Test of Bright Star Engineering Inc. MicroPod
MPOD2-C, Bluetooth

To: FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: BSTR39-U4 Rev B

TEST REPORT

FROM

Test of Bright Star Engineering Inc. MicroPod MPOD2-C, Bluetooth

to

To FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: BSTR39-U4 Rev B

This report supersedes: BSTR39-U4 Rev A

Applicant: Bright Star Engineering Inc
299 Ballardvale Street, Suite 5
Wilmington, MA 01887
USA

Product Function: Wireless Automobile OBDII Monitoring System

Copy No: pdf Issue Date: 1st October 2012

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
440 Boulder Court, Suite 200
Pleasanton, CA 94566 USA
Phone: +1 (925) 462-0304
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www.micomlabs.com

ACCREDITED
TEST CERTIFICATE #2381.01

MiCOM Labs is an ISO 17025 Accredited Testing Laboratory

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ACCREDITATION, LISTINGS & RECOGNITION

TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

Country	Recognition Body	Status	Phase	Identification No.
USA	Federal Communications Commission (FCC)	TCB	-	US0159 Listing #: 102167
Canada	Industry Canada (IC)	FCB	APEC MRA 2	US0159 Listing #: 4143A-2
Japan	MIC	CAB	APEC MRA 2	RCB 210
	VCCI	--	--	A-0012
Europe	European Commission	NB	EU MRA	NB 2280
Australia	Australian Communications and Media Authority (ACMA)	CAB	APEC MRA 1	US0159
Hong Kong	Office of the Telecommunication Authority (OFTA)	CAB	APEC MRA 1	
Korea	Ministry of Information and Communication Radio Research Laboratory (RRL)	CAB	APEC MRA 1	
Singapore	Infocomm Development Authority (IDA)	CAB	APEC MRA 1	
Taiwan	National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI)	CAB	APEC MRA 1	
Vietnam	Ministry of Communication (MIC)	CAB	APEC MRA 1	

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.
Phase I - recognition for product testing
Phase II – recognition for both product testing and certification
N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC Guide 65. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf

United States of America – Telecommunication Certification Body (TCB)
TCB Identifier – US0159

Industry Canada – Certification Body
CAB Identifier – US0159

Europe – Notified Body
Notified Body Identifier - 2280

Japan – Recognized Certification Body (RCB)
RCB Identifier - 210

DOCUMENT HISTORY

Document History		
Revision	Date	Comments
Draft		
Rev A	21st September 2012	Initial release.
Rev B	1st October 2012	Revised Section 3.1 “location for use” to outdoor. Clarification of test methodology used during radiated emissions testing.

1. TEST RESULT CERTIFICATE

Manufacturer:	Bright Star Engineering Inc 299 Ballardvale Street, Suite 5 Wilmington, MA 01887 USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
EUT:	Wireless Automobile OBDII Monitoring System	Telephone:	+1 925 462 0304
Model:	MicroPod MPOD2-C	Fax:	+1 925 462 0306
S/N's:	WCP-01084, WCP-01043		
Test Date(s):	1st June 2012 to 14th August '2012	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.247 & IC RSS-210 (Bluetooth Functionality Only)	EQUIPMENT COMPLIES

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested is capable of demonstrating compliance with the requirements as documented within this report.

Notes:

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

ACCREDITED
TEST CERTIFICATE #2381.01

Approved & Released for MiCOM Labs, Inc. by:

Graeme Grieve
Quality Manager MiCOM Labs,

Gordon Hurst
President & CEO MiCOM Labs, Inc.

2. REFERENCES AND MEASUREMENT UNCERTAINTY

2.1. Normative References

REF.	PUBLICATION	YEAR	TITLE
i.	FCC 47 CFR Part 15, Subpart C	2012	Title 47: Telecommunication PART 15 — Radio Frequency Devices Subpart C—Intentional Radiators
ii.	RSS-210 Annex 8	2010	Radio Standards Specification 210, Issue 8, Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment
iii.	FCC OET KDB 662911	4th April 2011	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
iv.	DA 00-705	2000	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems" released March 30, 2000
v.	RSS-GEN	2010	Radio Standards Specification-Gen, Issue 3, General Requirements and Information for the Certification of Radiocommunication Equipment
vi.	FCC 47 CFR Part 15, Subpart B	2010	47 CFR Part 15, SubPart B; Unintentional Radiators
vii.	ICES-003	2004	Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard Digital Apparatus; Issue 4
viii.	ANSI C63.4	2009	American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ix.	CISPR 22/ EN 55022	2008 2006 +A1:2007	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
x.	M 3003	Edition 2 Jan. 2007	Expression of Uncertainty and Confidence in Measurements
xi.	LAB34	Edition 1 Aug 2002	The expression of uncertainty in EMC Testing
xii.	ETSI TR 100 028	2001	Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics
xiii.	A2LA	July 2012	Reference to A2LA Accreditation Status – A2LA Advertising Policy

2.2. Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

3. PRODUCT DETAILS AND TEST CONFIGURATIONS

3.1. Technical Details

Details	Description
Purpose:	Test of the Bright Star Engineering Inc. MicroPod MPOD2-C to FCC Part 15.247 and Industry Canada RSS-210 regulations.
Applicant:	Bright Star Engineering Inc 299 Ballardvale Street, Suite 5 Wilmington, MA 01887 USA
Manufacturer:	As applicant.
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	BSTR39-U4 Rev B
Date EUT received:	27th August 2012
Standard(s) applied:	FCC 47 CFR Part 15.247 & IC RSS-210
Dates of test (from - to):	1st June 2012 to 14th August '2012
No of Units Tested:	One
Type of Equipment:	Bluetooth (Wi-Fi portion tested under separate MiCOM Labs test report BSTR39-C3).
Manufacturers Trade Name:	BrightStar
Model(s):	wiTECH microPOD II
Location for use:	Outdoor
Declared Frequency Range(s):	2400 - 2483.5 MHz;
Software Release	0.11
Type of Modulation:	GFSK
EUT Modes of Operation:	Test report only covers 802.15 (Bluetooth)
Transmit/Receive Operation:	Simplex
Output Power Type:	Fixed, not variable
Rated Input Voltage and Current:	12 Vdc 200 mA
Operating Temperature Range:	Declared range -40° to +85ºC
Equipment Dimensions:	7.2 cm x 2.2 cm x 4.3 cm
Weight:	6 oz
Primary function of equipment:	Wireless Data Communication
Equipment Secondary Function(s):	Automotive Diagnostics

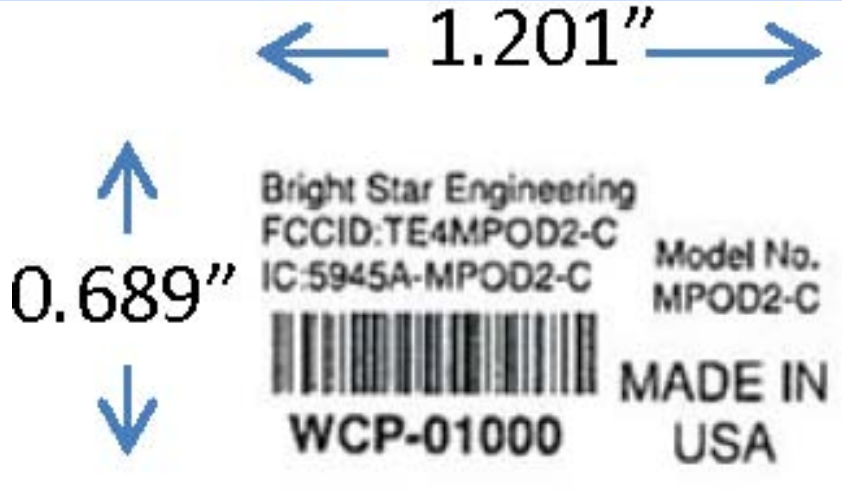
3.2. Scope of Test Program

Bright Star Engineering Inc. MicroPod MPOD2-C
The scope of the test program was to test the Bright Star Engineering Inc. MicroPod MPOD2-C Bluetooth configuration in the frequency range 2400 - 2483.5 MHz for compliance against FCC 47 CFR Part 15.247 and Industry Canada RSS-210 specifications.

The MicroPod MPOD2-C connects to an automobile OBDII port monitoring automobile performance and providing diagnostic capability.

MicroPod MPOD2-C 802.11 b/g/n + Bluetooth

MicroPod MPOD2-C 802.11 b/g/n + Bluetooth



3.3. Equipment Model(s) and Serial Number(s)

Equipment Type	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	Bluetooth	Brightstar Engineering Inc	MicroPod MPOD2-C	WCP-01084, WCP-01043
Support	Laptop PC	IBM	Thinkpad	None

3.4. Antenna Details

Antenna Type	Manufacturer	Model Number	Antenna Gain (dBi
			2.4 GHz
Rufa 2.4 GHz SMD	Antenova	A5887	Peak Gain 2.1

3.5. Cabling and I/O Ports

The following is a description of the cable and input, output ports available on the EUT.

Type of I/O Ports	Description	Screened (y/n)	Description	Qty
Vehicle	K-line, J1850, Can	N	--	1
USB	Mini USB @ EUT	Yes	2 meters	1

3.6. EUT Configurations

Band (GHz)	Mode	Freq Band (MHz)	Freq Range (MHz)	Low ch	Mid ch	High ch
2.4	Bluetooth	2400 - 2483.5	2402 - 2480	2402	2442	2480

3.7. Test Configurations

Testing was performed to determine the highest power level versus bit rate (GFSK or EDR variant). The variant with the highest power was used to exercise the product.

Operational Mode(s)	Variant	Data Rate with Highest Power	Frequencies (MHz)
GFSK	N/A	N/A	2,402 2,442 2,480

Results for the above configurations are provided in this report.

3.8. Equipment Modifications

The following modifications were required to bring the equipment into compliance

No modifications required

3.9. Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

1. NONE

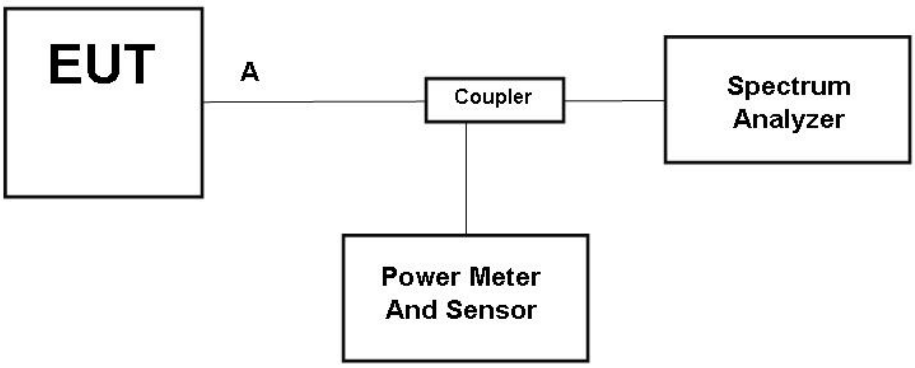
4. TESTING CONFIGURATION(S)

4.1. Conducted RF Emission Test Set-up

The following tests were performed using the conducted test set-up shown in the diagram below.

1. Section 6.1.1.1. 20 dB and 99% Bandwidth
2. Section 6.1.1.2. Peak Output Power
3. Section 6.1.1.3. Transmitter Channel Spacing, Occupancy etc.
4. Section 6.1.1.4. Conducted Spurious Emissions including band-edge

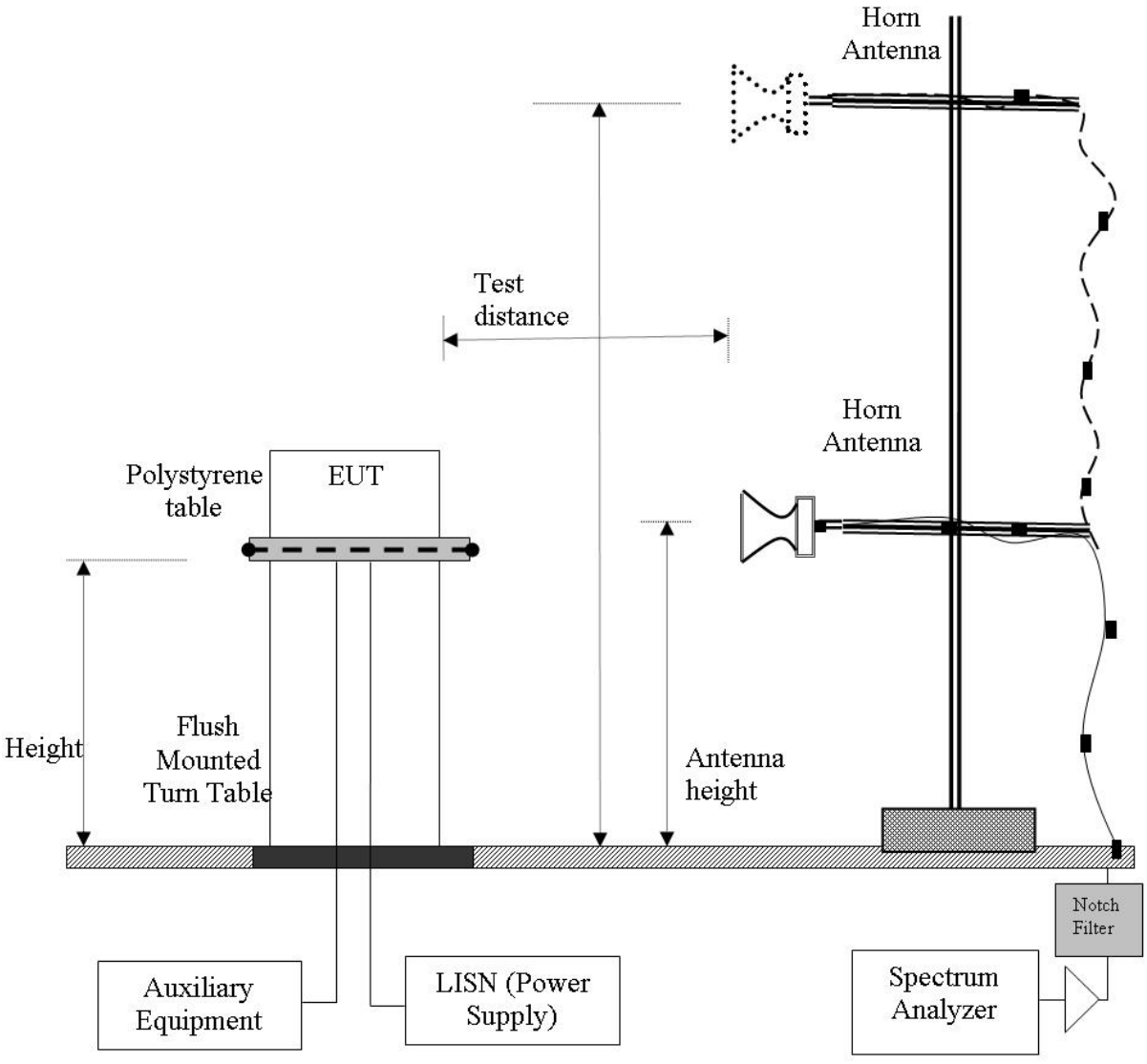
Conducted Test Set-Up Pictorial Representation



4.2. Radiated Spurious Emission Test Set-up > 1 GHz

The following tests were performed using the radiated test set-up shown in the diagram below.

