Test of
Digi ConnectCard for i.MX28 with Atheros AR6233
Bluetooth Mode
To: FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: DIGI28-U1 Rev A

TEST REPORT

FROM

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Bluetooth Mode
To FCC 47 CFR Part 15.247 & IC RSS-210

Test Report Serial No.: DIGI28-U1 Rev A

Note: this report only contains data with regard to the 2,400 to 2,483.5 MHz Bluetooth operational modes of the AR6233. For 2.4 WiFi Data see Micom Labs Test Report DIGI28-E2.

This report supersedes: NONE

Applicant: Digi International
355 South 520 West, Suite 180
Lindon
Utah, 84042 USA

Product Function: 802.11a/b/g/n and Bluetooth Wireless Module

Copy No: pdf Issue Date: 7th March 2013

This Test Report is Issued Under the Authority of;

MiCOM Labs, Inc.
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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 (Ministry of Internal Affairs and Communication)	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	7th March 2013	Initial release.

1. TEST RESULT CERTIFICATE

Manufacturer:	Digi International 355 South 520 West, Suite 180 Lindon Utah, 84042 USA	Tested By:	MiCOM Labs, Inc. 440 Boulder Court Suite 200 Pleasanton California, 94566, USA
EUT:	Atheros AR6233 802.11 a/b/g/n + BT Module (Operating in BT mode)	Telephone:	+1 925 462 0304
Model:	CCWMX28	Fax:	+1 925 462 0306
S/N's:	55001667.01		
Test Date(s):	19th December 2012 to 3rd January 2013	Website:	www.micomlabs.com

STANDARD(S)	TEST RESULTS
FCC 47 CFR Part 15.247 & IC RSS-210	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.

Approved & Released for MiCOM Labs, Inc. by:

ACCREDITED
TEST CERTIFICATE #2381.01

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 Digi ConnectCard for i.MX28 with Atheros AR6233 operating in Bluetooth mode in the frequency range 2400 - 2483.5 MHz for compliance against FCC Part 15.247 and Industry Canada RSS-210 regulations.
Applicant:	Digi International 355 South 520 West, Suite 180 Lindon Utah, 84042 USA
Manufacturer:	As applicant.
Laboratory performing the tests:	MiCOM Labs, Inc. 440 Boulder Court, Suite 200 Pleasanton, California 94566 USA
Test report reference number:	DIGI28-U1 Rev A
Date EUT received:	26th November 2012
Standard(s) applied:	FCC 47 CFR Part 15.247 & IC RSS-210
Dates of test (from - to):	19th December 2012 to 3rd January 2013
No of Units Tested:	One
Type of Equipment:	802.11a/b/g/n Wi-Fi and BT Module.
Manufacturers Trade Name:	Digi International
Model(s):	CCWMX28
Location for use:	Indoor/Outdoor
Declared Frequency Range(s):	2400 - 2483.5 MHz
Hardware Rev	30013772-04
Software Rev	DEL-5.9 Rev B
Rated Input Voltage and Current:	5 Vdc 0.625 A
Operating Temperature Range:	Declared range -40° to +75ºC at 95% humidity non condensing
Equipment Dimensions:	2” (L) x 1.375 (W) x 0.162” (H) inches
Weight:	< 0.5 oz
Primary function of equipment:	802.11 a/b/g/n + BT module

3.2. Scope of Test Program

Digi ConnectCard for i.MX28 with Atheros AR6233 RF Testing

The scope of the test program was to test the Digi ConnectCard for i.MX28 with Atheros AR6233 operating in Bluetooth mode in the frequency range 2400 - 2483.5 MHz for compliance against FCC 47 CFR Part 15.247 and Industry Canada RSS-210 specifications.

Wi-Fi and Bluetooth Single Port Module: 55001667.01

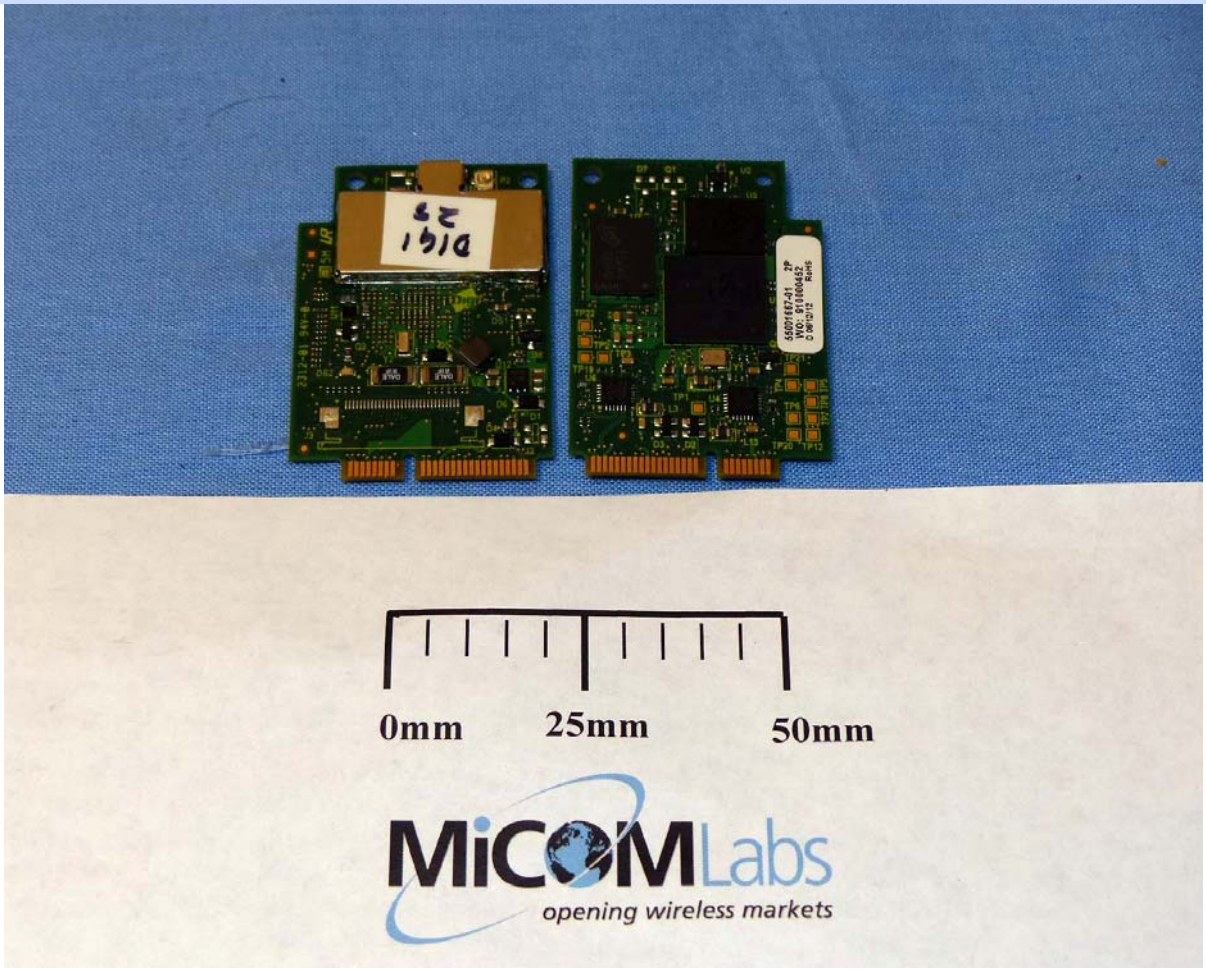
The following operational description of the module was provided by the customer.

The ConnectCard for i.MX28 module set contains a full 802.11 a b g n and Bluetooth radio with a programmable Freescale i.MX28 Processor. The RF section of the part is handled by a Qualcom Atheros Wi-Fi/BT module with a 5GHz RF front end module. Data is entered into the processor through a variety of interfaces including Ethernet, CAN, UART, SPI, I2C, I2S, USB, SDIO, etc. Data is sent to the Wi-Fi/BT module where it is processed and sent to the RF Antenna(s). Likewise data is received in the Wi-Fi/BT module and converted to baseband data where it is sent to the processor for baseband processing and sent out of the module using one of the interface ports.

The module is comprised of a Freescale i.MX28 processor, a Qualcom Atheros Wi-Fi/ Bluetooth Module, an RFMD 5GHz front end module, Diplex filter, and either a BT-2.4GHz Wi-Fi switch or Diversity antenna switch (if no BT). The ConnectCard for i.MX28 functions in both the 2.4 to 2.5GHz, and 4.9 to 6 GHz ISM bands.

The module uses an efficient architecture in which data streams directly from the processor (at baseband) to the Wi-Fi/BT module through data lines. The processor also controls the transceiver's modes within the 802.11 a, b, g, and n modes. The Wi-Fi module includes LNA's for the receive modes and a power amplifier for the transmit mode within the 2.4GHz band. Further a there are transmit-receive switches within the module for the 2.4GHz bands. The antenna(s) are connected to the module through u.FL connectors. With BT capable modules there is a single u.FL connector for a single antenna. For modules without BT, there is a diversity antenna switch and 2 u.FL antenna connectors. The module is available with different amounts of FLASH, and RAM, as well as various processors within the i.MX28 family for customers to store their programs.

Digi ConnectCard for i.MX28 with Atheros AR6233



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

Equipment Type	Equipment Description (Including Brand Name)	Mfr	Model No.	Serial No.
EUT	Bluetooth Module	Digi International	CCWMX28 (55001668.01)	Not Available
Support	Laptop PC	IBM	Thinkpad	None

3.4. Antenna Details

Antenna Type	Manufacturer	Model Number	Antenna Gain (dBi	
			2.4 GHz	5 GHz
Patch	Taoglas	PC.11	3.0	4.5
Patch	Taoglas	FXP.830	1.8	4.0
Single Band Omni	Bobbintron Electrical Corp.	SA-006-1	1.8	---
Dipole	World Products Inc	WPANTE3	3.4	5.0

3.5. Cabling and I/O Ports

Number and type of I/O ports

1. 1 x DB9 control port on interface card
2. 2 x 2.5 mm DC Power ports on interface card

3.6. Types of Modulation Supported

Operational Mode(s) (802.15.2)	Packet type	Frequencies (MHz)
FHSS	DH1	2,402 2,441 2,480
	DH3	
	DH5	

3.7. Operational Power Range

Declared O/P Power Range	Bluetooth	
	Max	Min
EUT	9 +/- 1 dBm	-----

3.8. EUT Configurations

Band (GHz)	Mode	Freq Band (MHz)	Freq Range (MHz	Low Ch.	Mid Ch.	High Ch.	# Ch.	Ch. Spacing (MHz)
2.4	Bluetooth	2400-2483.5	2402-2480	2402	2441	2480	79	1 MHz

3.9. Equipment Modifications

None.

3.10. Deviations from the Test Standard

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

1. NONE

4. TEST EQUIPMENT CONFIGURATION(S)

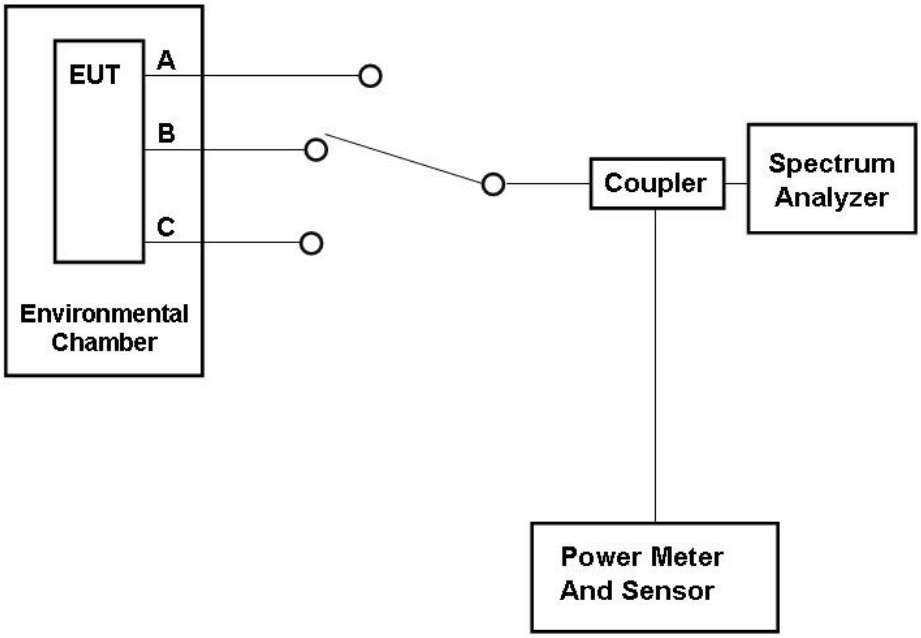
4.1. Conducted RF Emission Test Set-up

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

1. Section 6.1.1.1. 20 dB Bandwidth
2. Section 6.1.1.2. Carrier Frequency Separation
3. Section 6.1.1.3. Number of Hopping Frequencies
4. Section 6.1.1.4. Time of Occupancy (Dwell Time)
5. Section 6.1.1.5 Channel Occupancy
6. Section 6.1.1.5 Peak Output Power
7. Section 6.1.1.7 Band-Edge
8. Section 6.1.1.8 Spurious RF Conducted – Transmitter
9. Section 6.1.1.9 Spurious RF Conducted - Receiver

Conducted Test Set-Up Pictorial Representation

3 - Port Test Configuration

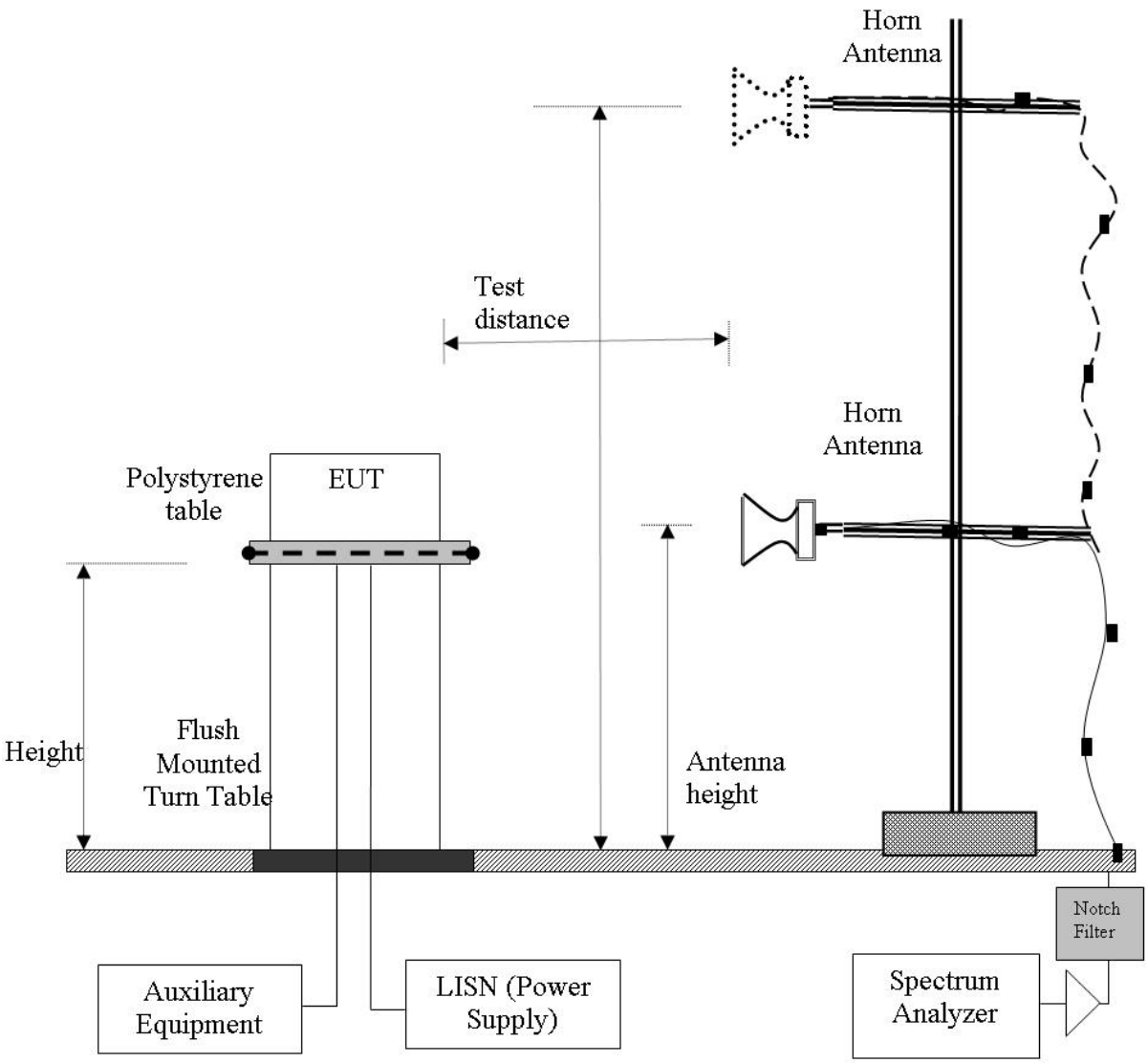


4.2. Radiated Spurious Emission Test Set-up > 1 GHz

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

1. Section 6.1.2.1. Patch PC.11
2. Section 6.1.2.2. Patch FXP.830
3. Section 6.1.2.3. Omni SA-006-1

Radiated Emission Measurement Setup – Above 1 GHz

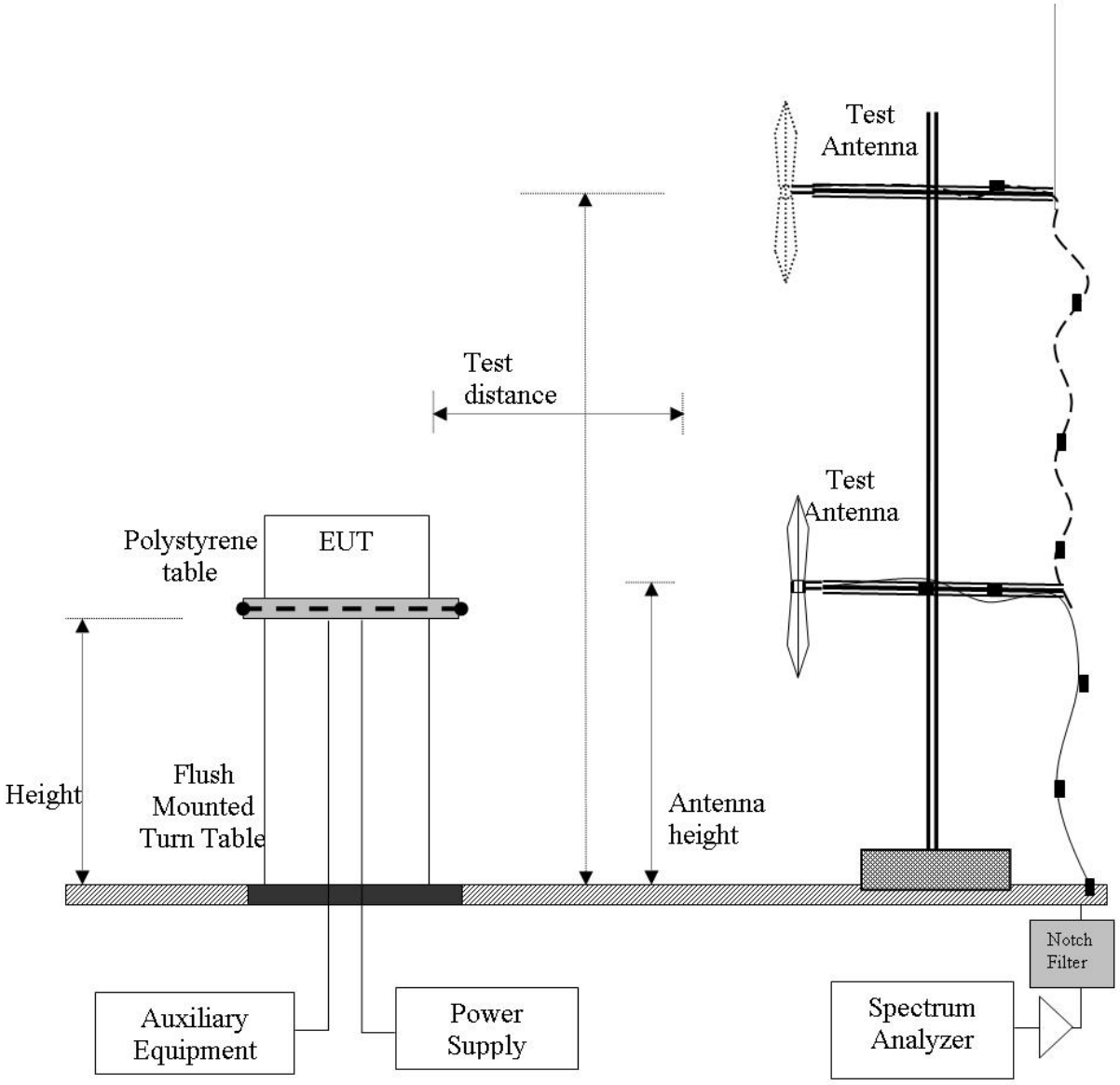


4.3. Digital Emissions Test Set-up (0.03 – 1 GHz)

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

1. Section 6.1.2.4. Patch PC.11

Digital Emission Measurement Setup – Below 1 GHz

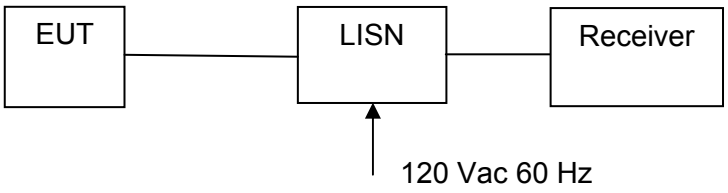


4.4. ac Wireline Emission Test Set-up

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

Not Required EUT not powered by AC.

1. Section 6.1.3 ac Wireline Conducted Emissions



Measurement Setup for Conducted Emissions Test

5. TEST SUMMARY

List of Measurements - Conducted

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(a)** **4.4**	20 dB Bandwidths	Conducted	Complies	6.1.1
15.247(a)(1) **A8.1(d)**	Carrier Frequency Separation	Conducted	Complies	6.1.2
15.247(a)(1) **A8.1(d)**	Number of Hopping Frequencies	Conducted	Complies	6.1.3
15.247(a)(1)(iii) **A8.1(d)**	Time of Occupany (Dwell Time)	Conducted	Complies	6.1.4
15.247(a)(1)(iii) **A8.1(d)**	Channel Occupancy	Conducted	Complies	6.1.5
15.247(b)(2) **A8.4(2)**	Peak Output Power	Conducted	Complies	6.1.6
15.247(d) **A8.5**	Band-Edge	Conducted	Complies	6.1.7
2.3 **RSS-Gen 4.10** **RSS-Gen 6.2**	Spurious RF Conducted Emissions – Receiver	Conducted	Complies	6.1.7

List of Measurements (continued)

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** **4.7**	Transmitter Radiated Spurious Emissions	Emissions above 1 GHz	Radiated	Complies	6.1.2.1-6.1.2.3
	Radiated Band Edge	Band-edge results	Radiated	Complies	6.1.2.1-6.1.2.3
15.205 / **15.209** **2.2**	Radiated Spurious Emissions	Emissions <1 GHz (30M-1 GHz)	Radiated	Complies	*6.1.2.4*
15.207 **7.2.2**	AC Wireline Conducted Emissions 150 kHz–30 MHz	Conducted Emissions	Conducted	N/A EUT is DC powered	*6.1.3*

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

Device Characteristics

6.1. Conducted Testing

6.1.1. 20 dB Bandwidth

Conducted Test Conditions for 20 dB Bandwidth			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	20 dB Bandwidth	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(2)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Test Procedure for 20 dB Bandwidth Measurement
The bandwidth at 20 dB was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate centre frequency.
Although there are no limits for 20 dB bandwidth for frequency hopping systems in the 2400-2483.5 MHz band. The 20 dB bandwidth is required to calculate the carrier frequency separation limits.

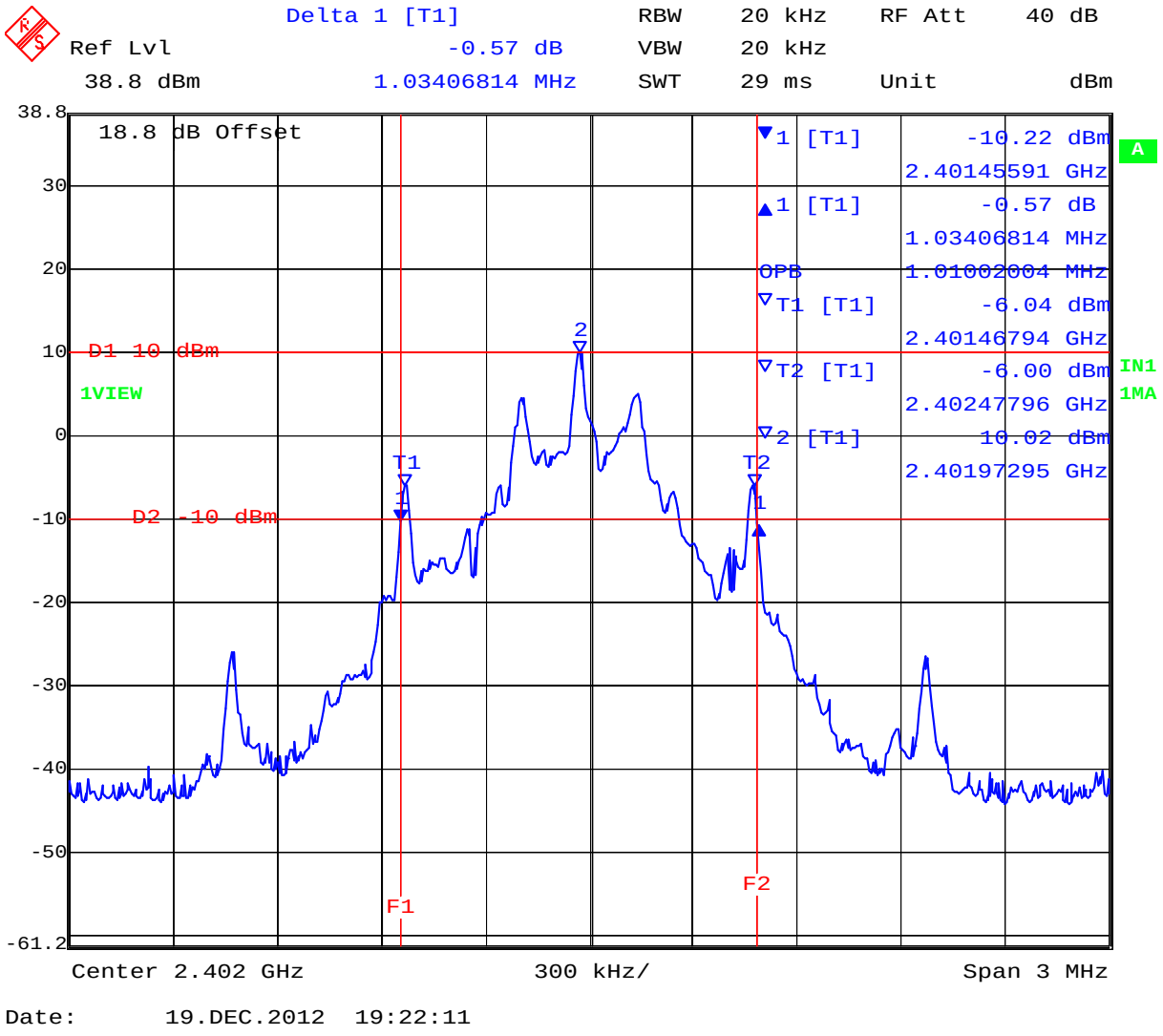
Equipment Configuration for 20 dB & 99% Bandwidth			
Variant:	802.15.2	**Duty Cycle (%):**	100%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:	EUT has only one basic rate 1 Mbs		

Test Measurement Results

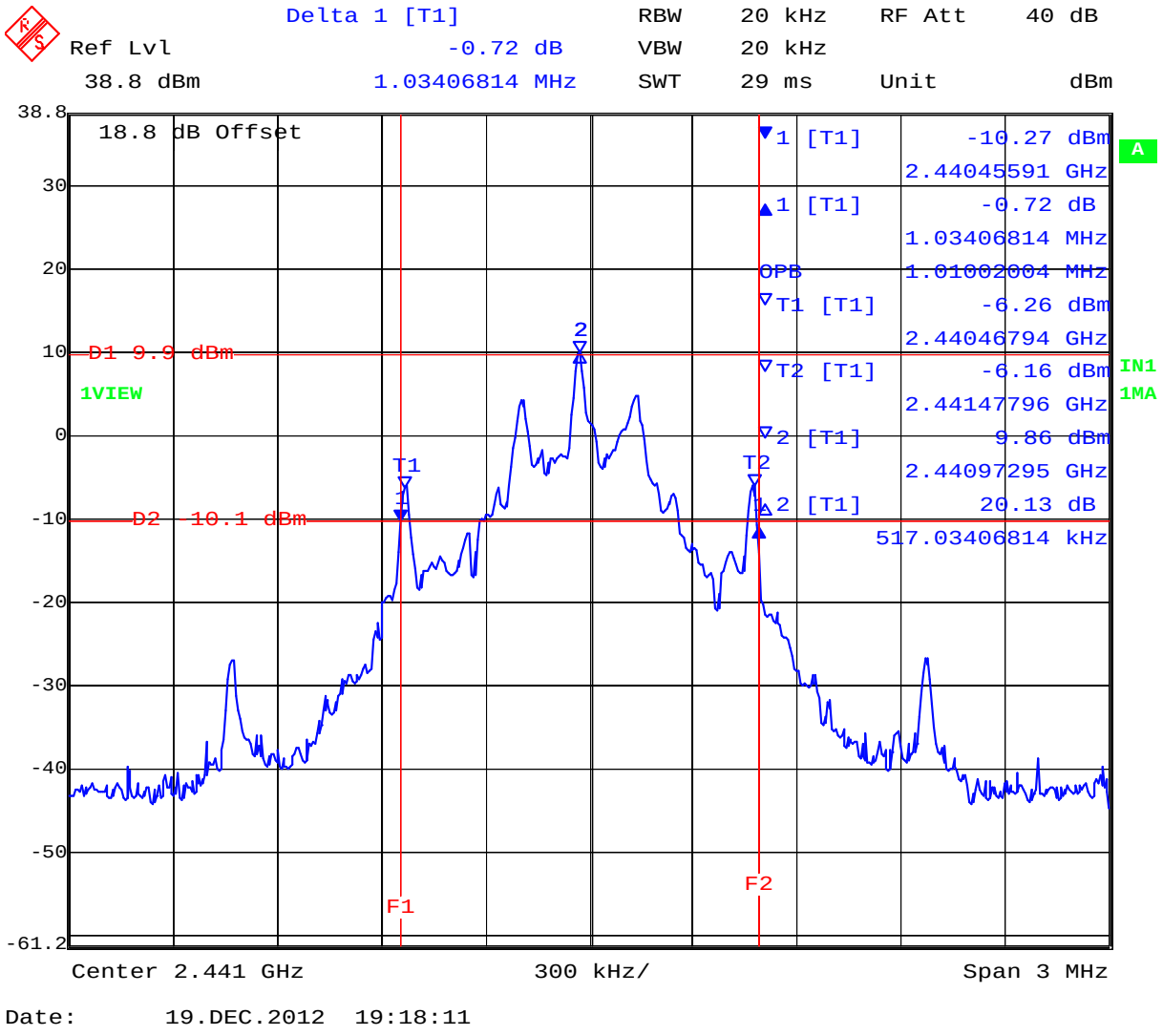
Test Frequency	Measured 20 dB Bandwidth (MHz)			
	Port(s)			
MHz	**a**	**b**	**c**	**d**
2402 (CH 0)	1.034	--	--	--
2441 (CH 39)	1.034	--	--	--
2480 (CH 78)	1.034	--	--	--

