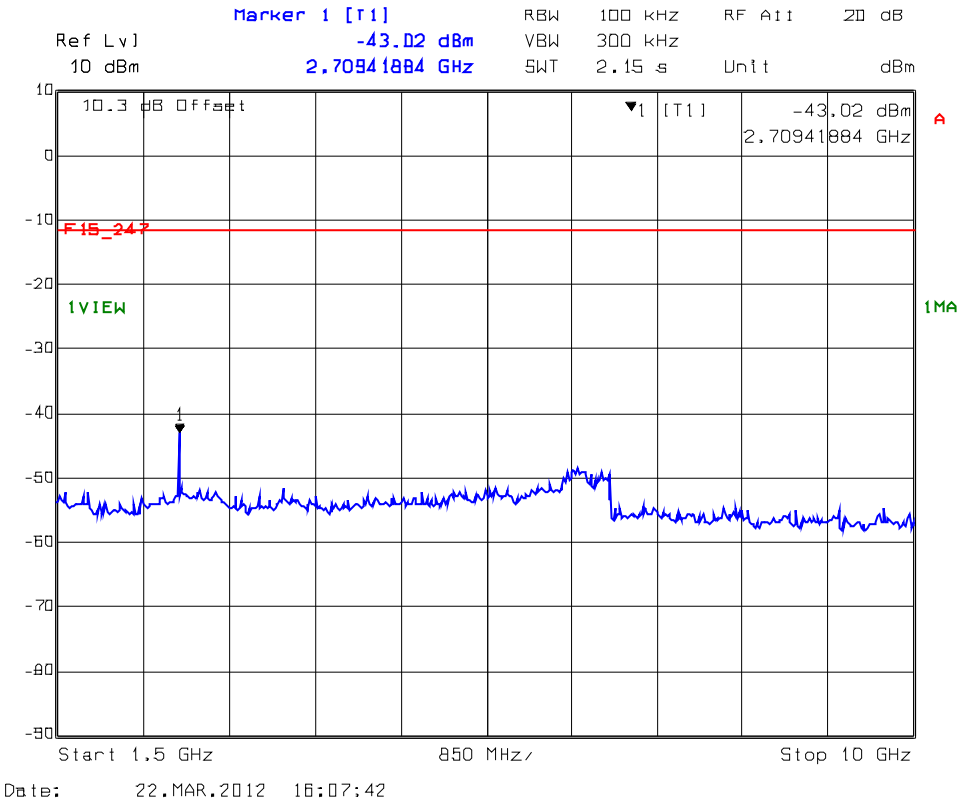
5.9.4.2. Spurious RF Conducted Emissions

The emissions were scanned from 10 MHz to 25 GHz; see the following test data plots for measurement results.

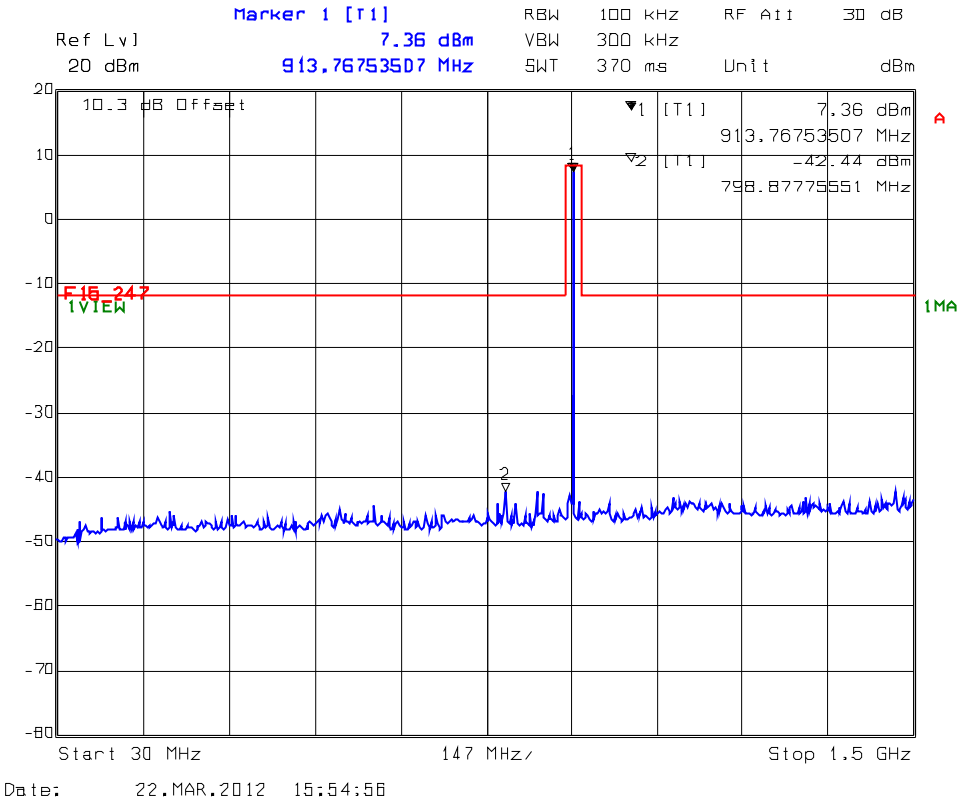
Plot 5.9.4.2.1 Spurious RF Conducted Emissions
Transmitter Frequency: 902.805 MHz



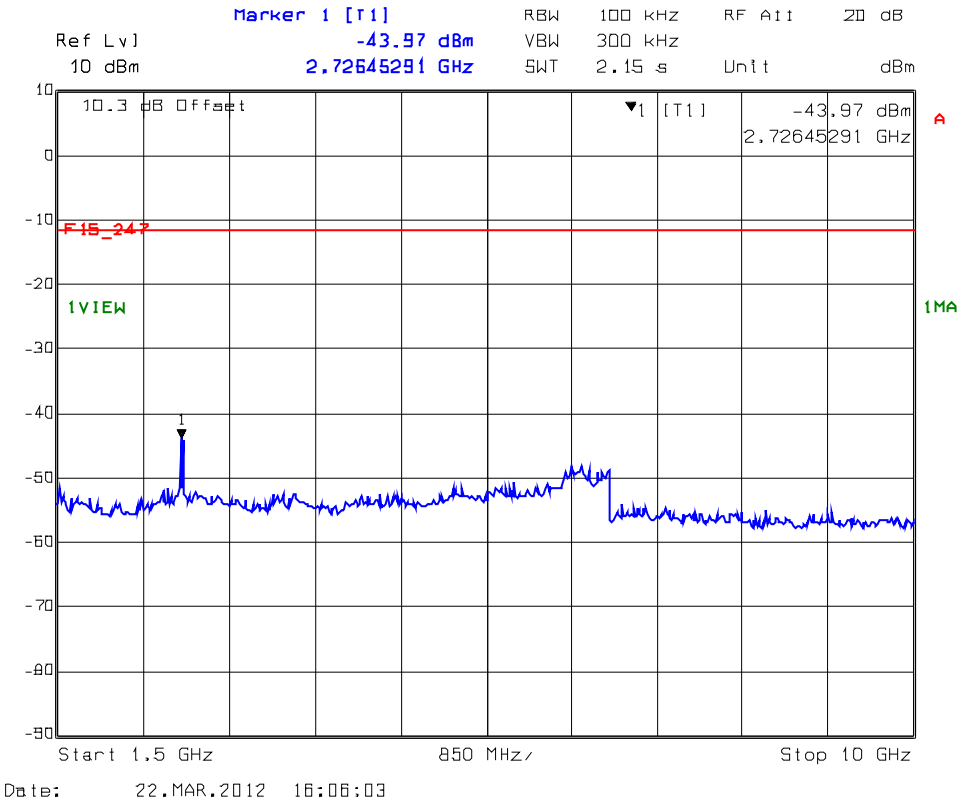
Plot 5.9.4.2.2 Spurious RF Conducted Emissions
Transmitter Frequency: 902.805 MHz