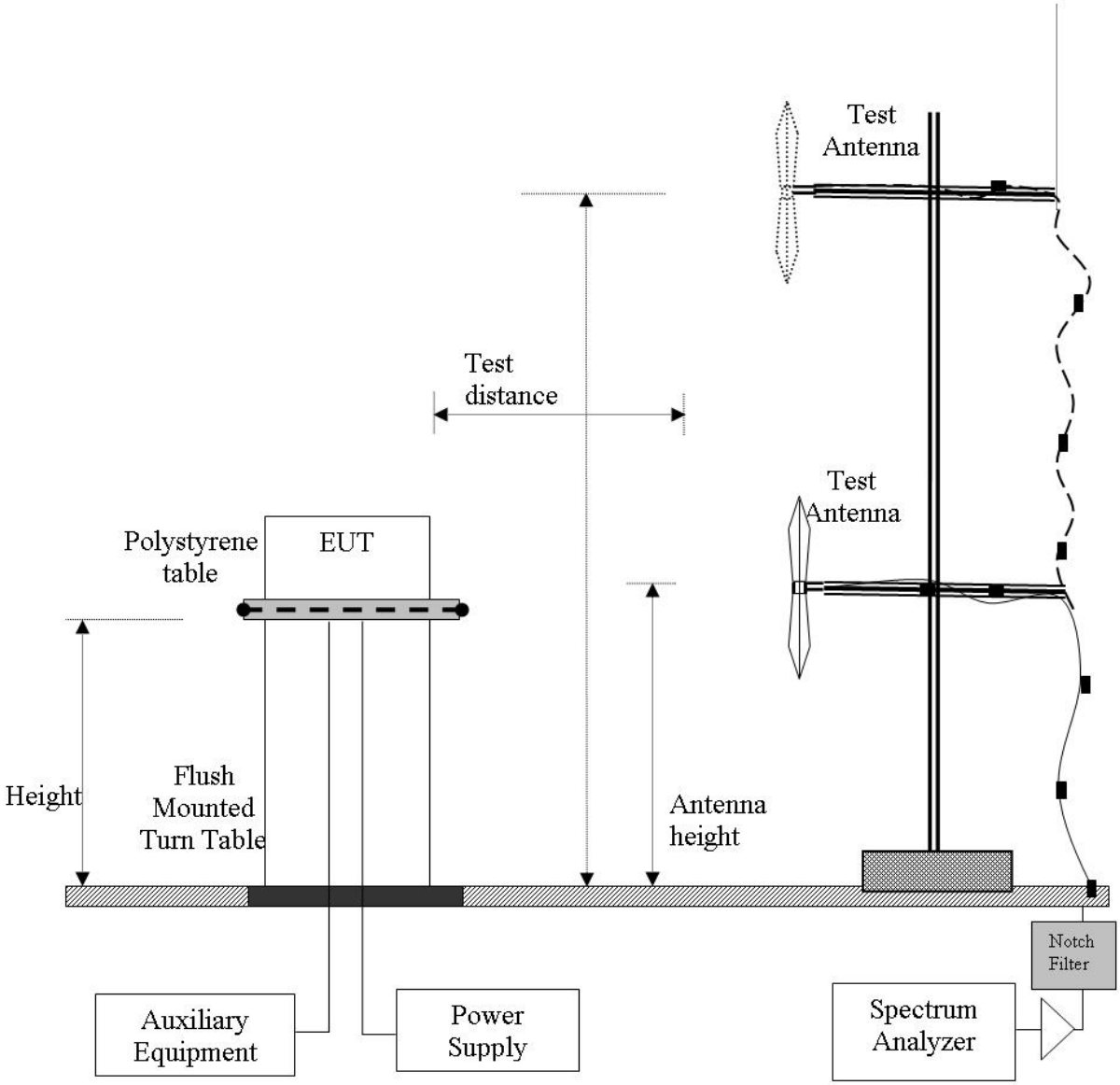
Radiated Emission Measurement Setup – Above 1 GHz



4.3. Digital Emissions Test Set-up (0.03 – 1 GHz)

The following tests were performed using the radiated test set-up shown in the diagram below.

Digital Emission Measurement Setup – Below 1 GHz



5. TEST SUMMARY

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247** and **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(a)(1) **A8.1**	20 dB BW	20 dB Bandwidth	Conducted	Complies	6.1.1.1
15.247(b)(2) **A8.4**	Output Power	Transmit Power	Conducted	Complies	6.1.1.2
15.247(a)(1) **A8.1**	Transmitter Channels	Channel Spacing	Conducted	Complies	6.1.1.3
15.247(a)(1) **A8.1**	Transmitter Channels	Number of Hopping Frequencies	Conducted	Complies	6.1.1.4 6.1.1.5
		Channel Occupancy	Conducted	Complies	6.1.1.6
15.247(d) **A8.5**	Conducted Spurious Emissions	Band Edge	Conducted	Complies	6.1.1.7 6.1.1.8
		Spurious Emissions Transmitter	Conducted	Complies	

List of Measurements

The following table represents the list of measurements required under the **FCC CFR47 Part 15.247**, **Industry Canada RSS-210** and **Industry Canada RSS-Gen.**

Section(s)	Test Items	Description	Condition	Result	Test Report Section
15.247(d) **15.205** **15.209** **A8.5** **2.2** **2.6** **4.9**	Radiated Emissions above 1 GHz	Transmitter	Radiated	Complies	*6.1.2.1*
4.10		Receiver	Radiated	Complies	
15.247(d) **15.205** **15.209** **A8.5** **2.2** **2.6**	Radiated Emissions below 1 GHz		Radiated	Complies	*6.1.2.2*
15.207 **7.2.2**	Conducted	AC Wireline Conducted Emissions	Conducted	Not Applicable EUT USB Powered	*N/A*

Note 1: *Test results reported in this document relate only to the items tested*
Note 2: *The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria*
Note 3: *Section 3.7 - Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix*

6. TEST RESULTS

6.1. Device Characteristics

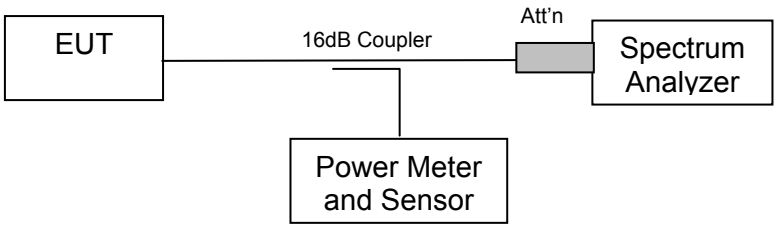
6.1.1. Conducted Testing

6.1.1.1. 20 dB and 99 % Bandwidth

Test Procedure

The 20 dB bandwidth is measured with a spectrum analyzer connected to the antenna terminal, while the EUT is operating in transmission mode at the appropriate center frequency and modulation.

Test Measurement Set up



Measurement set up for 20 dB bandwidth test

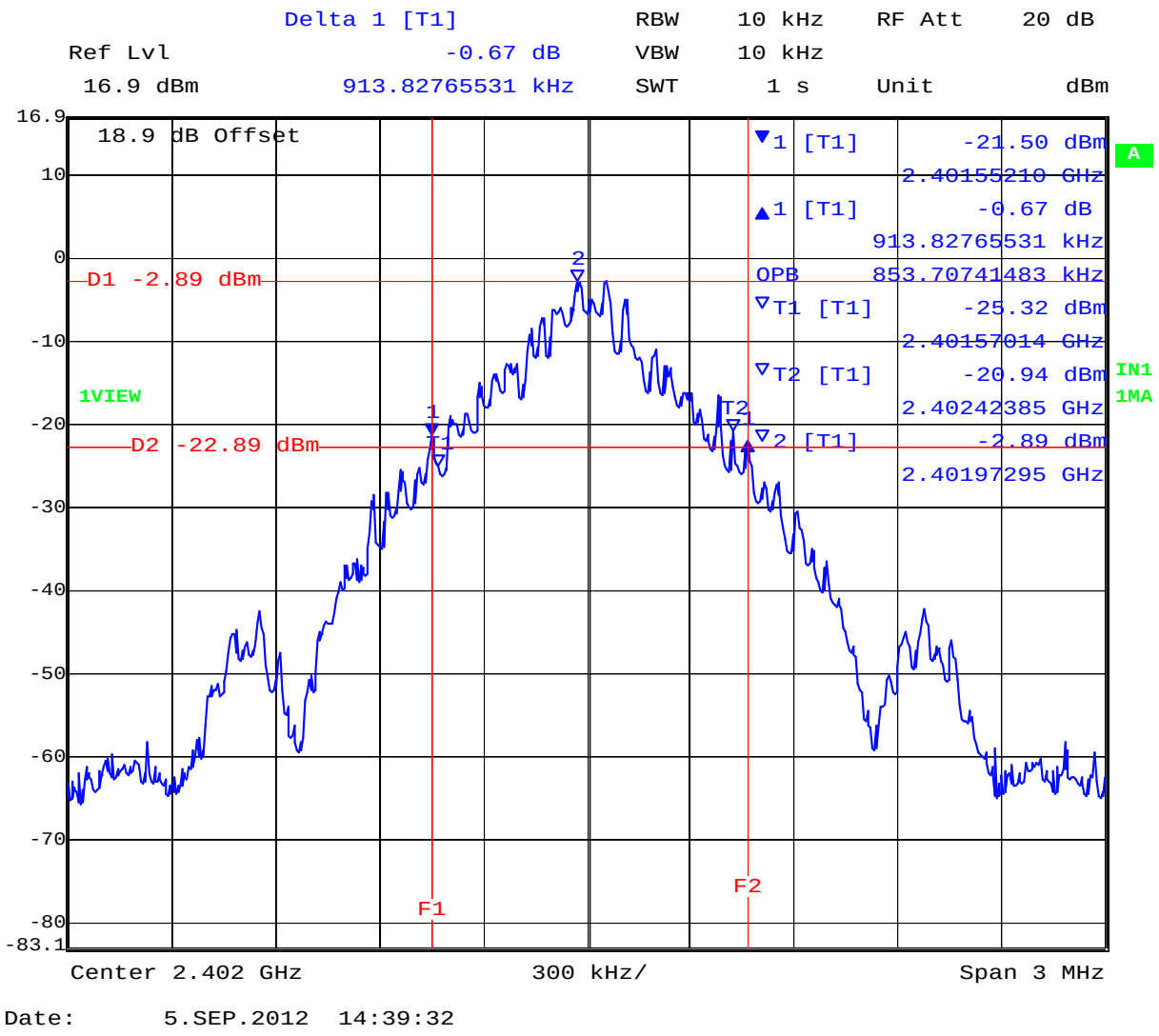
Test Results for 20 dB Bandwidth

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

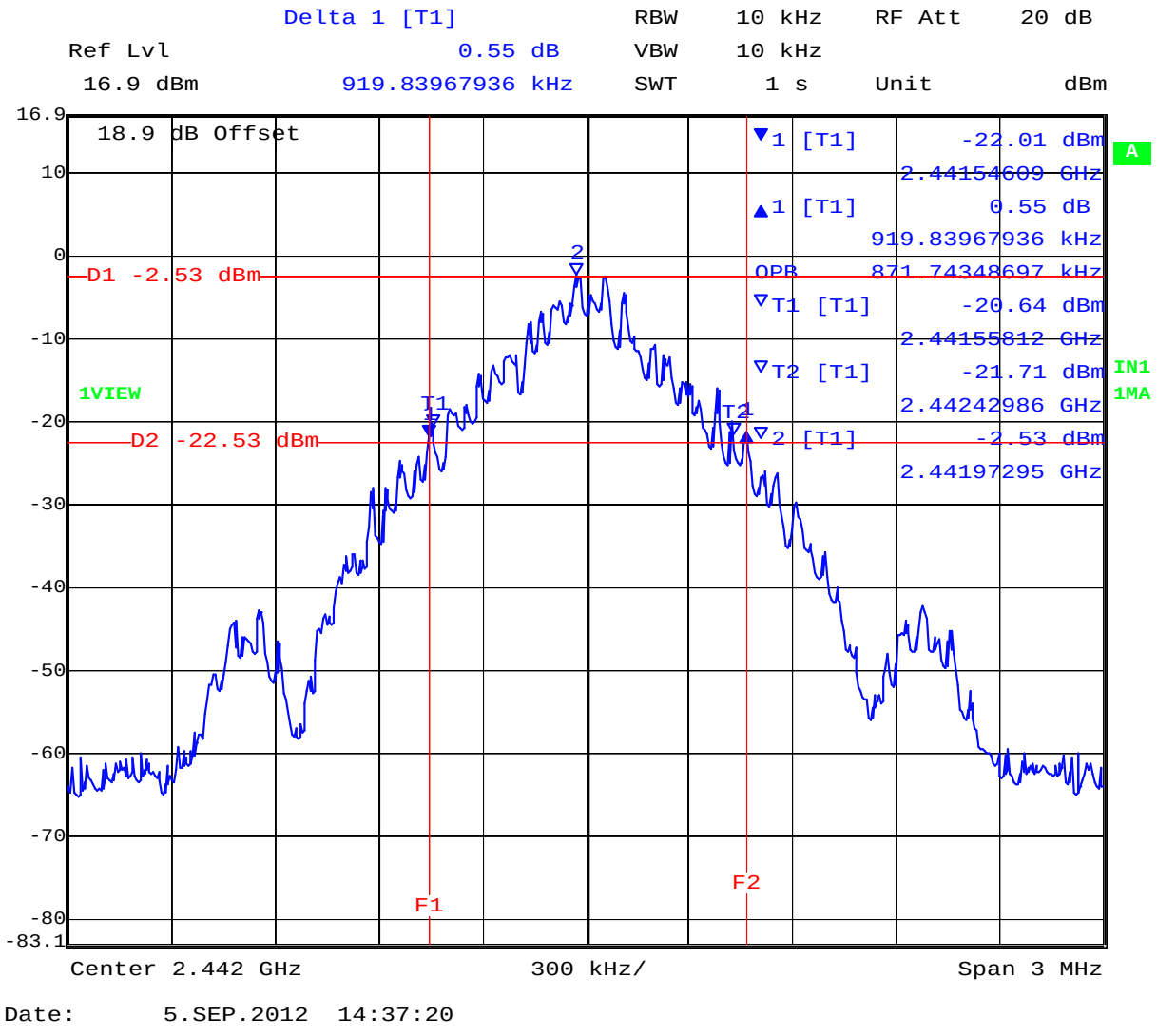
TABLE OF RESULTS

Channel #	Center Frequency (MHz)	20 dB Bandwidth (MHz)	Specification (MHz)
0	2402	0.914	<0.5
40	2442	0.920	
79	2480	0.914	