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

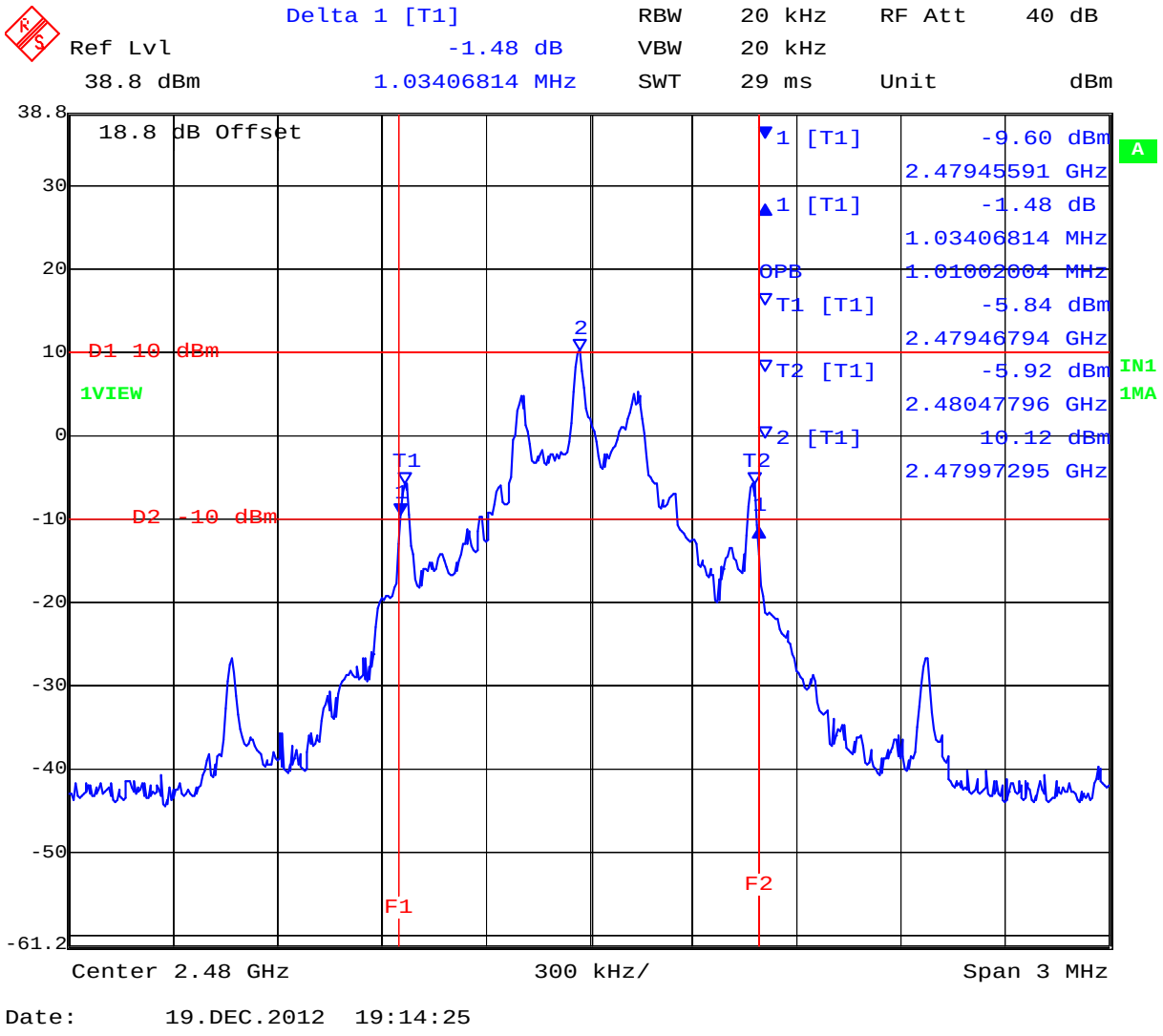
20 dB Bandwidth Channel 0, 1 Mbs



20 dB Bandwidth Channel 39, 1 Mbs



20 dB Bandwidth Channel 78, 1 Mbs



Specification

Limits

§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

RSS-210 §A8.1

a. The bandwidth of a frequency hopping channel is the -20 dB emission bandwidth, measured with the hopping stopped. The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.

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.

Traceability

Test Equipment Used
0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

6.1.2. Carrier Frequency Separation

Conducted Test Conditions for Carrier Frequency Separation			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 – 24.0
Test Heading:	Carrier Frequency Separation	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(1)	**Pressure (mBars):**	999 - 1004
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Test Procedure for Carrier Frequency Separation Measurement
The EUT must have its hopping function enabled.
The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure carrier frequency separation.
The Span was set wide enoug to campture two adjacent peaks. The resolution bandwidth (RBW) was set to ≥ 1% of the span, video bandwidth (VBW) ≥ RBW, peak detector selected and mox hold trace selected. After the trace is stabilized use marker delta function to determine the separation between adjacent channels.
The limit is > 2/3 of the 20 dB bandwidth.

Single Port Module:

Equipment Configuration for Carrier Frequecy Separation

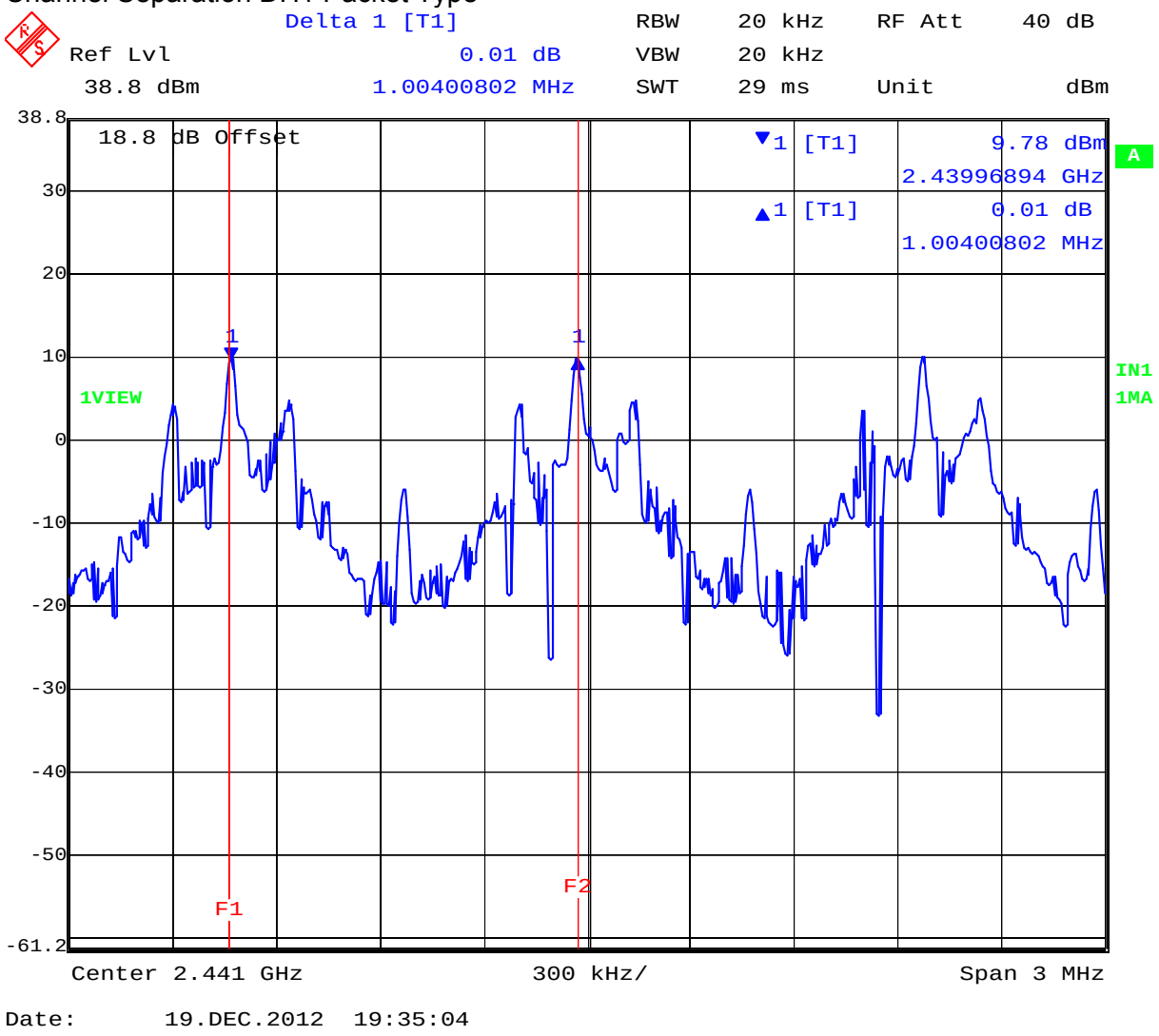
Variant:	802.15.2	**Duty Cycle (%):**	100%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:	Although EUT has only one basic rate, all 3 supported packet types were measured (DH1, DH3, DH5)		

Test Measurement Results

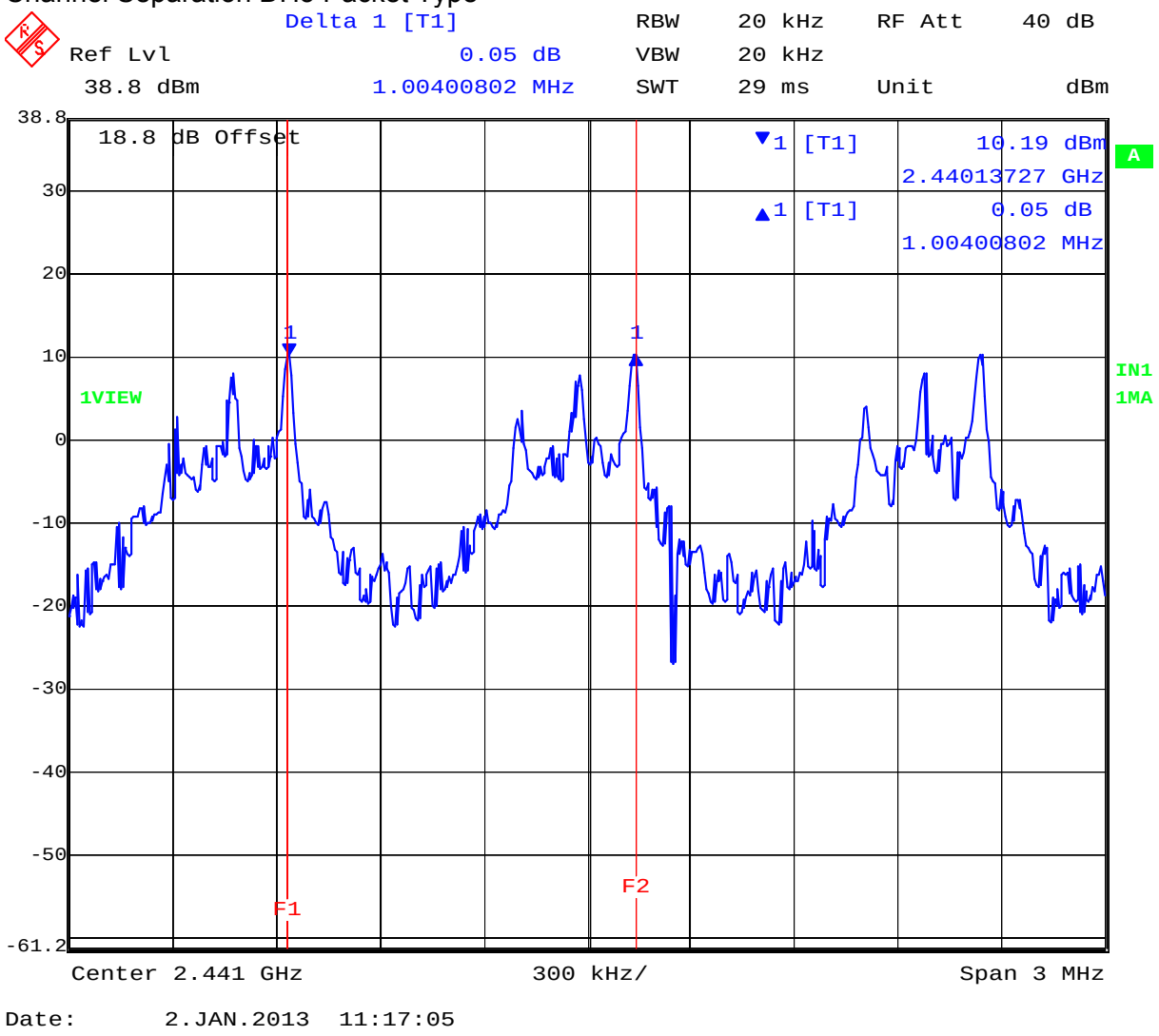
Test Frequency	Measured Carrier Frequency Separation (MHz) Port(s)				Maximum 20 dB Bandwidth	Specification	Results
MHz	a	b	c	d	MHz		
DH1 (CH 39)	1.004	--	--	--	1.034	> 2/3 of 20 dB Bandwidth	Pass
DH3 (CH 39)	1.004	--	--	--	1.034	> 2/3 of 20 dB Bandwidth	Pass
DH5 (CH 39)	1.004	--	--	--	1.034	> 2/3 of 20 dB Bandwidth	Pass

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Channel Separation DH1 Packet Type



Channel Separation DH3 Packet Type



Channel Separation DH5 Packet Type

Specification

Limits

§15.247 (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.

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.

Traceability

Test Equipment Used
0158, 0287, 0252, 0313, 0314, 0070, 0116, 0117

6.1.3. Number of Hopping Frequencies

Conducted Test Conditions for Number of Hopping Frequencies			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	Carrier Hopping Frequencies	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)	**Pressure (mBars):**	999 - 1008
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Test Procedure for Number of Hopping Frequencies

The EUT must have its hopping function Enabled

The transmitter output was connected to a spectrum analyzer and the span was set for the frequency of operation (Note 2 or more spans may be necessary for an accurate count). RBW ≥ 1% of the span, VBW ≥ RBW, Sweep = auto, detector function = peak, trace = max hold.

Allow trace to stabilize. It may prove necessary to break the span up into sections to clearly show the hopping frequencies.

Single Port Module:

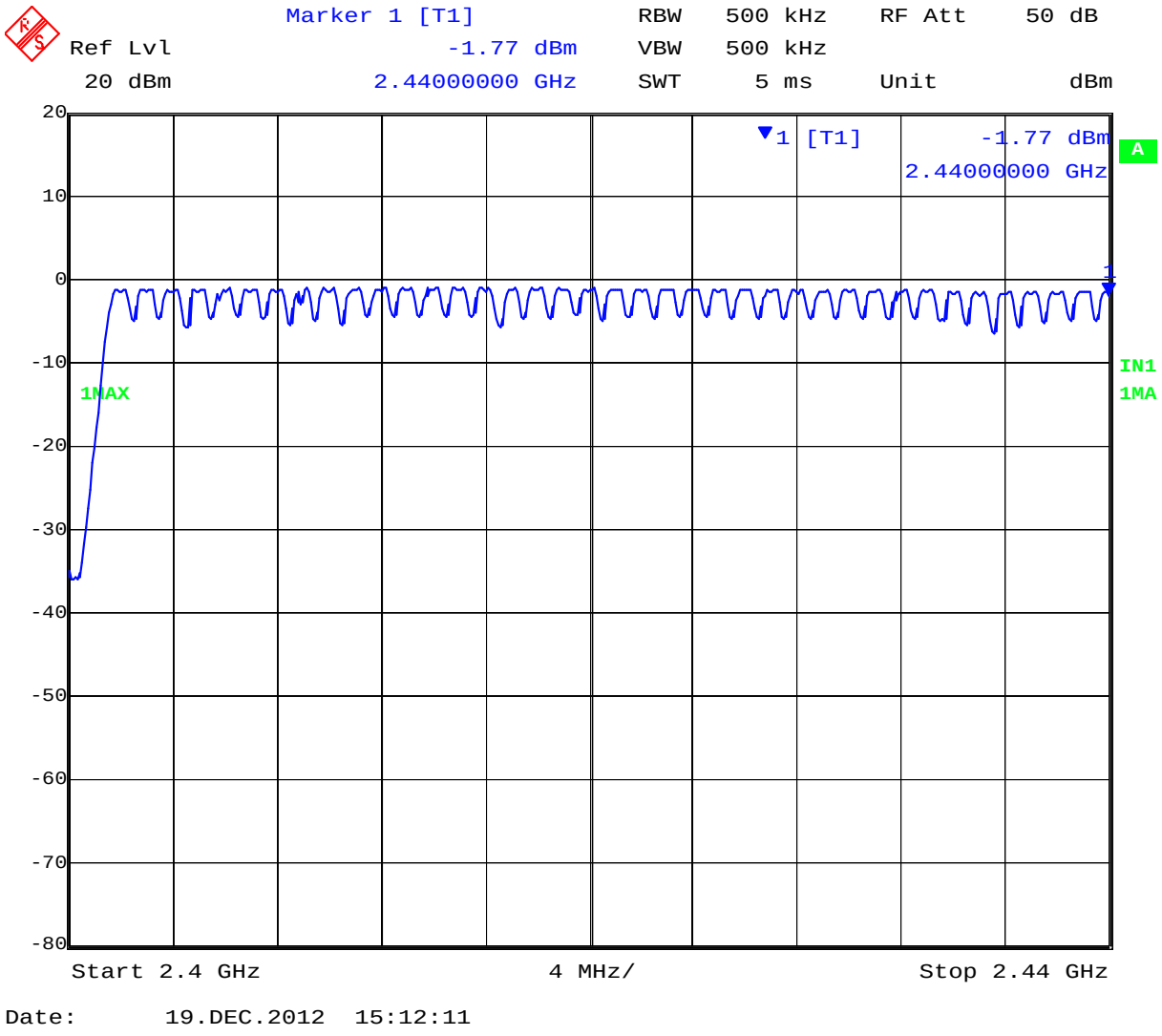
Equipment Configuration for Number of Hopping Frequencies			
Variant:	802.15.2	**Duty Cycle (%):**	100%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:			

Test Measurement Results

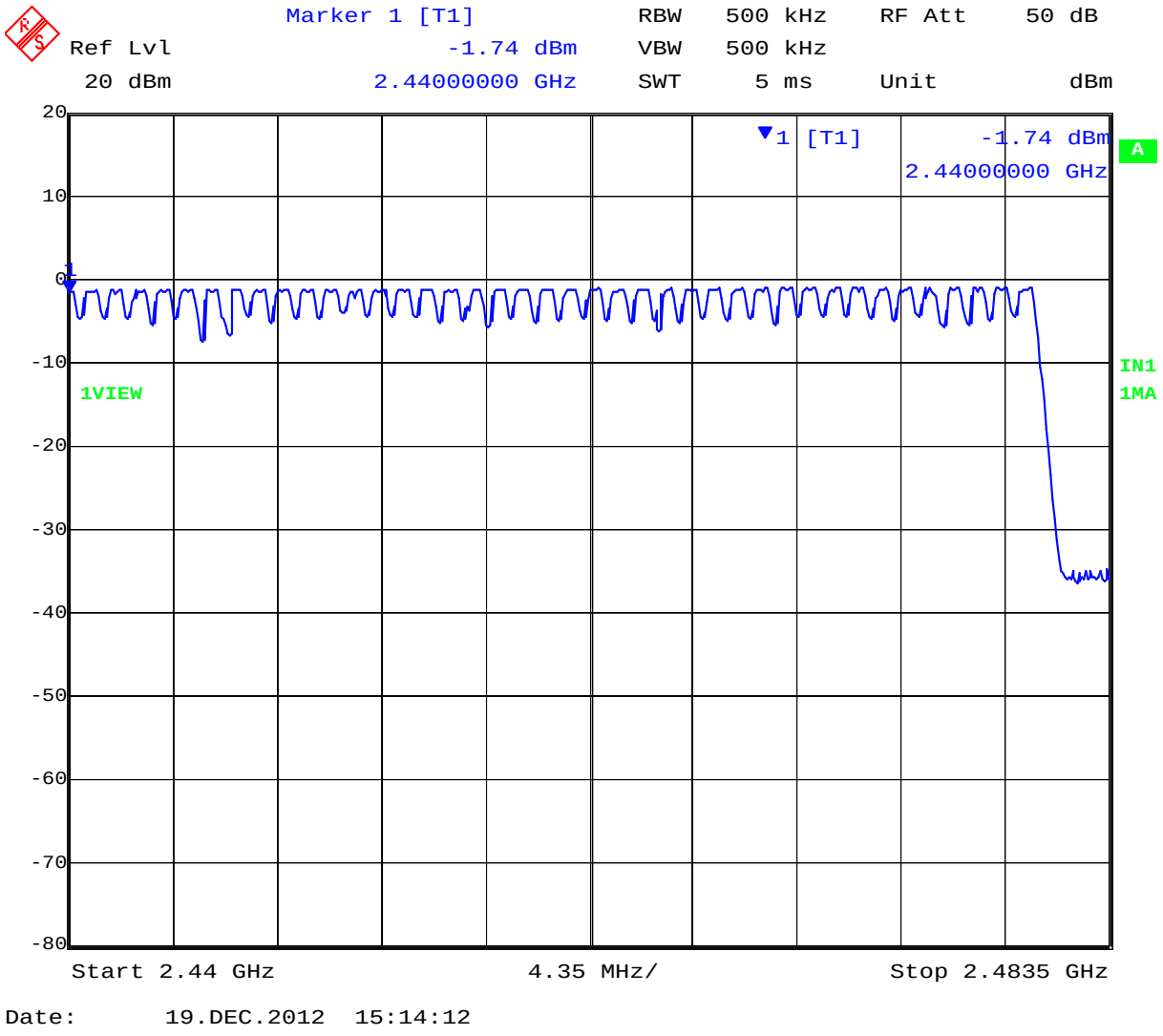
Test Frequency	Number of Hopping Frequencies Port(s)				Limit	Result
MHz	**a**	**b**	**c**	**d**	**dBm**	**dB**
NA	79	--	--	--	≥ 15	Pass

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-03 MEASURING RF SPECTRUM MASK
Measurement Uncertainty:	±2.81 dB

Number of Hoppng Channels 2400 – 2441



Number of Hoppng Channels 2441 – 2483.5



Specification
Number of Hopping Frequencies

§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.

RSS-210 §A8.1 (d) Frequency hopping systems operating in the 2400–2483.5 MHz band 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 frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Traceability

Method	Test Equipment Used
FCC DA 00-175	0078, 0134, 0158, 0184, 0193, 0287, 0250, 0252, 0310, 0312

6.1.4. Time of Occupancy (Dwell Time)

Conducted Test Conditions for Time of Occupancy (Dwell Time)			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Time of Occupancy (Dwell Time)	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Test Procedure for Time of Occupancy (Dwell Time)

The EUT must have its hopping function Enabled

The transmitter output was connected to a spectrum analyzer and the span was set for the frequency of operation. RBW = 1 MHz, VBW ≥ RBW, Sweep = as necessary to capture the entire dwell time period, detector function = peak, trace = max hold.

If possible use the marker-delta function to detrmine 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.

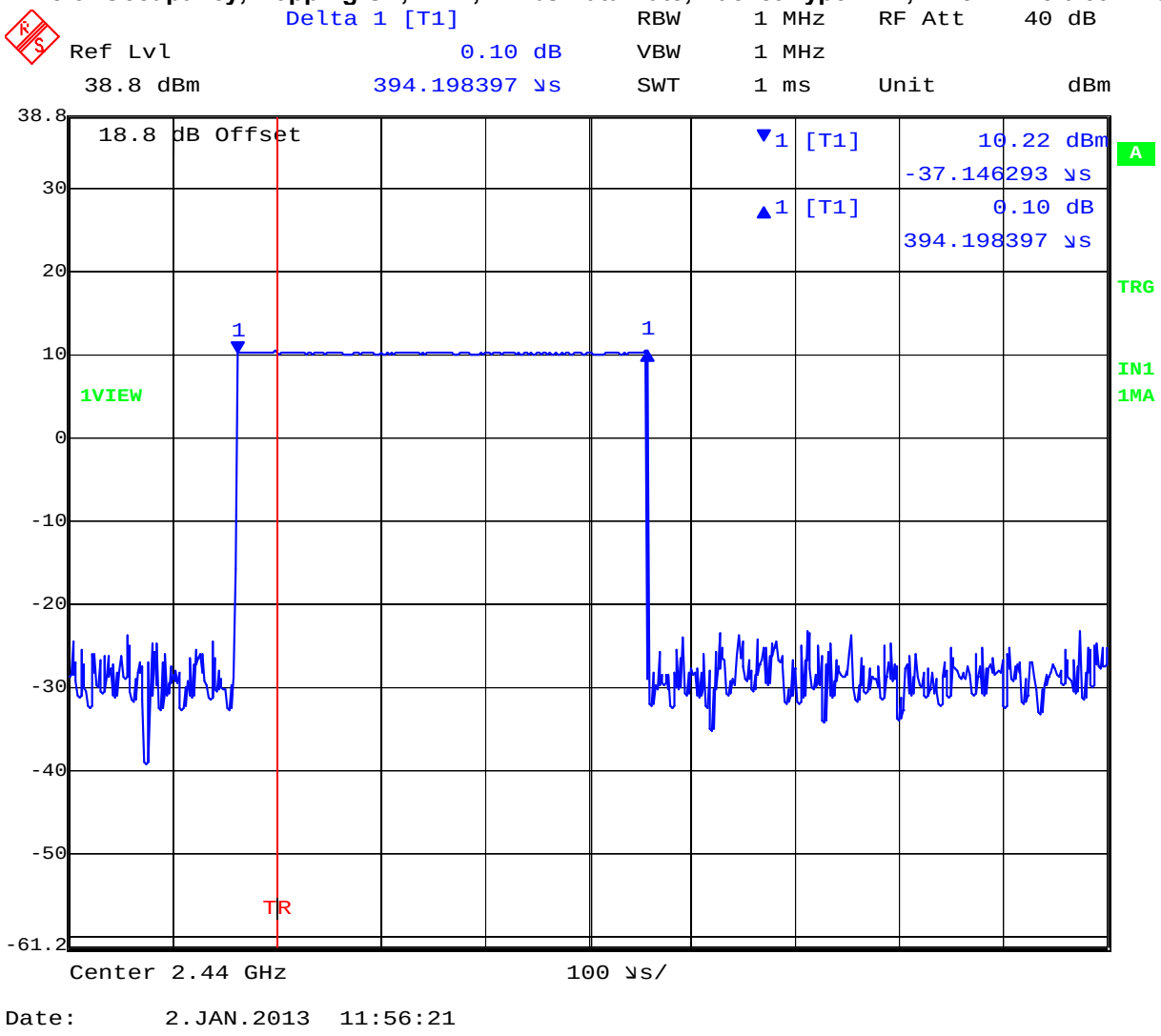
Equipment Configuration for Time of Occupancy (Dwell Time)			
Variant:	802.15.2	**Duty Cycle (%):**	100%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:	System only supported 1 Mbs data rate and DH1, DH3, DH3 Packet types		

Test Measurement Results

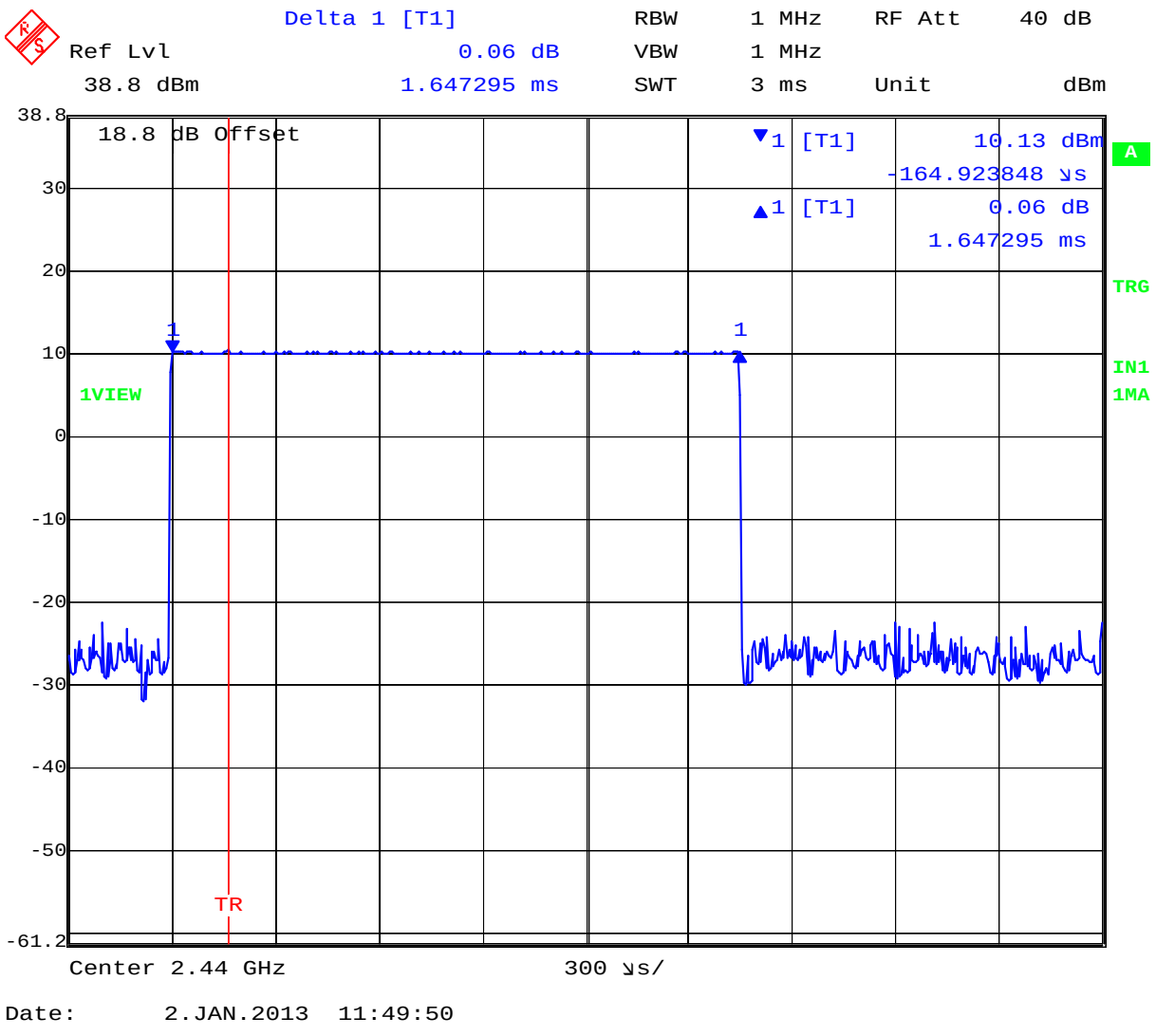
Centered on Channel	Center Frequency	Data Rate	Packet Type	Dwell Time (Single Channel)	Limit (Single Channel)	Result
	MHz	Mbs		mS	mS	
39	2441	1	DH1	0.394	400	Pass
39	2441	1	DH3	1.647	400	Pass
39	2441	1	DH5	2.898	400	Pass