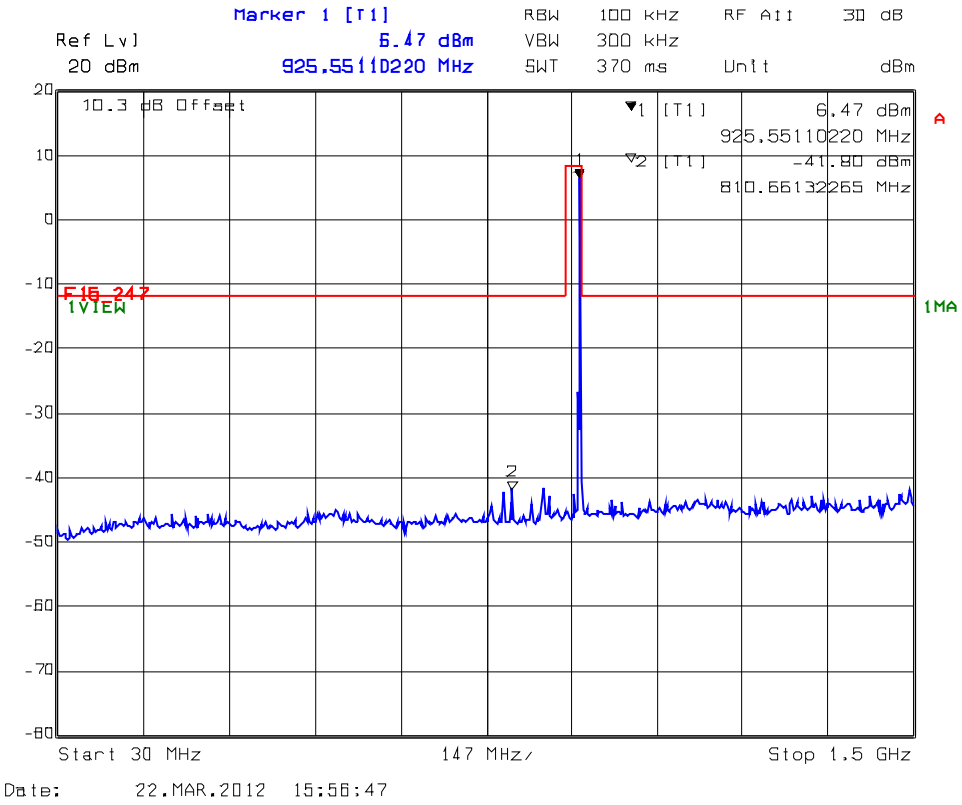
Plot 5.9.4.2.3 Spurious RF Conducted Emissions
Transmitter Frequency: 913.605 MHz



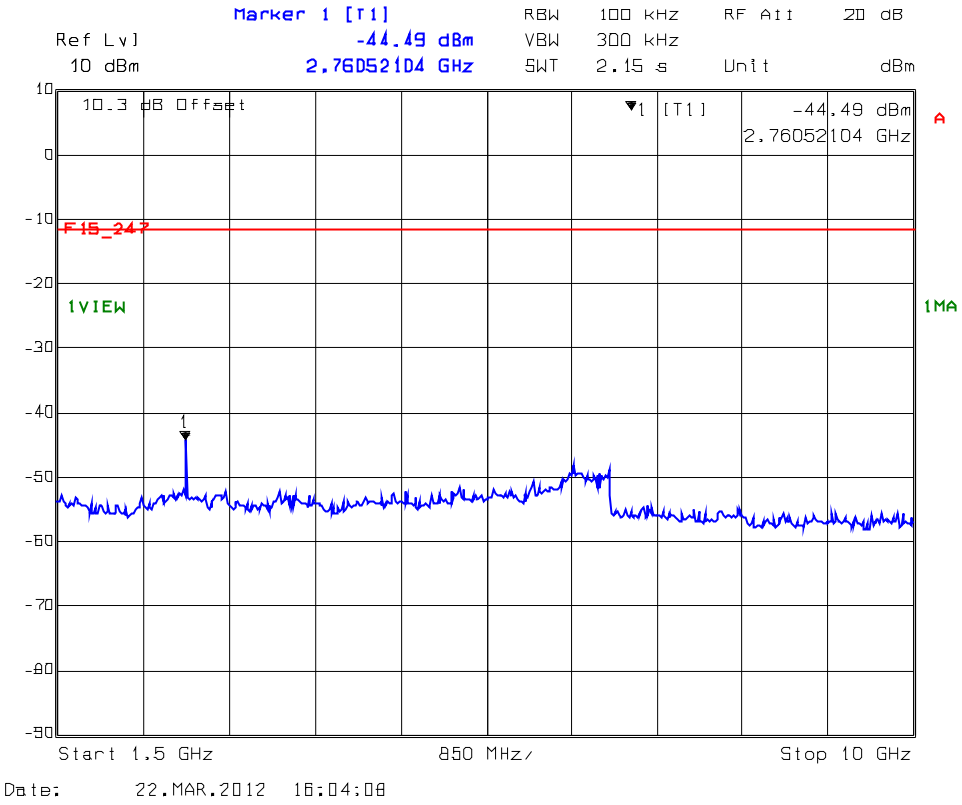
Plot 5.9.4.2.4 Spurious RF Conducted Emissions
Transmitter Frequency: 913.605 MHz



Plot 5.9.4.2.5 Spurious RF Conducted Emissions
Transmitter Frequency: 924.855 MHz



Plot 5.9.4.2.6 Spurious RF Conducted Emissions
Transmitter Frequency: 924.855 MHz



5.10. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

5.10.1. Limit

§ 15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Section 15.205(a) - Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	([2])
13.36–13.41.			

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

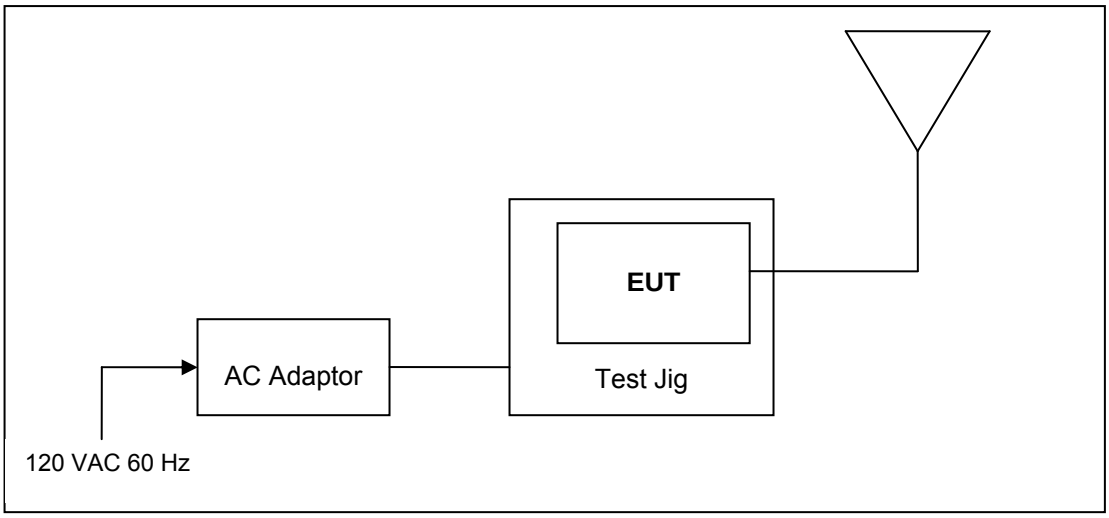
5.10.2. Method of Measurements

ANSI C63.10-2009.

The following measurement procedures were also applied:

- Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.
- For measurement below 1 GHz, set RBW = 100 KHz, VBW $\geq$ 100 KHz, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.
- If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

5.10.3. Test Arrangement



5.10.4. Test Data

5.10.4.1. Module with ¼ wave Di-pole antenna, Model: ANT-916-CW-QW-SMA

Fundamental Frequency:	902.805 MHz
Measured Conducted Power:	8.18 dBm
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.805	109.57	--	V	--	--	--	--
902.805	111.09	--	H	--	--	--	--
2708.415	61.89	55.70 / 37.73**	V	54.0	91.1	-16.3	Pass*
2708.415	64.52	59.45 / 41.48**	H	54.0	91.1	-12.5	Pass*
3611.22	56.13	50.47	V	54.0	91.1	-3.5	Pass*
3611.22	54.64	49.37	H	54.0	91.1	-4.6	Pass*
4514.025	53.35	47.61	V	54.0	91.1	-6.4	Pass*
4514.025	51.16	44.85	H	54.0	91.1	-9.1	Pass*
5416.83	49.37	42.07	V	54.0	91.1	-11.9	Pass*
5416.83	51.87	44.55	H	54.0	91.1	-9.4	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit. See the following test data plots for band-edge emissions.

- *Emission within the restricted frequency bands.
- **Average Emission after applying the Duty Cycle factor [20log(Dwell time/100ms) = 20log(12.635271/100) = 20log(0.12635271) = **-17.97**

Fundamental Frequency:	913.605 MHz
Measured Conducted Power:	7.58 dBm
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
913.605	108.73	--	V	--	--	--	--
913.605	108.18	--	H	--	--	--	--
2740.815	62.60	57.12 / 39.15**	V	54.0	88.7	-14.8	Pass*
2740.815	62.21	57.03 / 39.06**	H	54.0	88.7	-14.9	Pass*
3654.42	56.83	52.05	V	54.0	88.7	-1.9	Pass*
3654.42	56.91	52.04	H	54.0	88.7	-1.9	Pass*
4568.025	50.45	42.84	V	54.0	88.7	-11.2	Pass*
4568.025	48.86	42.83	H	54.0	88.7	-11.2	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit. See the following test data plots for band-edge emissions.