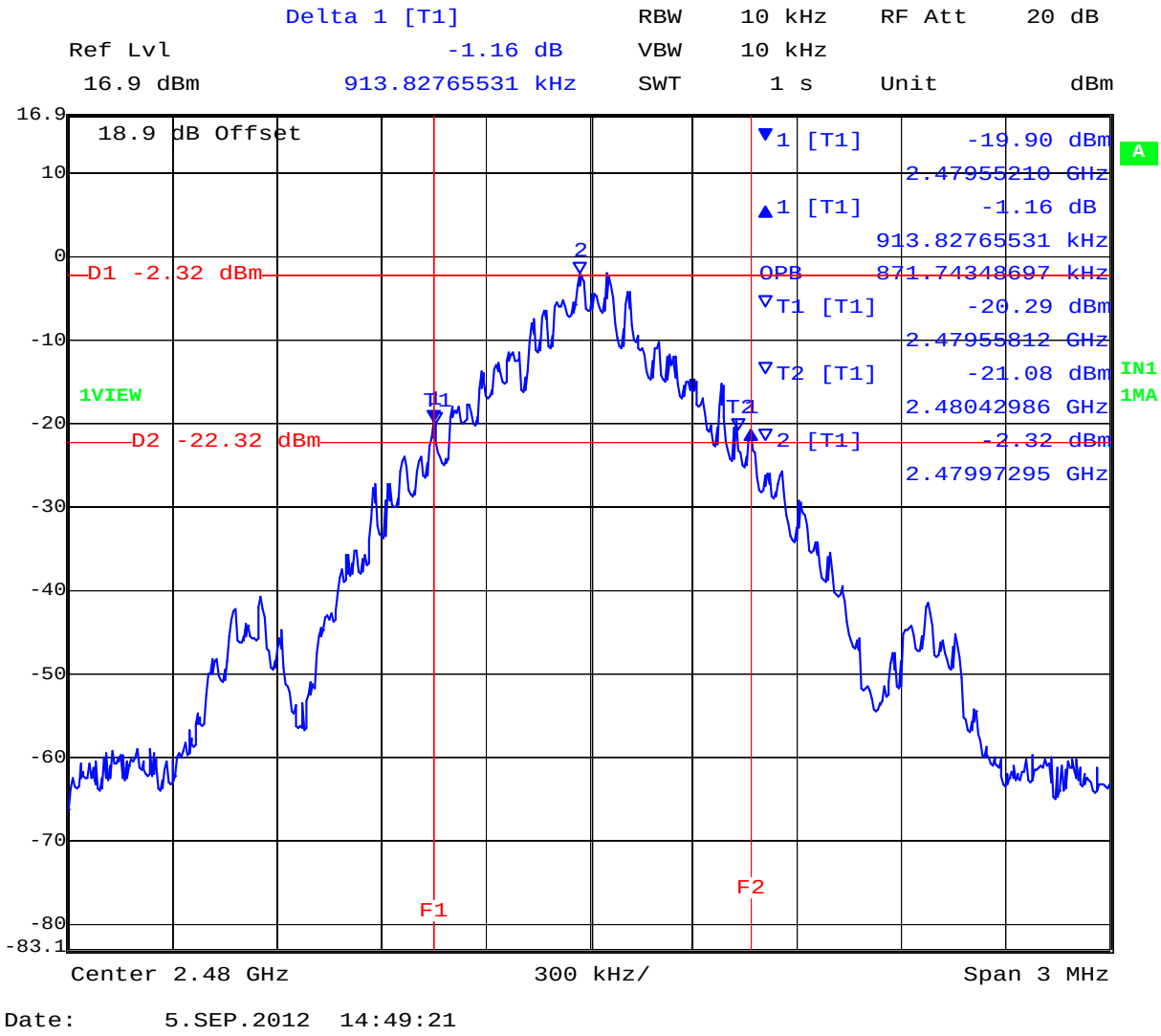
CH 0 2,402 MHz 20 dB Bandwidth



CH 33 2,442 MHz 20 dB Bandwidth



CH 63 2,480 MHz 20 dB Bandwidth



Specification

Limits

FCC §15.247 (a)(1)
Industry Canada RSS-210 §8.1

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(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.

(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.

Laboratory Measurement Uncertainty for Spectrum Measurement

Measurement uncertainty	±2.81 dB

Traceability

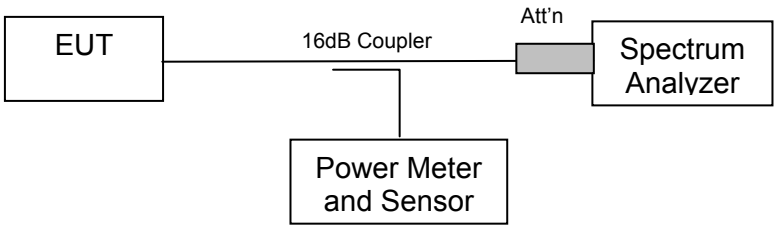
Method	Test Equipment Used
Measurements were made per work instruction WI-03 ‘Measurement of RF Spectrum Mask’	0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117

6.1.1.2. Peak Output Power

FCC, Part 15 Subpart C §15.247(b)(2)
Industry Canada RSS-210 §A8.4

Test Procedure
The transmitter terminal of EUT was set for the channel of interest and connected to the input of the power meter which was calibrated to measure power. The value of measured power including antenna cable loss was reported.

Test Measurement Set up



Measurement set up for Transmitter Output Power

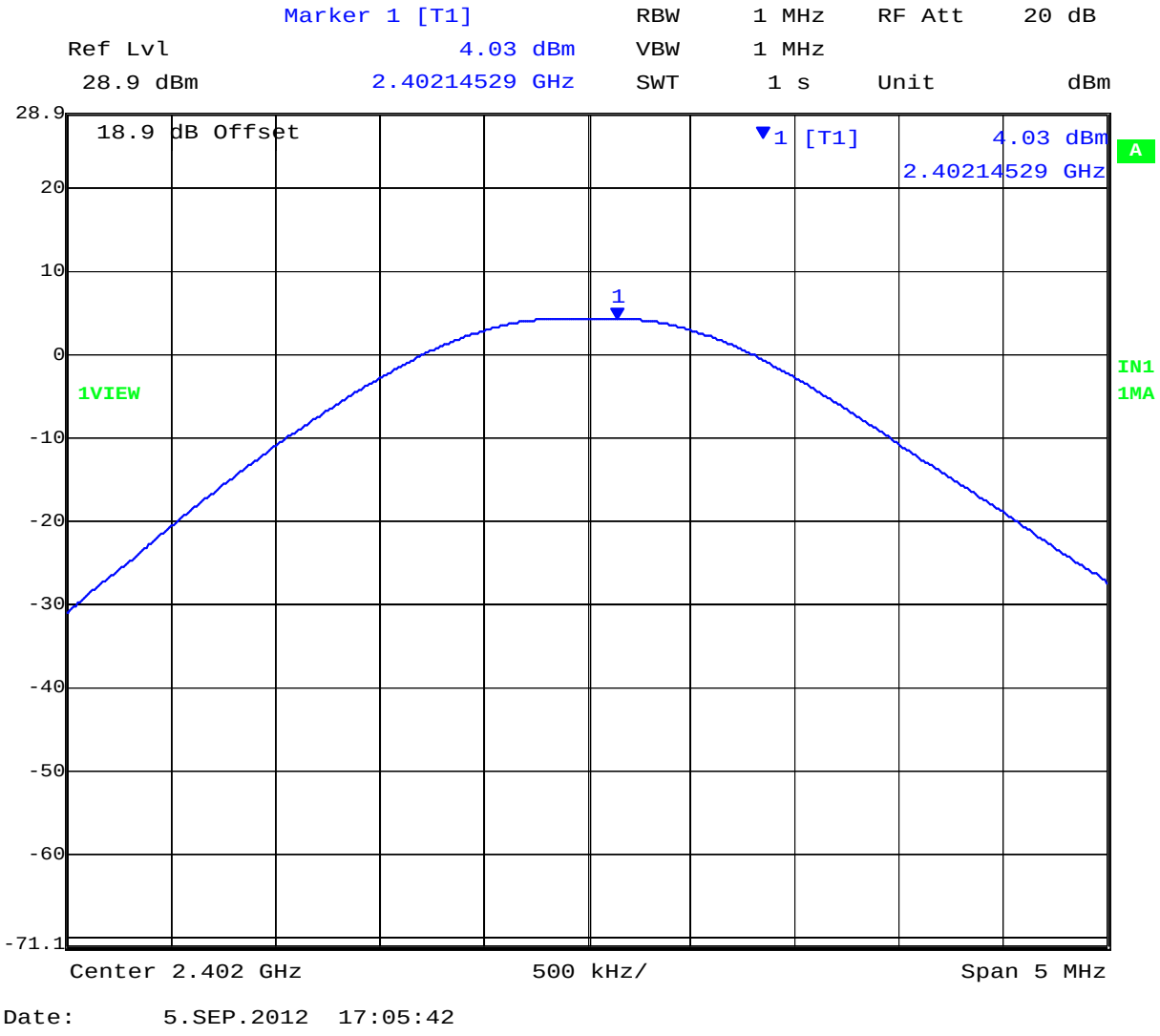
Measurement Results for Peak Output Power

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

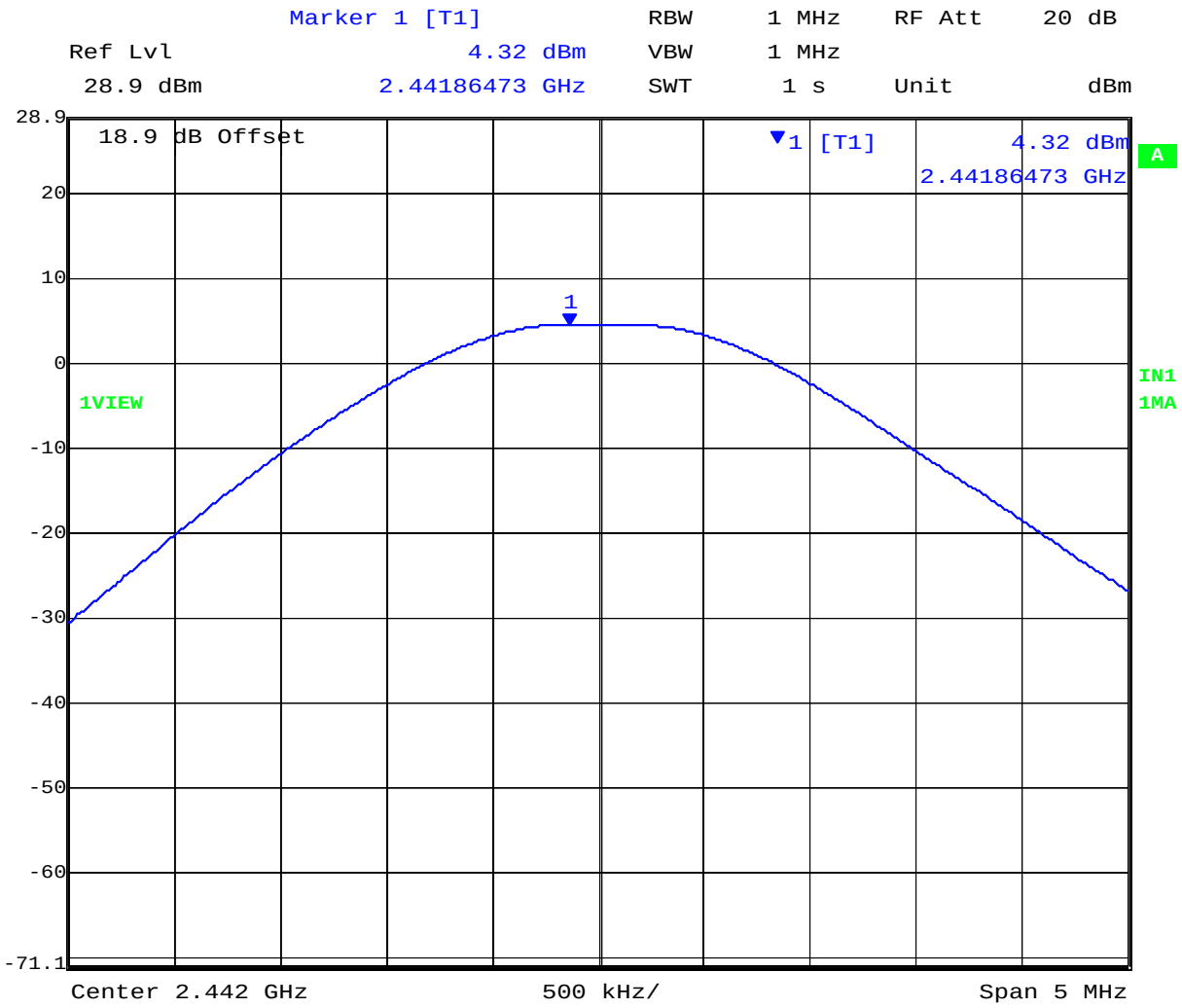
TABLE OF RESULTS

Channel #	Center Frequency (MHz)	Power (dBm)
0	2,402	+4.03
33	2,442	+4.32
63	2,480	+4.51

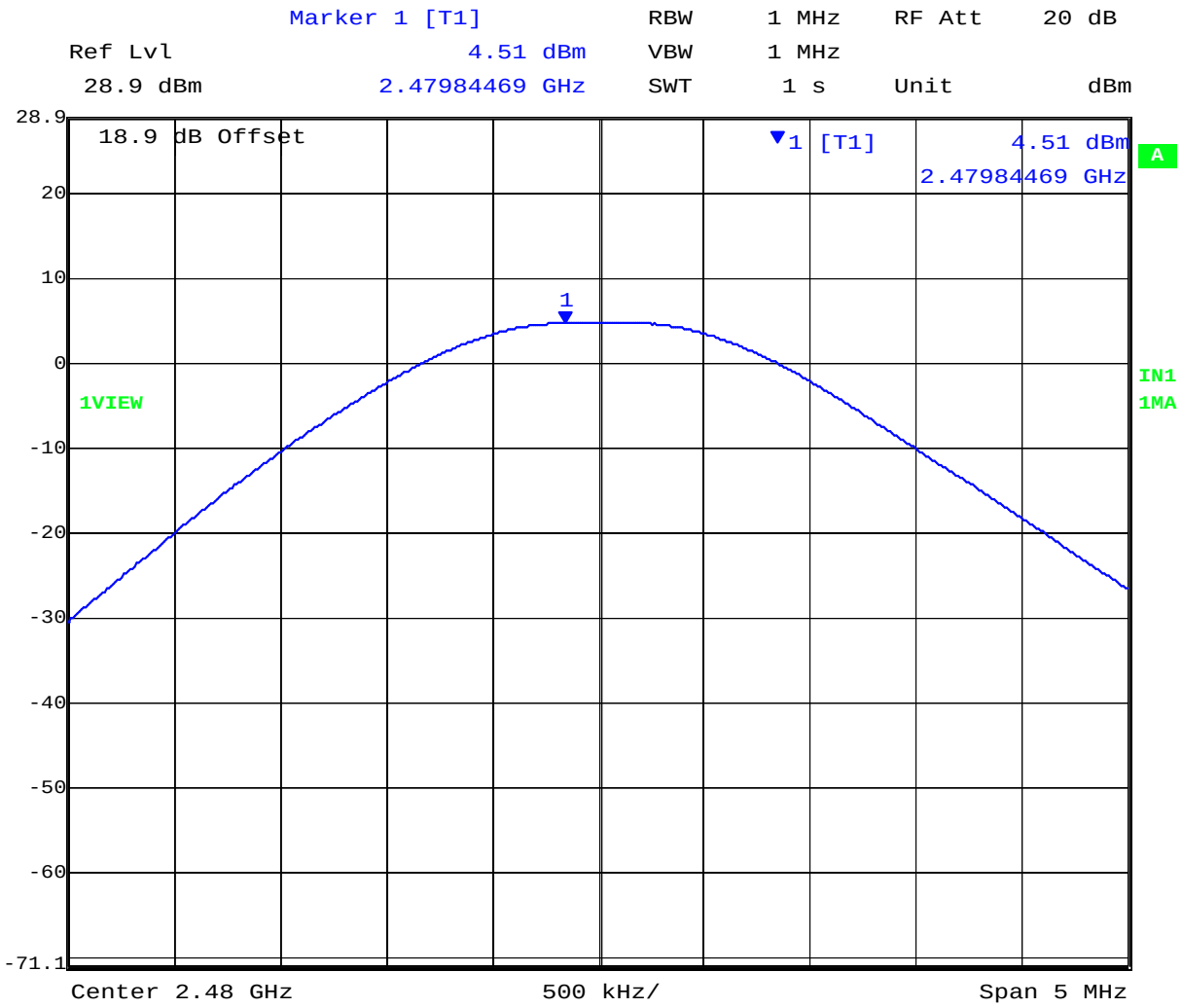
2,402 MHz Peak Output Power



2,442 MHz Peak Output Power



2,480 MHz Peak Output Power



Specification

Limits

FCC Part 15 Subpart C §15.247 (b)(1)

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
(1) For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Industry Canada RSS-210 §A8.4 (2)

For frequency hopping systems operating in the band 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. Except as provided in Section A8.4 (5), the e.i.r.p. shall not exceed 4 W.