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	FCC DA 00-0705
Measurement Uncertainty:	±2.81 dB (Spectrum/Amplitude), ±0.86 ppm (Frequency)

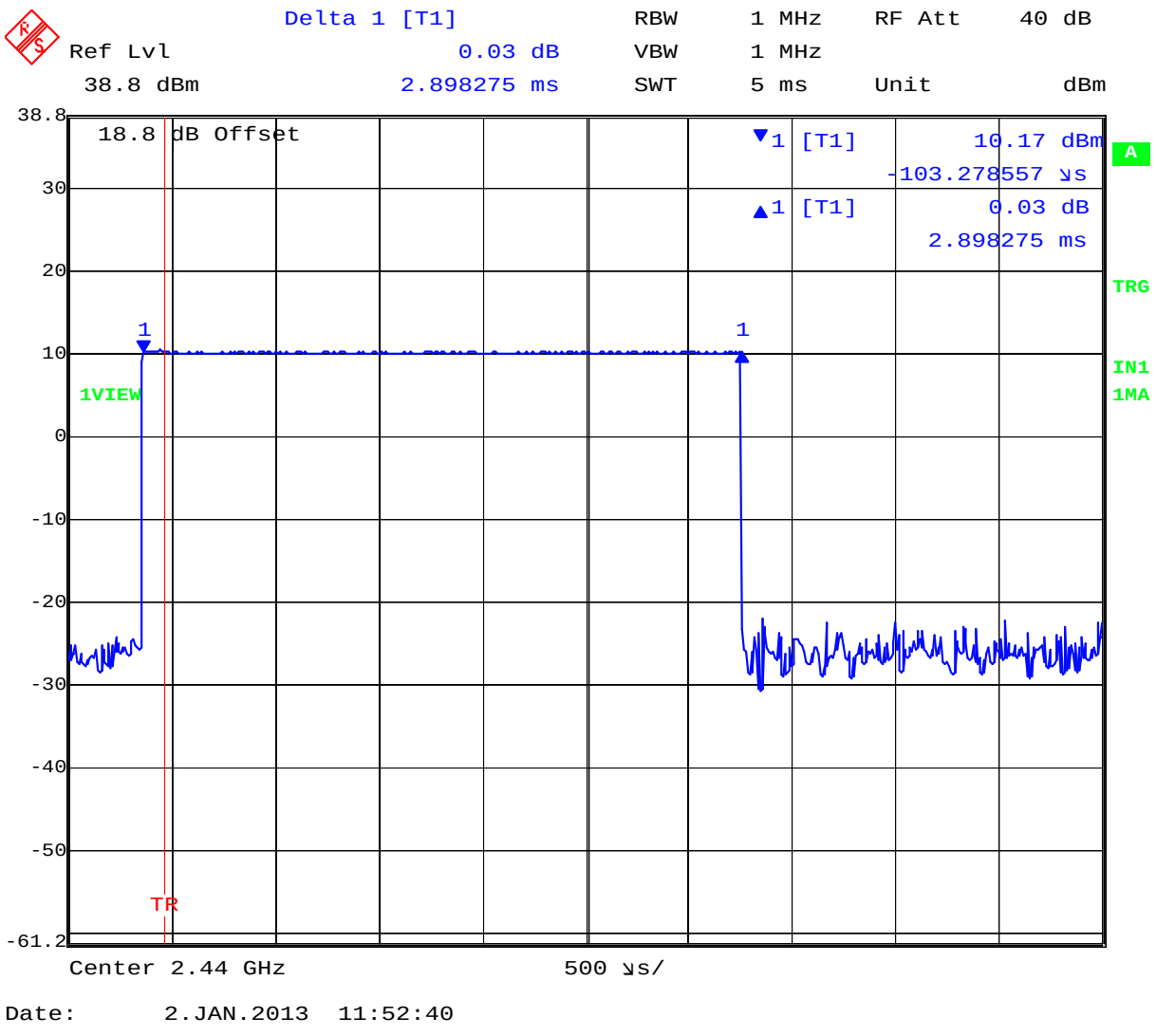
Time of Occupancy; Hopping On; 2441; 1 Mbs Data Rate; Packet Type DH1; Dwell Time 0.394 ms



Time of Occupancy; Hopping On; 2441; 1 Mbs Data Rate; Packet Type DH3; Dwell Time 1.647 ms



Time of Occupancy; Hopping On; 2441; 1 Mbs Data Rate; Packet Type DH5; Dwell Time 2.898 ms



Specification

Limits Channel Occupancy (Dwell Time)

§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.

RSS-210 §A8.1 (d) Frequency hopping systems operating in the 2400–2483.5 MHz band 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 frequencies may be avoided or suppressed provided that a minimum of 15 hopping channels are used.

Traceability

Method	Test Equipment Used
FCC DA 00-175	0078, 0134, 0158, 0184, 0193, 0287, 0250, 0252, 0310, 0312

6.1.5. Channel Occupancy

Conducted Test Conditions for Channel Occupancy			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Channel Occupancy	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Test Procedure for Time of Occupancy (Dwell Time)

The EUT must have its hopping function Enabled

The transmitter output was connected to a spectrum analyzer and the span was set for the frequency of operation. RBW = 1 MHz, VBW ≥ RBW, Sweep = Dwell time x number of hopping frequencies, detector function = peak, trace = max hold.

Equipment Configuration for Channel Occupancy			
Variant:	802.15.2	**Duty Cycle (%):**	100%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:	System only supported 1 Mbs data rate and DH1, DH3, DH3 Packet types		

Test Measurement Results

Centered on Channel	Center Frequency	Data Rate	Packet Type	Dwell Time (Single Channel)	Number of Hops	Channel Occupancy	Limit	Result
	MHz	Mbs		mS		mS	mS	mS
39	2441	1	DH1	0.394	316	124.50	400	Pass
39	2441	1	DH3	1.647	221	363.99	400	Pass
39	2441	1	DH5	2.898	126	365.14	400	Pass

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	FCC DA 00-0705
Measurement Uncertainty:	±2.81 dB (Spectrum/Amplitude), ±0.86 ppm (Frequency)

Channel Occupancy was performed using a sweep time of 32 seconds (79 x 0.4 = 31.6 seconds) and the packet type with the highest dwell time (DH5).

All packet types were then checked with a sweep time of 1 second to verify the number of times the transmitter occupied Channel 39 (2441 MHz). Each packet type transmitted on channel 39 at the following rates:
DH1 = 10
DH3 = 7
DH5 = 4

The number of hops = hops per one second x 31.6 seconds
Finally the channel occupancy time = number of hops x single channel dwell time

Specification Limits

§15.247 (b) The maximum peak 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.

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..

Laboratory Measurement Uncertainty for Power Measurements

Measurement uncertainty	±1.33 dB

6.1.6. Peak Output Power

Conducted Test Conditions for Fundamental Emission Output Power			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	24.0 - 27.5
Test Heading:	Emission Output Power	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (d)	**Pressure (mBars):**	999 - 1004
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Test Procedure for Fundamental Emission Output Power Measurement
The transmitter terminal of EUT was connected to the input of the spectrum analyzer set to measure peak power. The span was set to approximately 5 times the 20 dB bandwidth, centered on a hopping channel. RBW > 20 dB bandwidth of the emission being measured, VBW ≥ RBW, sweep = auto, detector function = peak and trace = max hold.

Equipment Configuration for Peak Output Power			
Variant:	802.15.2	**Duty Cycle (%):**	10%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:			

Test Measurement Results DH1

Test Frequency	Measured Output Power (dBm) Port(s)				Calculated Total Power (dBm)	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s)	dBm	dBm	
2402 (CH0)	8.06	--	--	--	8.06	30	-21.94	Max
2441 (CH39)	8.07	--	--	--	8.07	30	-21.93	Max
2480 (CH78)	7.38	--	--	--	7.38	30	-22.62	Max

Test Measurement Results DH3

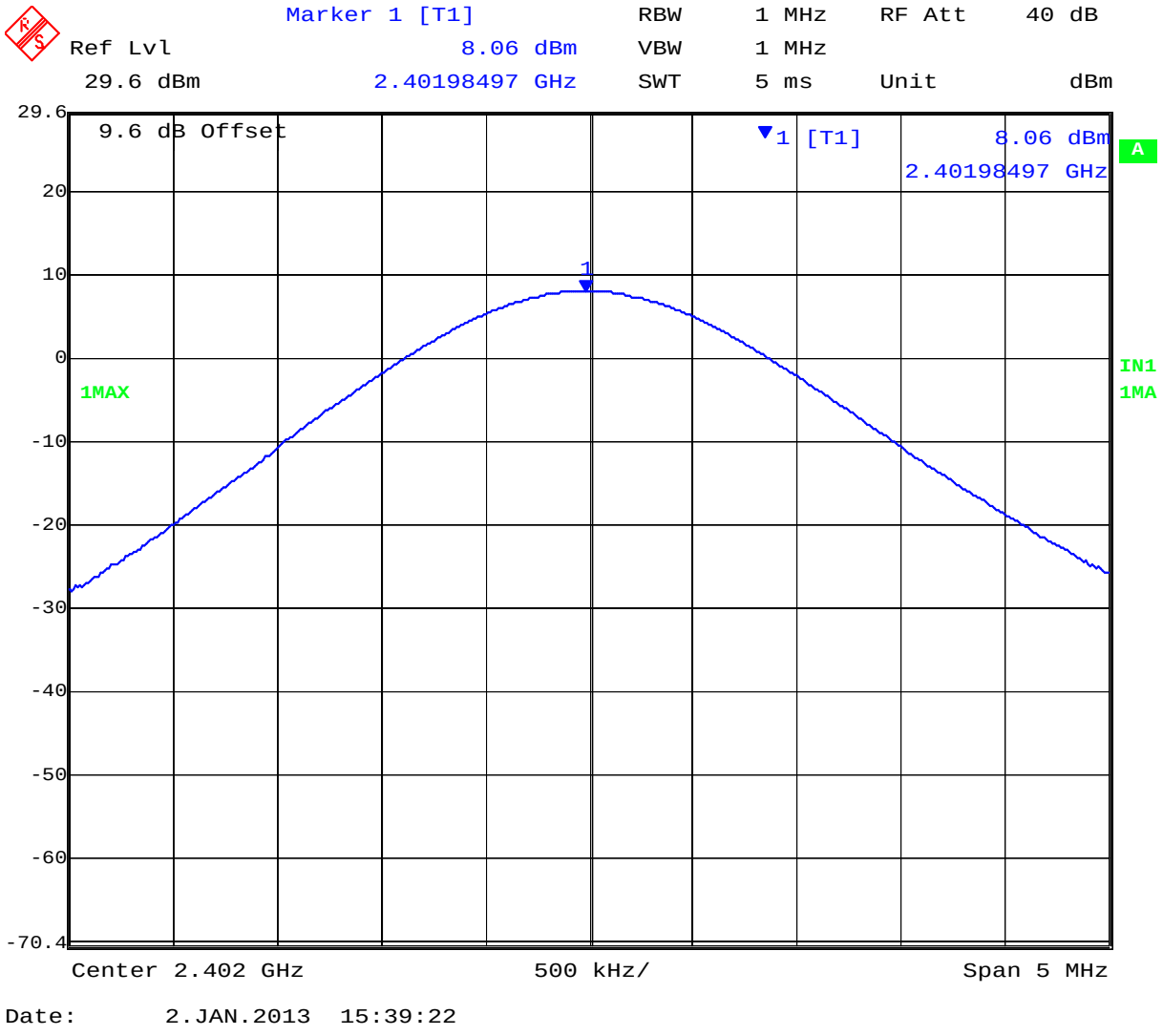
Test Frequency	Measured Output Power (dBm) Port(s)				Calculated Total Power (dBm)	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s)	dBm	dBm	
2402 (CH0)	8.03	--	--	--	8.03	30	-21.97	Max
2441 (CH39)	7.92	--	--	--	7.92	30	-22.08	Max
2480 (CH78)	7.31	--	--	--	7.31	30	-22.69	Max

Test Measurement Results DH5

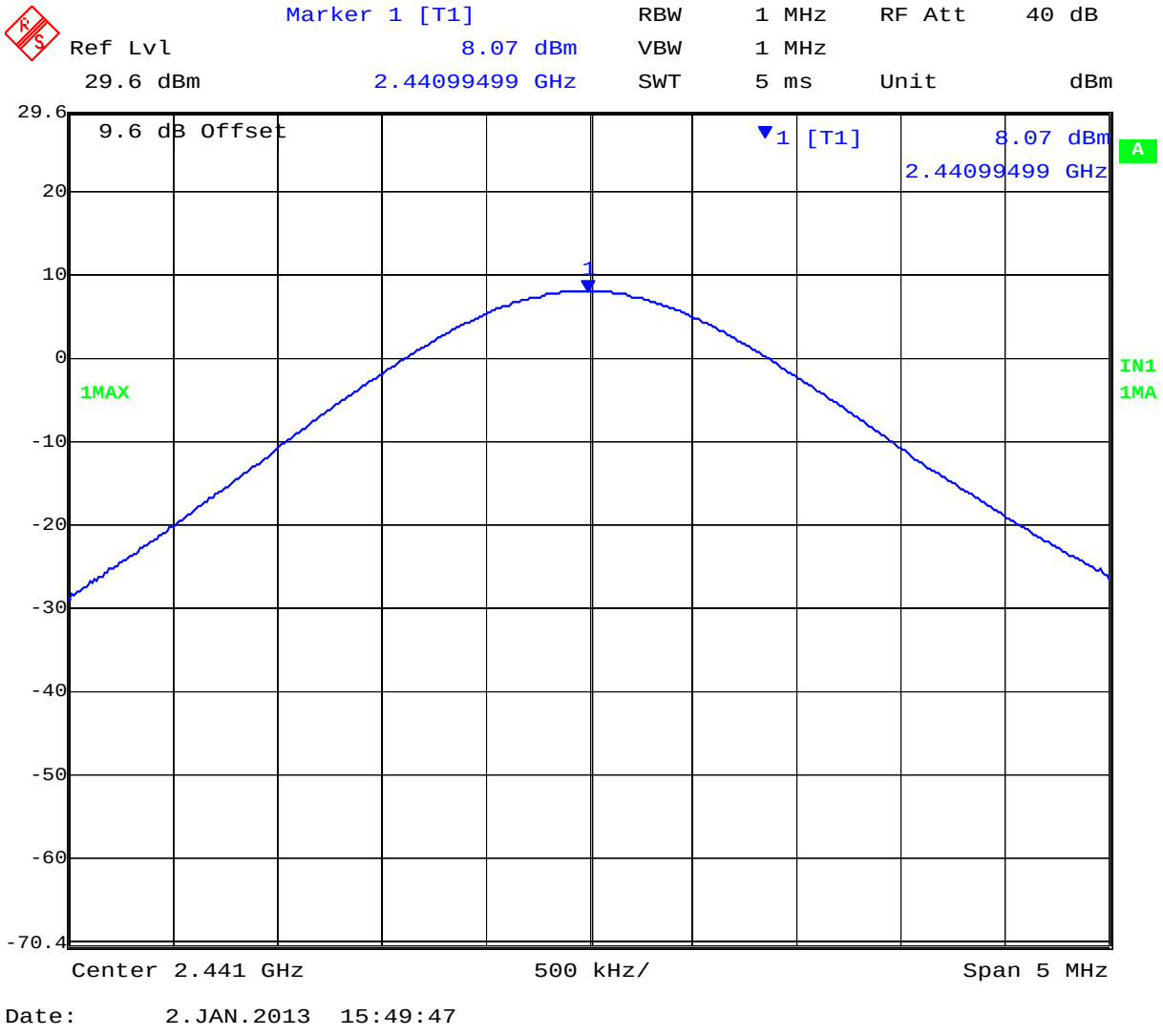
Test Frequency	Measured Output Power (dBm) Port(s)				Calculated Total Power (dBm)	Limit	Margin	EUT Power Setting
MHz	a	b	c	d	Σ Port(s)	dBm	dBm	
2402 (CH0)	7.96	--	--	--	7.96	30	-22.04	Max
2441 (CH39)	7.92	--	--	--	7.92	30	-22.08	Max
2480 (CH78)	7.34	--	--	--	7.34	30	-22.66	Max

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-01 MEASURING RF OUTPUT POWER
Measurement Uncertainty:	±1.33 dB