- *Emission within the restricted frequency bands.
- **Average Emission after applying the Duty Cycle factor [20log(Dwell time/100ms) = 20log(12.635271/100) = 20log(0.12635271) = **-17.97**

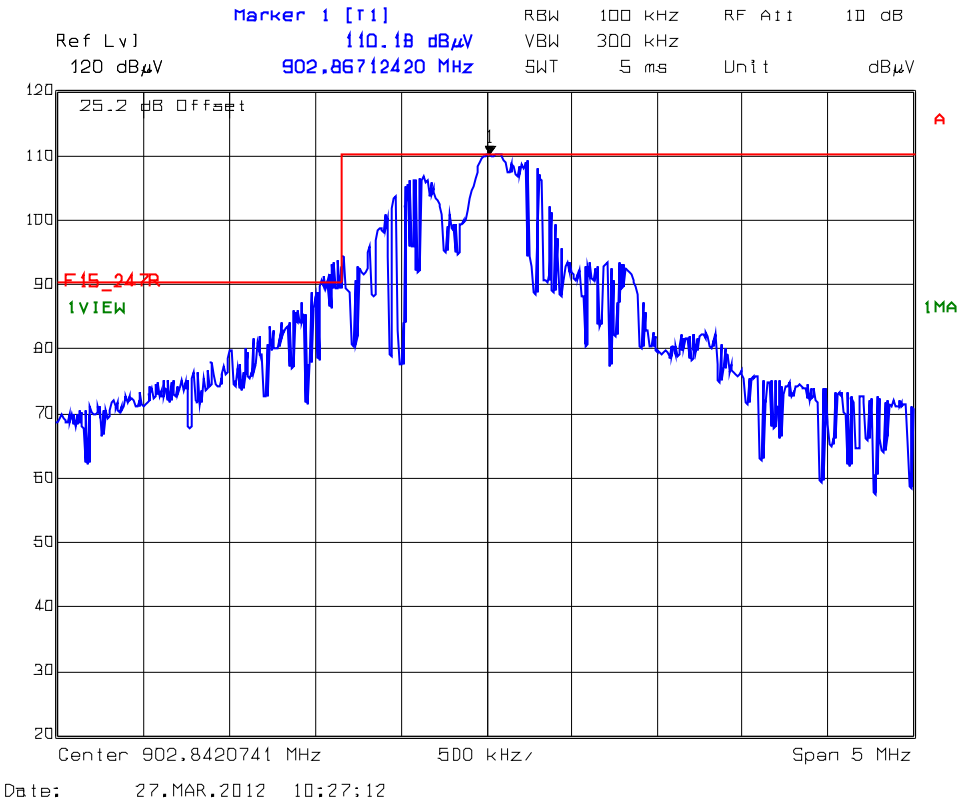
Fundamental Frequency:	924.855 MHz
Measured Conducted Power:	6.62 dBm
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
924.855	106.13	--	V	--	--	--	--
924.855	107.80	--	H	--	--	--	--
2774.565	60.15	55.16 / 37.19**	V	54.0	87.8	-16.8	Pass*
2774.565	61.77	56.45 / 38.48**	H	54.0	87.8	-15.5	Pass*
3699.42	54.93	49.30	V	54.0	87.8	-4.7	Pass*
3699.42	54.33	49.06	H	54.0	87.8	-4.9	Pass*
4624.275	47.28	37.78	V	54.0	87.8	-16.2	Pass*
4624.275	49.03	40.71	H	54.0	87.8	-13.3	Pass*

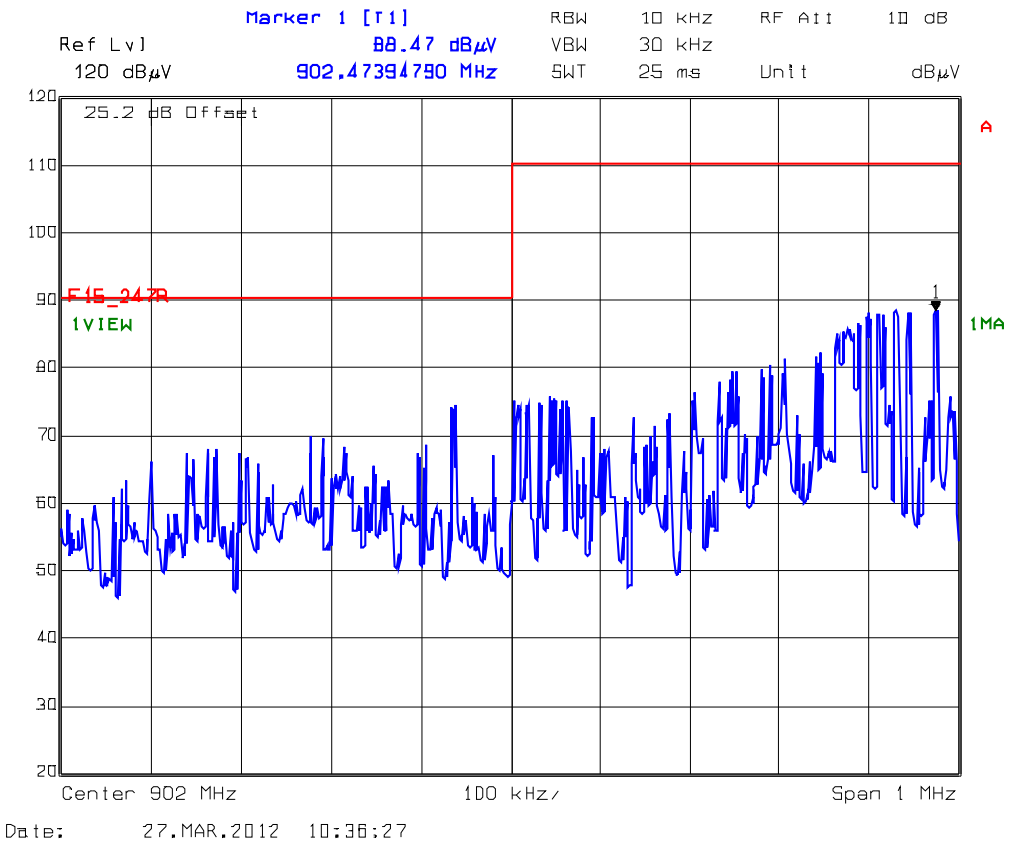
All other spurious emissions and harmonics are more than 20 dB below the applicable limit. See the following test data plots for band-edge emissions.

- *Emission within the restricted frequency bands.
- **Average Emission after applying the Duty Cycle factor [20log(Dwell time/100ms) = 20log(12.635271/100) = 20log(0.12635271) = **-17.97**

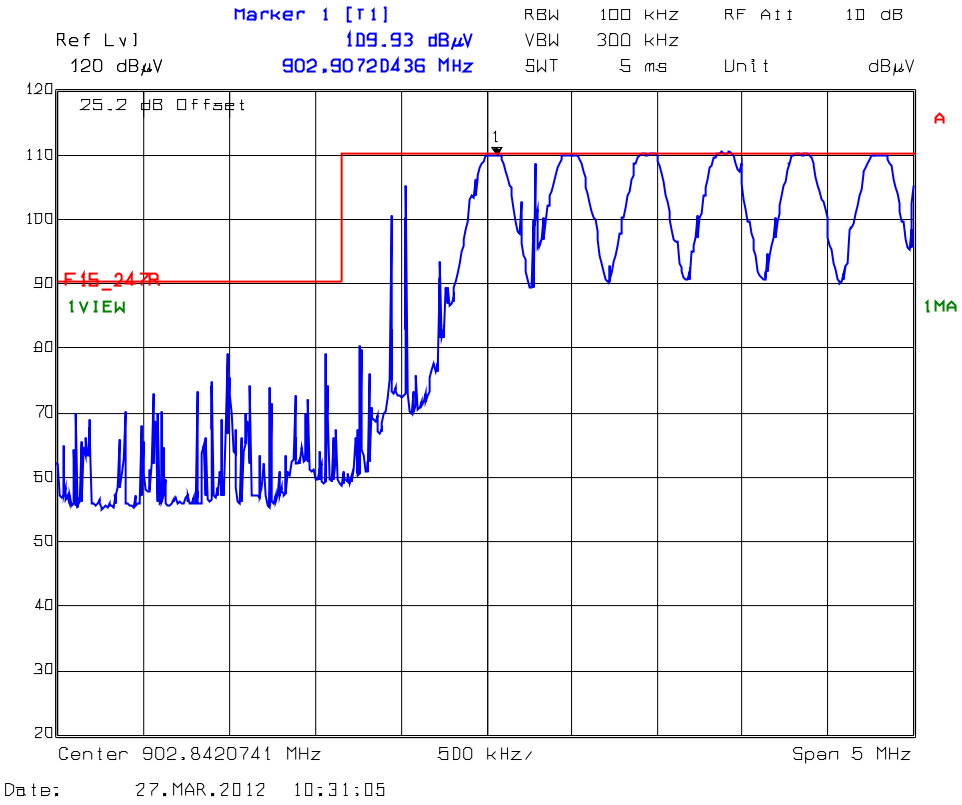
Plot 5.10.4.1.1 Lower Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Horizontal