Frequency hopping systems operating in the band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W.

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

Traceability

Method	Test Equipment Used
FCC DA 00-705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

6.1.1.3. Carrier Frequency Separation

Test Procedure

The EUT must have its hopping function enabled.

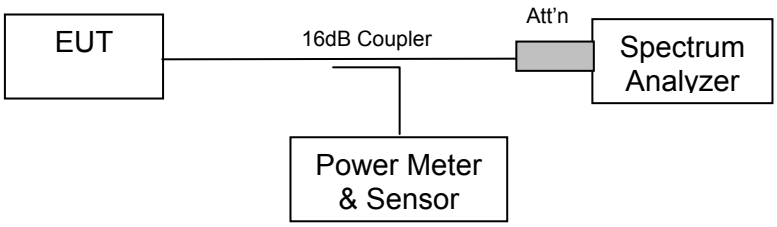
The following spectrum analyzer settings were used:

Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≥ 1 % of the span
Video (or Average) Bandwidth (VBW) ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Carrier Frequency Separation Limits

FCC §15.247 (a)(1)

(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.

Industry Canada RSS-210 §A8.1 (b)

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 band 2400-2483.5 MHz 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 that the systems operate with an output power no greater than 0.125 W. 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.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB

Traceability

Method	Test Equipment Used
FCC DA 00-705	0078, 0134, 0158, 0184, 0193, 0287, 0250, 0252 0310, 0312.

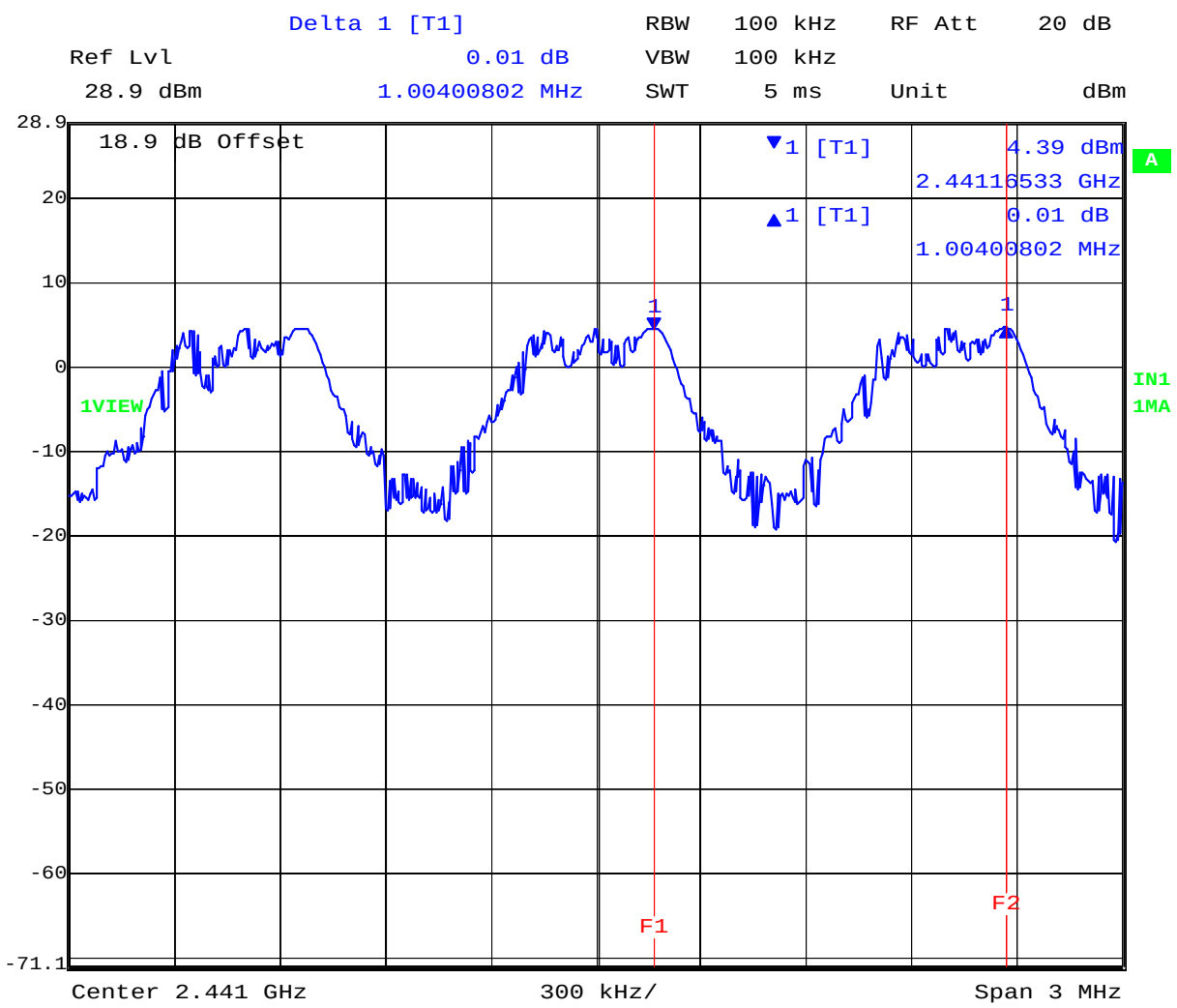
Test Results for Carrier Frequency Separation

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Channel Spacing (MHz)	Maximum 20 dB Bandwidth (MHz)	Specification	Results
1.004	0.920	Greater than 2/3 of the 20 dB Bandwidth	PASS

Carrier Frequency Separation; Hopping On = 1.004 MHz



6.1.1.4. Number of Hopping Frequencies

Test Procedure

The EUT must have its hopping function enabled.

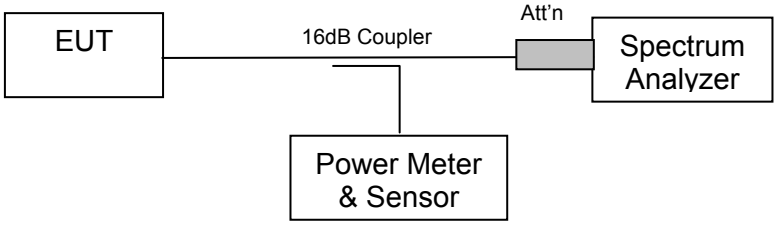
The following spectrum analyzer settings were used:

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

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Number of Hopping Frequencies Limits

FCC §15.247 (a)(1)(iii)

(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.

Industry Canada RSS-210 §A8.1 (d)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0078, 0134, 0158, 0184, 0193, 0287, 0250, 0252 0310, 0312.

Test Results for Number of Hopping Frequencies

Ambient conditions.

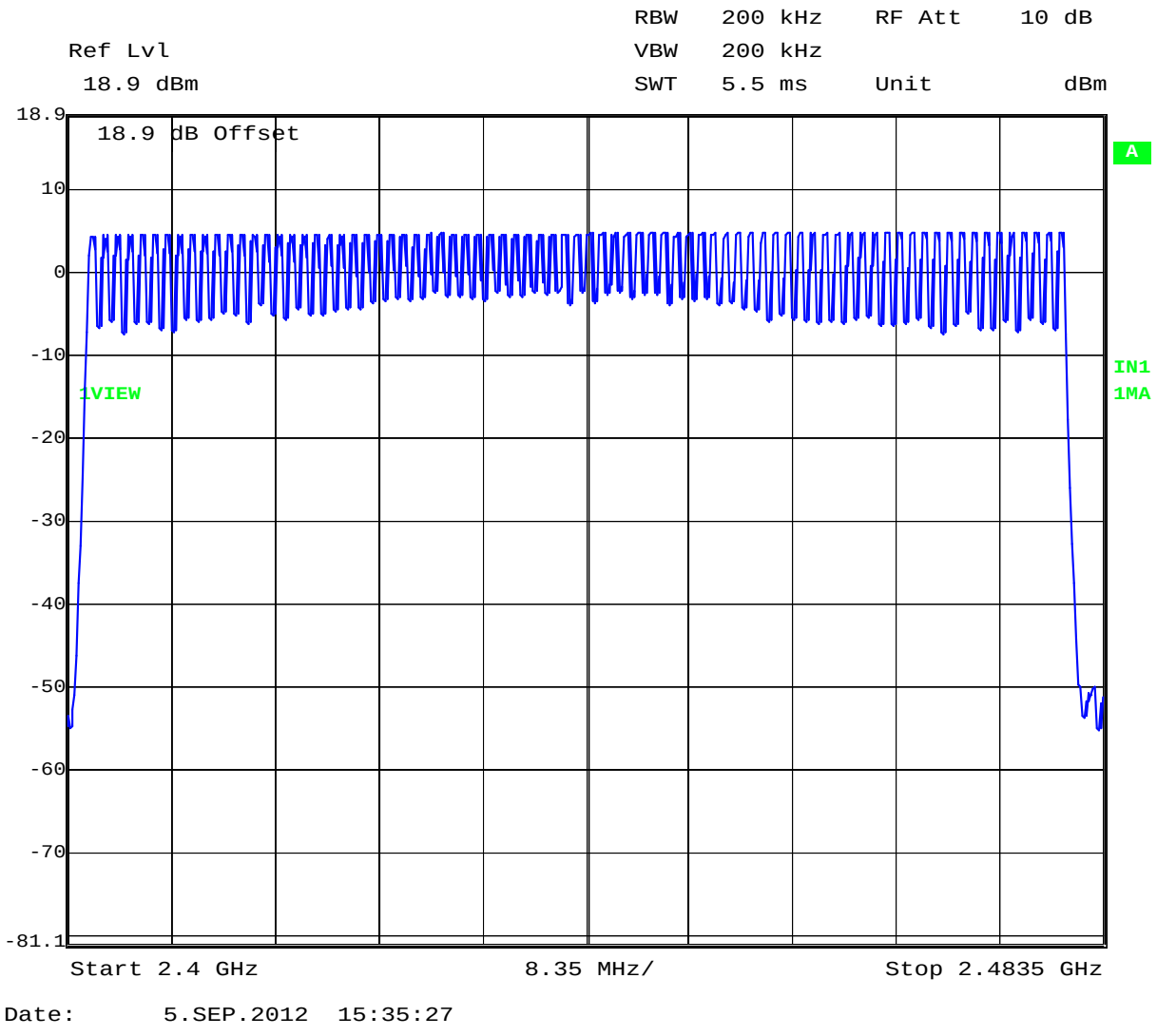
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Number of Channels	Specification
79	1 Watt Output Power - Minimum 75 hopping channels 0.125 Watt Output Power - Minimum of 15 hopping channels

There is also a provision for avoiding interference in the band by hopping around channels being interfered with (Adaptive Frequency Hopping). There will always be at least 20 channels in the list of hopping channels.

EUT operates at a peak output power less than 0.125 Watts.

Number of Hopping Frequencies; Hopping On; 2400-2480 MHz



6.1.1.5. Time of Occupancy (Dwell Time)

Test Procedure

The EUT must have its hopping function enabled.

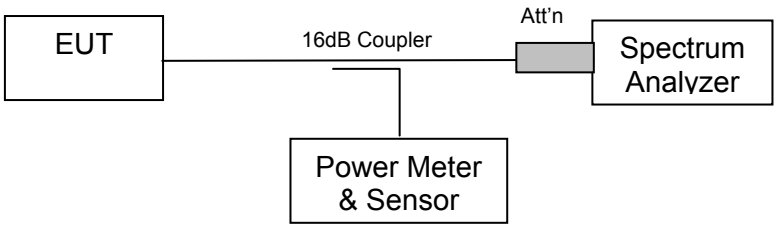
The following spectrum analyzer settings were used:

Span = zero span, centered on a hopping channel
RBW = 1MHz
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector function = 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., data 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.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Time of Occupancy (Dwell Time) Limits

FCC §15.247 (a)(1)(iii)

(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.

Industry Canada RSS-210 §A8.1 (d)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0078, 0134, 0158, 0184, 0193, 0287, 0250, 0252 0310, 0312.

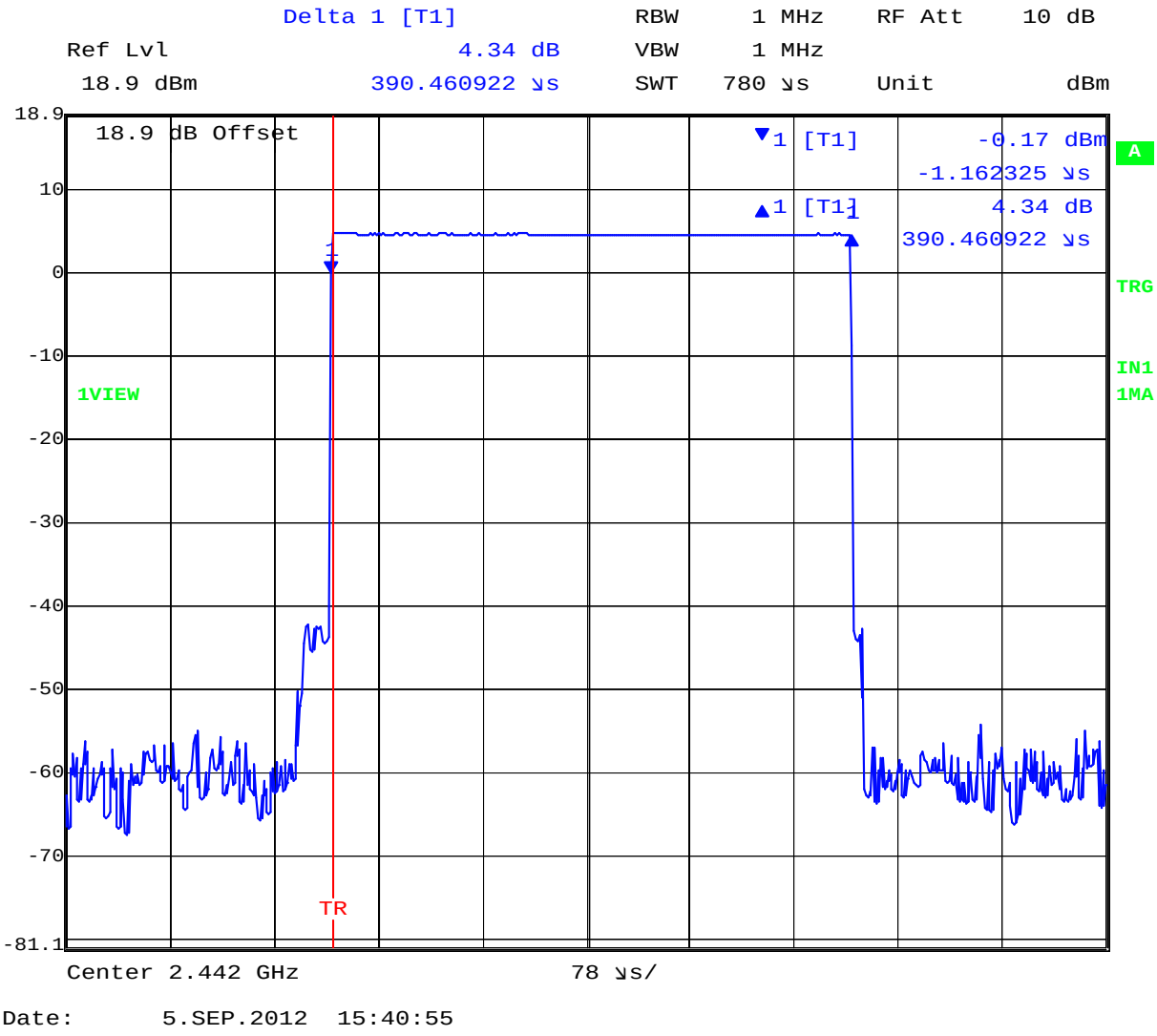
Test Results for Time of Occupancy (Dwell Time)

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Centered on Channel	Center Frequency (MHz)	Channel Dwell Time (single channel) (µs)
40	2442	390.5

Time of Occupancy; Hopping On; 2442 MHz; 390.5 µs



6.1.1.6. Channel Occupancy

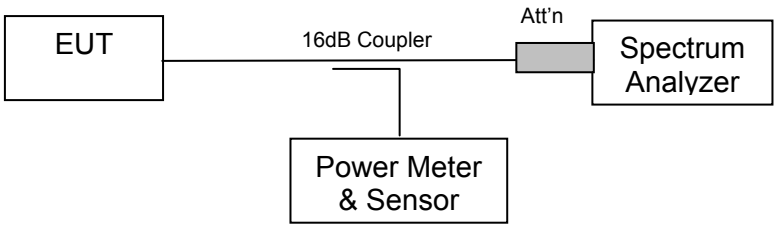
Test Procedure

The EUT must have its hopping function enabled.