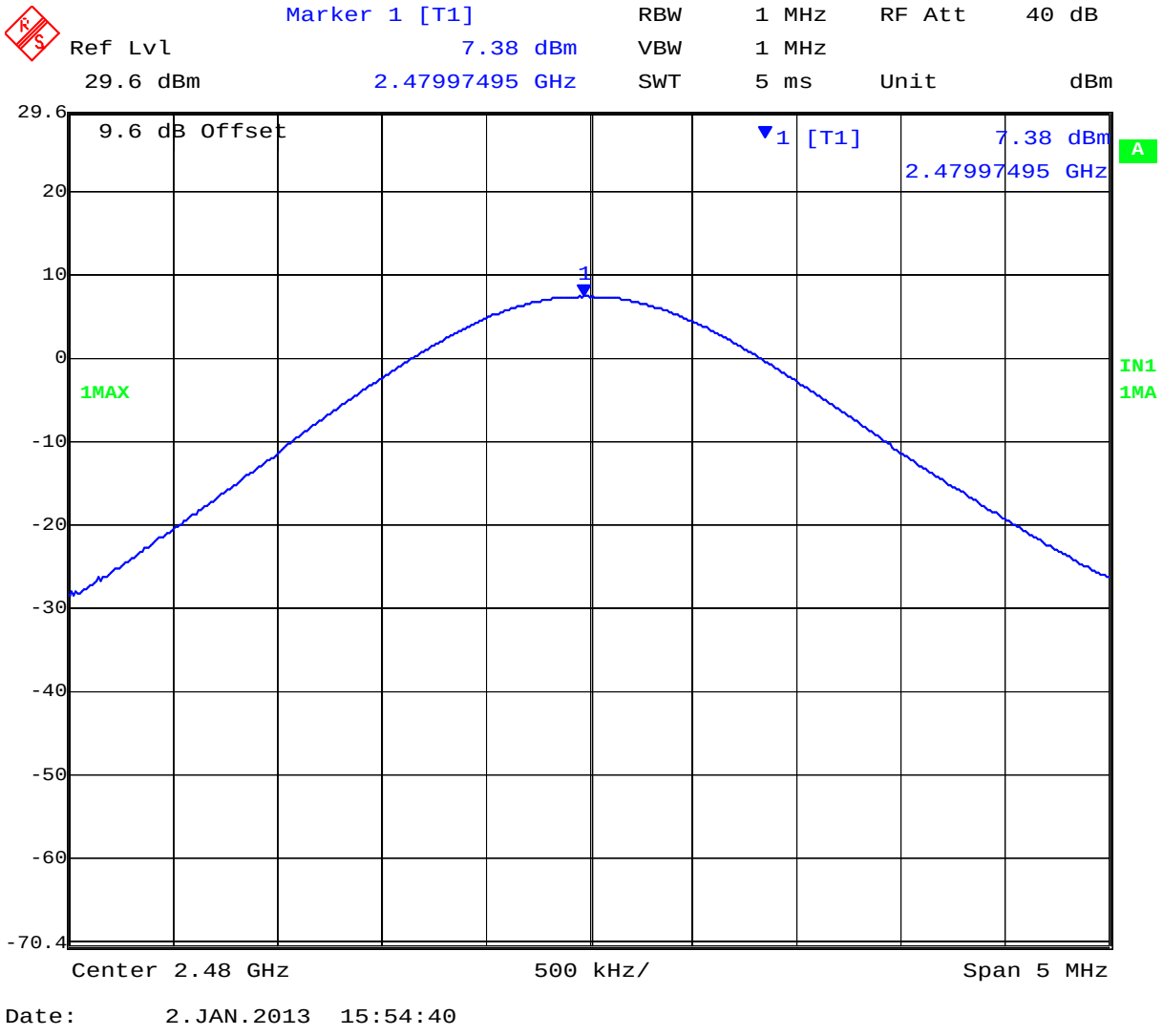
Peak Power, Channel 0, DH1 Packet Type



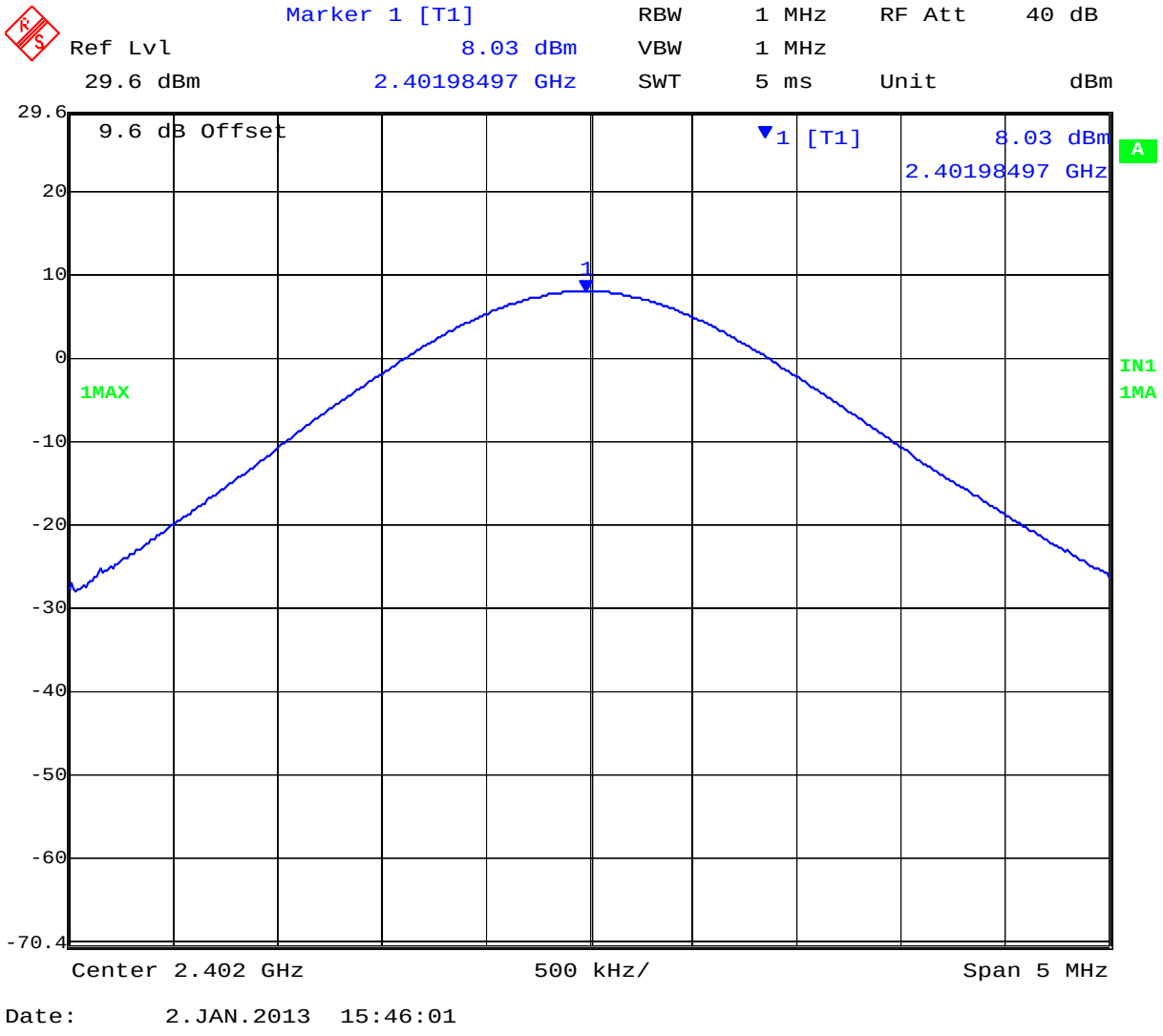
Peak Power, Channel 39, DH1 Packet Type



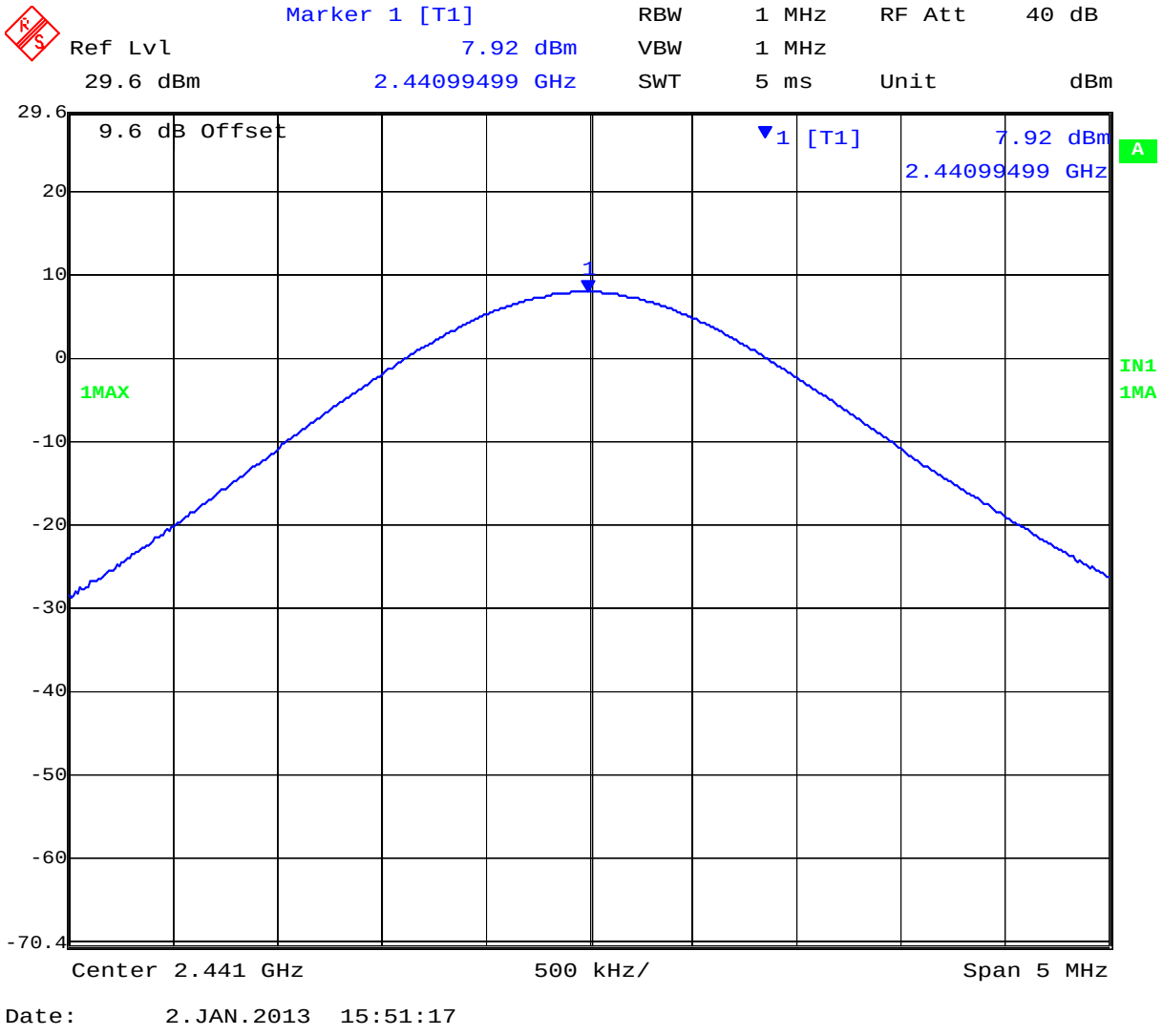
Peak Power, Channel 78, DH1 Packet Type



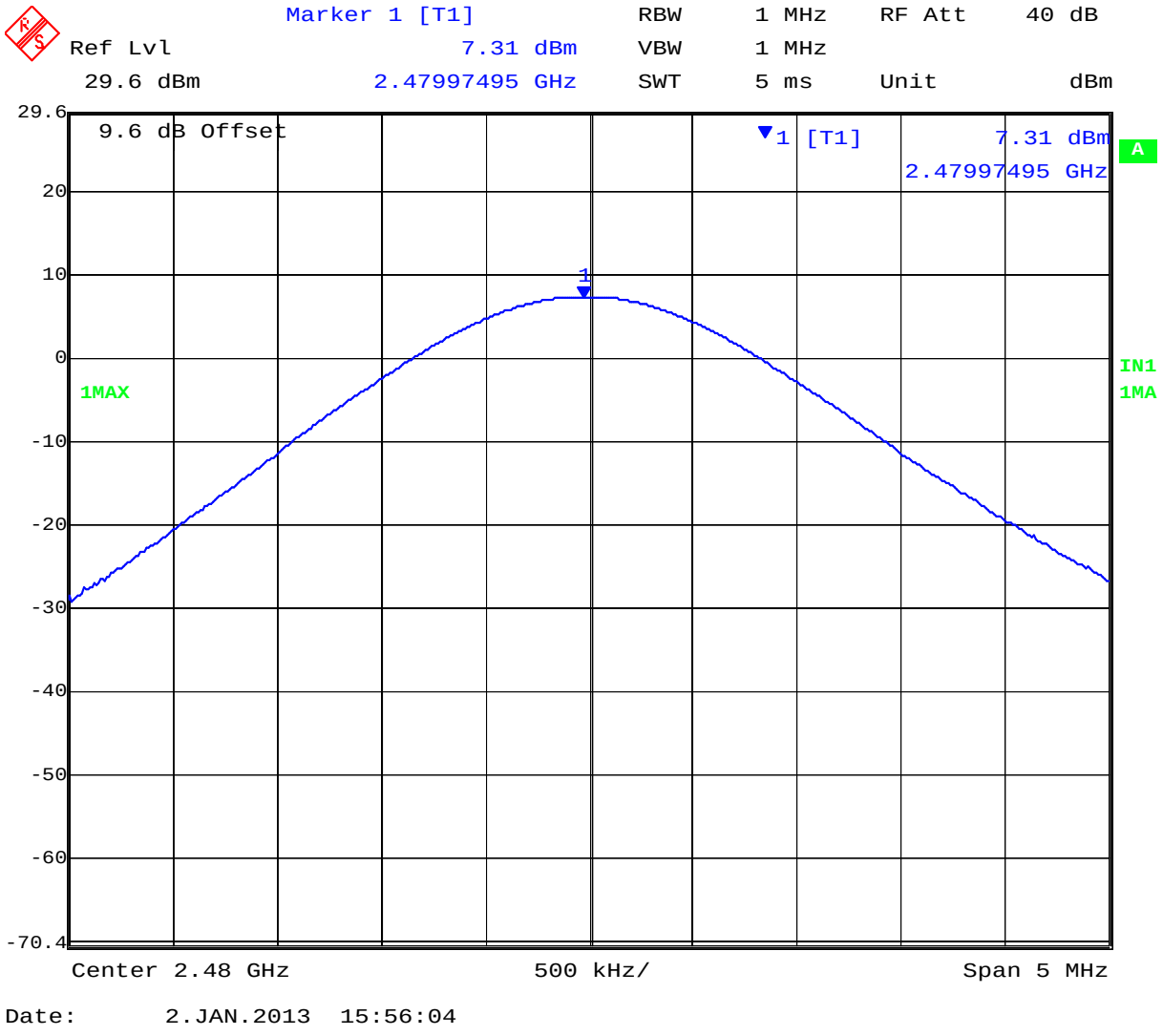
Peak Power, Channel 0, DH3 Packet Type



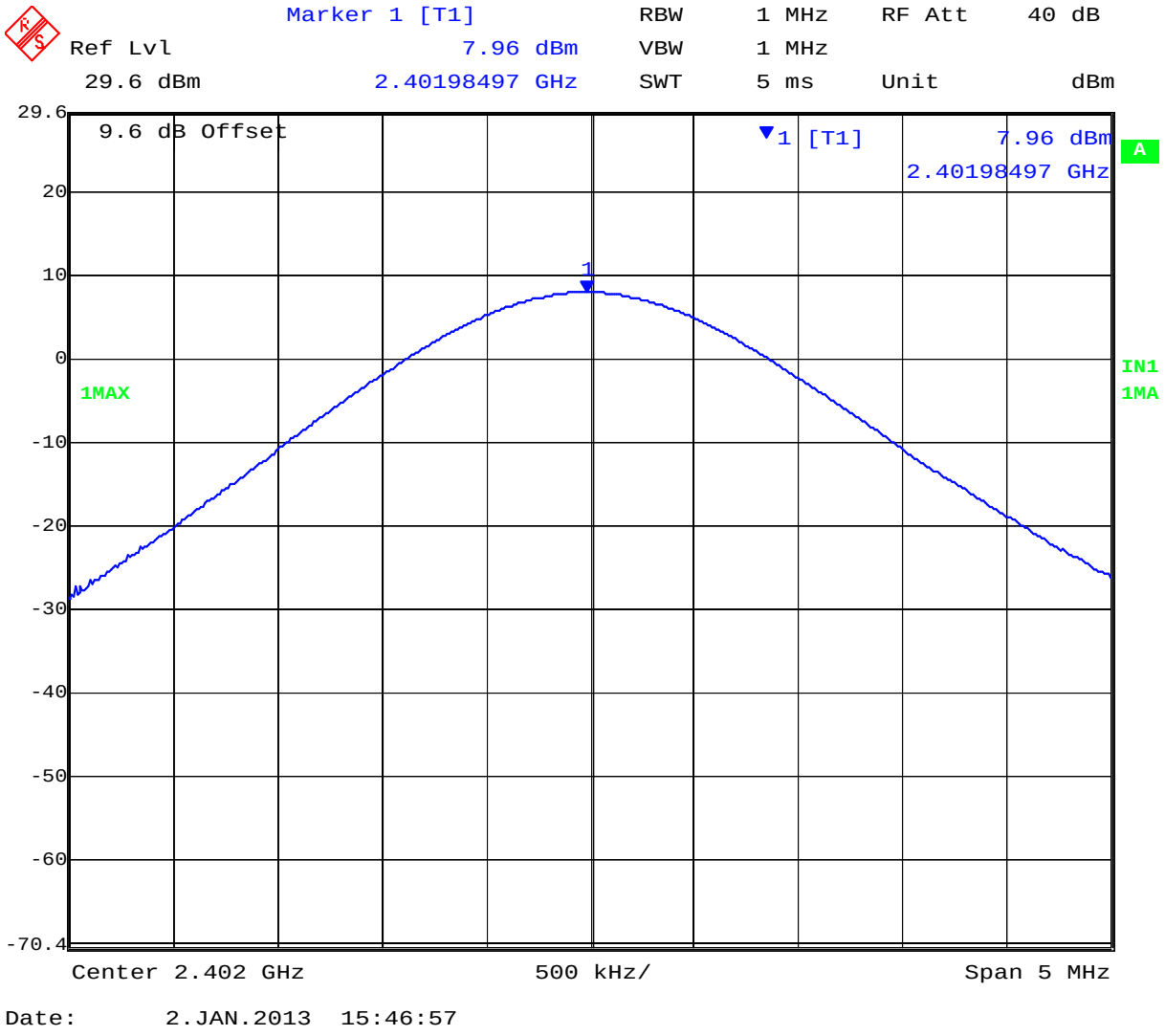
Peak Power, Channel 39, DH3 Packet Type



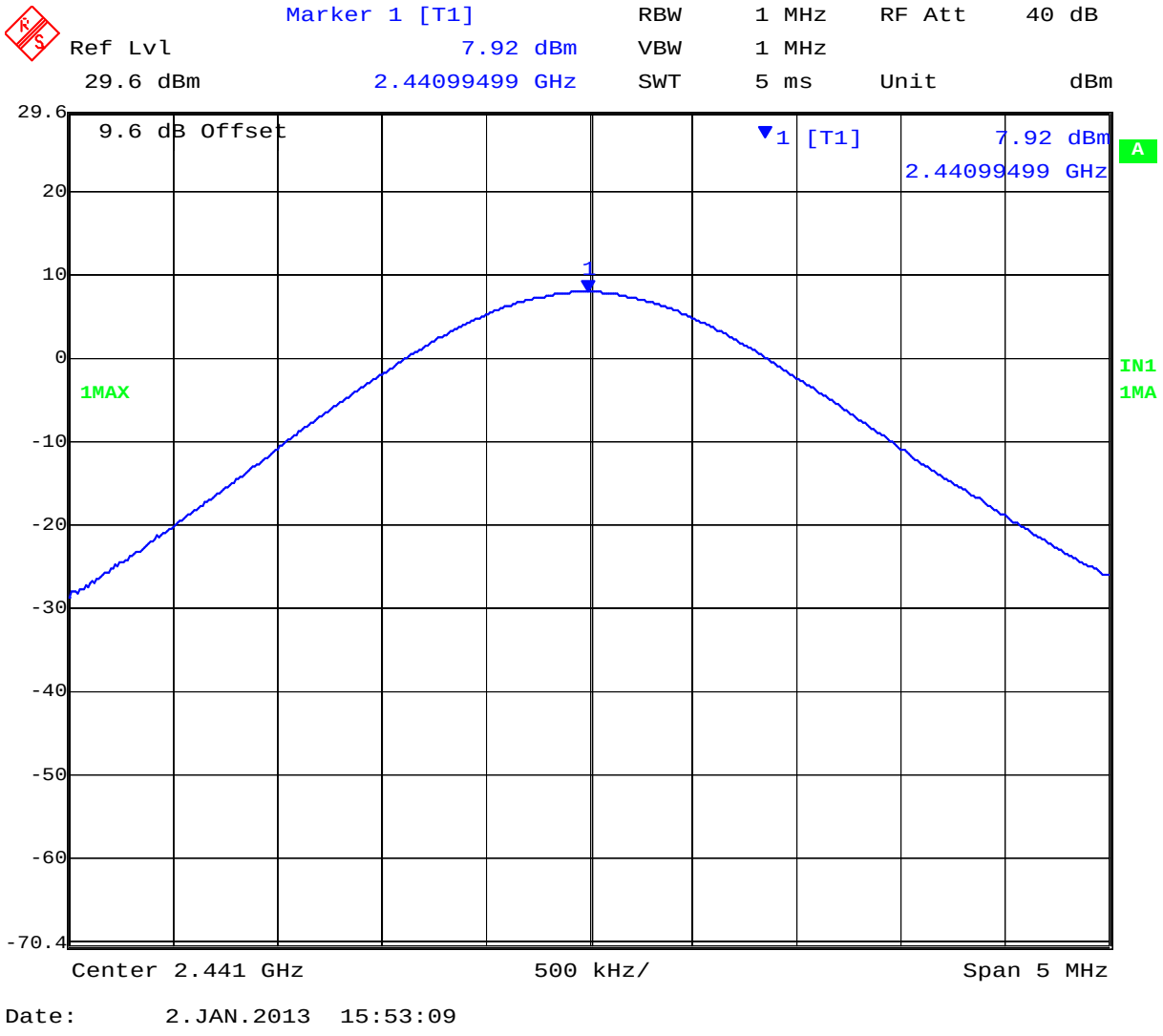
Peak Power, Channel 78, DH3 Packet Type



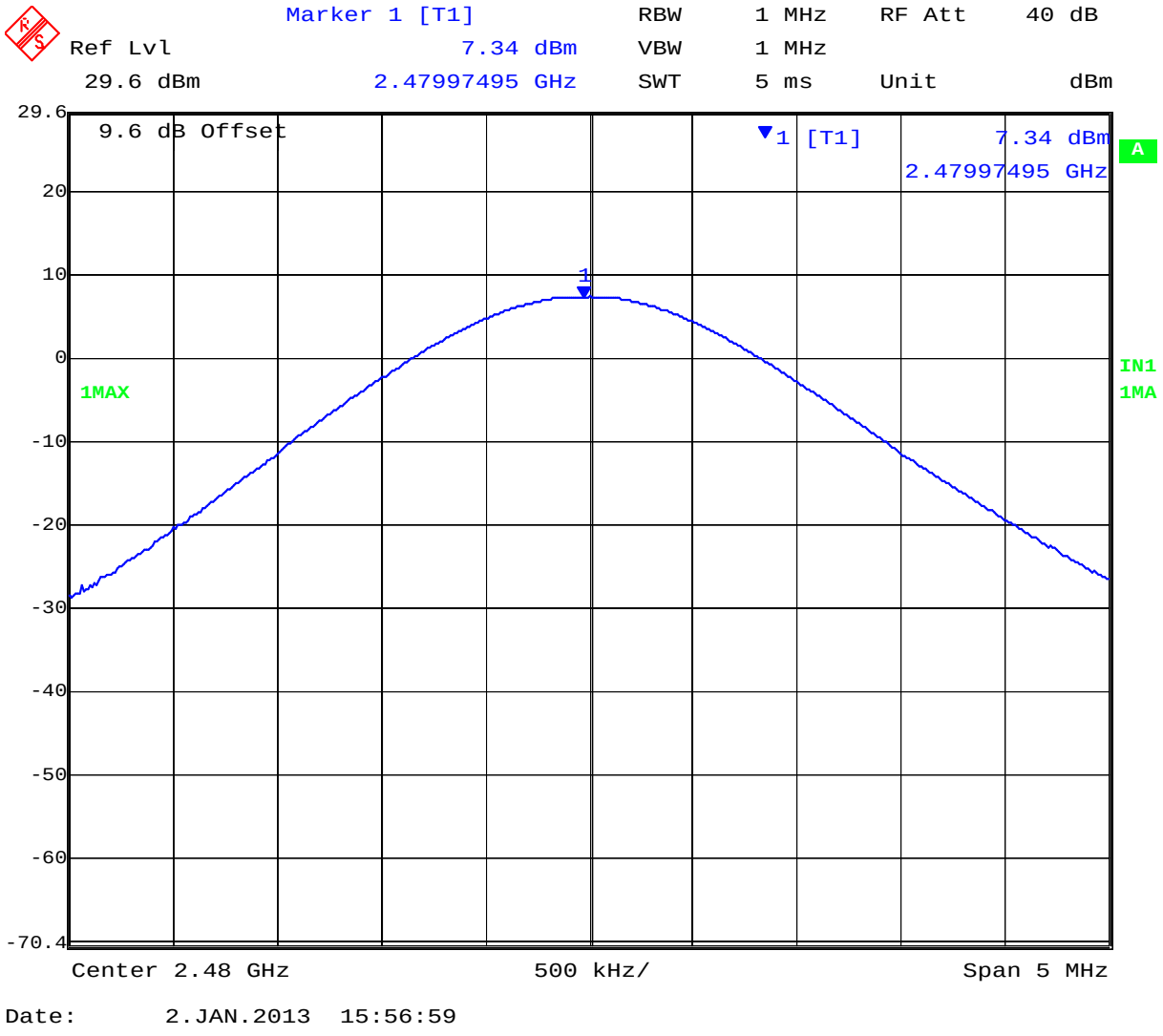
Peak Power, Channel 0, DH5 Packet Type



Peak Power, Channel 39, DH5 Packet Type



Peak Power, Channel 78, DH5 Packet Type



Specification Limits

§15.247 (b)(1)

(b) The maximum peakconducted output power of the intentional radiator shall not exceed the following.

(1) For frequency hopping systems 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.

§ RSS-210 A8.4(2) For frequency hopping systems operating in the 2400-2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted power shall not exceed 1 W; for all other frequency hopping systems in the band, the maximum peak conducted 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.

Traceability

Method	Test Equipment Used
FCC DA 00-0705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

6.1.7. Spurious RF Conducted Emissions –

Conducted Test Conditions for Transmitter Conducted Spurious and Band-Edge Emissions			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	Max Unwanted Emission Levels	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (d)	**Pressure (mBars):**	999 - 1001
Reference Document(s):	KDB 558074 - D01 DTS Measurement Guidance v01: Section 5.4 Maximum Unwanted Emission Levels		

Test Procedure for Transmitter Conducted Spurious and Band-Edge Emissions Measurement
Transmitter Conducted Spurious and Band-Edge emissions were measured at a limit of 20 dB below the highest in-band spectral density measured with a spectrum analyzer connected to the antenna terminal. Measurements were made while EUT was operating in transmit mode of operation at the appropriate centre frequency closest to the band-edge. Emissions were maximized during the measurement and limits derived from the peak spectral power and drawn on each plot.

Equipment Configuration for Transmitter Conducted Spurious and Band-Edge Emissions			
Variant:	802.15.2	**Duty Cycle (%):**	10%
Data Rate:	1 Mbit/s	**Antenna Gain (dBi):**	Not Applicable
Modulation:	GFSK	**Beam Forming Gain (Y):**	Not Applicable
TPC:	N/A		
Engineering Test Notes:			

Test Measurement Results DH5

Test Frequency	Frequency Range	Transmitter Conducted Spurious Emissions (dBm)							
		Port a		Port b		Port c		Port d	
MHz	MHz	SE	Limit	SE	Limit	SE	Limit	SE	Limit
2402.0	30.0 - 26000.0	-30.50	-13.3	--	--	--	--	--	--
2441.0	30.0 - 26000.0	-30.33	-12.0	--	--	--	--	--	--
2480.0	30.0 - 26000.0	-30.99	-18.6						
Hopping	30.0 - 26000.0	-30.42	-18.6	--	--	--	--	--	--

SE - Maximum spurious emission found

Test Frequency	Band-Edge Frequency	Transmitter Conducted Band-Edge Emissions (dBm)							
		Port a		Port b		Port c		Port d	
MHz	MHz	BE	Limit	BE	Limit	BE	Limit	BE	Limit
Hopping	2400.0	-34.8	-19.0	--	--	--	--	--	--
2402.0	2400.0	-37.21	-13.03						
Hopping	2483.5	-36.46	-18.60						
2480.0	2483.5	-35.39	-13.30	--	--	--	--	--	--

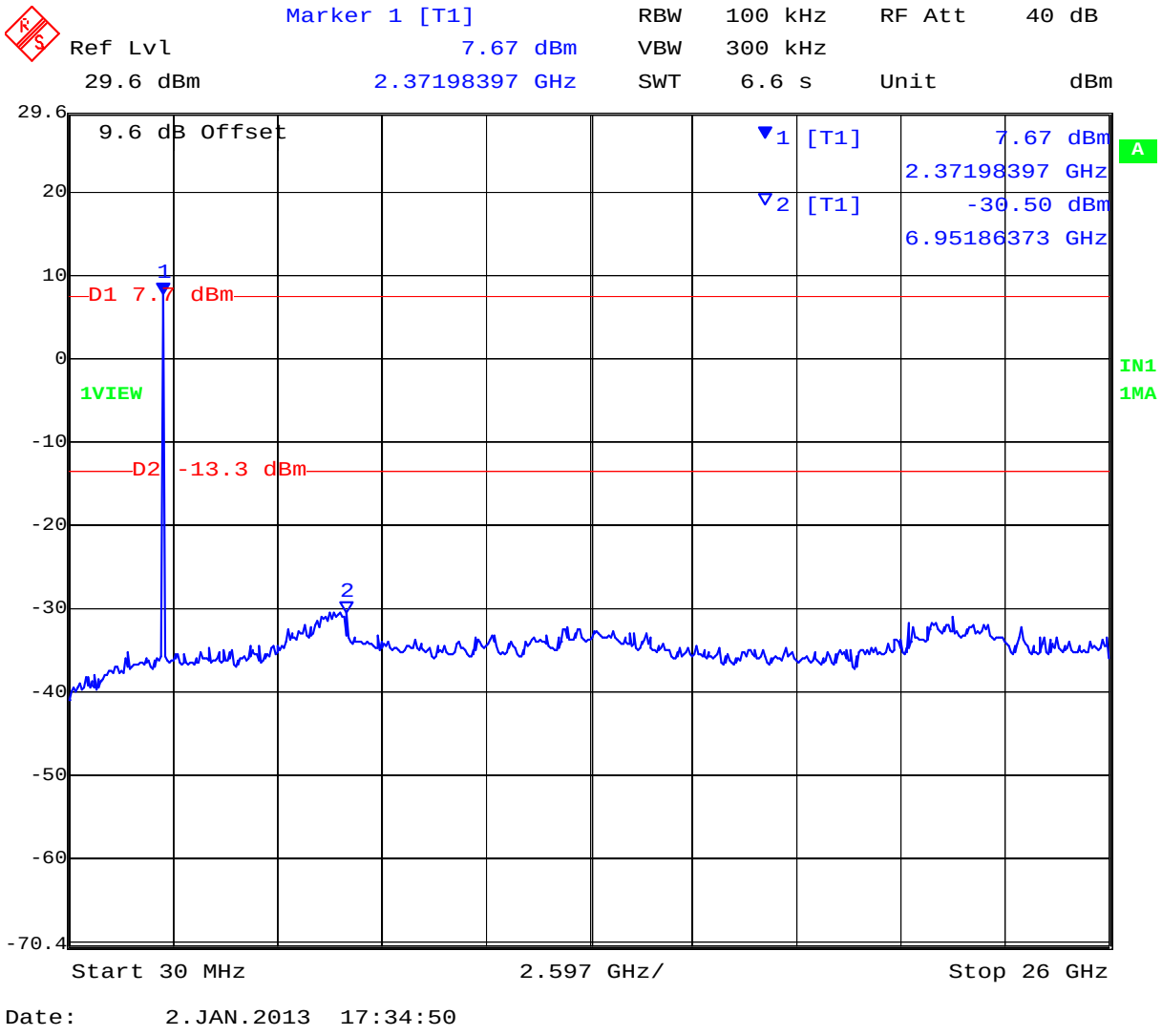
BE - Maximum band-edge emission found

Test Frequency	Frequency Range	Receiver Conducted Spurious Emissions (dBm)							
		Port a		Port b		Port c		Port d	
MHz	MHz	RE	Limit	SE	Limit	SE	Limit	SE	Limit
NA	30.0 - 1000.0	-30.50	-57.0	--	--	--	--	--	--
NA	1000.0 - 26000.0	-30.33	-54.0	--	--	--	--	--	--

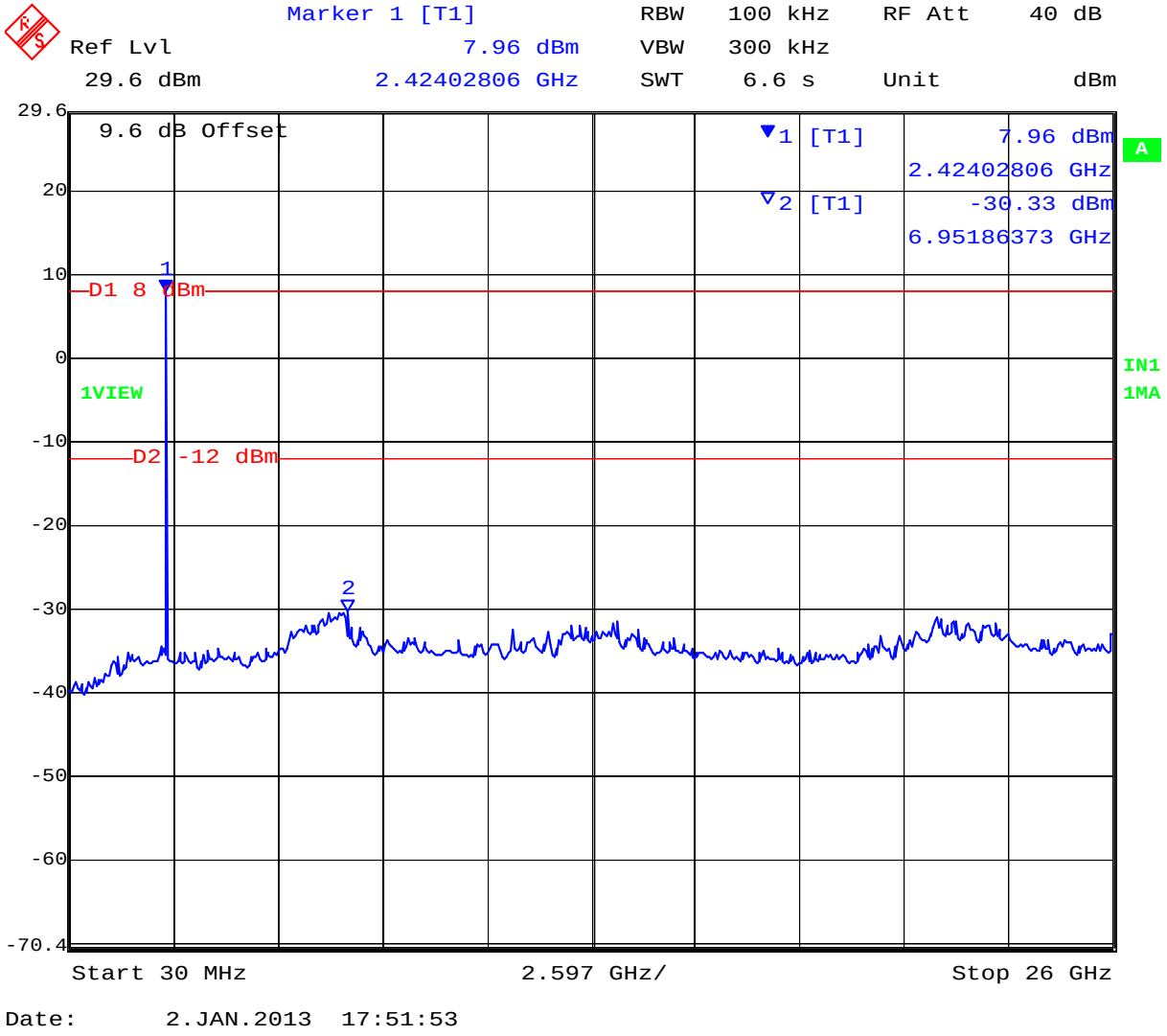
RE - Maximum spurious emission found

Traceability to Industry Recognized Test Methodologies	
Work Instruction:	WI-05 MEASUREMENT OF SPURIOUS EMISSIONS
Measurement Uncertainty:	= 40 GHz ±2.37 dB, > 40 GHz ±4.6 dB

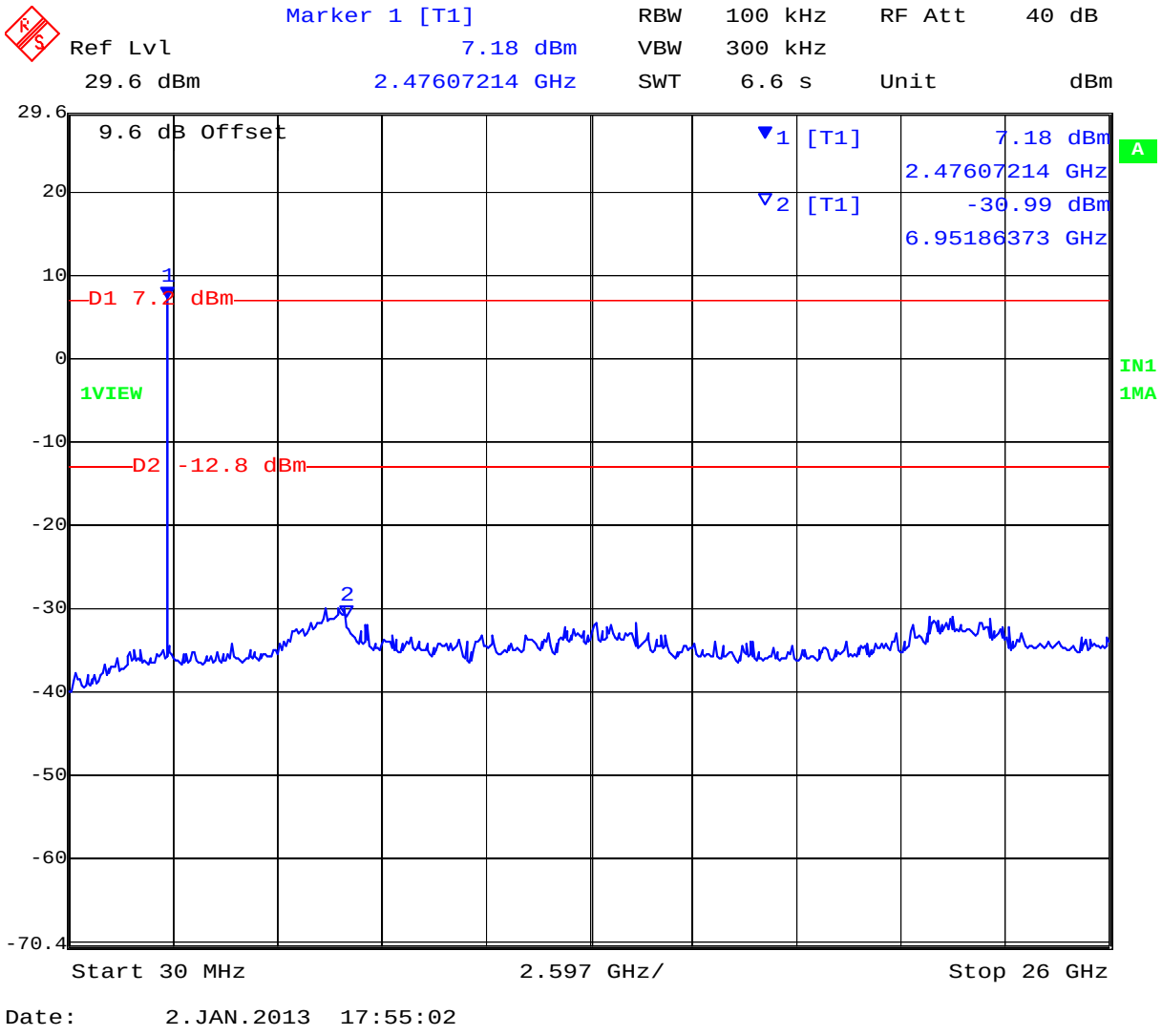
Test Results Transmitter Conducted Spurious Emissions CH0:



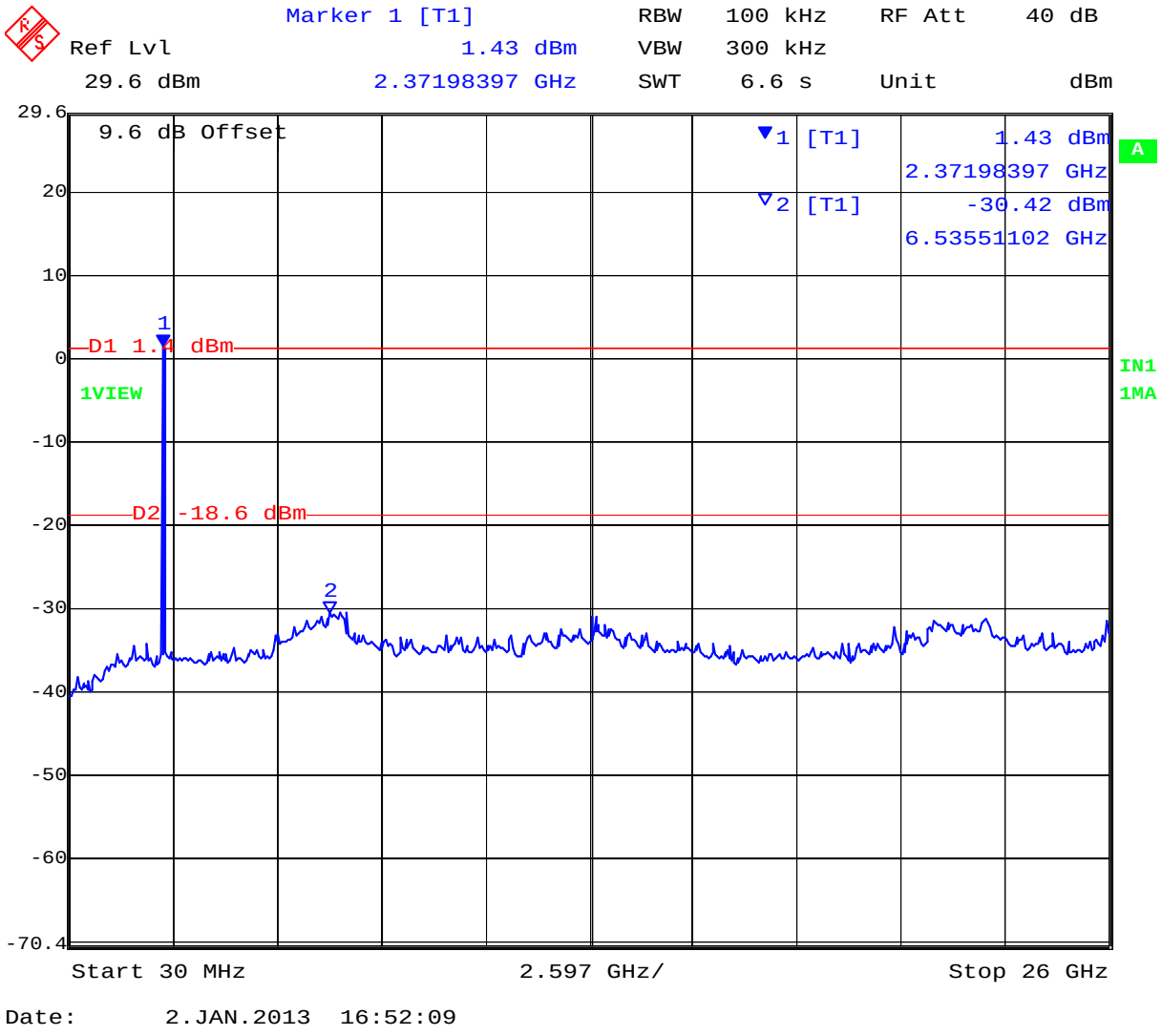
Test Results Transmitter Conducted Spurious Emissions CH39:



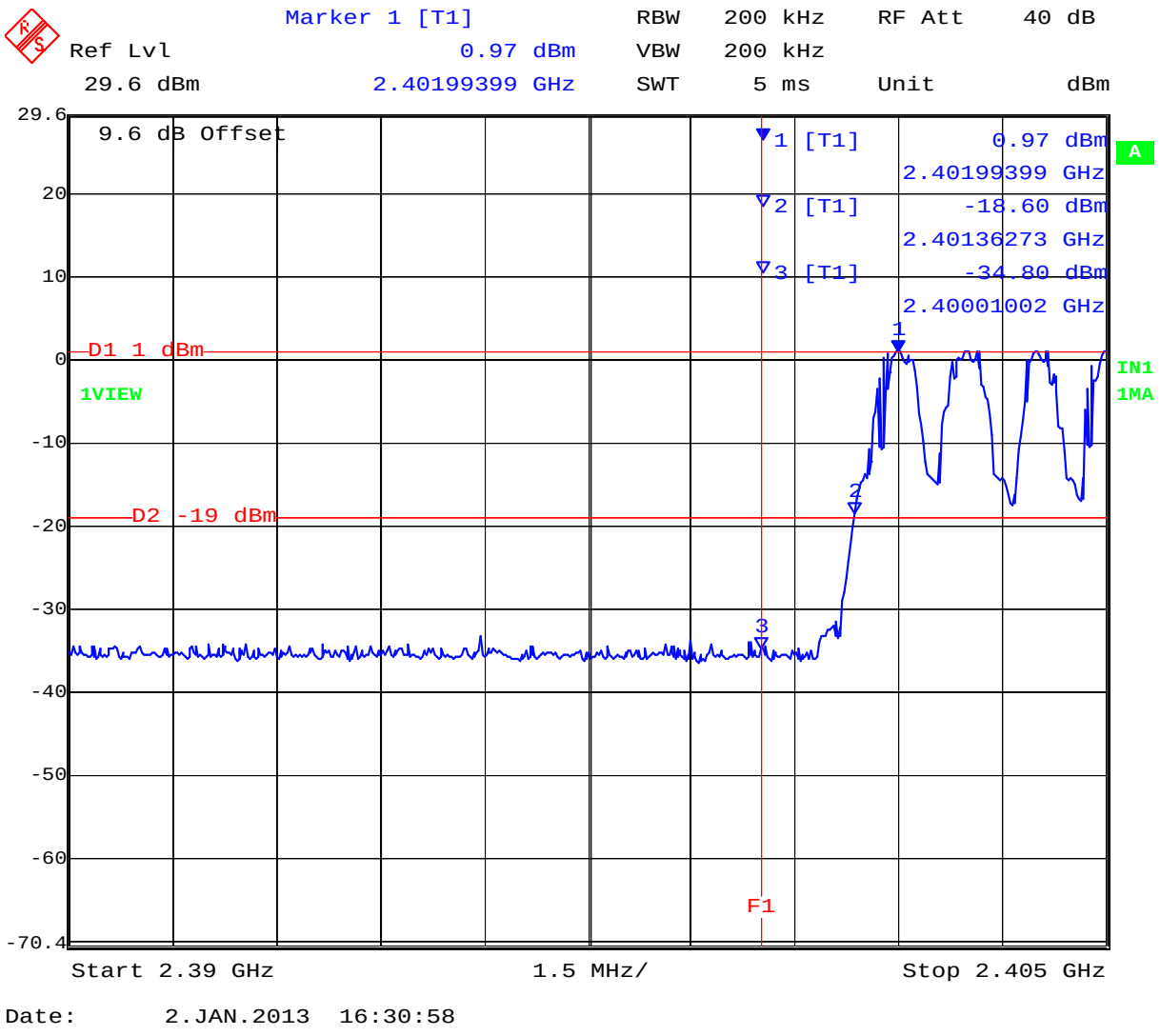
Test Results Transmitter Conducted Spurious Emissions CH78:



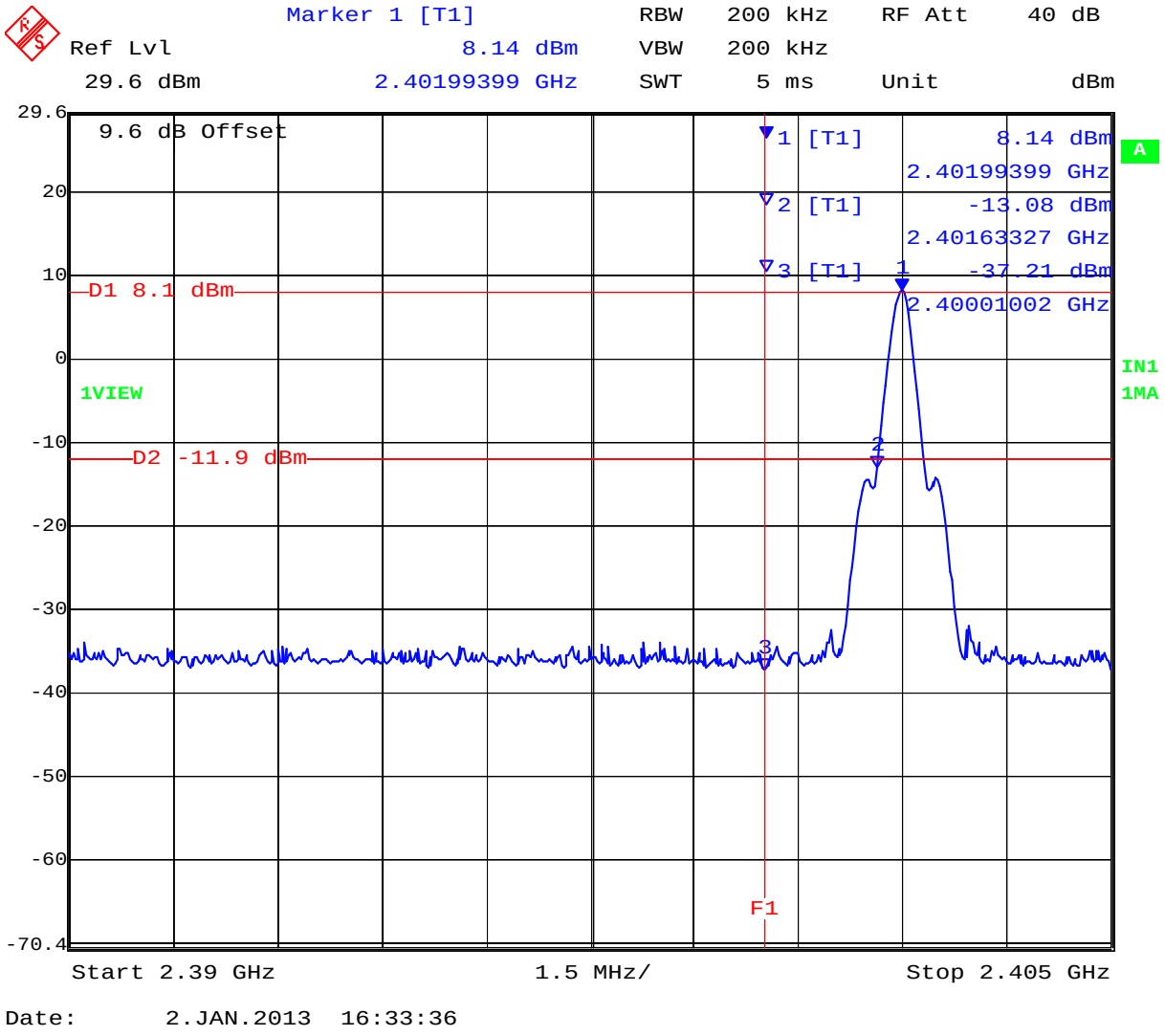
Test Results Transmitter Conducted Spurious Emissions Hopping:



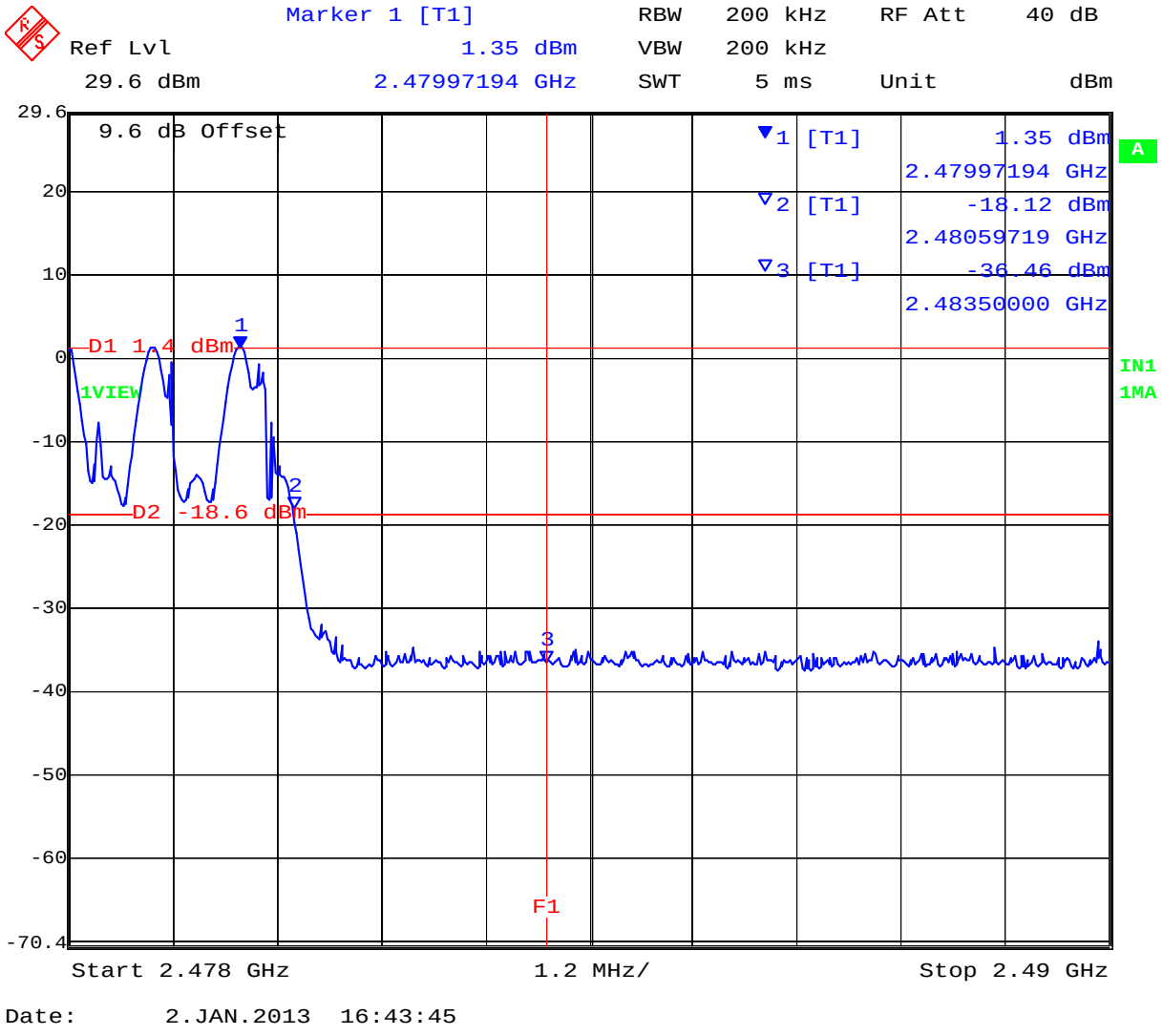
Lower Band Edge; Channel 0 -2402; Hopping On



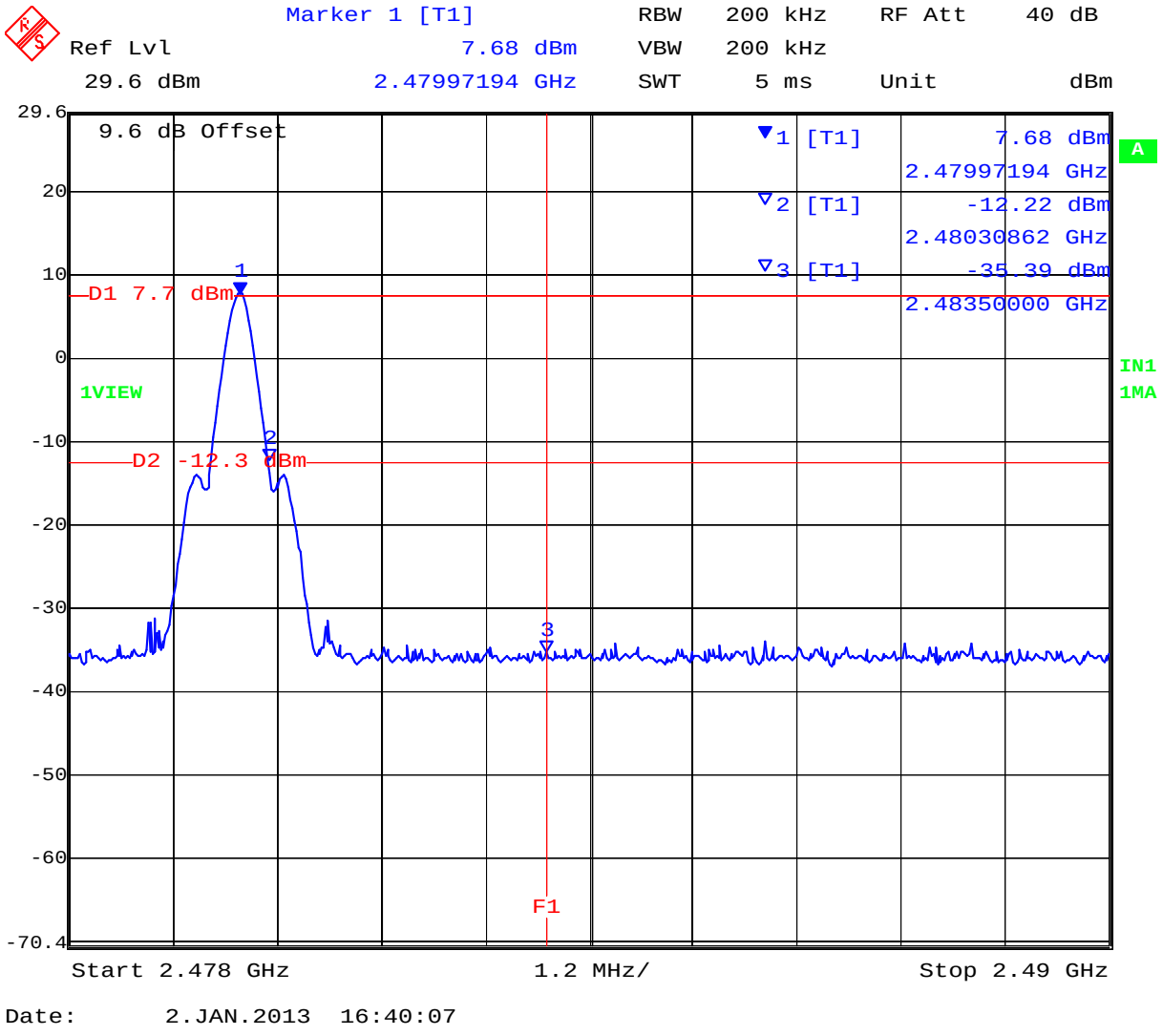
Lower Band Edge; Channel 0 -2402; Hopping Off



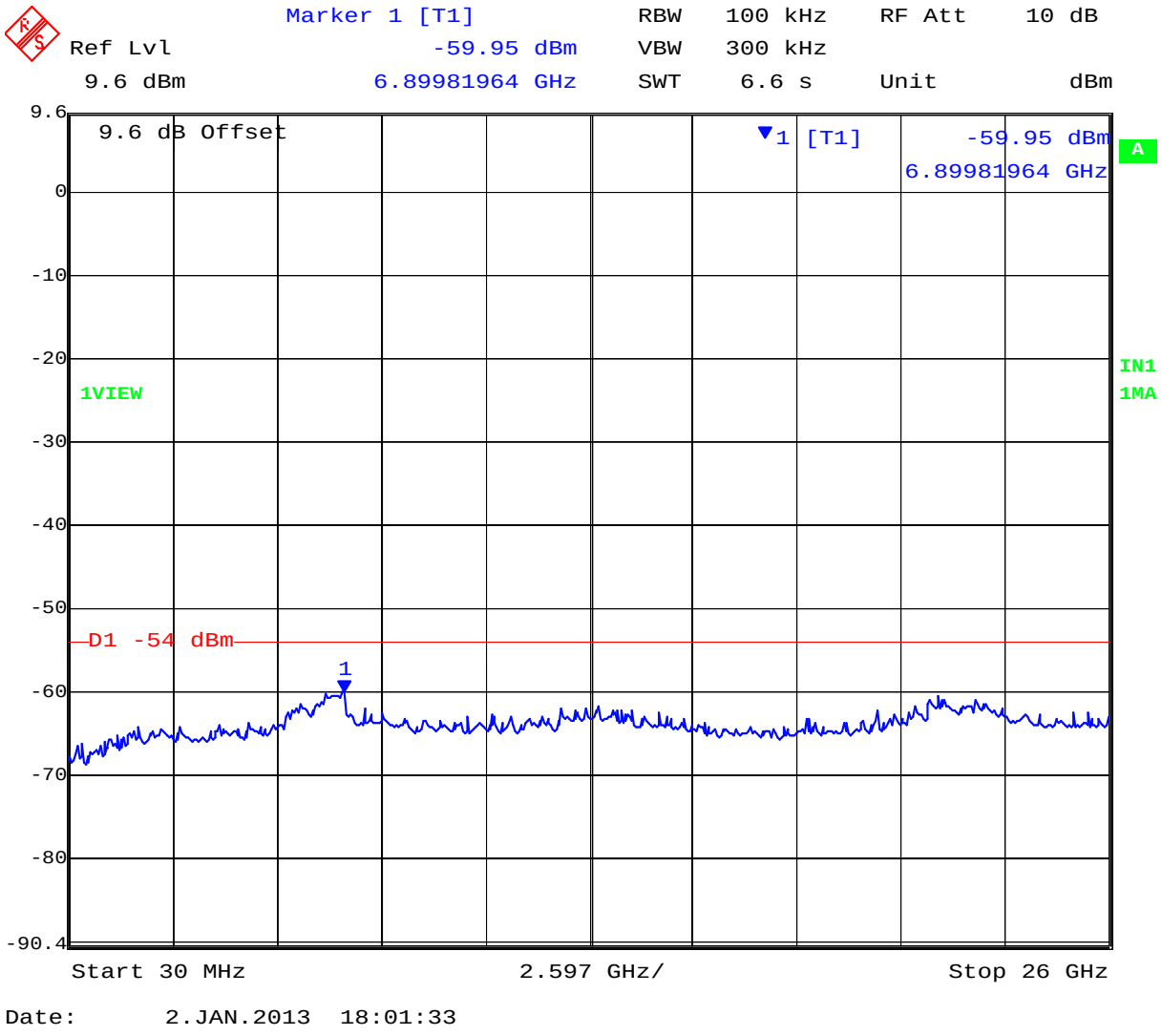
Upper Band Edge; Channel 78 -2480; Hopping On



Upper Band Edge; Channel 0 -2480; Hopping Off



Test Results Receiver Conducted Spurious Emissions:



§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 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 into the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) (see §15.205(c)).

§ 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 or 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 the 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:

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

Traceability

Method	Test Equipment Used
FCC DA 00-0705	0158, 0193, 0287, 0252, 0313, 0314, 0070, 0116, 0117

6.1.8. Pseudorandom Hopping Frequency Sequence

Test Conditions for Pseudorandom Hopping Frequency Sequence			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	Pseudorandom Hopping Sequence	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(1)	**Pressure (mBars):**	999 - 1004
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

Pseudorandom Frequency Hopping Sequence

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 (a)(1).

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 Bluetooth standard defines an algorithmic basis for determining the pseudorandom sequence to use.

Specifications

§15.247 (a) (1)

(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.

6.1.9. Equal Hopping Frequency Use

Test Conditions for Equal Hopping Frequency Use			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	Equal Hopping Frequency Use	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(1)	**Pressure (mBars):**	999 - 1004
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

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 hoppinfg sequence after the final channel used in the previous transmission event). See Section (a)(1).

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.

Specifications

§15.247 (a) (1)

(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.

6.1.10. System Receiver Input Bandwidth

Test Conditions for System Receiver Input Bandwidth			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	System Receiver Input Bandwidth	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(1)	**Pressure (mBars):**	999 - 1004
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

System Receiver Input Bandwidth

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 hoppinfg sequence after the final channel used in the previous transmission event). See Section (a)(1).

Declaration from the Manufacturer

Chipset by Atheros AR6233 802.11abgn +BT is used in the design and 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.

Specifications

§15.247 (a) (1)

(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.

§ RSS-210 A8.1 (b) (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

6.1.11. System Receiver Hopping Capability

Test Conditions for System Receiver Hopping Capability			
Standard:	FCC CFR 47:15.247	**Ambient Temp. (ºC):**	18.0 - 27.5
Test Heading:	System Receiver Hopping Capability	**Rel. Humidity (%):**	32 - 45
Standard Section(s):	15.247 (a)(1)	**Pressure (mBars):**	999 - 1004
Reference Document(s):	FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems		

System Receiver Hopping Capability

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals. See Section (a)(1).

Declaration from the Manufacturer

A slave device follows the master device's hopping sequence by quickly scanning 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 detmine 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.

Specifications

§15.247 (a) (1)

(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.

§ RSS-210 A8.1 (b) (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

6.2. 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

The worst case highest spectral density 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

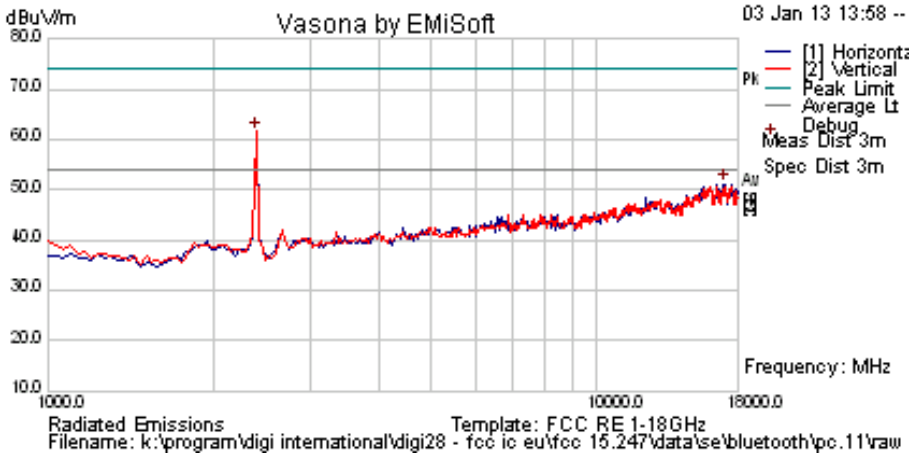
Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

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

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

6.2.1. Patch PC.11

Test Freq.	Chan 0	**Engineer**	JMH
Variant	Bluetooth	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	PC.11	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

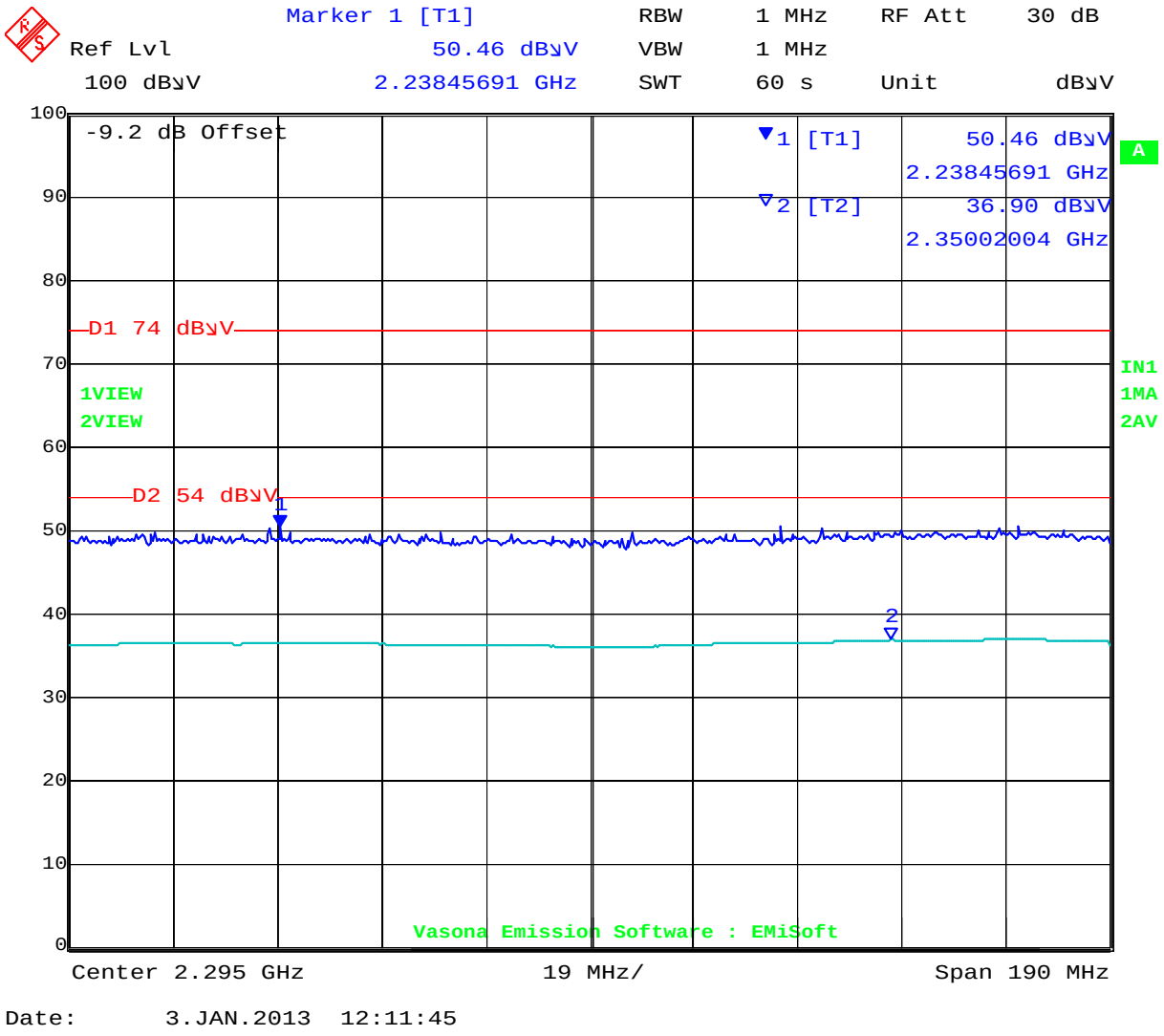


Formally measured emission peaks

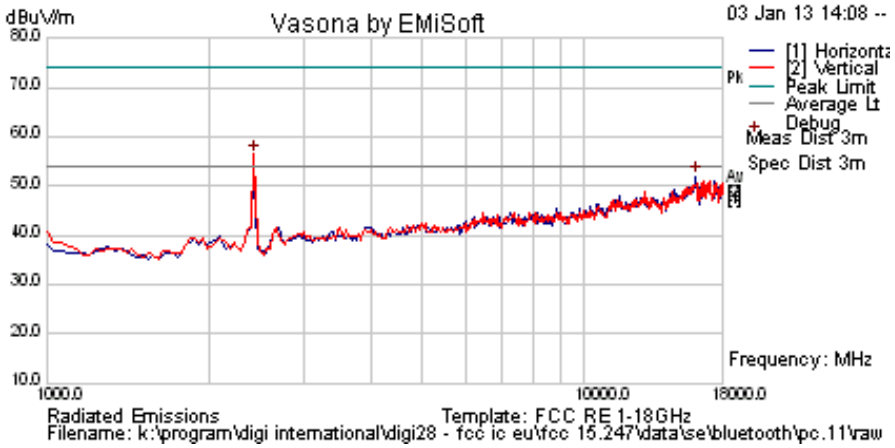
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2396.794	70.4	3.0	-11.7	61.7	Peak [Scan]	H						Fund
17012.024	42.4	8.5	0.3	51.2	Peak [Scan]	H	150	0	54.0	-2.8	Pass	Noise

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



Test Freq.	Chan 39	**Engineer**	JMH
Variant	Bluetooth	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	PC.11	**Duty Cycle (%)**	100
Test Notes 1	0		
Test Notes 2			

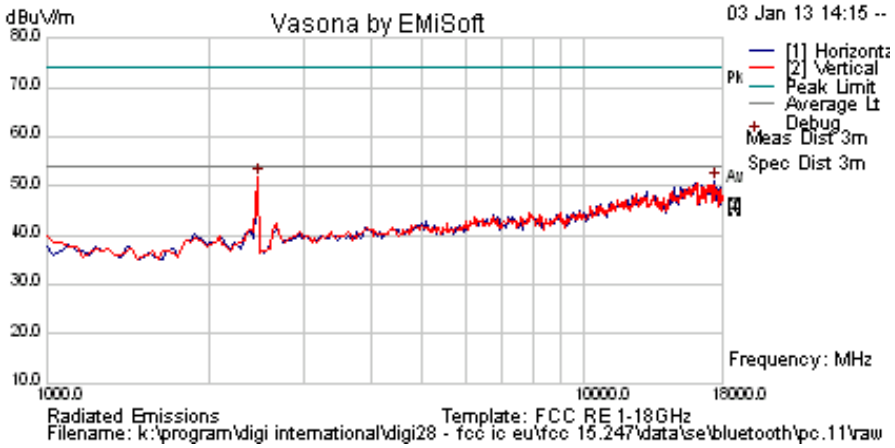


Formally measured emission peaks

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
2441.002	65.0	3.0	-11.5	56.4	Peak [Scan]	V						Fund
16092.184	42.6	9.0	0.3	51.9	Peak [Scan]	H	100	0	54.0	-2.1	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.	Chan 78	**Engineer**	JMH
Variant	Bluetooth	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	PC.11	**Duty Cycle (%)**	100
Test Notes 1	0		
Test Notes 2			