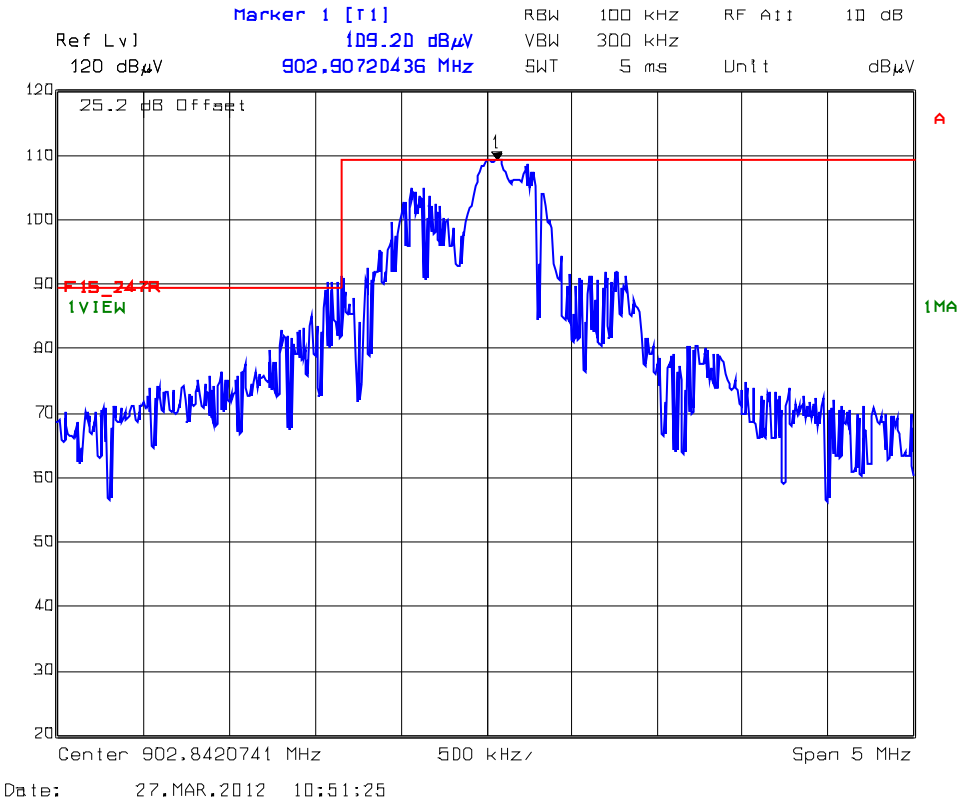
(Zoom In Plot)


Marker 1 [T1]
88.47 dBµV
902.473947 90 MHz
RBW 10 kHz
VBW 30 kHz
SWT 25 ms
RF Att 10 dB
Unit dBµV
Ref Lvl
120 dBµV
25.2 dB Offset
A
FCC_247B
1VIEW
1MA
120
110
100
90
80
70
60
50
40
30
20
Center 902 MHz
100 kHz/
Span 1 MHz
Date: 27.MAR.2012 10:36:27

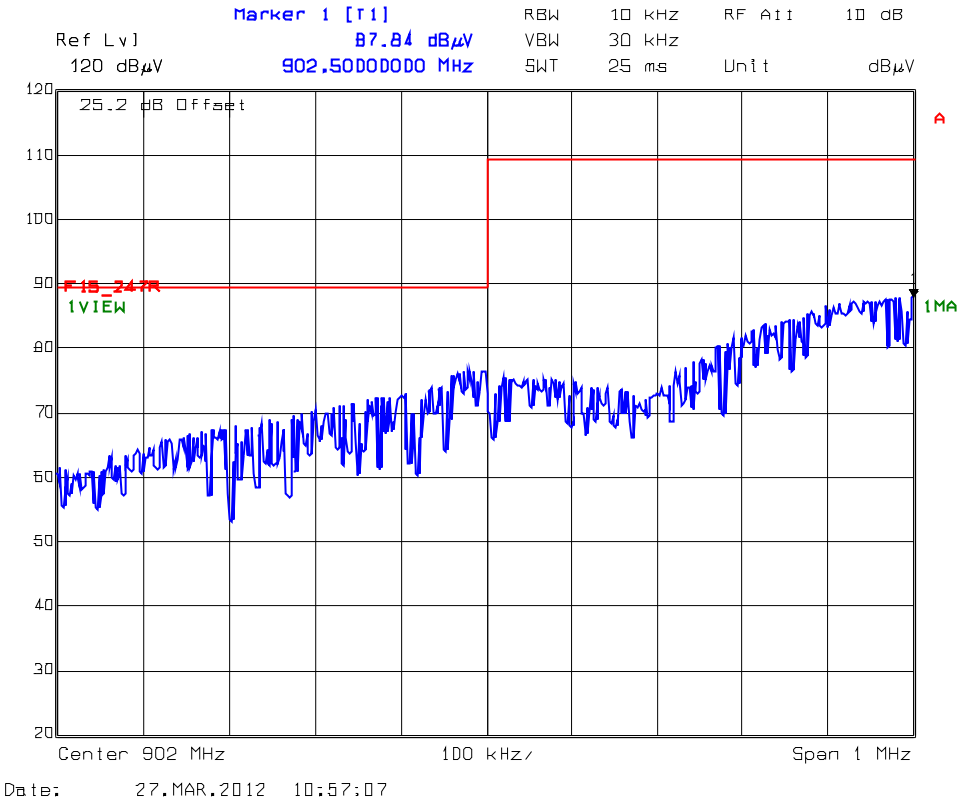
Lower Band Edge with Hopping Function ON



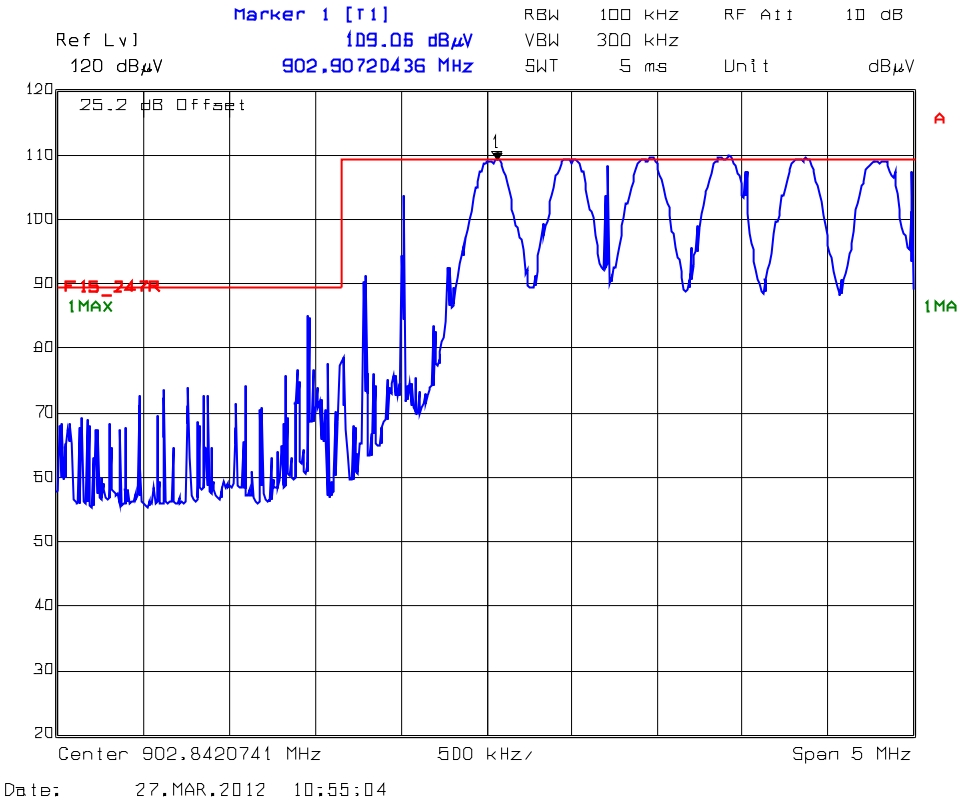
Plot 5.10.4.1.2 Lower Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Vertical