The following spectrum analyzer settings were used:

Span = zero span, centered on a hopping channel
RBW = 1MHz (or appropriate RBW to distinguish center channel from adjacent channels)
VBW ≥ RBW
Sweep = Dwell time x Number of Hopping Frequencies
Detector function = peak
Trace = max hold

Test Setup



Specification for Number of Channels and Channel Occupancy Limits

FCC §15.247 (a)(1)(iii)

(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.

Industry Canada RSS-210 §A8.1 (d)

Frequency hopping systems operating in the band 2400-2483.5 MHz shall use at least 15 hopping 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. Transmissions on particular hopping frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0078, 0134, 0158, 0184, 0193, 0287, 0250, 0252 0310, 0312.

Test Results for Channel Occupancy

Ambient conditions.

Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

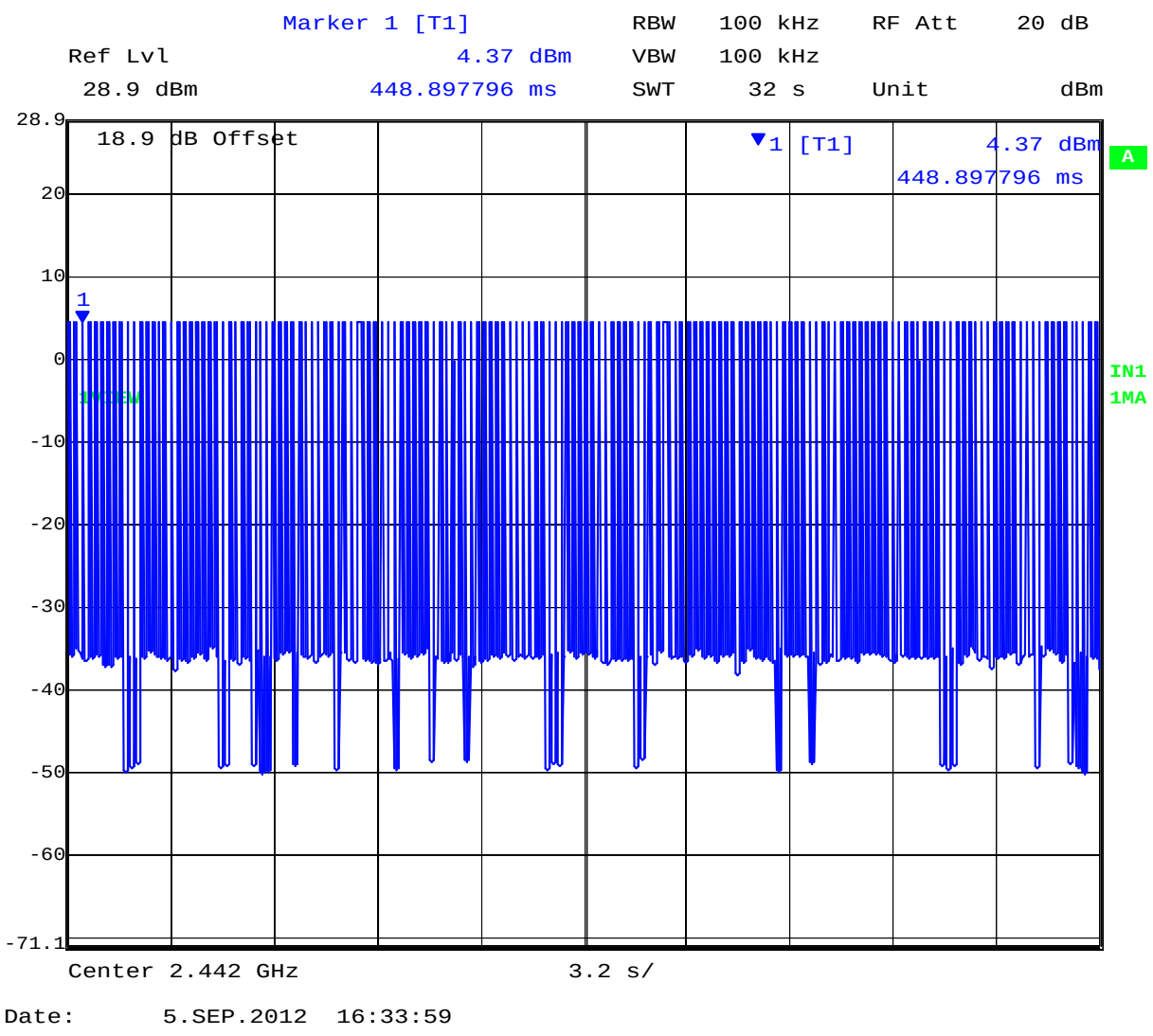
Channel #	Center Frequency (MHz)	Channel Dwell Time (single channel) (µs)	Number of Hops	Channel Occupancy (ms)	Limit (ms)	Result
40	2442	390.5	316	123.398	400	PASS

Channel occupancy was performed using a sweep time of 32 seconds (79 x 0.4 = 31.6 seconds) and the data rate with the highest dwell time.

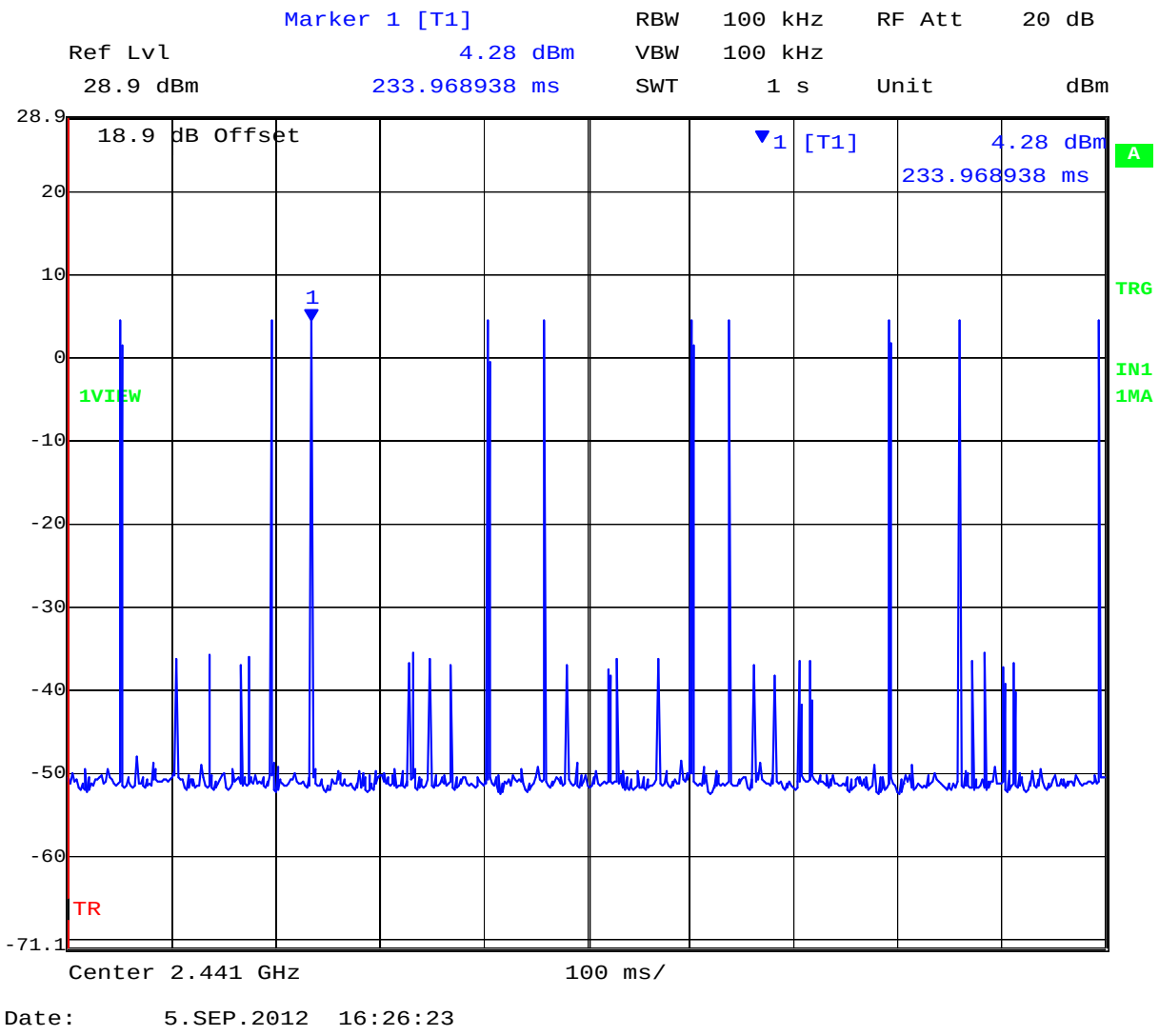
Sweep time of 1 second to verify the number of time the transmitter occupied Channel 40 (2442 MHz). Each data rate transmitted on Channel 40 a total of 10 times per second.

Number of hops = 10 hops per sec x 31.6 seconds = 316 hops

Channel Occupancy; 2442 MHz Channel 40; Sweep Time 32 s



Channel Occupancy; 2441 MHz Channel 39; Sweep Time 1 s



6.1.1.7. Band-Edge Compliance of RF Conducted Emissions

Test Procedure

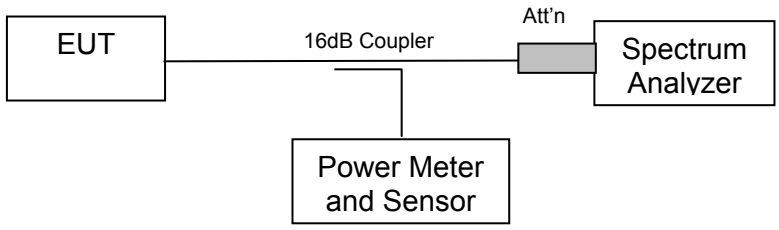
The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section. Submit this plot.

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit. Submit this plot.

Test Setup



Specification for Band-edge Limits

FCC Part 15 Subpart C §15.247(d)

(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)).

Industry Canada RSS-210 §A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

RSS-GEN 6.2

If the receiver has a detachable antenna of known impedance, antenna conducted spurious emissions measurement is permitted as an alternative to radiated measurement. However, the radiated method of Section 6.1 is recommended:

The antenna conducted test shall be performed with the antenna disconnected and the receiver antenna terminals connected to a measuring instrument having equal impedance to that specified for the antenna

The receiver spurious emissions measured at the antenna terminals by the antenna conducted method shall then comply with the following limits:

Receiver spurious emissions at any discrete frequency shall not exceed 2 nanowatts in the band 30-1000 MHz, and 5 nanowatts above 1000 MHz.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

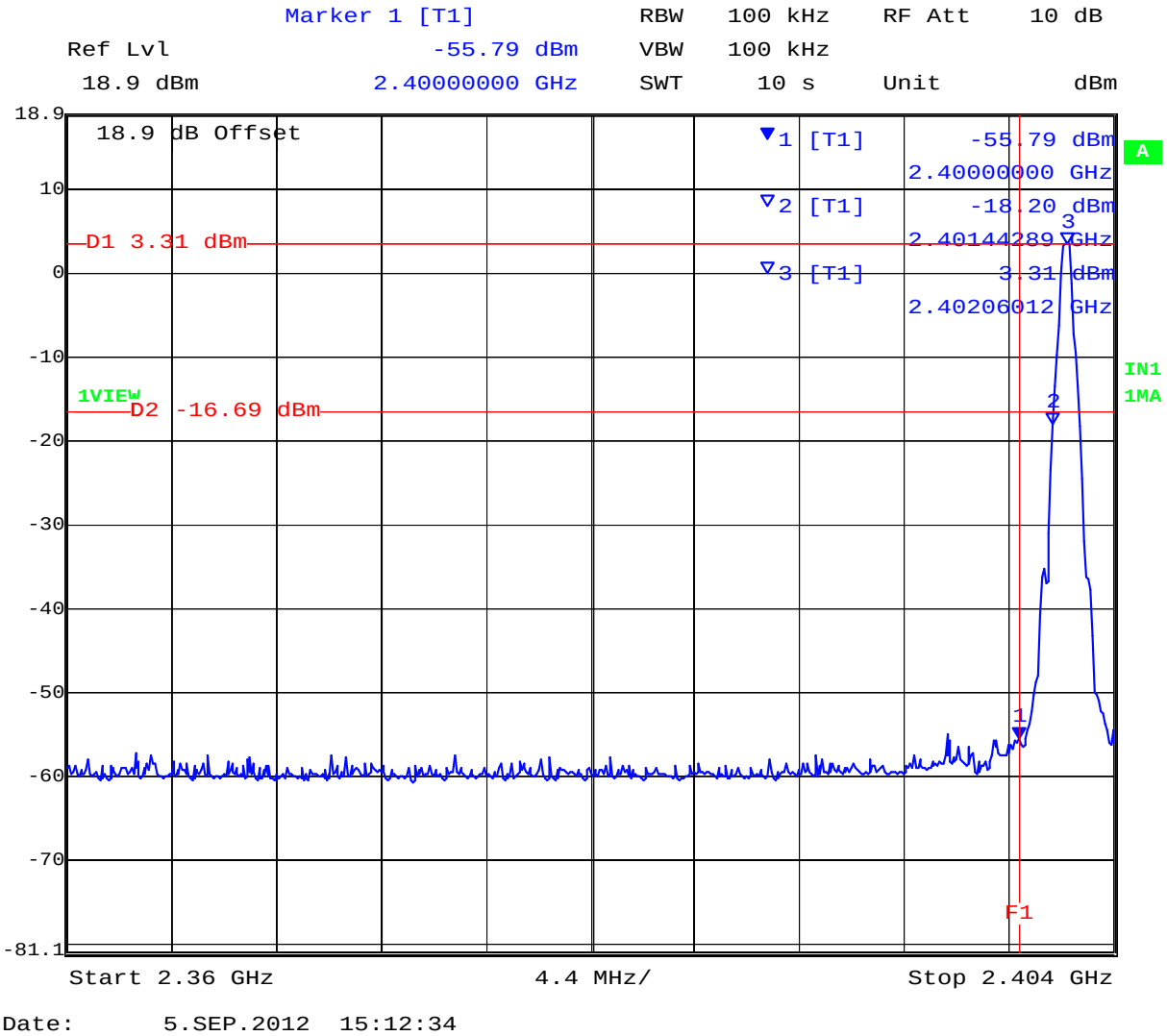
Traceability

Method	**Test Equipment Used**
FCC DA 00-705	0287, 0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117.