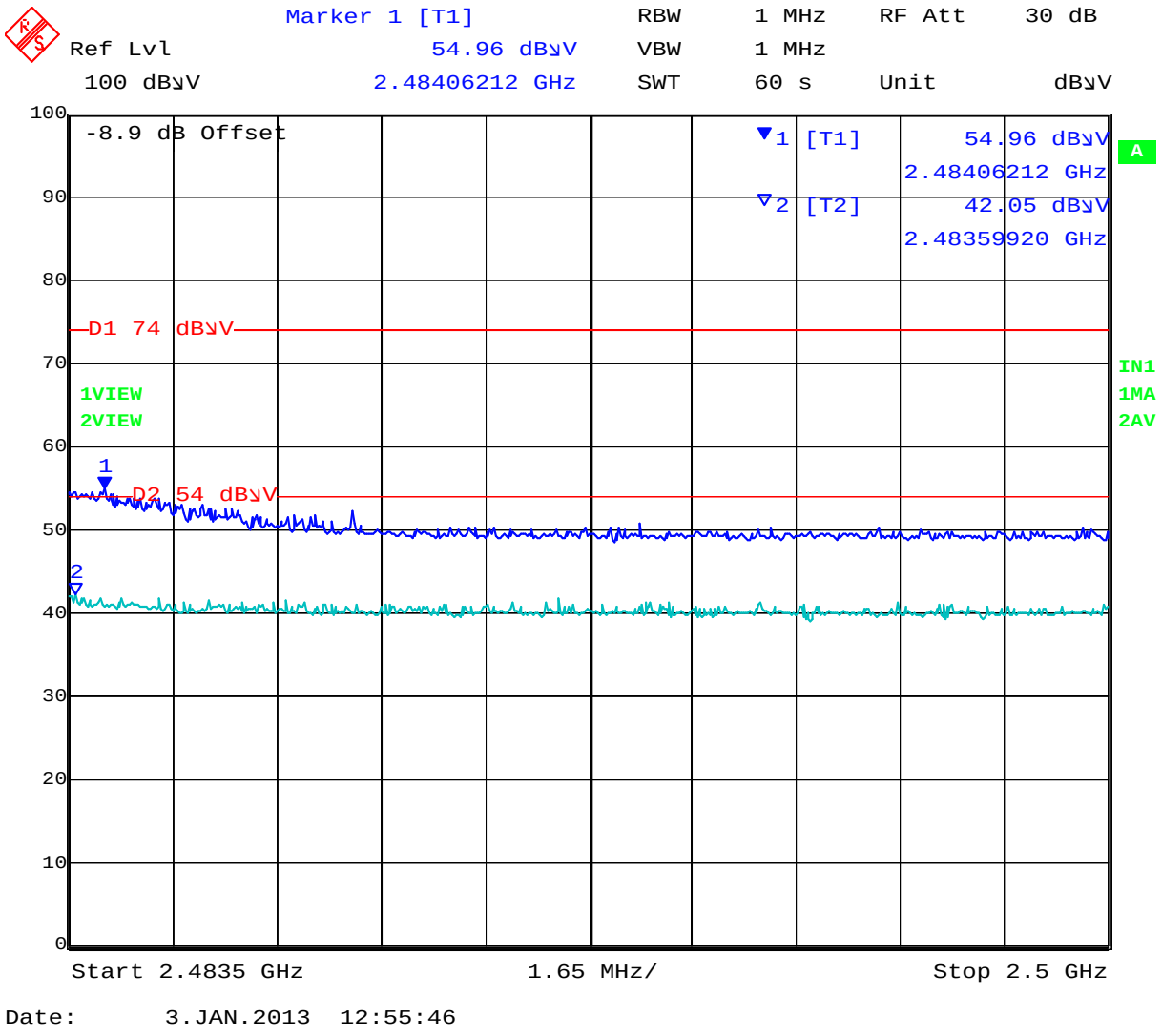


Formally measured emission peaks

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
2479.960	60.2	3.0	-11.5	51.7	Peak [Scan]	V						Fund
17454.91	41.1	8.7	1.2	51.0	Peak [Scan]	H	150	0	54.0	-3.0	Pass	Noise

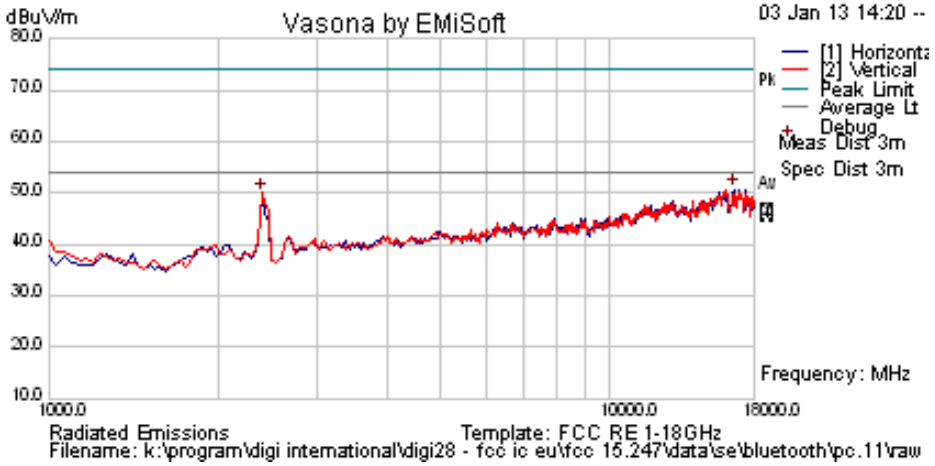
Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Band Edge



Hopping

Test Freq.	Hopping	**Engineer**	0
Variant	Bluetooth	**Temp (ºC)**	0
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	0
Power Setting	Max	**Press. (mBars)**	0
Antenna	PC.11	**Duty Cycle (%)**	100
Test Notes 1	Chan 78		
Test Notes 2	Bluetooth Master Blaster		

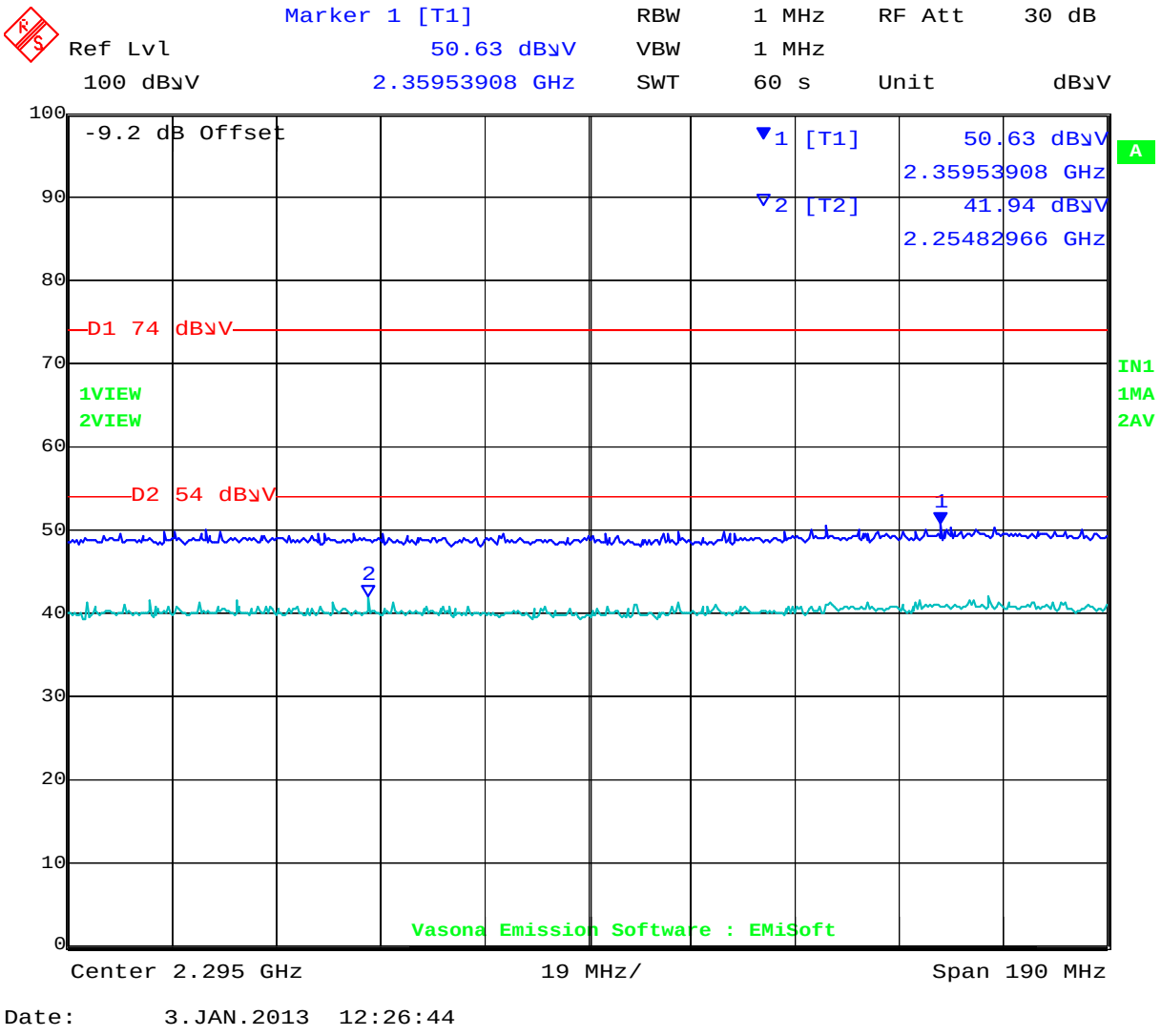


Formally measured emission peaks

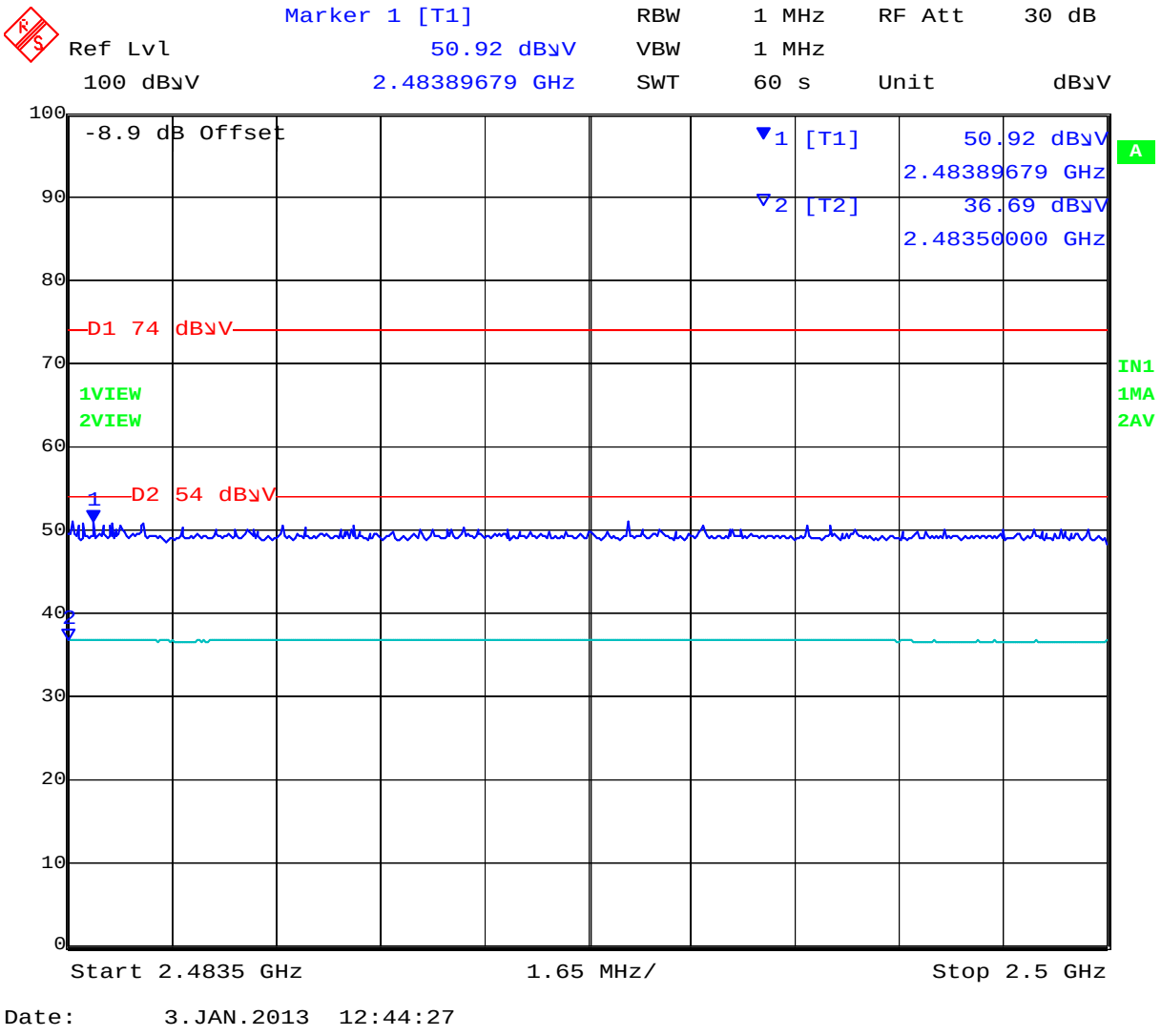
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2396.794	58.8	3.0	-11.7	50.1	Peak [Scan]	V						Fund
16569.138	41.5	8.8	0.5	50.8	Peak [Scan]	H	100	0	54.0	-3.2	Pass	Noise

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 2390-2400



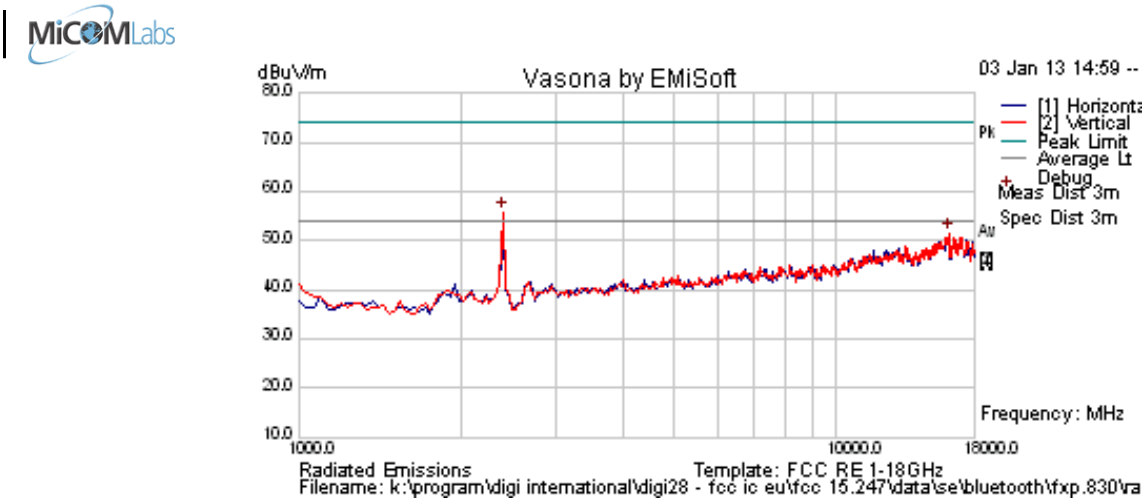
Band Edge 2483.5-2500



Date: 3.JAN.2013 12:44:27

6.2.2. FXP.830 Antenna:

Test Freq.	Chan 0	**Engineer**	JMH
Variant	Bluetooth Master Blaster	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	FXP830 patch	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

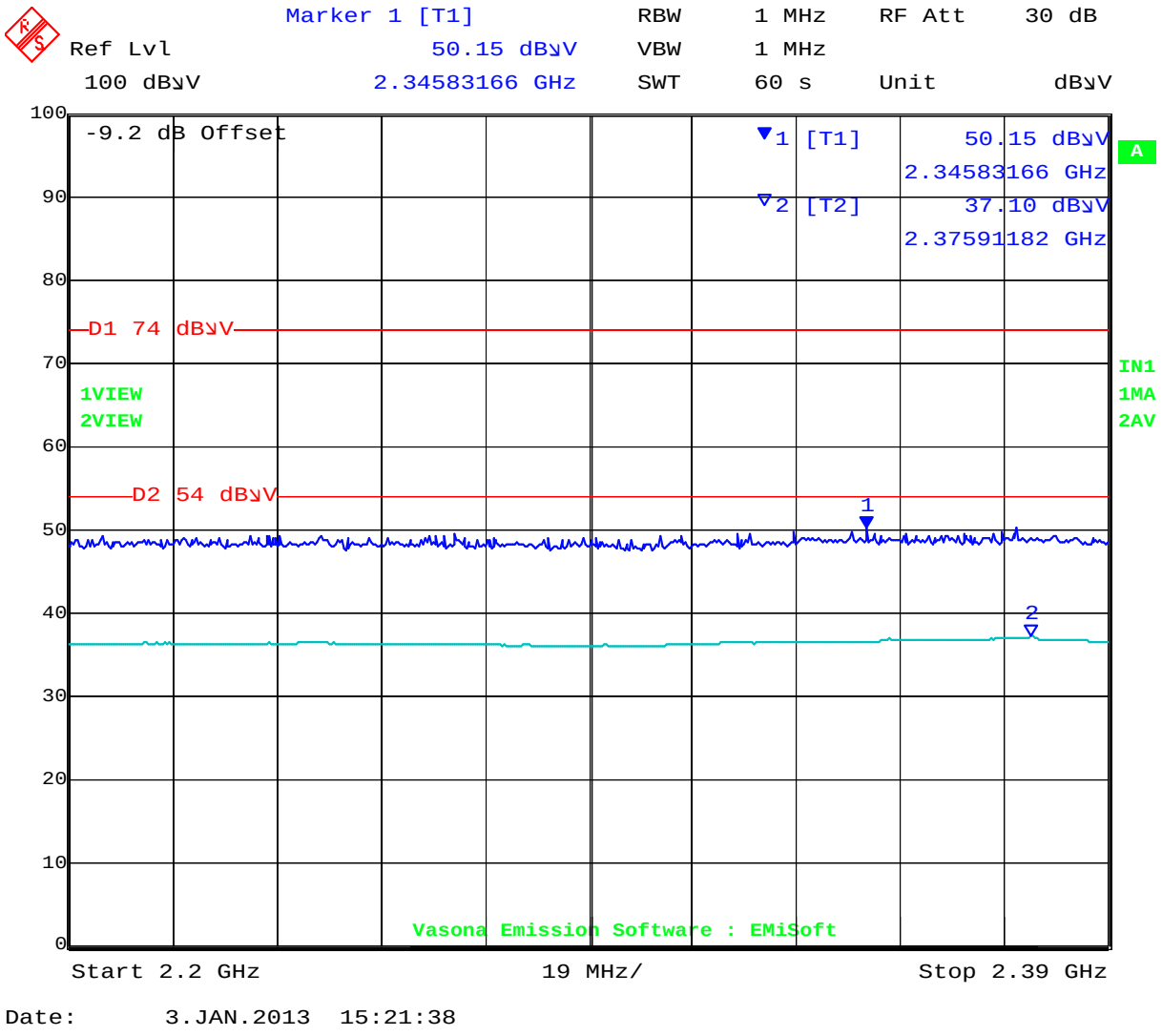


Formally measured emission peaks

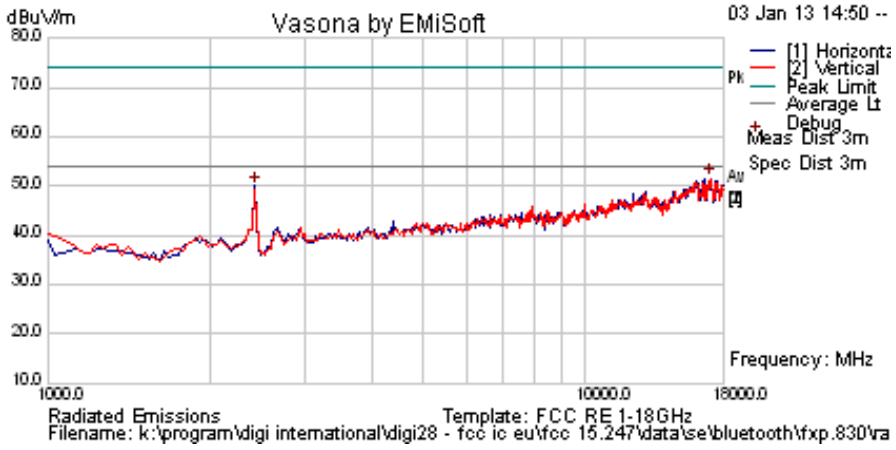
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2402.104	64.6	3.0	-11.6	55.9	Peak [Scan]	V						FUND
16126.253	42.4	9.0	0.2	51.6	Peak [Scan]	V	100	0	54.0	-2.4	Pass	Noise

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



Test Freq.	Chan 39	**Engineer**	JMH
Variant	Bluetooth Master Blaster	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	FXP830 patch	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

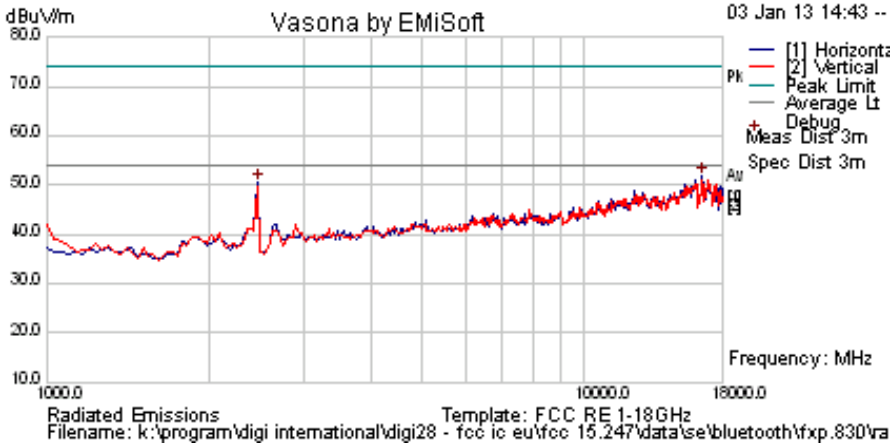


Formally measured emission peaks

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
2441.082	58.5	3.0	-11.5	49.9	Peak [Scan]	H						FUND
17080.16	42.7	8.5	0.4	51.6	Peak [Scan]	H	100	0	54.0	-2.4	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.	Chan 78	**Engineer**	JMH
Variant	Bluetooth Master Blaster	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	FXP830 patch	**Duty Cycle (%)**	100
Test Notes 1	0		
Test Notes 2			

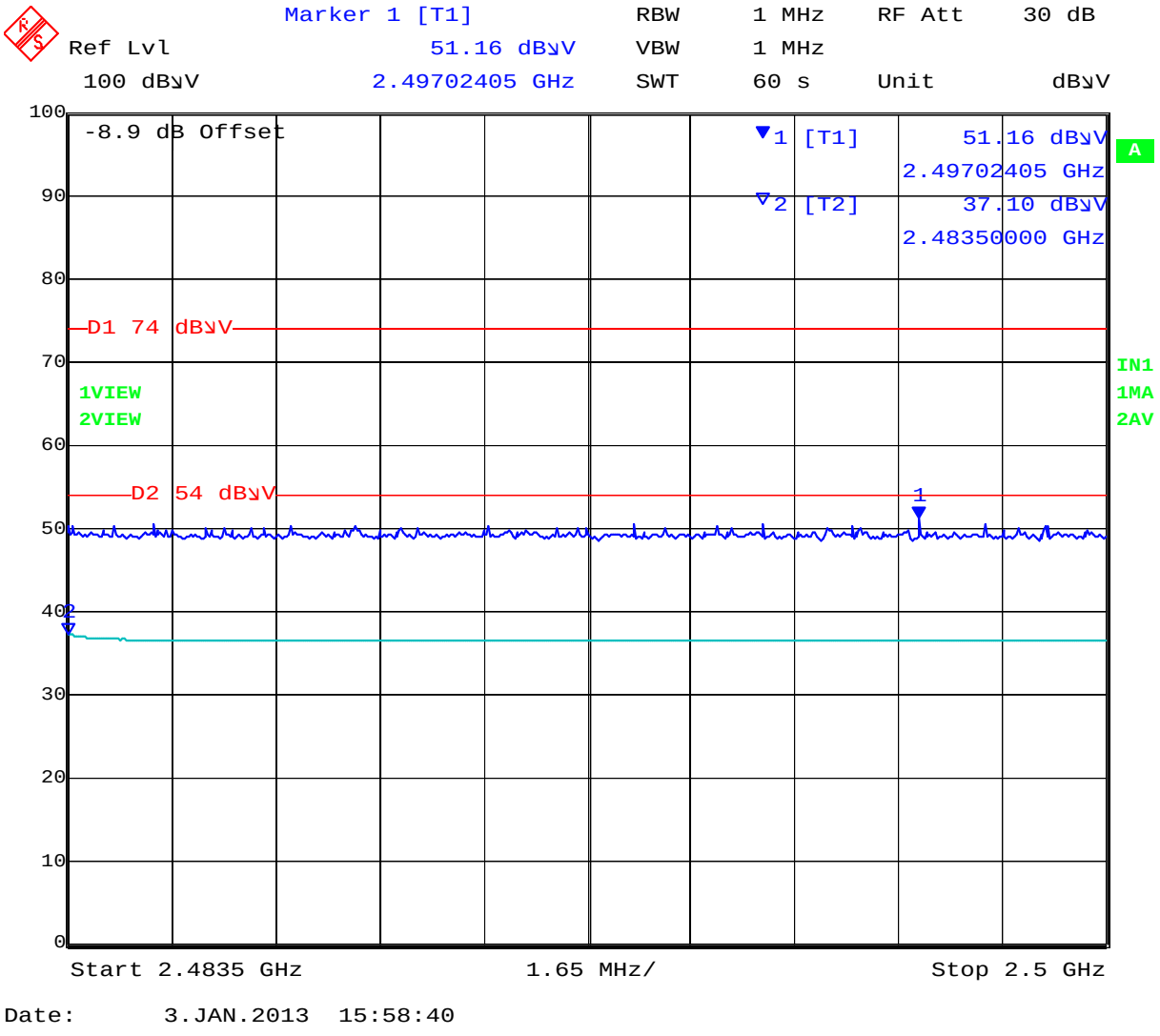


Formally measured emission peaks

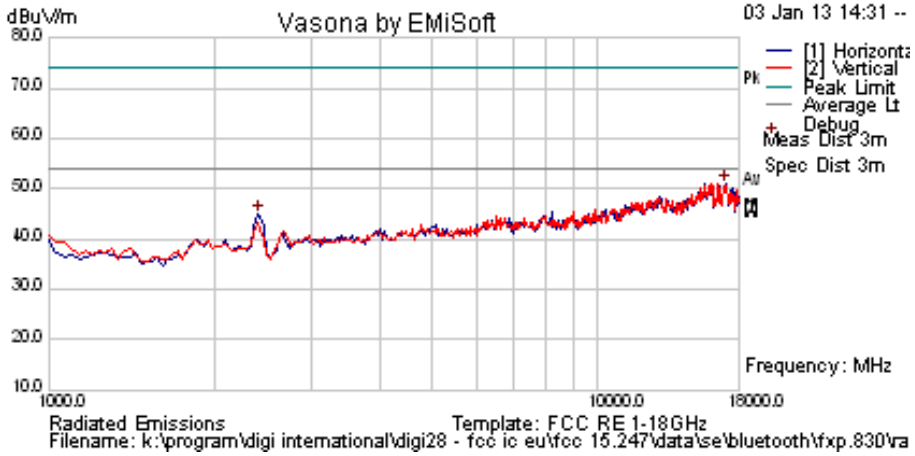
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2480.040	59.1	3.0	-11.5	50.6	Peak [Scan]	H						FUND
16535.07	42.5	8.8	0.4	51.7	Peak [Scan]	H	150	0	54.0	-2.3	Pass	Noise

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



Test Freq.	Hopping	**Engineer**	0
Variant	Bluetooth Master Blaster	**Temp (ºC)**	0
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	0
Power Setting	Max	**Press. (mBars)**	0
Antenna	FXP830 patch	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2	Bluetooth Master Blaster		