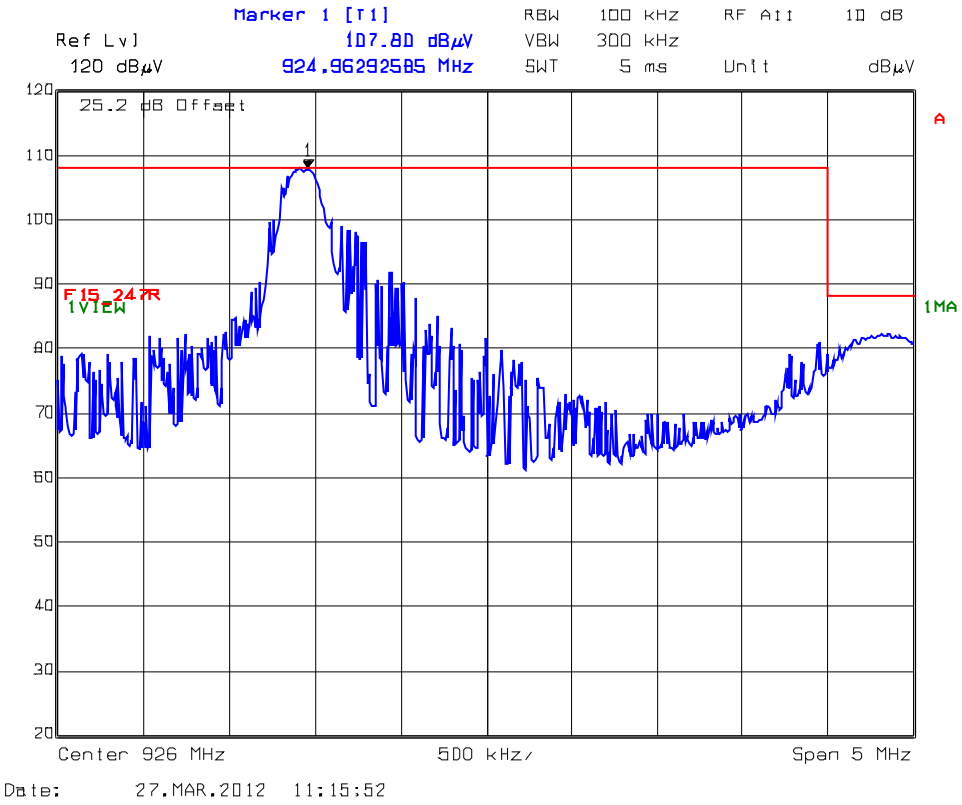
(Zoom In Plot)


Marker 1 [T1]
87.84 dBµV
902.50000000 MHz
RBW 10 kHz
VBW 30 kHz
SWT 25 ms
RF Att 10 dB
Unit dBµV
Ref Lvl
120 dBµV
25.2 dB Offset
FIS_247R
VIEW
A
1MA
120
110
100
90
80
70
60
50
40
30
20
Center 902 MHz
100 kHz/
Span 1 MHz
Date: 27.MAR.2012 10:57:07

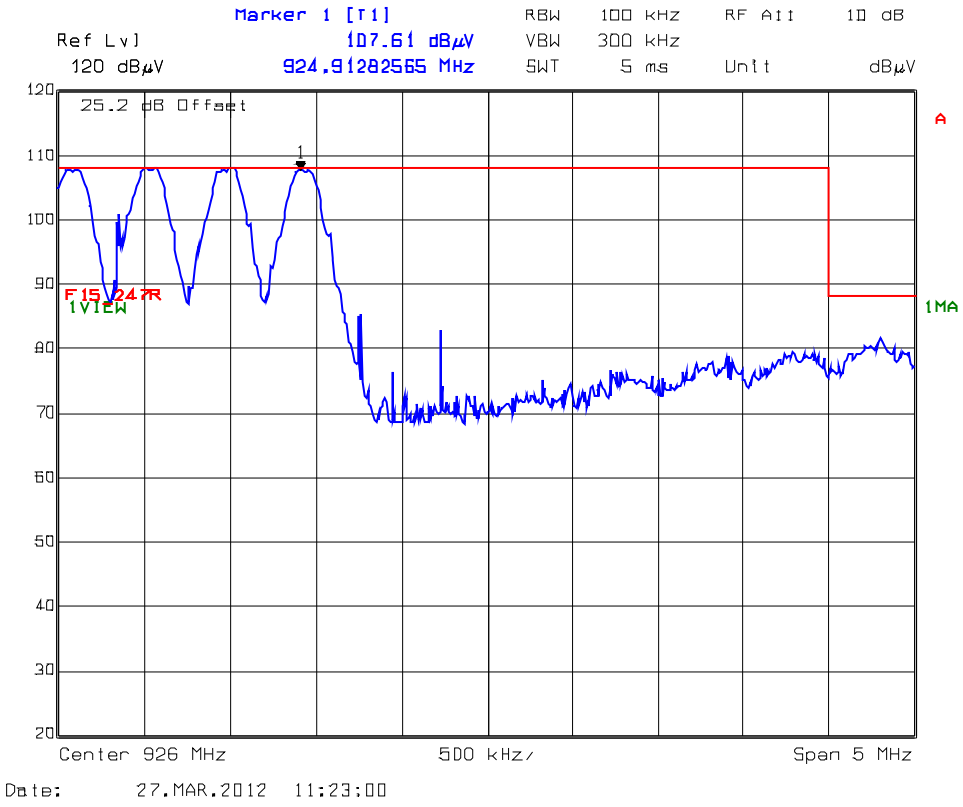
Lower Band Edge with Hopping Function ON



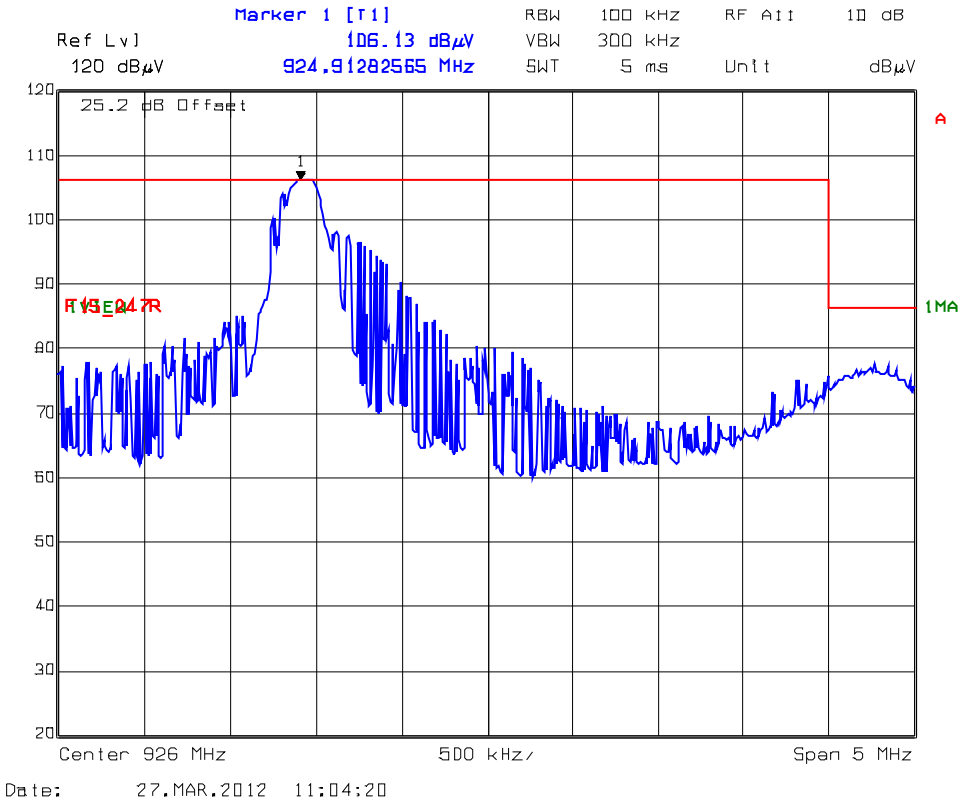
Plot 5.10.4.1.3 Upper Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Horizontal