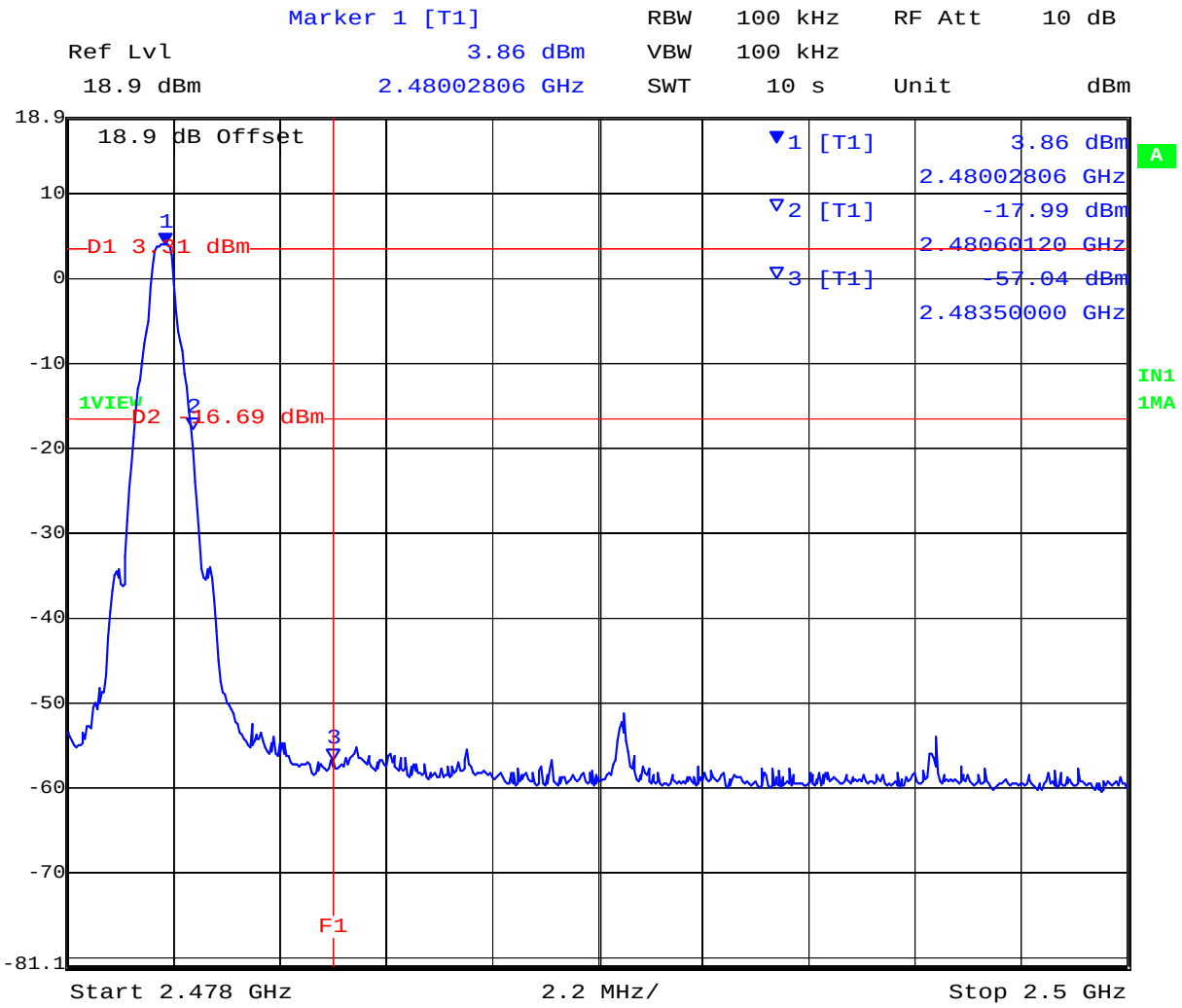
Test Results for Band-edge Compliance of RF Conducted Emissions

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Lower Band-edge; Channel 0 - 2402 MHz



Upper Band-edge; Channel 78 - 2480 MHz



6.1.1.8. Spurious RF Conducted Emissions - Transmitter

Test Procedure

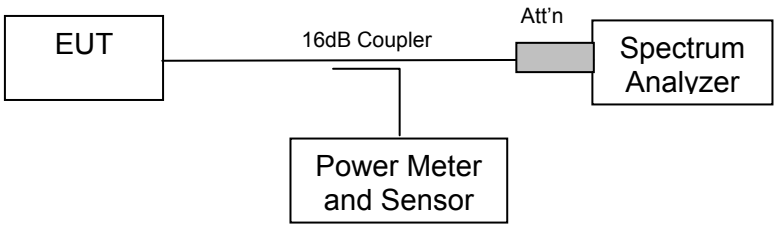
The following spectrum analyzer settings were used:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the
10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section. Submit these plots.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Test Setup



Specification for Spurious RF Conducted Emissions

FCC Part 15 Subpart C §15.247(d)

(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)).

Industry Canada RSS-210 §A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section A8.4 (4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Laboratory Measurement Uncertainty

Measurement Uncertainty (Spectrum/Amplitude)	±2.81 dB
Measurement Uncertainty (Frequency)	±0.86 ppm

Traceability

Method	Test Equipment Used
FCC DA 00-705	0287, 0158, 0193, 0252, 0313, 0314, 0070, 0116, 0117.

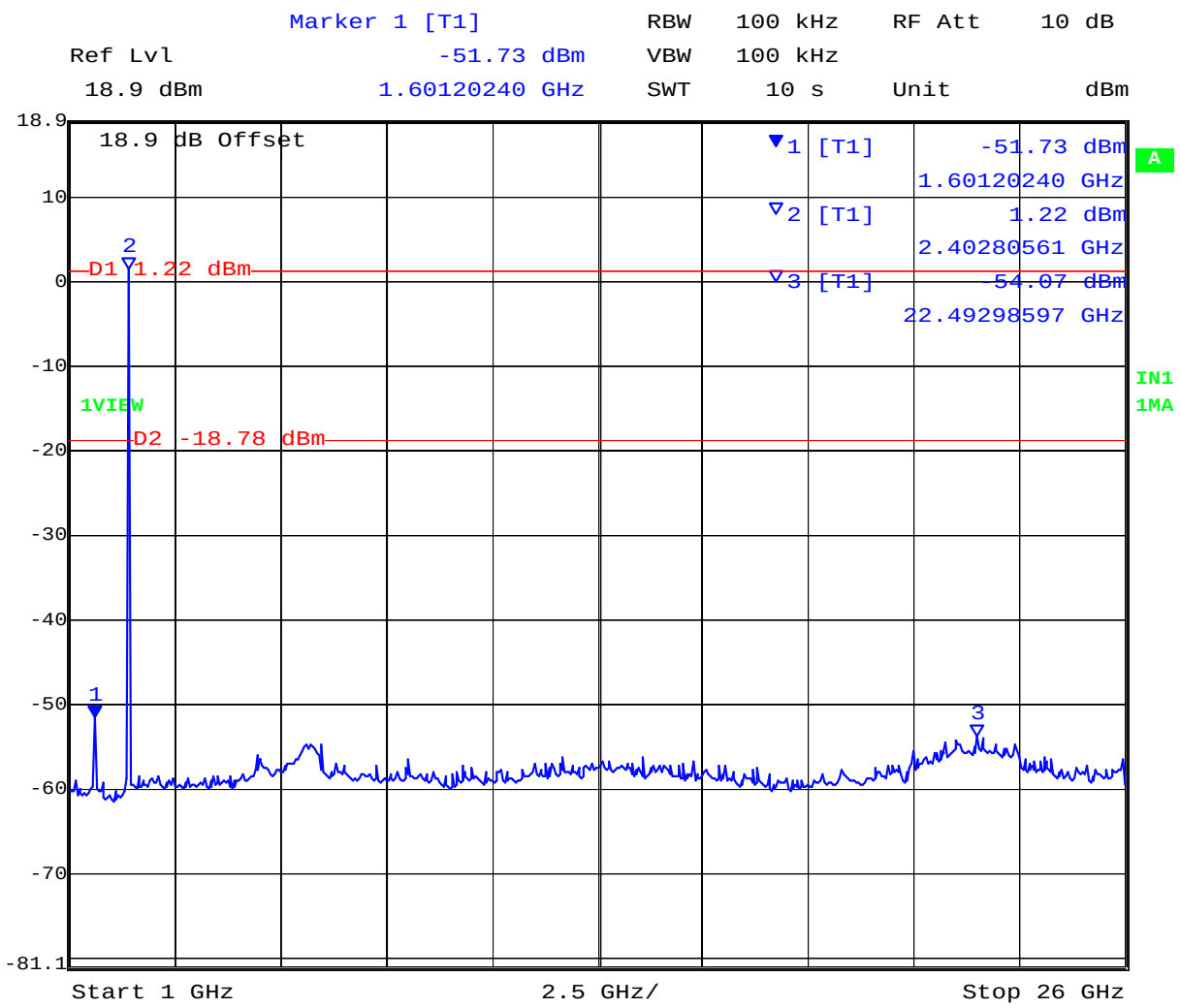
Test Results for Spurious RF Conducted Emissions

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

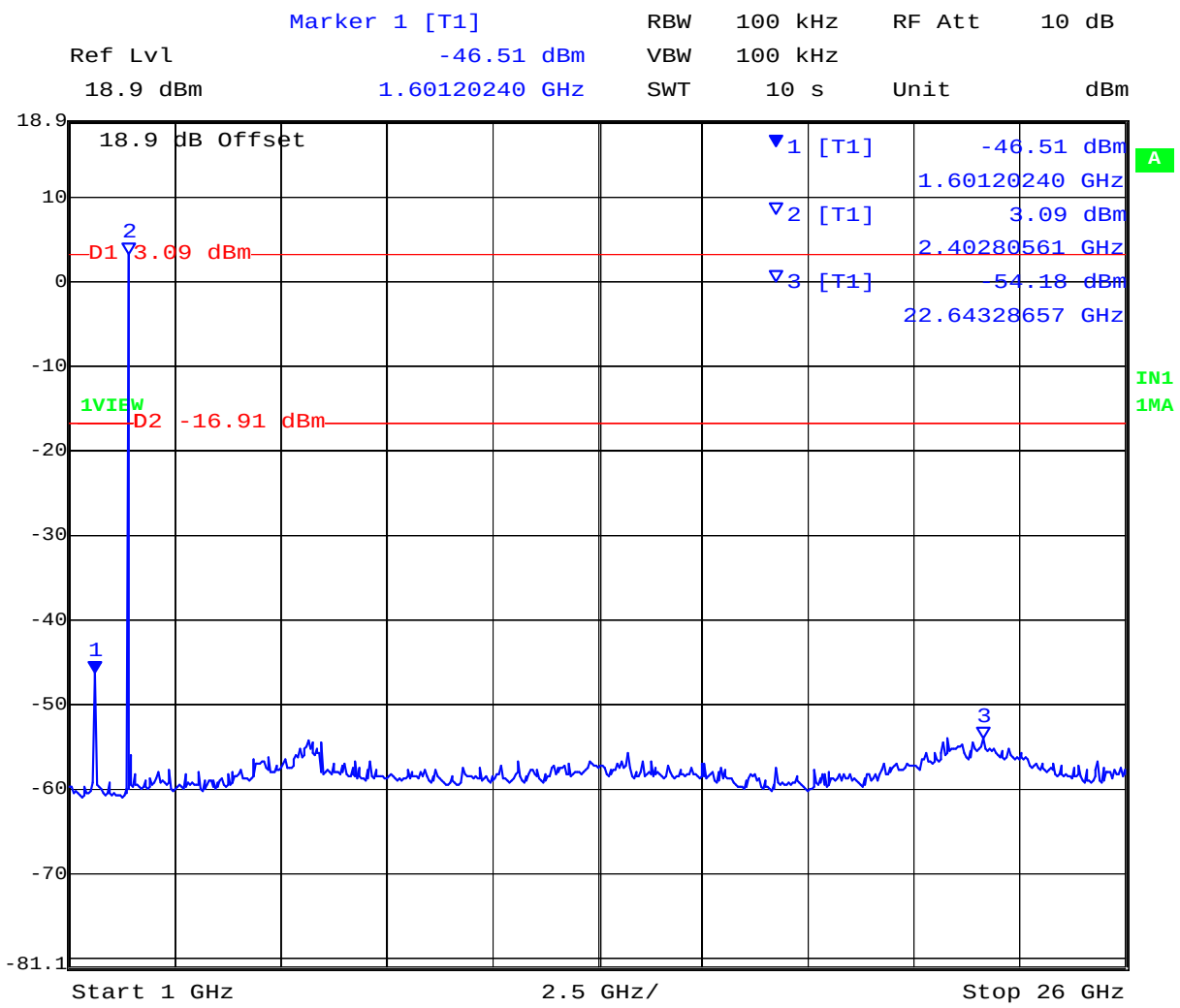
Conducted spurious emissions (30 MHz - 10 GHz) are provided below. The maximum emissions observed are indicated in the table below.