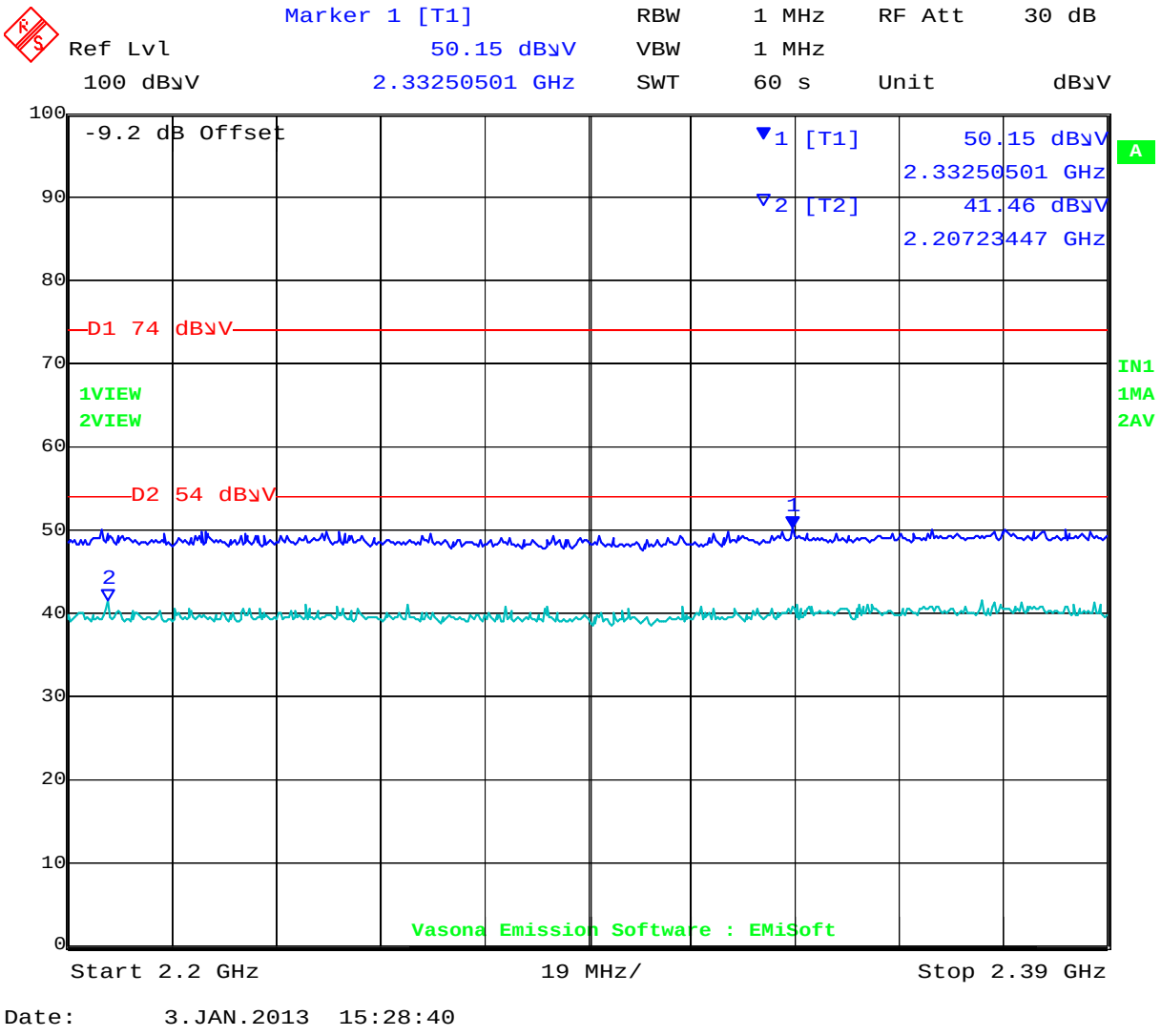


Formally measured emission peaks

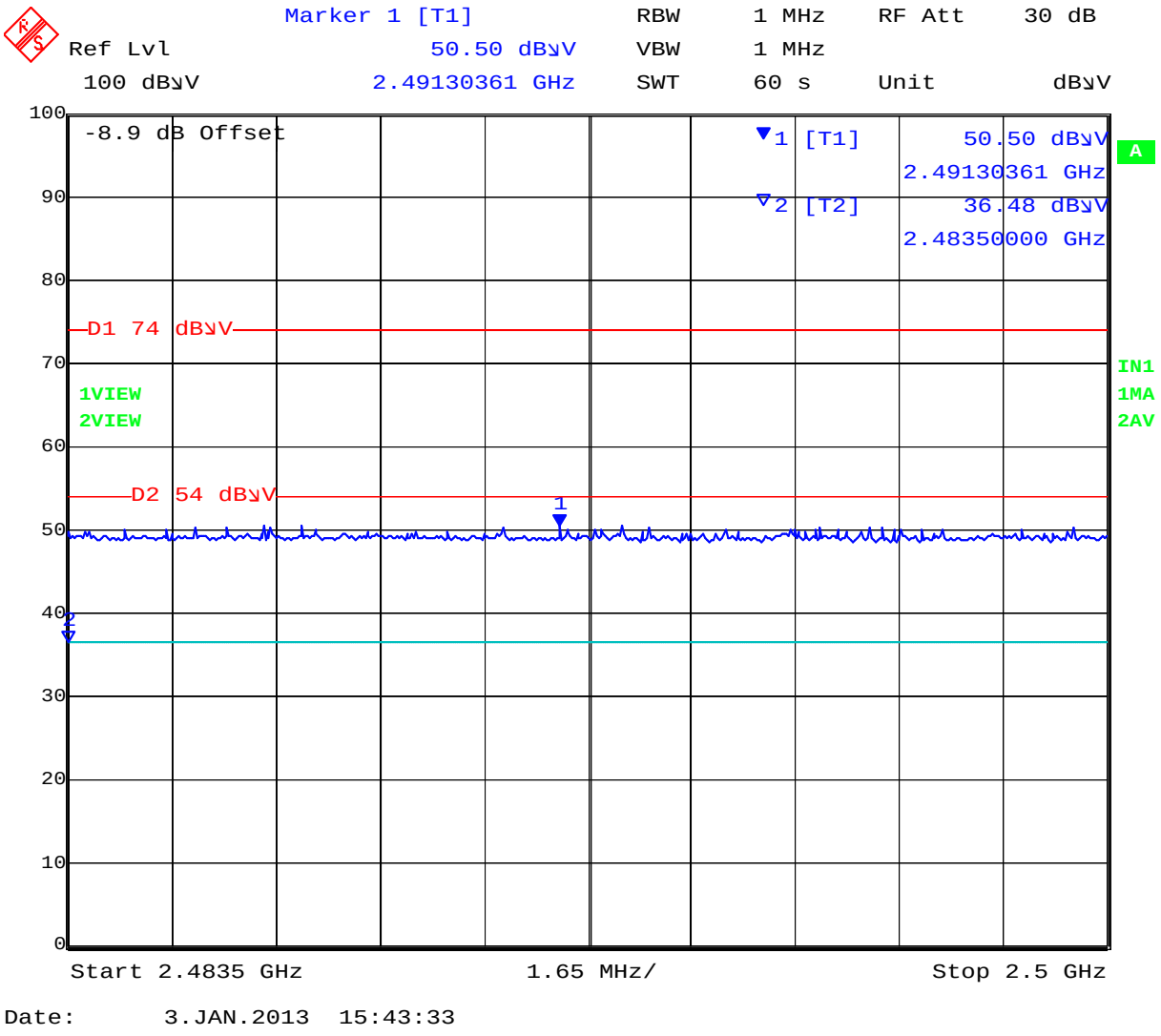
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2425.163	53.2	3.0	-11.6	44.6	Peak [Scan]	H						FUND
17114.228	42.0	8.5	0.5	51.0	Peak [Scan]	H	150	0	54.0	-3.0	Pass	Noise

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 2390-2400

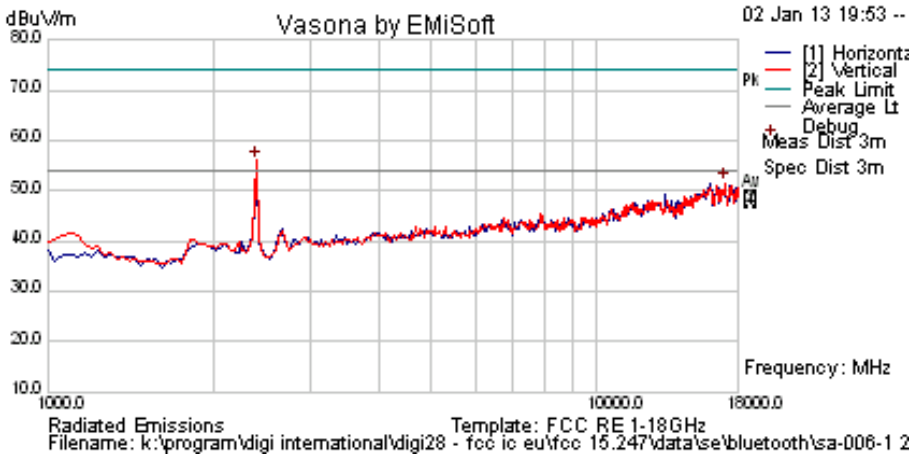


Band Edge 2483.5-2500



6.2.3. SA-006 Monopole:

Test Freq.	Chan 0	**Engineer**	JMH
Variant	Bluetooth Master Blaster	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	SA-006 monopole	**Duty Cycle (%)**	100
Test Notes 1	1.8 dBi		
Test Notes 2			

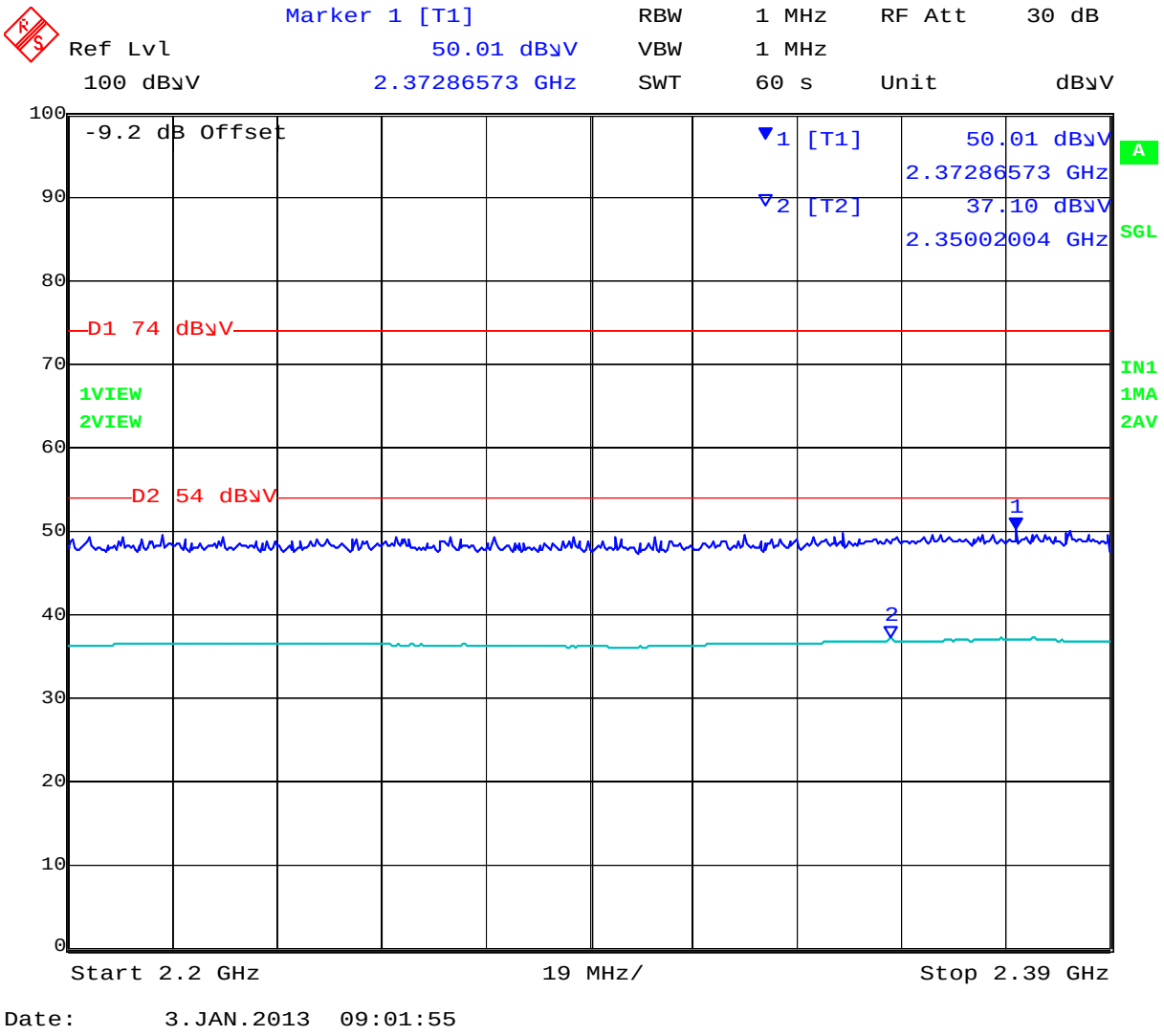


Formally measured emission peaks

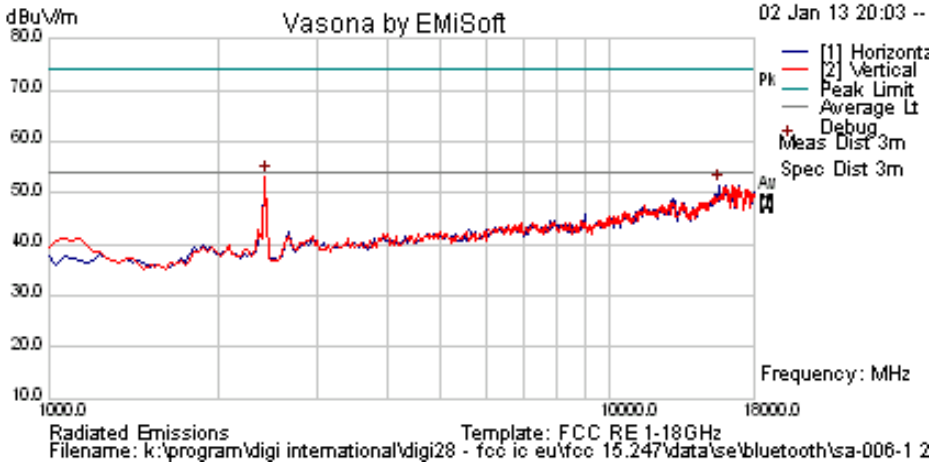
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2402.044	64.6	3.0	-11.6	55.9	Peak [Scan]	V						FUND
17080.16	42.6	8.5	0.4	51.5	Peak [Scan]	V	150	0	54.0	-2.5	Pass	Noise

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



Test Freq.	Chan 39	**Engineer**	JMH
Variant	Bluetooth Master Blaster	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	SA-006 monopole	**Duty Cycle (%)**	100
Test Notes 1	1.8 dBi		
Test Notes 2			

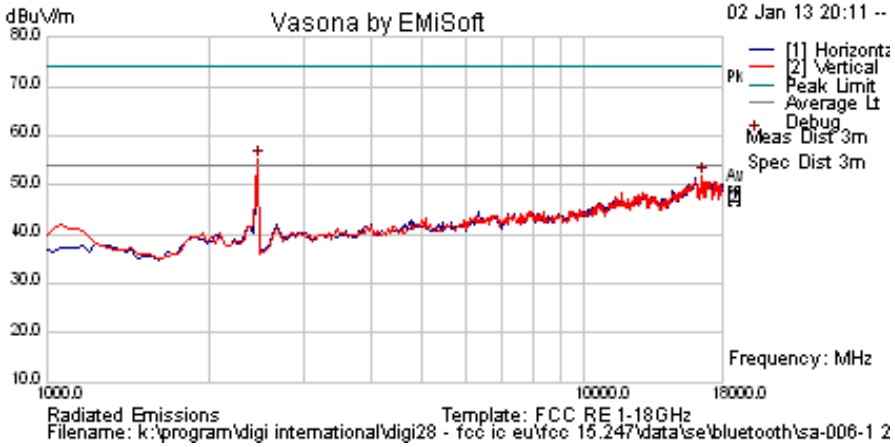


Formally measured emission peaks

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
2441.002	61.9	3.0	-11.5	53.3	Peak [Scan]	V						FUND
15649.299	43.7	8.5	-0.5	51.6	Peak [Scan]	H	100	0	54.0	-2.4	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.	Chan 78	**Engineer**	JMH
Variant	Bluetooth Master Blaster	**Temp (ºC)**	19
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	34
Power Setting	Max	**Press. (mBars)**	1008
Antenna	SA-006 monopole	**Duty Cycle (%)**	100
Test Notes 1	1.8 dBi		
Test Notes 2			

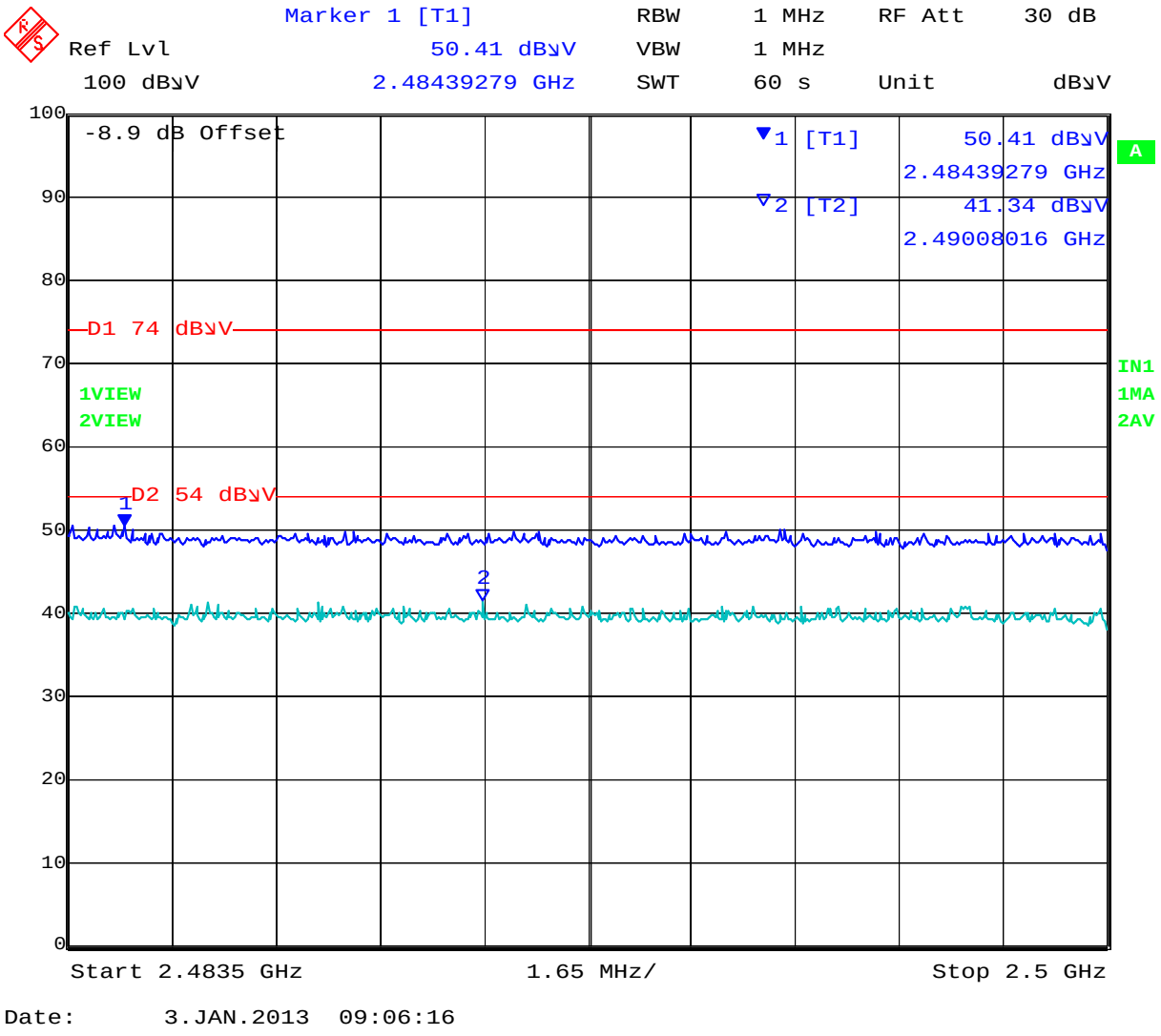


Formally measured emission peaks

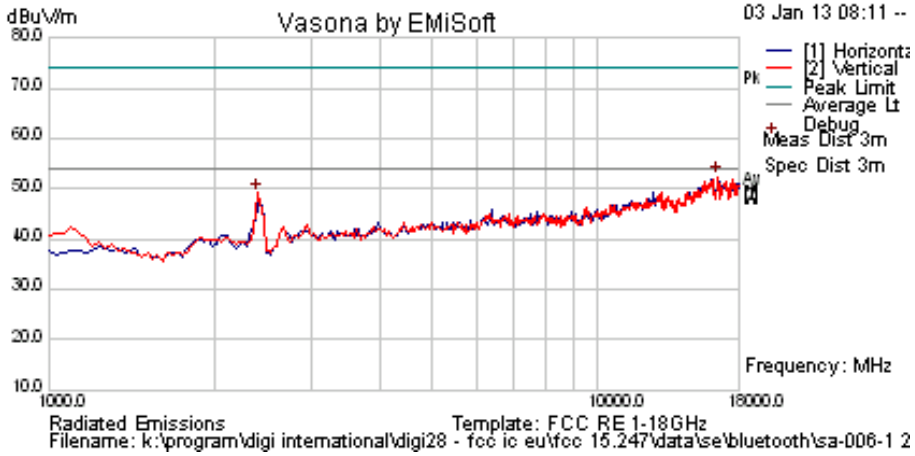
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2480.040	63.8	3.0	-11.5	55.3	Peak [Scan]	V						FUND
16535.07	42.5	8.8	0.4	51.7	Peak [Scan]	V	100	0	54.0	-2.4	Pass	Noise

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:



Test Freq.	Hopping	**Engineer**	0
Variant	Bluetooth Master Blaster	**Temp (ºC)**	0
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	0
Power Setting	Max	**Press. (mBars)**	0
Antenna	SA-006 monopole	**Duty Cycle (%)**	100
Test Notes 1	Chan 78		
Test Notes 2	Bluetooth Master Blaster		

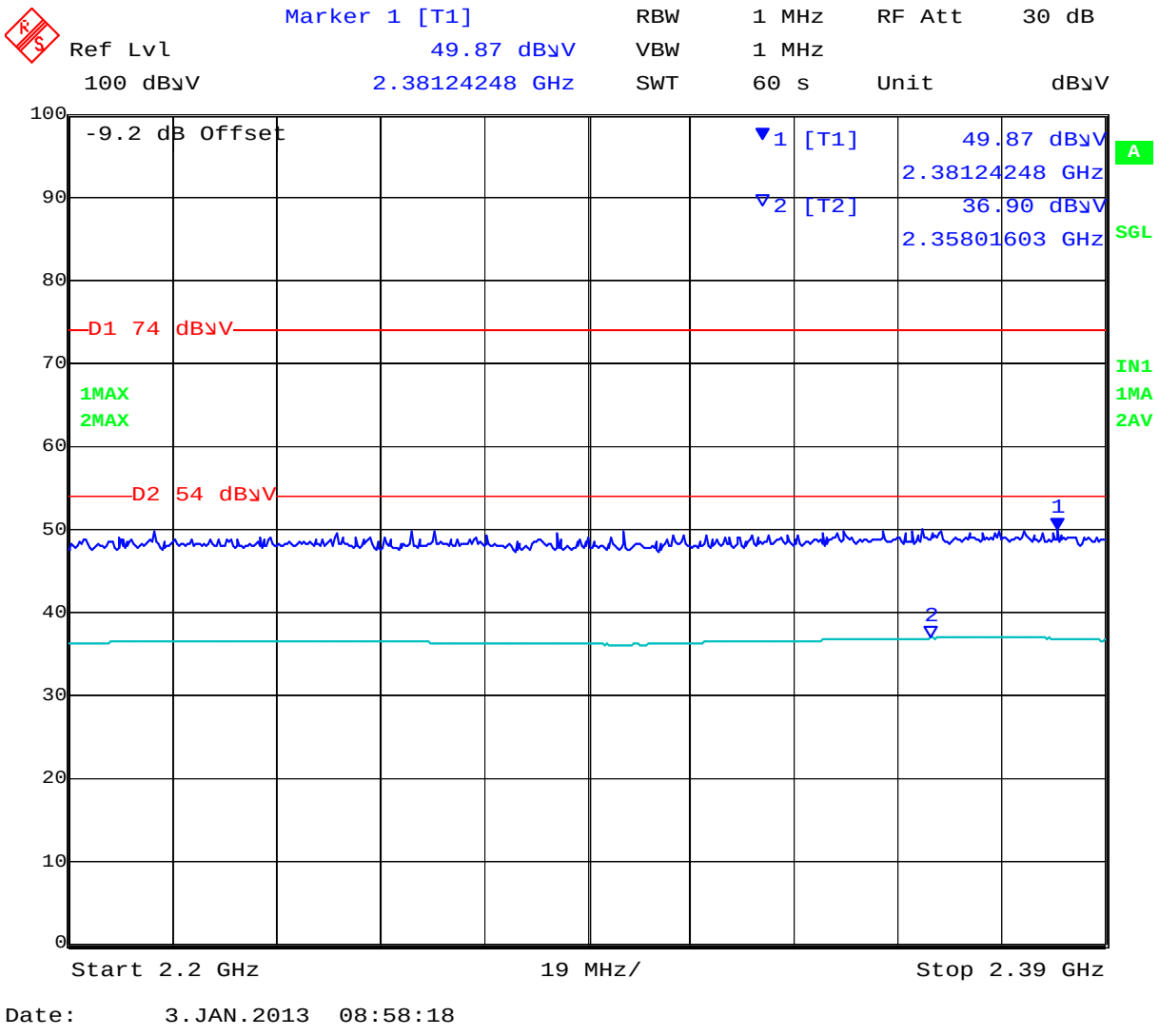


Formally measured emission peaks

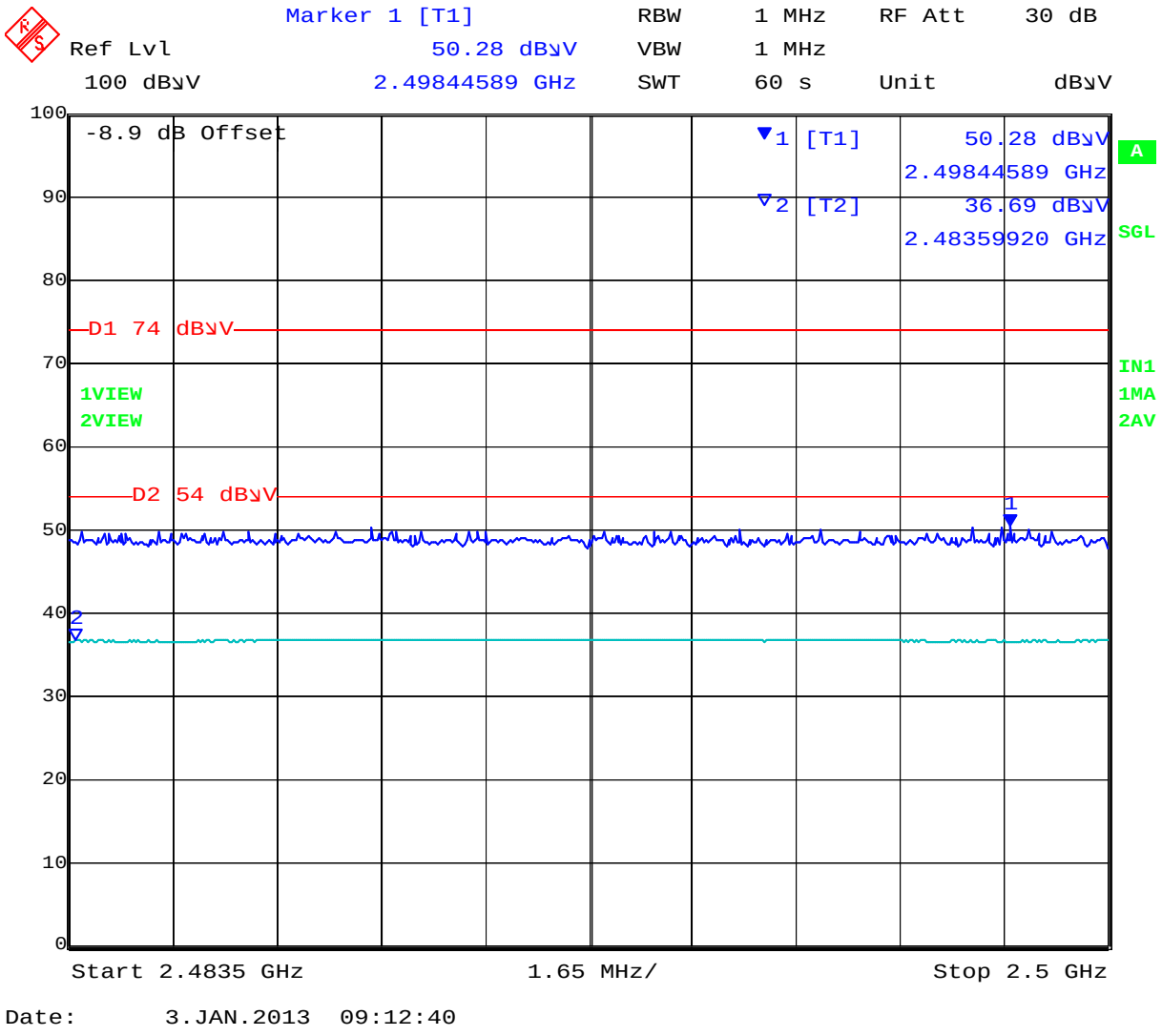
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2396.794	58.0	3.0	-11.7	49.3	Peak [Scan]	V						FUND
16501.002	43.3	8.8	0.3	52.5	Peak [Scan]	V	100	0	54.0	-1.5	Pass	Noise

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: 2390-2400

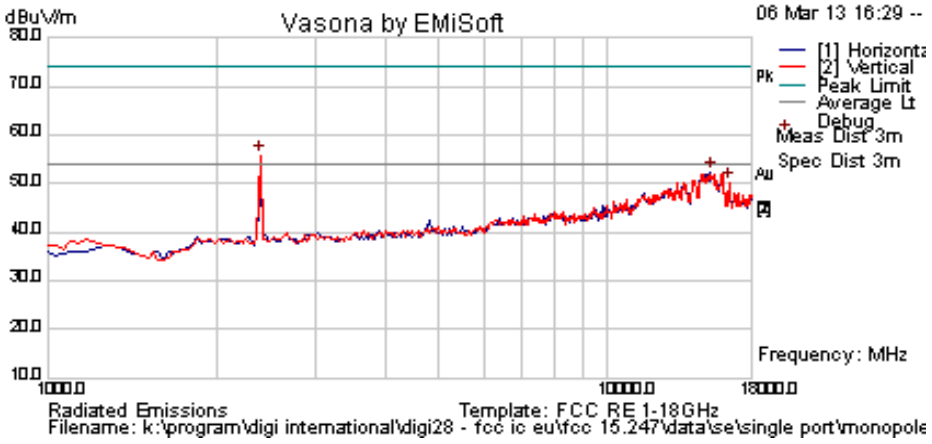


Band Edge: 2483.5-2500



6.2.4. WPANTE3:

Test Freq.	Chan 0	**Engineer**	JMH
Variant	NA	**Temp (ºC)**	20
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	Max	**Press. (mBars)**	1003
Antenna	5 dBi Monopole	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