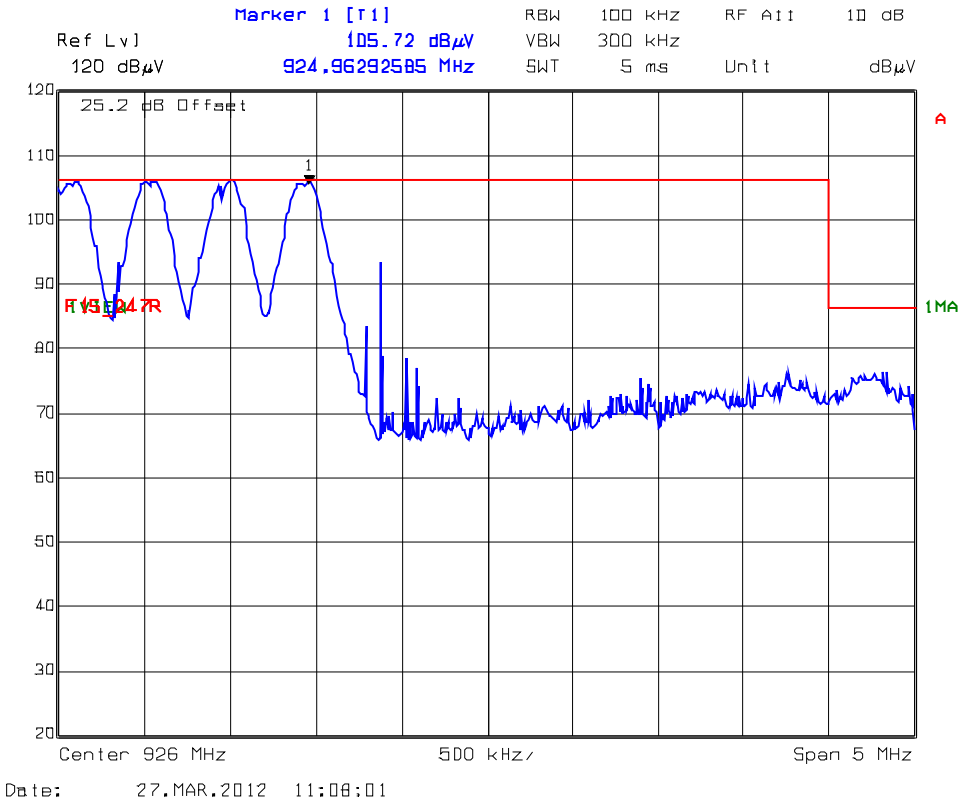
Upper Band Edge with Hopping Function ON



Plot 5.10.4.1.4 Upper Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Vertical



Upper Band Edge with Hopping Function ON



5.10.4.2. Module with Wire Antenna

Fundamental Frequency:	902.805 MHz
Measured Conducted Power:	8.18 dBm
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
902.805	108.06	--	V	--	--	--	--
902.805	107.48	--	H	--	--	--	--
2708.415	57.32	51.27	V	54.0	88.1	-2.7	Pass*
2708.415	52.86	47.65	H	54.0	88.1	-6.3	Pass*
3611.22	50.39	42.16	V	54.0	88.1	-11.8	Pass*
3611.22	51.74	42.89	H	54.0	88.1	-11.1	Pass*
5416.83	46.67	34.02	V	54.0	88.1	-20.0	Pass*
5416.83	46.69	34.28	H	54.0	88.1	-19.7	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit. See the following test data plots for band-edge emissions.

- *Emission within the restricted frequency bands.

Fundamental Frequency:	913.605 MHz
Measured Conducted Power:	7.58 dBm
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
913.605	107.28	--	V	--	--	--	--
913.605	106.36	--	H	--	--	--	--
2740.815	57.09	50.65	V	54.0	87.3	-3.3	Pass*
2740.815	56.55	48.73	H	54.0	87.3	-5.3	Pass*
3654.42	52.32	47.19	V	54.0	87.3	-6.8	Pass*
3654.42	50.18	43.26	H	54.0	87.3	-10.7	Pass*
4568.025	46.28	35.64	V	54.0	87.3	-18.4	Pass*

All other spurious emissions and harmonics are more than 20 dB below the applicable limit. See the following test data plots for band-edge emissions.

- *Emission within the restricted frequency bands.

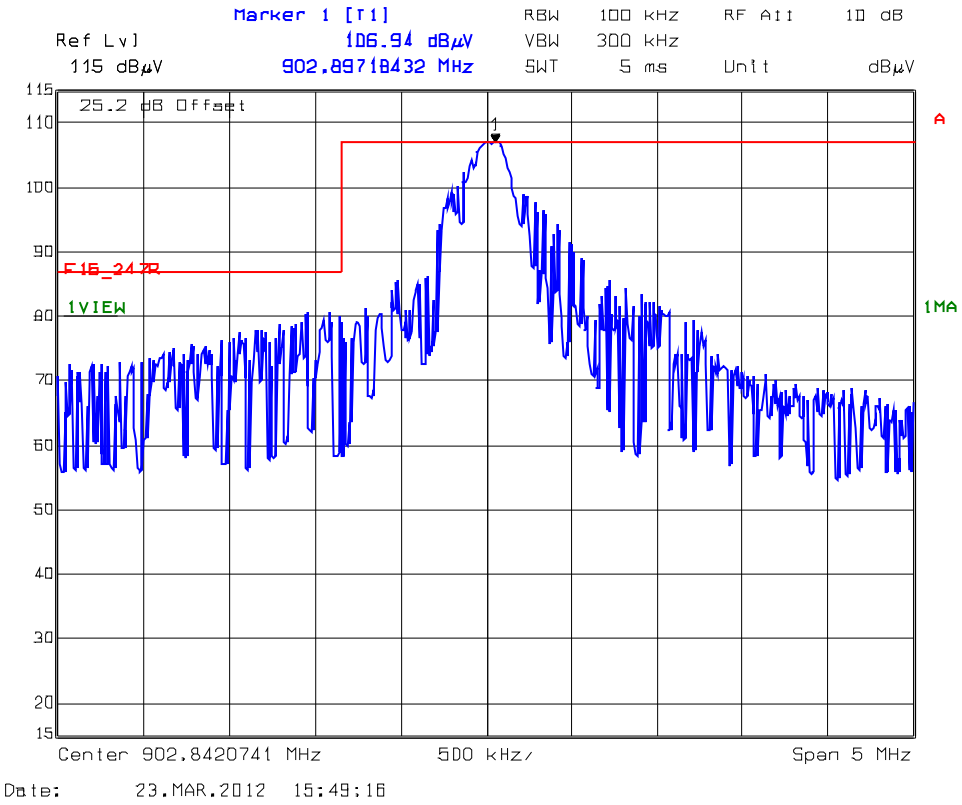
Fundamental Frequency:	924.855 MHz
Measured Conducted Power:	6.62 dBm
Frequency Test Range:	30 MHz – 25 GHz

Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/ Fail
924.855	105.22	--	V	--	--	--	--
924.855	106.26	--	H	--	--	--	--
2774.565	56.61	49.82	V	54.0	86.3	-4.2	Pass*
2774.565	57.70	50.41	H	54.0	86.3	-3.6	Pass*
3699.42	50.30	43.99	V	54.0	86.3	-10.0	Pass*
3699.42	54.55	46.09	H	54.0	86.3	-7.9	Pass*

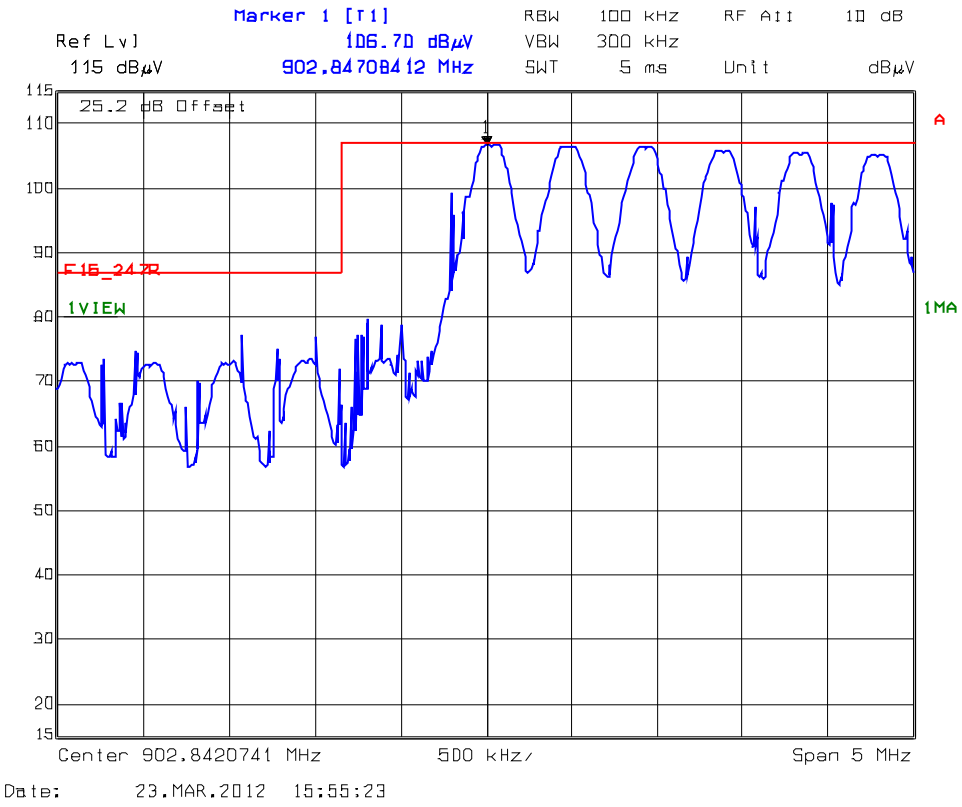
All other spurious emissions and harmonics are more than 20 dB below the applicable limit. See the following test data plots for band-edge emissions.