Channel Centre Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Maximum Emission Observed (dBm)	Limit (dBm)	Margin (dB)
2402	30	26000	-51.73	-18.78	-32.95
2442	30	26000	-46.51	-16.91	-29.60
2480	30	26000	-47.72	-16.91	-30.81

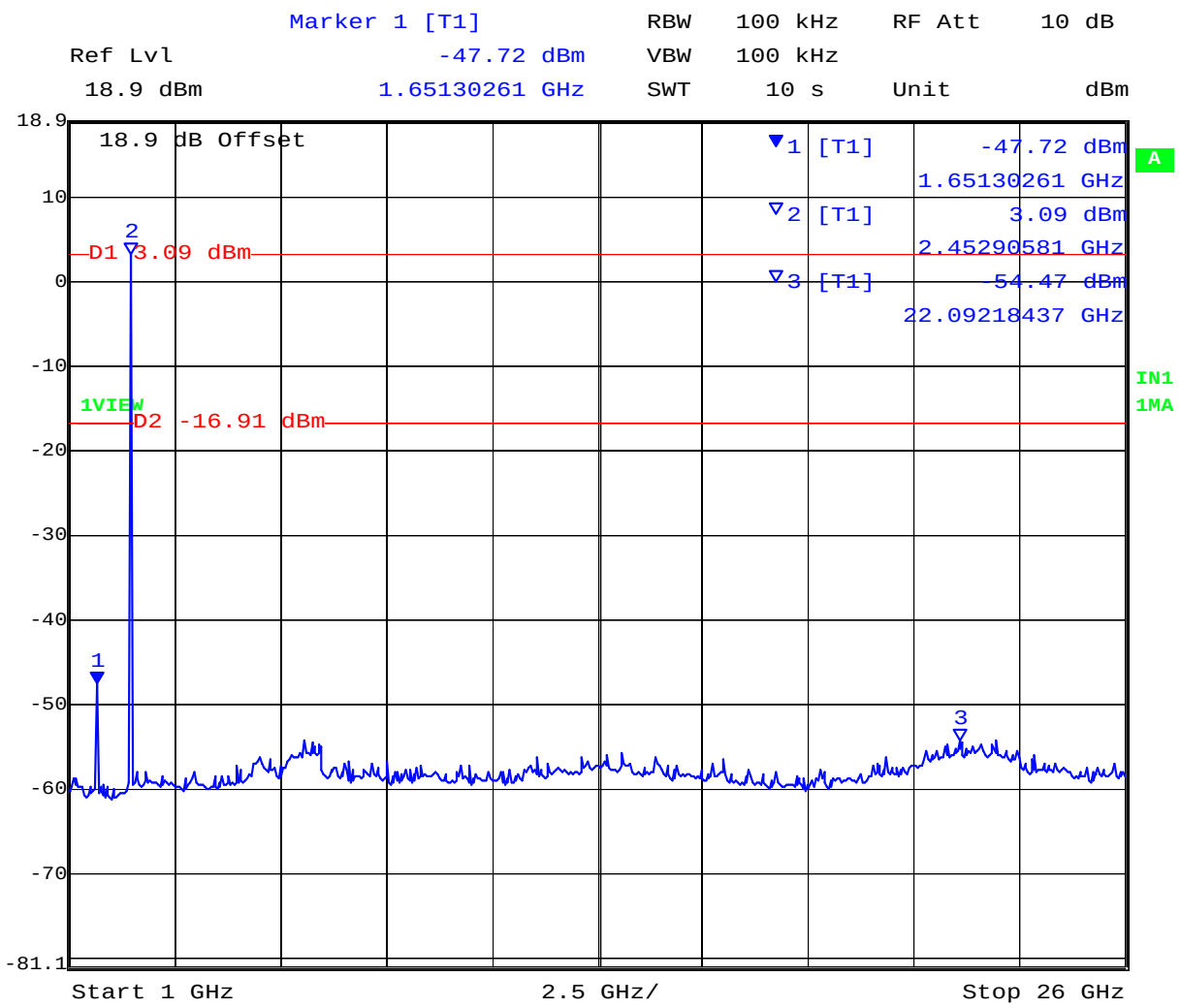
Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 0



Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 40



Spurious RF Conducted Emissions; 30 MHz-26000 MHz; Tx SPR; Channel 78



6.1.1.9. Pseudorandom Frequency Hopping Sequence

Description

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

The hopping sequence is selected according to the Bluetooth standard. There are a total of 79 channels available in the 2.4 GHz band. The standard defines an algorithmic basis for determining the pseudorandom sequence to use. There is also a provision for avoiding interference in the band by hopping around channels being interfered with (Adaptive Frequency Hopping). There will always be at least 20 channels in the list of hopping channels.

6.1.1.10.Equal Hopping Frequency Use

Description

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 the final channel used in the previous transmission event).

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

Bluetooth uses a packet based air interface with a fixed timing. Each packet goes out on a different channel in the sequence, so all frequencies in the hopping sequence get used equally.

6.1.1.11.System Receiver Input Bandwidth

Description

Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

The Texas Instruments TI WL1271 chip set is used in the design complies with Bluetooth specifications. There are no external channel filters present, but filters are present in the chipset design in order to achieve the receiver sensitivity.

6.1.1.12.System Receiver Hopping Capability

Description

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

Reference: FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Declaration from the Manufacturer

A slave device follows the master device's hopping sequence by scanning quickly through channels to find the master's transmission (this is called discovery). It then uses information in that packet and the same algorithmic process described in the standard to determine what the hopping sequence is that the master is using. The slave also synchronizes to the master's transmit packet timing so it knows when to hop.

6.1.2. Radiated Emission Testing

Transmitter Radiated Spurious Emissions (above 1 GHz); Peak Field Strength Measurements; and Radiated Band Edge Measurements – Restricted Bands

FCC, Part 15 Subpart C §15.247(d) 15.205; 15.209
Industry Canada RSS-210 §A8.5, §2.2, §2.6
Industry Canada RSS-Gen §4.7

Test Procedure

Radiated emissions above 1 GHz are measured in the anechoic chamber at a 3-meter distance on every azimuth in both horizontal and vertical polarities. The emissions are recorded and maximized as a function of azimuth by rotation through 360° with a spectrum analyzer in peak hold mode. Depending on the frequency band spanned a notch filter and waveguide filter was used to remove the fundamental frequency. The highest emissions relative to the limit are listed for each frequency spanned.

All measurements on any frequency or frequencies over 1 MHz are based on the use of measurement instrumentation employing an average detector function. All measurements above 1 GHz were performed using a minimum resolution bandwidth of 1 MHz.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

FS = R + AF + CORR - FO

where: FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

For example:
Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

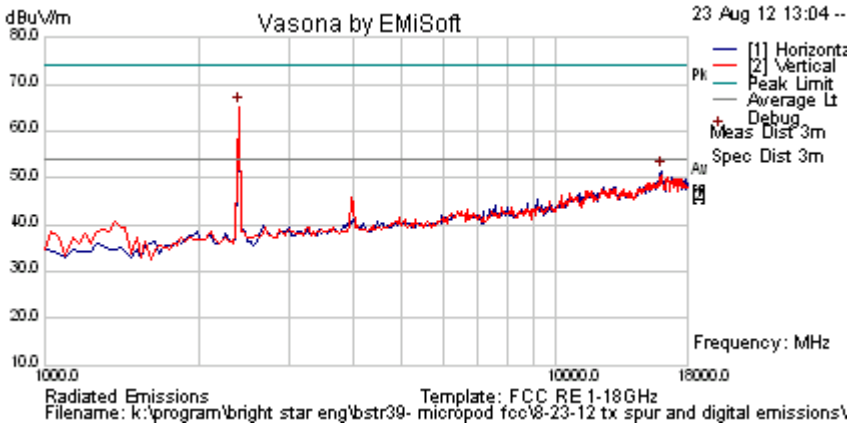
Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

6.1.2.1. Transmitter Radiated Spurious Emissions (>1 GHz)

The EUT was evaluated to determine orientation where maximum emissions were observed (i.e. horizontal or vertical). The EUT was positioned vertically on the test table during radiated emissions testing and was tested with the receive antenna positioned both horizontally and vertically such that testing was performed in three orthogonal axis.

Test Freq.	2402 MHz	**Engineer**	JMH
Variant	Bluetooth	**Temp (ºC)**	27
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	33
Power Setting	Maximum	**Press. (mBars)**	998
Antenna	Integral	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

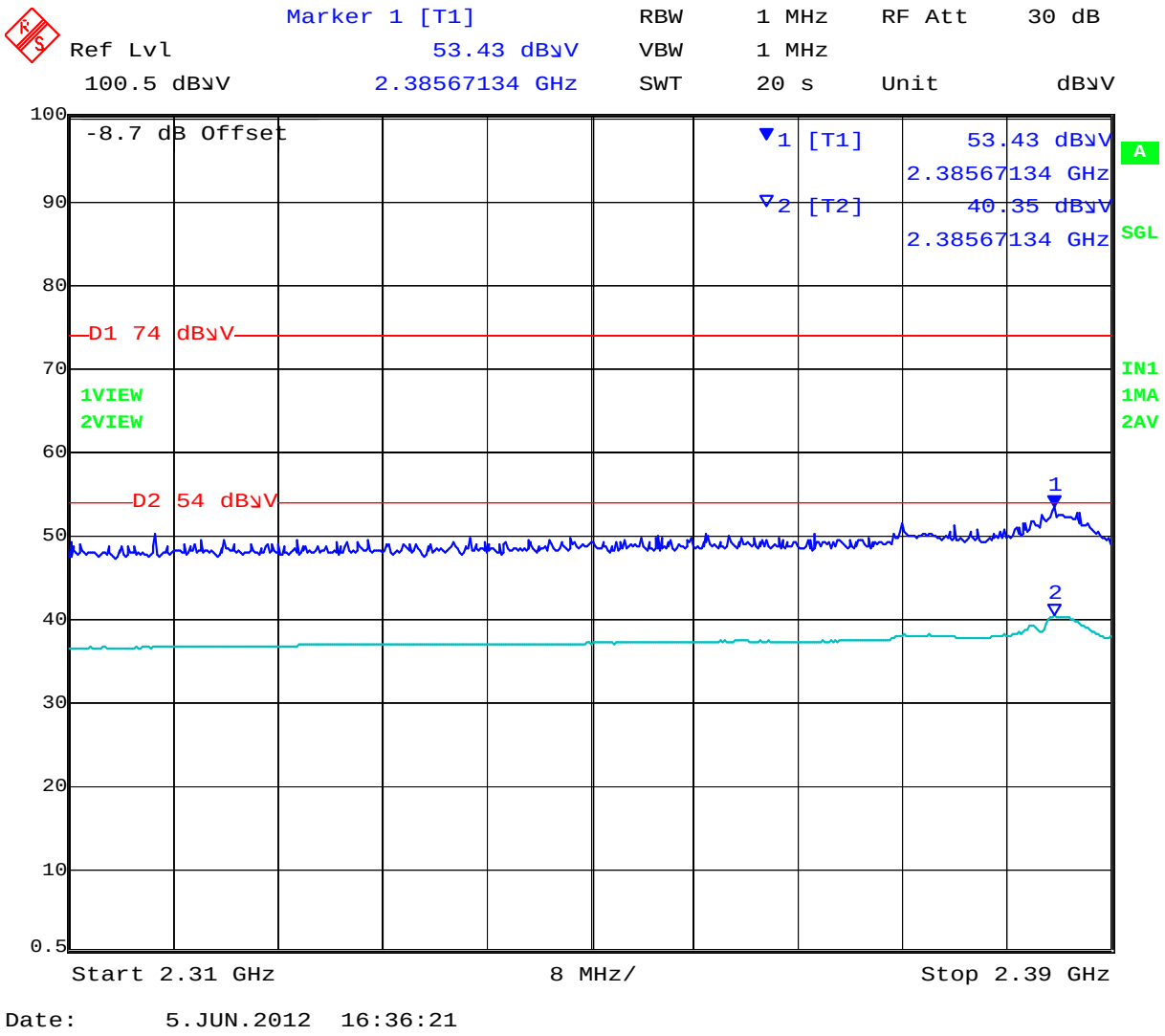


Formally measured emission peaks

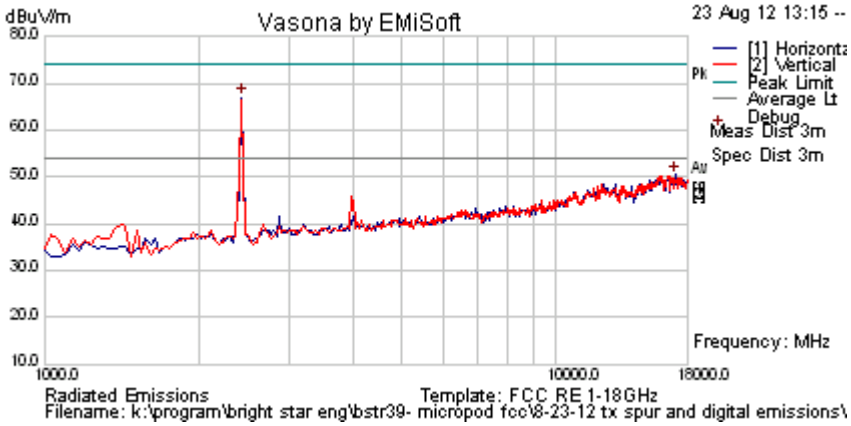
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2396.794	73.9	3.0	-11.7	65.2	Peak [Scan]	V	150					Fund
15989.98	42.3	9.0	0.1	51.5	Peak [Scan]	H	200	0	54.0	-2.5	Pass	Noise

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Band-Edge Channel 2402 MHz



Test Freq.	2442 MHz	**Engineer**	JMH
Variant	Bluetooth	**Temp (ºC)**	27
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	33
Power Setting	Maximum	**Press. (mBars)**	998
Antenna	Integral	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

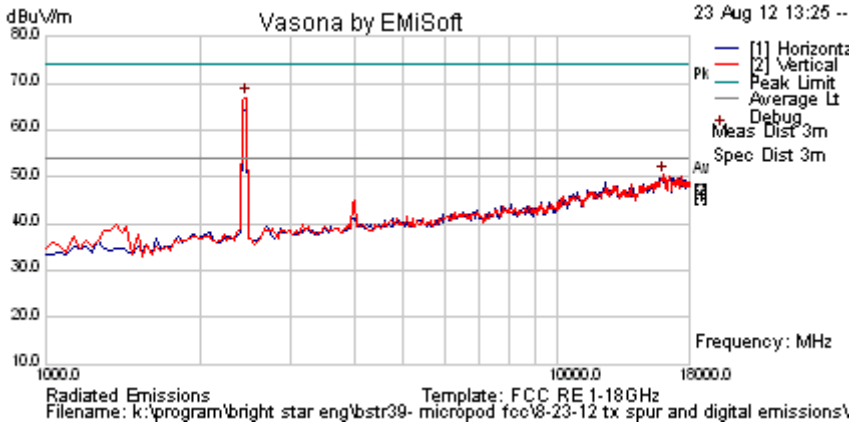


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2430.862	75.5	3.0	-11.6	66.9	Peak [Scan]	H	150					Fund
17114.228	41.5	8.5	0.5	50.4	Peak [Scan]	H	150	0	54.0	-3.6	Pass	Noise

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Test Freq.	2480 MHz	**Engineer**	JMH
Variant	Bluetooth	**Temp (ºC)**	27
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	33
Power Setting	Maximum	**Press. (mBars)**	998
Antenna	Integral	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