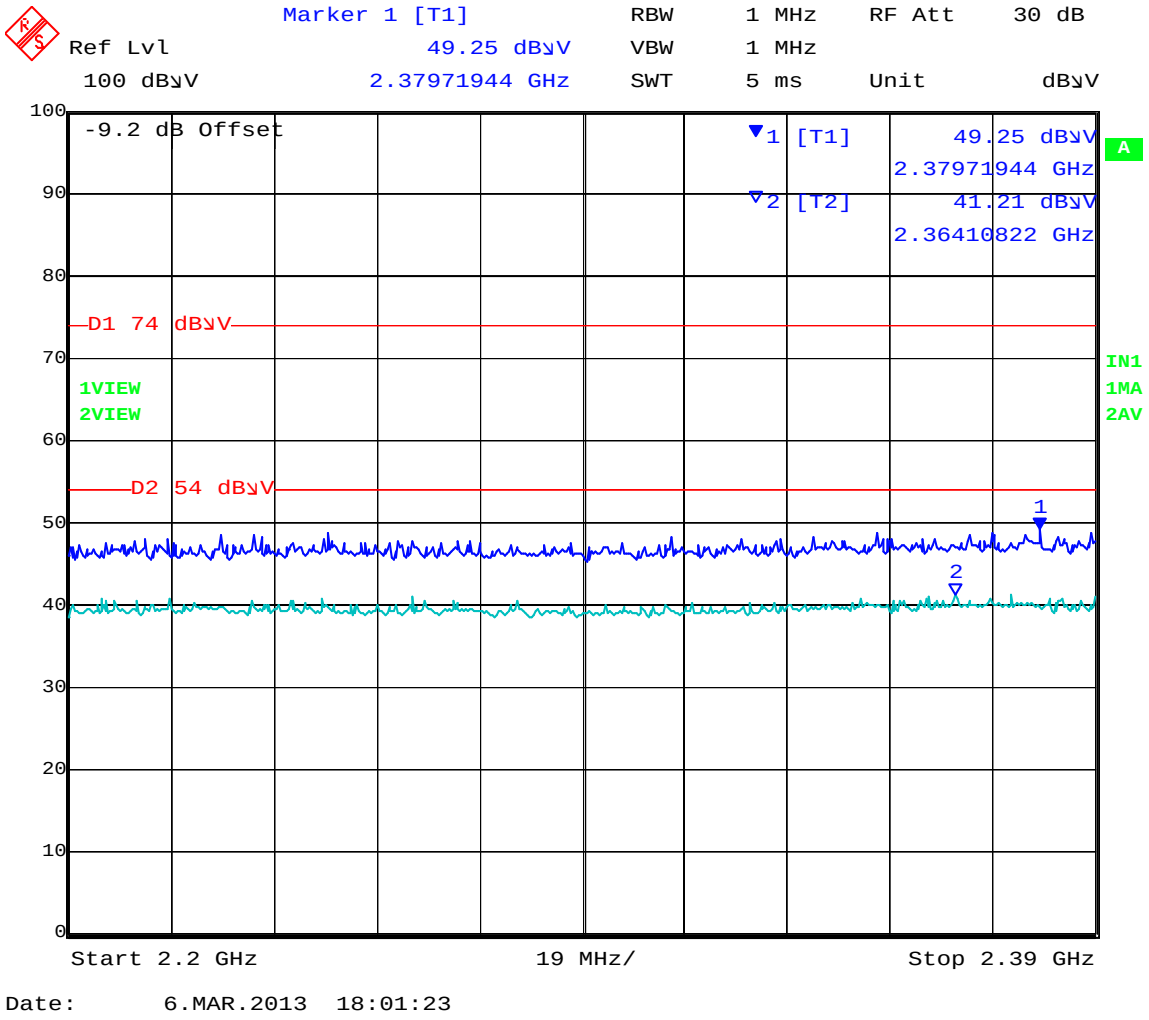


Formally measured emission peaks

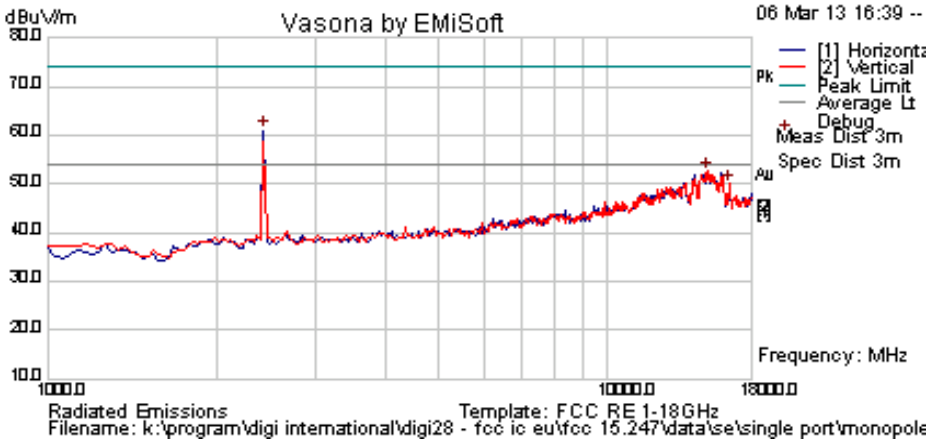
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
2396.794	64.4	3.2	-11.7	55.9	Peak [Scan]	V						FUND
15274.549	44.9	8.7	-1.2	52.4	Peak [Scan]	H	200					NRB
16466.934	40.6	9.4	0.3	50.2	Peak [Scan]	V	200					NRB

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



Test Freq.	chan 39	**Engineer**	JMH
Variant	NA	**Temp (ºC)**	20
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	Max	**Press. (mBars)**	1003
Antenna	5 dBi Monopole	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

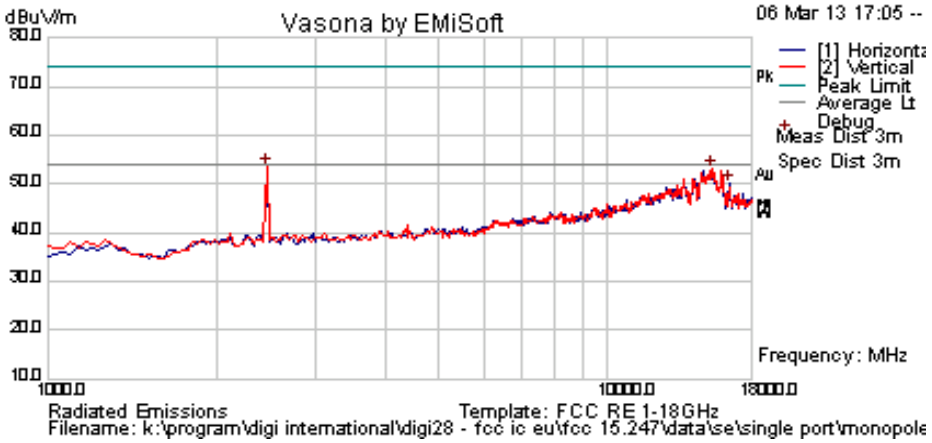


Formally measured emission peaks

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	69.3	3.2	-11.6	60.9	Peak [Scan]	H						FUND
15070.14	45.8	8.6	-1.9	52.5	Peak [Scan]	V	200					NRB
16466.934	40.5	9.4	0.3	50.1	Peak [Scan]	V	150					NRB

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.	Chan 78	**Engineer**	JMH
Variant	NA	**Temp (ºC)**	20
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	35
Power Setting	Max	**Press. (mBars)**	1003
Antenna	5 dBi Monopole	**Duty Cycle (%)**	100
Test Notes 1			
Test Notes 2			

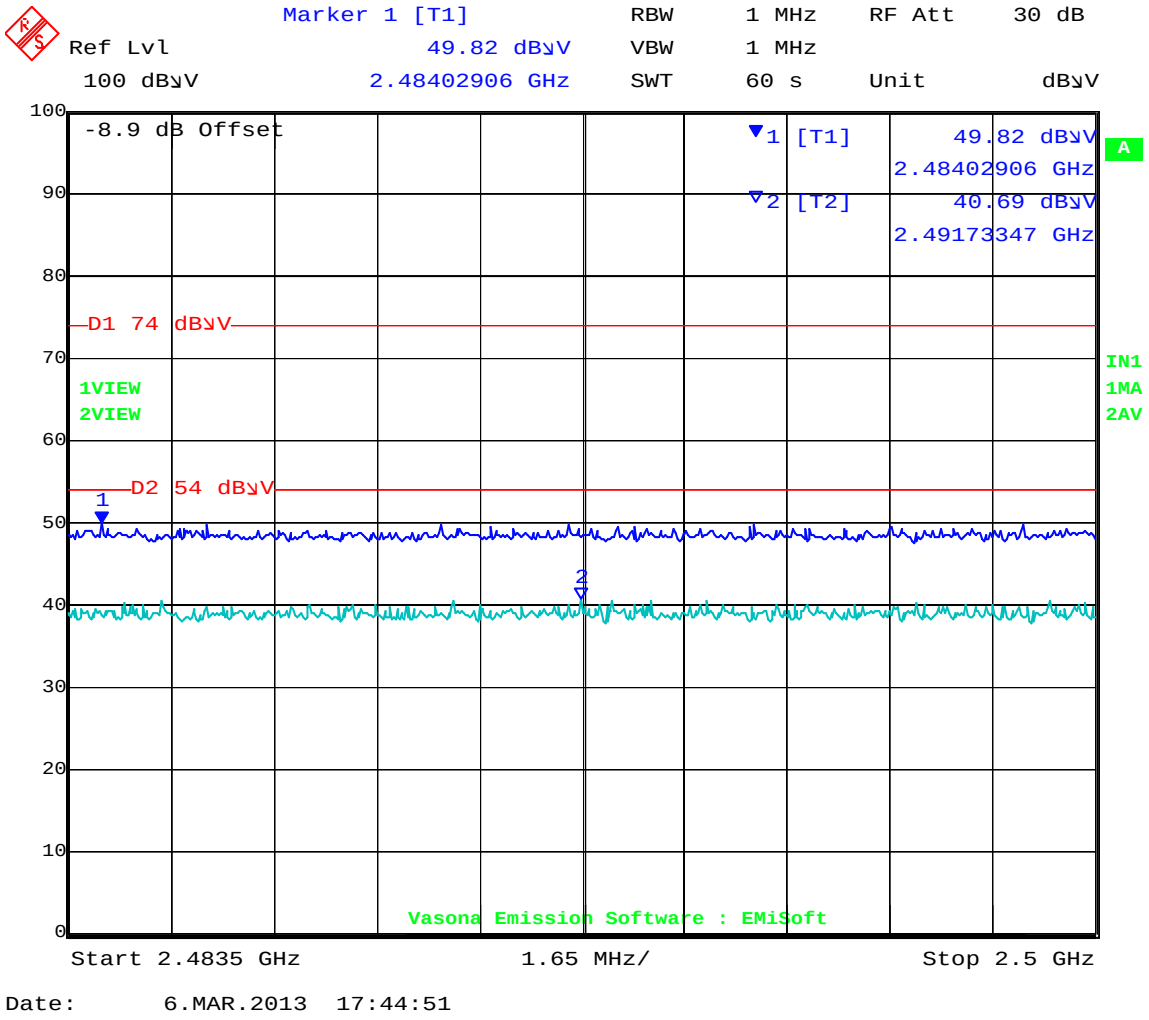


Formally measured emission peaks

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	61.8	3.2	-11.5	53.5	Peak [Scan]	V						FUND
15342.685	45.1	8.7	-0.9	53.0	Peak [Scan]	V	100	0	54.0	-1.0	Pass	Noise
16466.934	40.3	9.4	0.3	50.0	Peak [Scan]	H	200					NRB

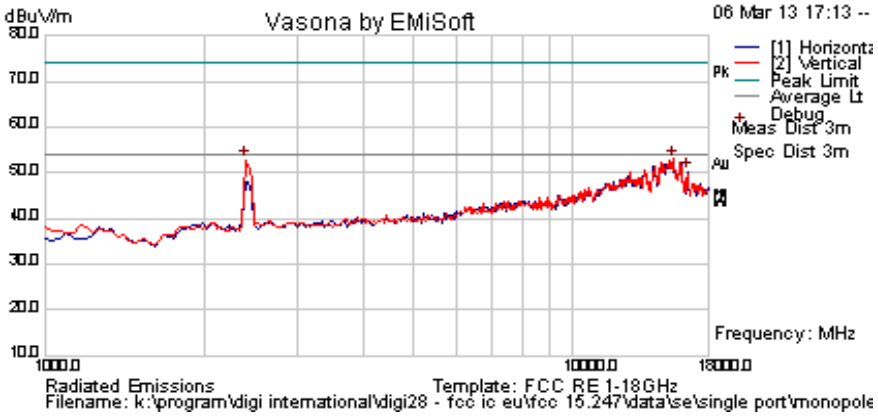
Legend:	TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; WB = Wideband Emission
	RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak

Band Edge



Hopping

Test Freq.	Hopping	**Engineer**	0
Variant	NA	**Temp (ºC)**	0
Freq. Range	1000 MHz - 18000 MHz	**Rel. Hum.(%)**	0
Power Setting	Max	**Press. (mBars)**	0
Antenna	5 dBi Monopole	**Duty Cycle (%)**	100
Test Notes 1	NA		
Test Notes 2	1000 MHz - 18000 MHz		

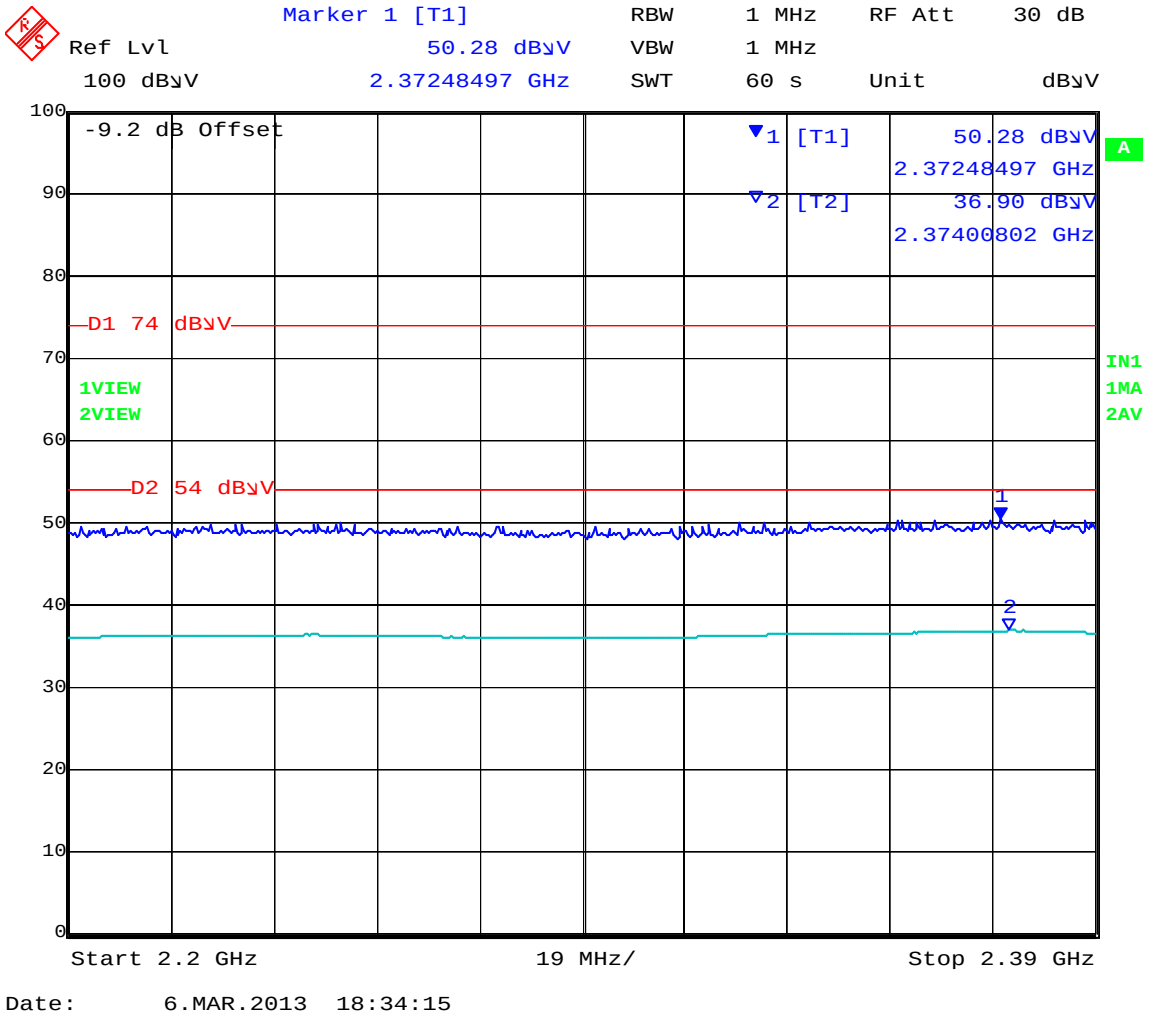


Formally measured emission peaks

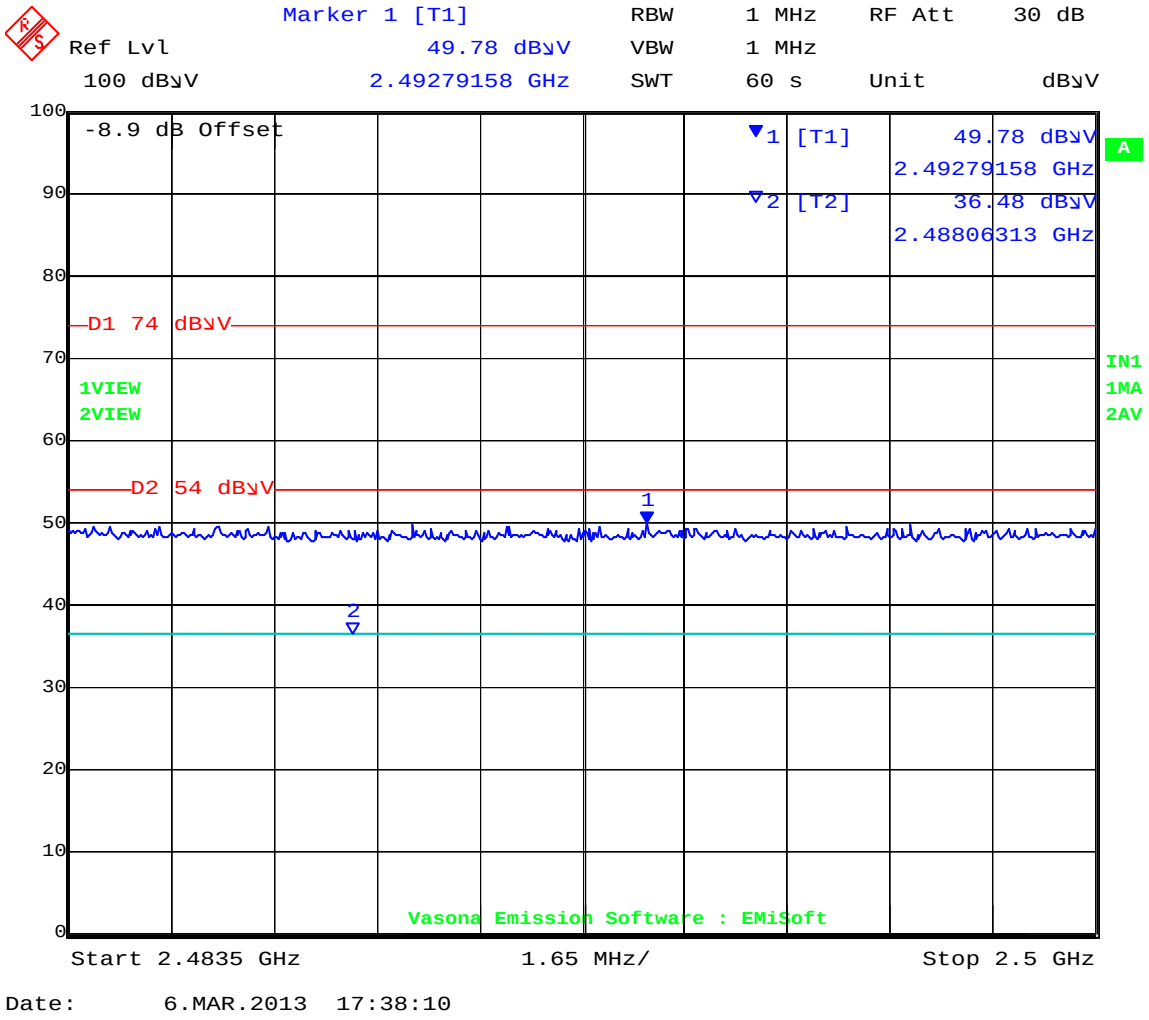
Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
15444.890	44.9	8.8	-0.6	53.1	Peak [Scan]	V	100	0	54.0	-0.9	Pass	Noise
2396.793587	61.4	3.2	-11.7	52.9	Peak [Scan]	V						FUND
16432.866	40.8	9.3	0.2	50.3	Peak [Scan]	H	200					NRB

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 2390-2400 MHz



Band Edge 2483.5 -2500 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
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.

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

6.2.5. Digital Emissions (0.03-1 GHz)

FCC, Part 15 Subpart C §15.205/ §15.209

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:

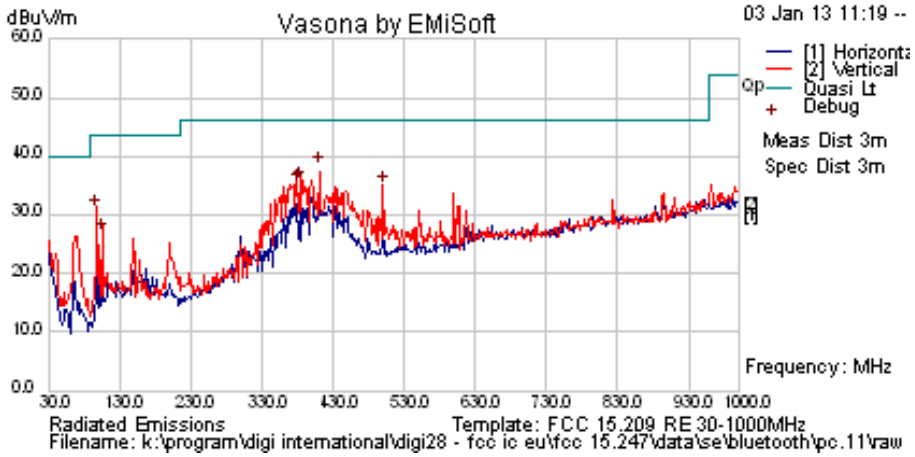
$$FS = 51.5 + 8.5 + 1.3 - 26.0 + 1 = 36.3 dB\mu V/m$$

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

$$Level (dB\mu V/m) = 20 * Log (level (\mu V/m))$$

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

Test Freq.	CH0	**Engineer**	JMH
Variant	Digital Emissions	**Temp (ºC)**	18
Freq. Range	30-1000 MHz	**Rel. Hum.(%)**	33
Power Setting	NA	**Press. (mBars)**	1010
Antenna	PC.11	**Duty Cycle (%)**	100
Test Notes 1			



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
411.451	47.1	5.5	-14.4	38.2	Quasi Max	V	98	112	46.0	-7.8	Pass	
384.046	45.4	5.4	-15.3	35.5	Quasi Max	V	125	287	46.0	-10.5	Pass	
380.248	45.1	5.4	-15.3	35.3	Peak [Scan]	V	98	360	46	-10.7	Pass	
500.446	42.2	5.8	-12.8	35.1	Peak [Scan]	V	98	360	46	-10.9	Pass	
98.105	48.7	4.1	-21.8	31.0	Peak [Scan]	V	98	360	43.5	-12.5	Pass	
106.054	42.5	4.1	-19.6	27.0	Peak [Scan]	V	98	360	43.5	-16.5	Pass	

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

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

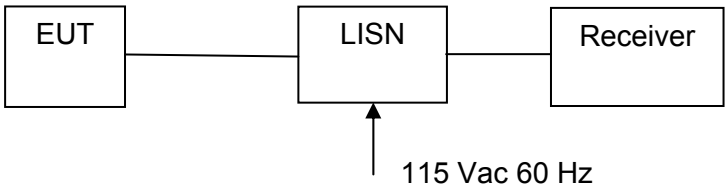
6.2.6. AC Wireline Conducted Emissions (150 kHz – 30 MHz)

Not required - EUT is power by DC only.

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.

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

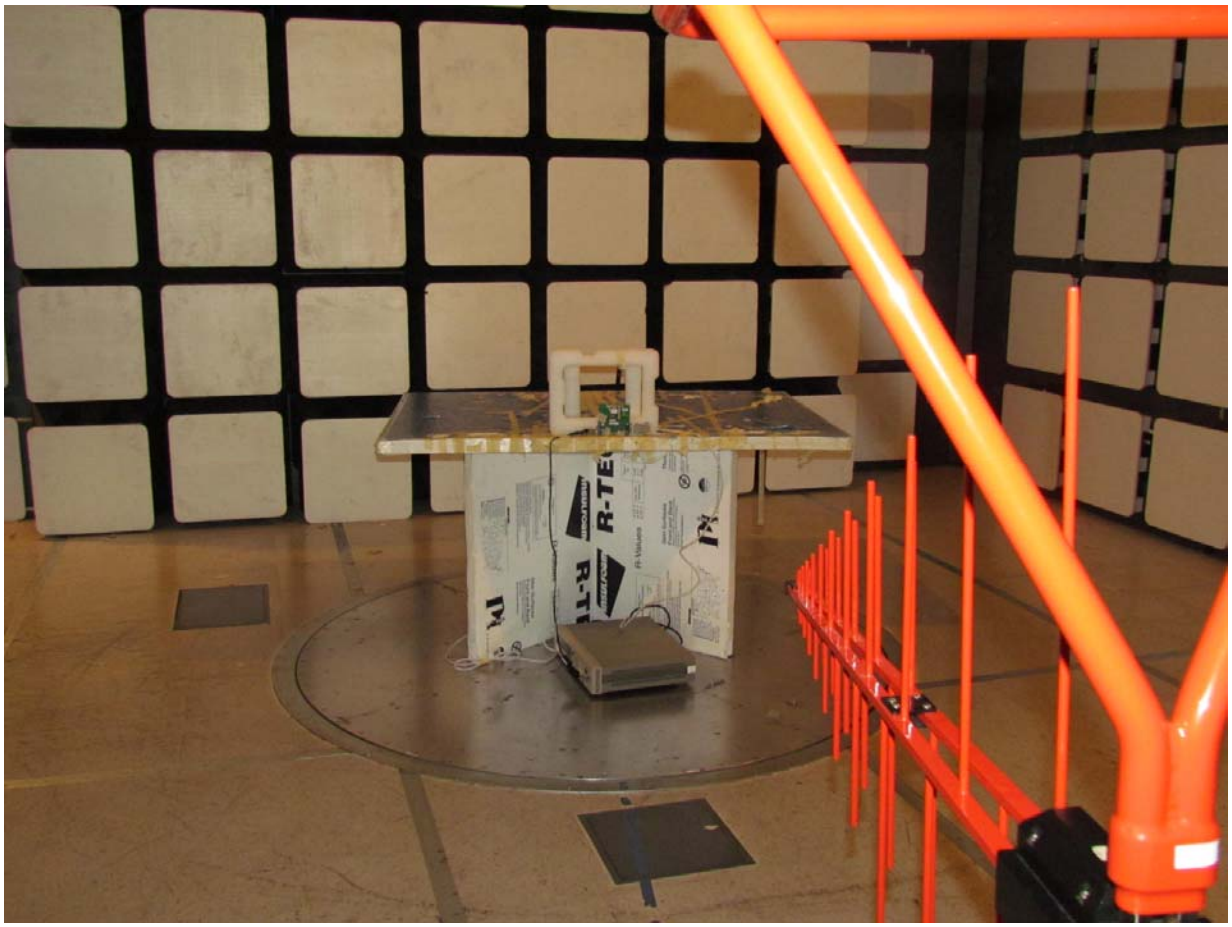
Traceability

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

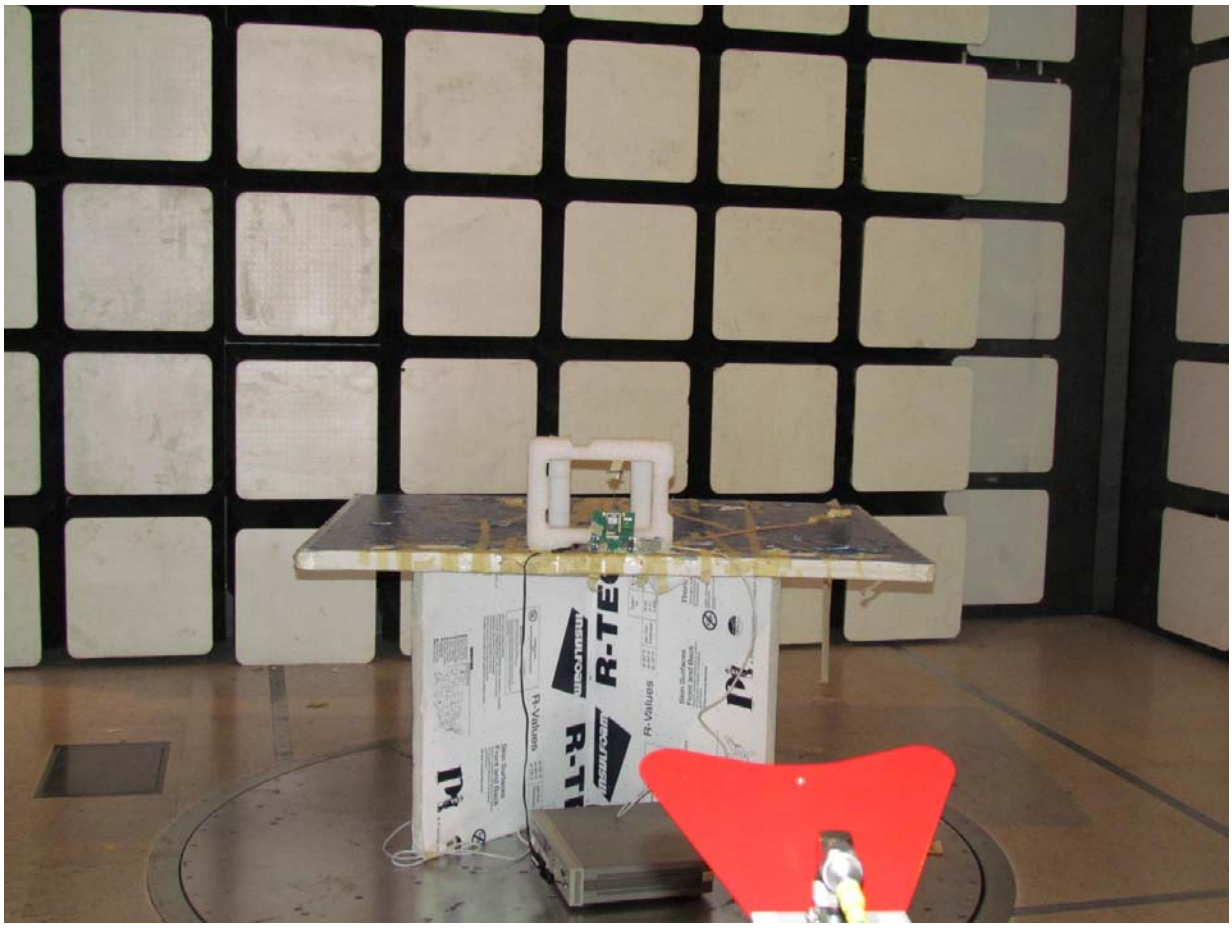
7. PHOTOGRAPHS

7.1. Conducted Test Setup

7.2. Test Setup - Digital Emissions below 1 GHz



7.3. Radiated Emissions Test Setup >1 GHz



8. TEST EQUIPMENT

Asset #	Instrument	Manufacturer	Part #	Serial #	Calibration Due Date
0070	Power Meter	Hewlett Packard	437B	3125U11552	28th Nov 13
0117	Power Sensor	Hewlett Packard	8487D	3318A00371	15th Nov 13
0223	Power Meter	Hewlett Packard	EPM-442A	US37480256	15th Nov 13
0374	Power Sensor	Hewlett Packard	8485A	3318A19694	29th Nov 13
0376	Power Sensor	Agilent	U2000A	MY51440005	8th Dec 13
0158	Barometer /Thermometer	Control Co.	4196	E2846	8th Dec 13
0193	EMI Receiver	Rhode & Schwartz	ESI 7	838496/007	2nd Dec 13
0287	EMI Receiver	Rhode & Schwartz	ESIB40	100201	16th Nov 13
0338	30 - 3000 MHz Antenna	Sunol	JB3	A052907	8th Nov 13
0335	1-18 GHz Horn Antenna	EMCO	3117	00066580	7th Nov 13
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 1.5	N/A

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