- *Emission within the restricted frequency bands.

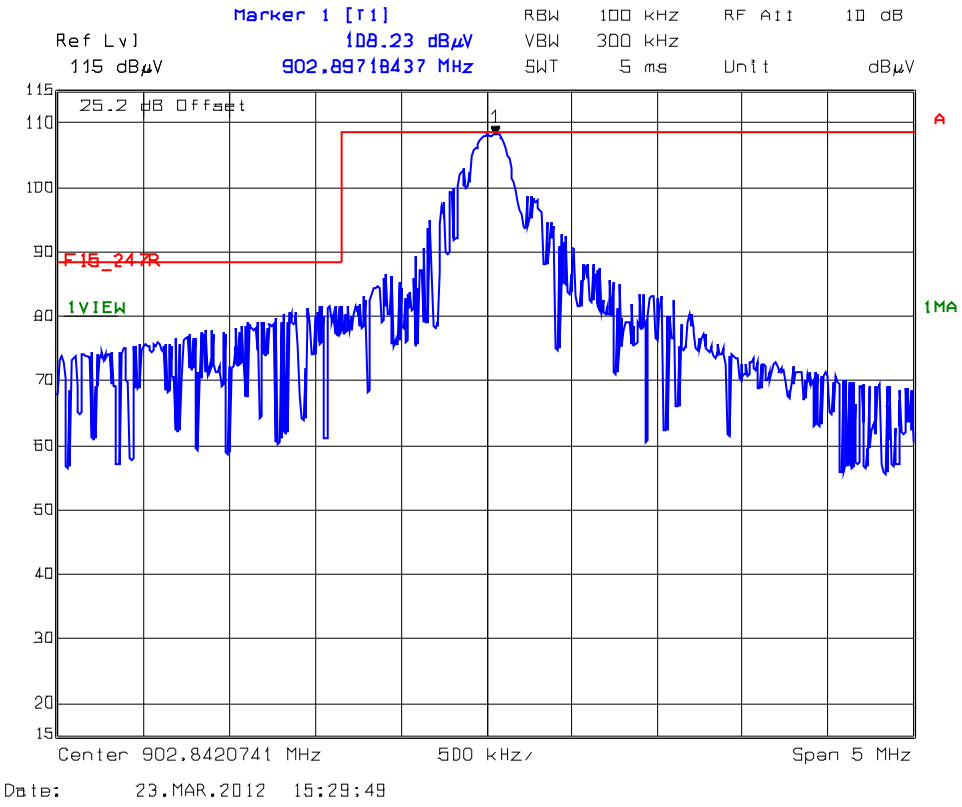
Plot 5.10.4.1.1 Lower Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Horizontal



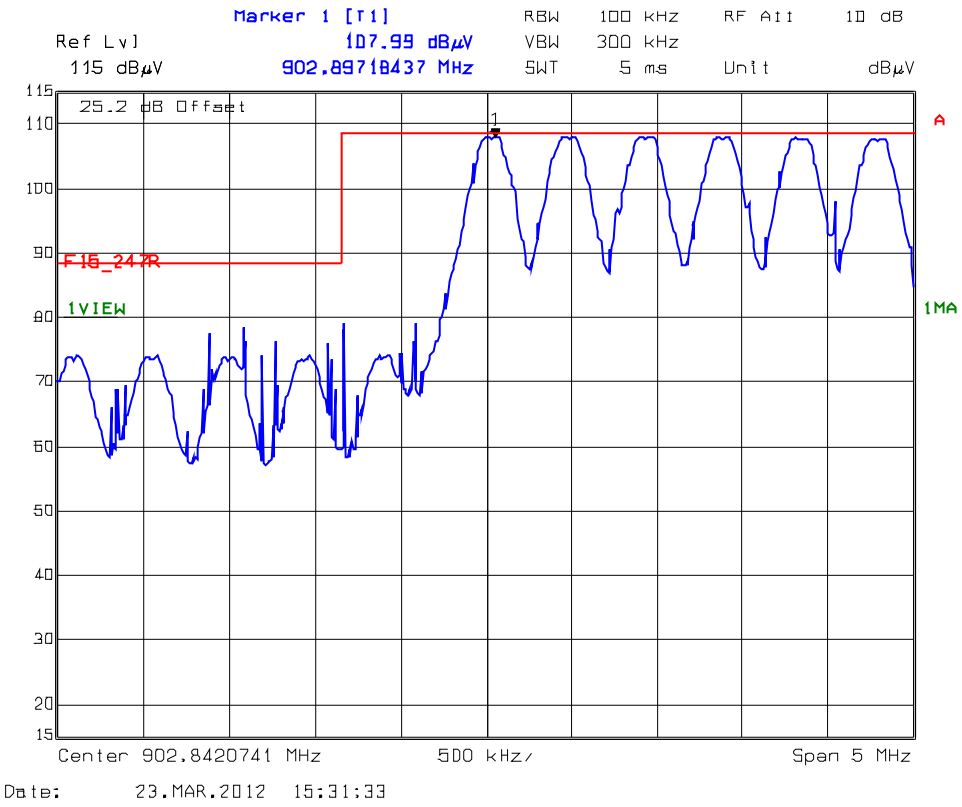
Lower Band Edge with Hopping Function ON



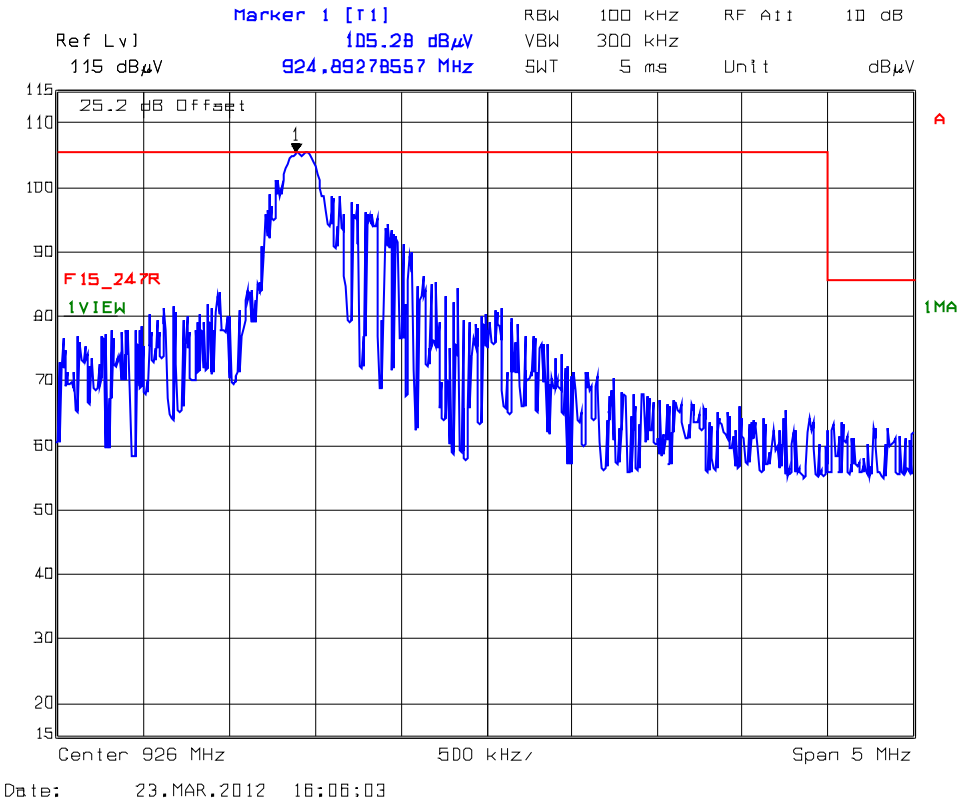
Plot 5.10.4.1.2 Lower Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Vertical