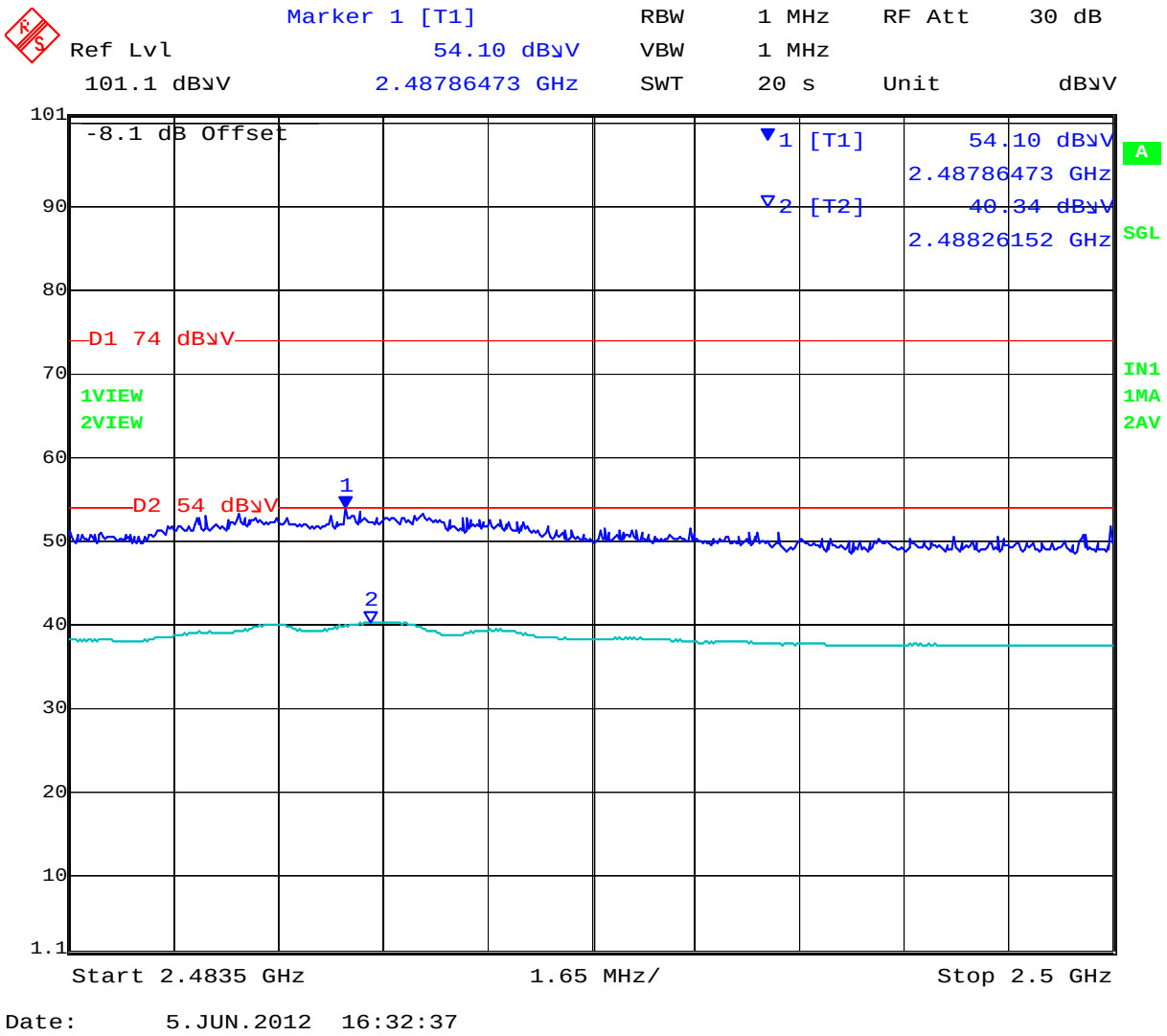


Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2464.930	75.4	3.0	-11.5	66.9	Peak [Scan]	V	150					Fund
15989.98	41.4	9.0	0.1	50.5	Peak [Scan]	V	200	0	54.0	-3.5	Pass	Noise

Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Band-Edge Channel 2480 MHz



Specification Limits

FCC §15.247(d) and RSS-210 §A8.5 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 radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

FCC §15.247(d)
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 §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section §15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(a)).

IC RSS-210 §A8.5 If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under section A8.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Tables 2 and 3 is not required. In addition, radiated emissions which fall in the restricted bands of Table 1 must also comply with the radiated emission limits specified in Tables 2 and 3.

IC RSS-Gen §4.7
The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate of carrier frequency), or from 30 MHz , whichever is the lowest frequency, to the 5^{th} harmonic of the highest frequency generated without exceeding 40 GHz.

FCC §15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

FCC §15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

FCC §15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

§15.209 (a) Limit Matrix

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

6.1.2.2. Digital Emissions (0.03-1 GHz)

FCC, Part 15 Subpart C §15.205/ §15.209
Industry Canada RSS-210 §2.2

Test Procedure

Testing 30M-1 GHz was performed in a 3-meter anechoic chamber using a CISPR compliant receiver. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. To further maximize emissions the receive antenna was varied between 1 and 4 meters. The emissions are recorded with receiver in peak hold mode. Emissions closest to the limits are measured in the quasi-peak mode with the tuned receiver using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed. The anechoic chamber test set-up is identified in Section 6 Test Set-Up Photographs.

The EUT had two methods of powering on ac/dc converter and Power over Ethernet (POE). Both modes were tested for emissions below 1GHz.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. In this test facility, the Antenna Factor, Cable Loss, and Amplifier Gains are loaded into the Rohde & Schwarz Receiver and the corrected field strength can be read directly on the receiver.

$$FS = R + AF + CORR$$

where:

FS = Field Strength
R = Measured Receiver Input Amplitude
AF = Antenna Factor
CORR = Correction Factor = CL – AG + NFL
CL = Cable Loss
AG = Amplifier Gain

For example:
Given a Receiver input reading of 51.5dBμV; Antenna Factor of 8.5dB; Cable Loss of 1.3dB; Falloff Factor of 0dB, an Amplifier Gain of 26dB and Notch Filter Loss of 1dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3dBμV/m

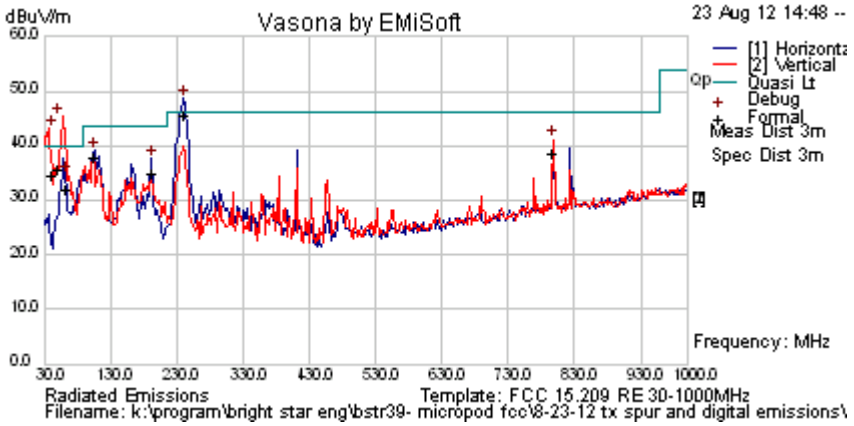
Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100μV/m
48 dBμV/m = 250μV/m

The EUT was evaluated to determine orientation where maximum emissions were observed (i.e. horizontal or vertical). The EUT was positioned vertically on the test table during radiated emissions testing and was tested with the receive antenna positioned both horizontally and vertically such that testing was performed in three orthogonal axis.

Test Freq.	2437 MHz	**Engineer**	SB
Variant	Digital Emissions	**Temp (°C)**	24.2
Freq. Range	30 MHz - 1000 MHz	**Rel. Hum.(%)**	33
Power Setting	Maximum	**Press. (mBars)**	1008
Antenna	Integral		
Test Notes 1			
Test Notes 2			



Formally measured emission peaks

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
52.677	56.0	3.7	-23.8	35.9	Quasi Max	V	112	174	40	-4.2	Pass	
41.267	49.5	3.6	-18.4	34.7	Quasi Max	V	108	135	40	-5.4	Pass	
242.421	59.8	4.8	-19.0	45.7	Quasi Max	H	122	50	46	-0.4	Pass	
105.812	53.4	4.1	-19.7	37.8	Quasi Max	H	158	21	43.5	-5.7	Pass	
798.148	40.7	6.8	-8.9	38.6	Quasi Max	V	99	78	46	-7.4	Pass	
62.429	52.1	3.8	-23.8	32.0	Quasi Max	V	103	102	40	-8.0	Pass	
191.986	49.7	4.6	-19.4	34.9	Quasi Max	V	99	337	43.5	-8.6	Pass	

Legend:	DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency
	NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band

Specification

Limits

§15.205 (a) Except as shown in paragraph (d) of 15.205 (a), only spurious emissions are permitted in any of the frequency bands listed.

§15.205 (a) Except as shown in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.209 (a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

§15.209 (a) and **RSS-Gen §2.2** Limit Matrix

Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance (meters)
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

Laboratory Measurement Uncertainty for Radiated Emissions

Measurement uncertainty	+5.6/ -4.5 dB

Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-03 'Measurement of Radiated Emissions'	0088, 0158, 0134, 0304, 0311, 0315, 0310, 0312

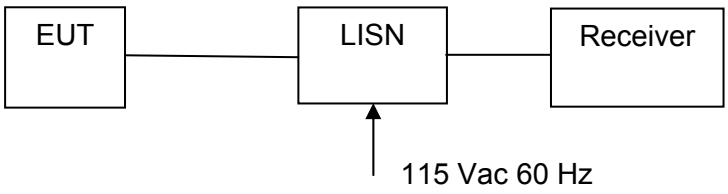
6.1.3. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

FCC, Part 15 Subpart C §15.207
Industry Canada RSS-Gen §7.2.2

Test Procedure

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

Test Measurement Set up



Measurement set up for AC Wireline Conducted Emissions Test

Measurement Results for AC Wireline Conducted Emissions (150 kHz – 30 MHz)

Ambient conditions.
Temperature: 17 to 23 °C Relative humidity: 31 to 57 % Pressure: 999 to 1012 mbar

Not required - EUT is power by DC only (USB).

Specification

Limit

§15.207 (a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

RSS-Gen §7.2.2
The radio frequency voltage that is conducted back into the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table below. The tighter limit applies at the frequency range boundaries.

§15.207 (a) and **RSS-Gen §7.2.2** Limit Matrix
The lower limit applies at the boundary between frequency ranges

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Laboratory Measurement Uncertainty for Conducted Emissions

Measurement uncertainty	±2.64 dB

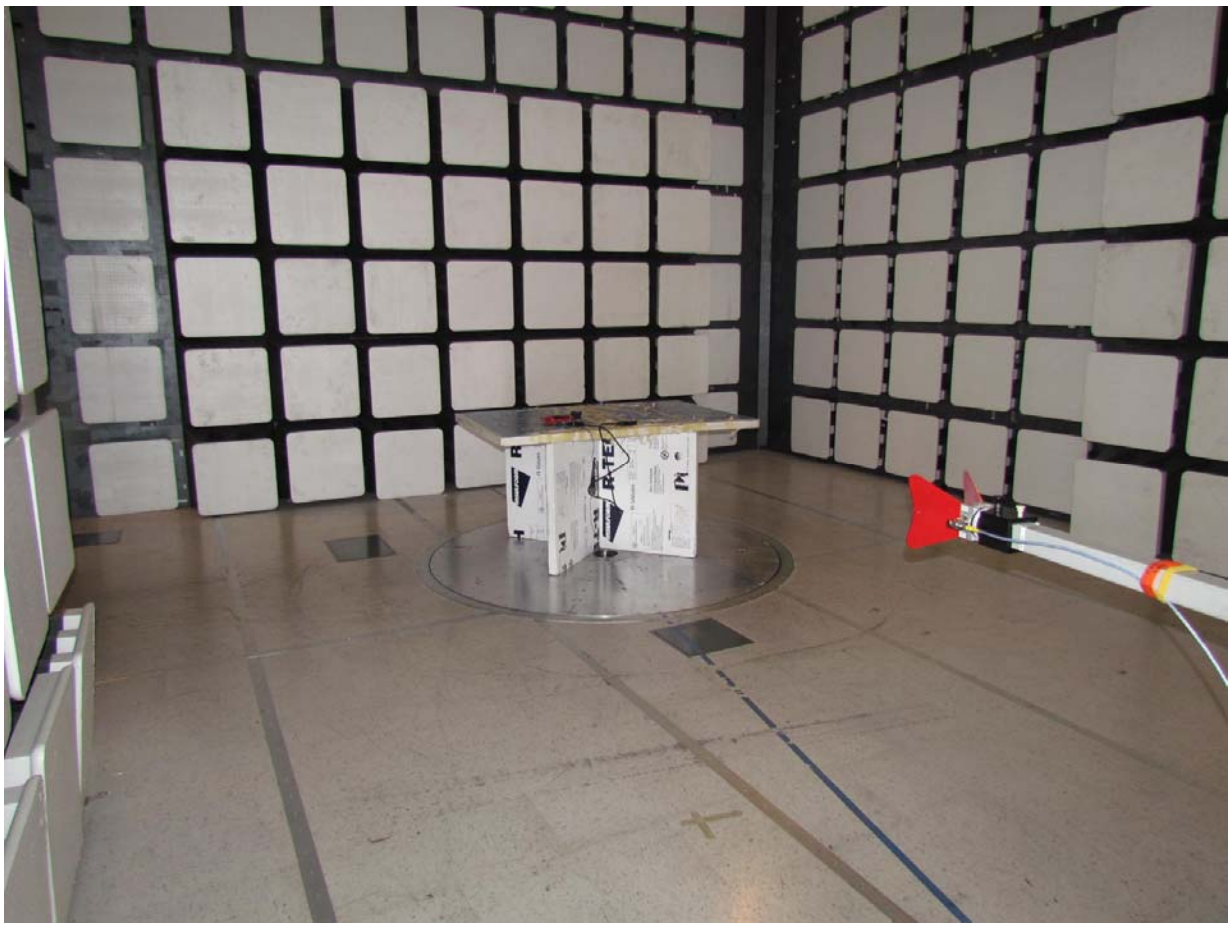
Traceability

Method	Test Equipment Used
Measurements were made per work instruction WI-EMC-01 'Measurement of Conducted Emissions'	0158, 0184, 0287, 0190, 0293, 0307

7. PHOTOGRAPHS

7.1. Test Setup - Digital Emissions below 1 GHz

7.2. Test Setup - Spurious Emissions Above 1 GHz



8. TEST EQUIPMENT

Asset #	Instrument	Manufacturer	Part #	Serial #	Calibration Due Date
0070	Power Meter	Hewlett Packard	437B	3125U11552	28th Nov 12
0117	Power Sensor	Hewlett Packard	8487D	3318A00371	15th Nov 12
0223	Power Meter	Hewlett Packard	EPM-442A	US37480256	15th Nov 12
0374	Power Sensor	Hewlett Packard	8485A	3318A19694	29th Nov 12
0158	Barometer /Thermometer	Control Co.	4196	E2846	8th Dec 12
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007	2nd Dec 12
0287	EMI Receiver	Rhode & Schwartz	ESIB40	100201	16th Nov 12
0338	30 - 3000 MHz Antenna	Sunol	JB3	A052907	8th Nov 12
0335	1-18 GHz Horn Antenna	EMCO	3117	00066580	7th Nov 12
0252	SMA Cable	Megaphase	Sucoflex 104	None	N/A
0293	BNC Cable	Megaphase	1689 1GVT4	15F50B001	N/A
0307	BNC Cable	Megaphase	1689 1GVT4	15F50B002	N/A
0310	2m SMA Cable	Micro-Coax	UFA210A-0-0787-3G03G0	209089-001	N/A
0312	3m SMA Cable	Micro-Coax	UFA210A-1-1181-3G0300	209092-001	N/A
0314	30dB N-Type Attenuator	ARRA	N9444-30	1623	N/A
	EMC Test Software	EMISoft	Vasona	5.0051	N/A
	RF Conducted Test Software	National Instruments	Labview	Version 8.2	N/A
	RF Conducted Test Software	MiCOM Labs ATS		Version 1.4	N/A

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