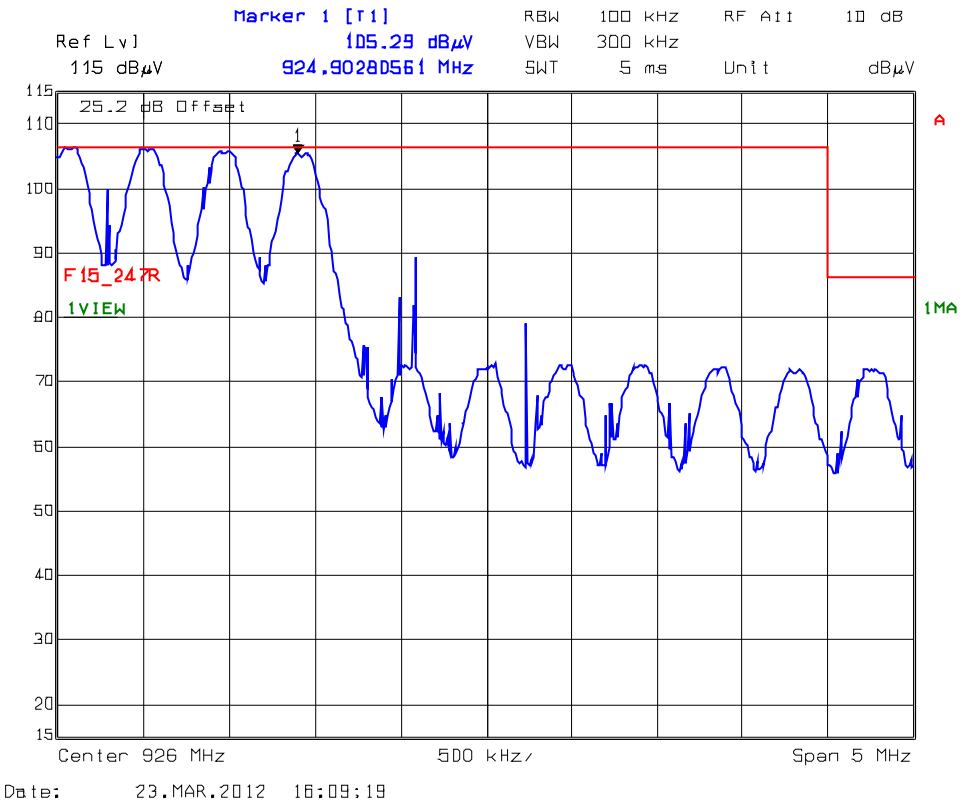
Lower Band Edge with Hopping Function ON



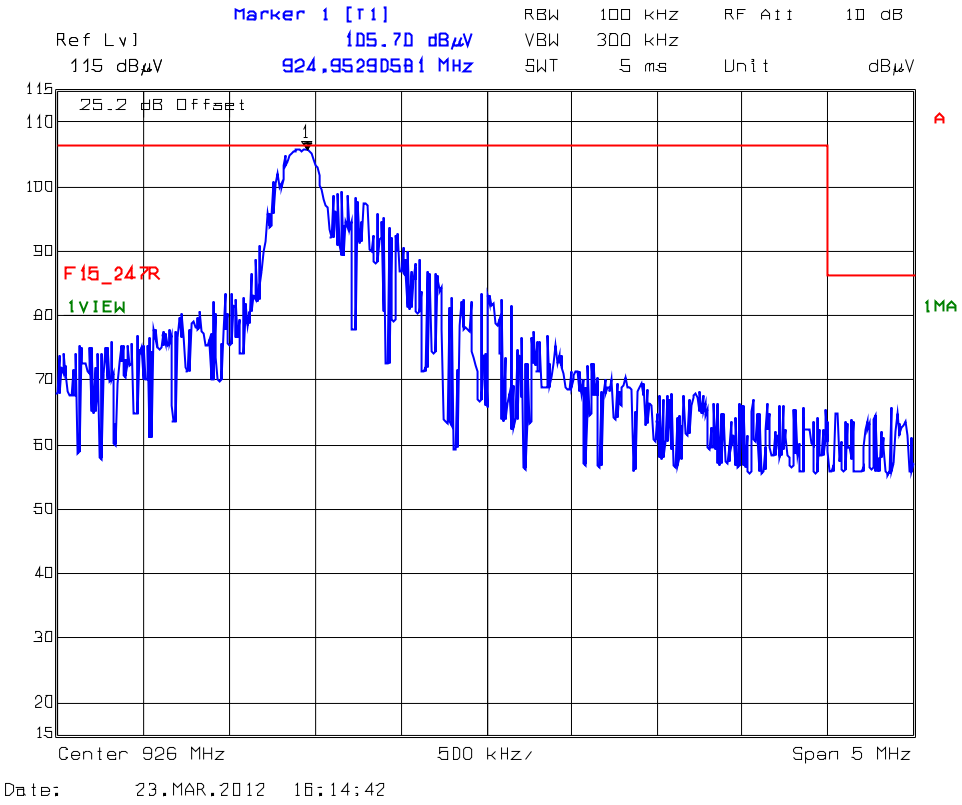
Plot 5.10.4.1.3 Upper Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Horizontal



Upper Band Edge with Hopping Function ON



Plot 5.10.4.1.4 Upper Band-Edge RF Radiated Emissions @ 3 meter
Rx Antenna Orientation: Vertical



Upper Band Edge with Hopping Function ON

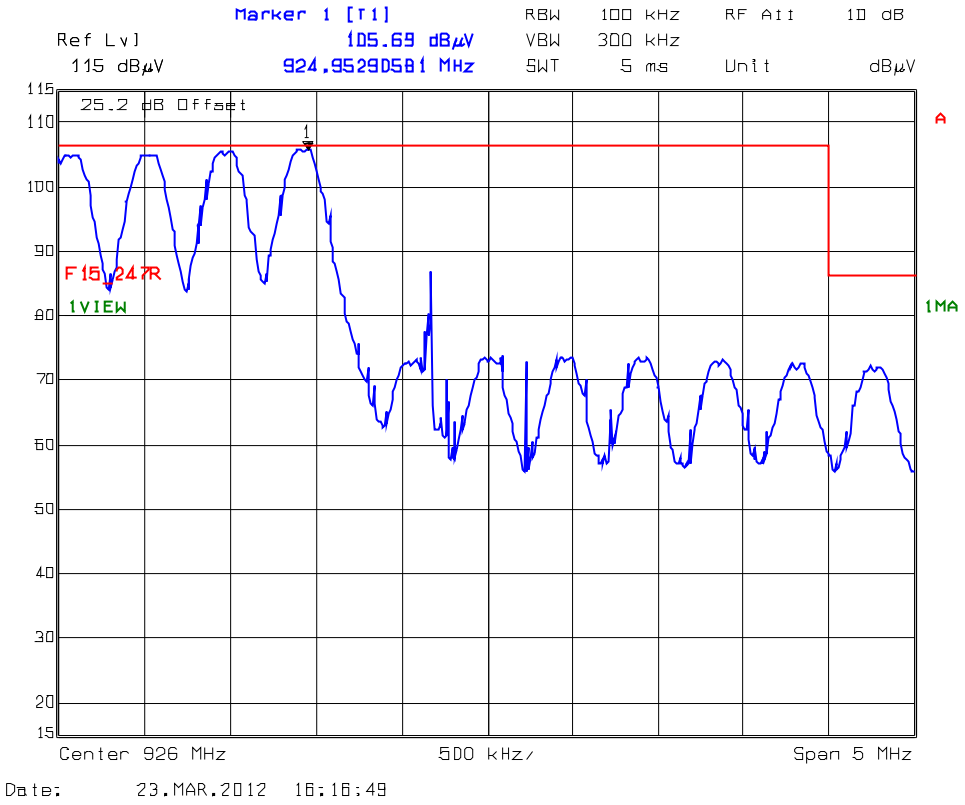


EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSEK	834157/005	9 KHz – 40 GHz	18 Jul 2012
Spectrum Analyzer	Rohde & Schwarz	ESU40	100037	20 Hz – 40 GHz	19 Mar 2013
RF Amplifier	AH System	PAM-0118	225	20 MHz – 18 GHz	16 Mar 2013
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2.4 GHz	Cal. on use
Horn Antenna	Emco	3115	9701-5061	1 – 18 GHz	25 Jan 2013
Biconi-Log Antenna	Emco	3142C	00034792	26 – 3000 MHz	26 April 2012
Signal Generator	Hewlett Packard	8648C	3443U00391	100 kHz – 3200 MHz	16 Dec 2011
Attenuator	Narda	4768-20	-	DC – 40 GHz	Cal. on use
Power Divider	Mini-Circuits	15542	0235	DC – 18 GHz	Cal. on use
Spectrum Analyzer	Hewlett Packard	HP 8593EM	3710A00223	9 kHz – 22 GHz	25 April 2012
Attenuator	Pasternack	PE7010-20	-	-	18 Jan 2012

EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1. Line Conducted Emission Measurement Uncertainty (0.15-30 MHz)

	Line Conducted Emission Measurement Uncertainty (150 kHz – 30 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.57**	**± 1.8**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 3.14**	**± 3.6**

7.2. Radiated Emission Measurement Uncertainty

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.15**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.30**	**± 5.2**

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 2.39**	**± 2.6**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 4.78**	**± 5.2**

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal & Vertical (1 – 18 GHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{I=1}^{m} u_i^2(y)}$	**± 1.87**	Under consideration
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 3.75**	Under consideration