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Precisely Right.

Test Report No.:	**13110503.fcc01**	*Page 1 of 68*

Client:	**Grohe AG** Industriepark Edelburg, Hemer 58675 Germany		
Test Item:	**Spread Spectrum Transmitter (DSS)** Bluetooth 2.1 + EDR		
Identification:	**BT01A**	*Serial No.:*	**--**
Project No.:	**13110503**	*Date of Receipt:*	**April 03 , 2014**
Testing Location:	**TÜV Rheinland Nederland B.V.** Eiberkamp 10 9351VT Leek		
Test Specification:	FCC 47 CFR Part 15, Subpart C, Section 15.209 and15.247 (10-1-13 Edition) FCC Public Notice DA 00-705 (March 30, 2000) RSS-Gen (issue 3, December 2010) and RSS-210 (Issue 8, December 2010) Note: The EUT has been tested and found to comply with FCC part 15B and ICES-003. The test results are issued in another report.		
Test Result:	*The test item **passed** the test specification(s).*		
Testing Laboratory:	**TÜV Rheinland Nederland B.V.** Eiberkamp 10 9351 VT Leek		

Tested by:			*Reviewed by:*		
2014-11-04	R.van der Meer / Inspector		2014-11-04	O. Hoekstra / Reviewer	
Date	*Name/Position*	*Signature*	*Date*	*Name/Position*	*Signature*

Other Aspects:--

Abbreviations:

P(ass)	=	***passed***
F(ail)	=	***failed***
N/A	=	***not applicable***
N/T	=	***not tested***

TEST SUMMARY

5.1 Conducted Measurements at Antenna Port

5.1.1 CONDUCTED OUTPUT POWER
RESULT: PASS

5.1.2 20DB AND 99% BANDWIDTH
RESULT: PASS

5.1.3 NUMBER OF CHANNELS AND OCCUPANCY TIME
RESULT: PASS

5.1.4 CARRIER FREQUENCY SEPARATION
RESULT: PASS

5.1.5 BAND EDGE CONDUCTED EMISSIONS
RESULT: Pass

6.1 RADIATED EMISSIONS IN RESTRICTED BANDS
RESULT: PASS

7 AC POWER LINE CONDUCTED EMISSION OF TRANSMITTER
RESULT: PASS

Contents

1. General Remarks

1.1 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

The Federal Communications Commission and Industry Canada has reviewed the technical characteristics of the test facilities at TÜV Rheinland Nederland B.V., located in Leek, 9351VT Eiberkamp 10, The Netherlands, and has found these test facilities to be in compliance with the requirements of 47 CFR Part 15, section 2.948.

The description of the test facilities has been filed at the Office of the Federal Communications Commission under registration number 90828. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

The description of the test facilities has been filed to Industry Canada under registration number 2932G-2. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

Normal test conditions:

Temperature (*) : +15°C to +35°C
Relative humidity(*) : 20 % to 75 %
Supply voltage : 120VAC/60Hz
Air pressure : 950 – 1050 hPa

When it was impracticable to carry out the tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests are stated separately.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Inventory number	Calibration date (mm/yyyy)	Calibration due date (mm/yyyy)
For Antenna Port Conducted Emission					
Spectrum Analyzer	Rohde & Schwarz	FSV	99733	05/2013	05/2015
Temperature-Humiditymeter	Extech	SD500	99857	02/2014	02/2015
RF Cable	H&S	--	99738	04-14/2013	04-14/2015
For Radiated Emission					
Measurement Receiver	Rohde & Schwarz	ESCI	99699	03/2014	03/2015
RF Cable S-AR	Gigalink	APG0500	99858	02/2014	02/2015
Controller	Heinrich Deisel	4630-100	99107	N/A	N/A
Test fascility	Comtest	FCC listed: 90828	99580	02/2012	02/2015
Spectrum Analyzer	Rohde & Schwarz	FSV	99733	05/2013	05/2014
Controller	EMCS	DOC202	99608	N/A	N/A
Antenna mast	EMCS	AP-4702C	99609	N/A	N/A
Temperature-Humiditymeter	Extech	SD500	99855	02/2014	02/2015
Guidehorn 1-18 GHz	EMCO	3115	12484	04-14/2013	04-14/2014
Filter section	Reactel	--	99606	10/2012	10/2014
Guidehorn 18-26.5 GHz	EMCO	RA42-K-F-4B-C	12488	04-14/2013	04-14/2014
Biconilog Testantenna	Teseq	CBL 6111D	99877	06/2013	06/2014
For AC Power Line Conducted Emission					
Measurement Receiver	Rohde & Schwarz	ESCS30	15667	09-2013	09-2014
LISN	EMCO	3625/2	12512	01/2014	01/2016
Pulse limiter	R&S	ESH3-Z2	13313	01/2014	01/2015
Shielded room for Conducted emissions	Euroshield	RFD-100 359	99848	N/A	N/A
Variac 250V 6A	RFT	LTS006	99220	N/A	N/A
Temperature-Humiditymeter	Extech	SD500	99852	02/2014	02/2015

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2005 has been confirmed before testing.

2.3 Measurement Uncertainty

Table 2: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	±0.5dB
	> 1GHz	±0.7dB
AC Line Conducted emissions	150kHz - 30MHz	±3.5dB
Radiated Emission	150kHz - 30MHz	±5.0dB
	30MHz - 1GHz	±5.0dB
	> 1GHz	±5.5dB

3. General Product Information

3.1 Product Function and Intended Use

The brand Grohe model BT01A, hereafter referred to as EUT, is a Spread Spectrum Transmitter (DSS) / Bluetooth power class 2 device working in the 2.4 GHz ISM frequency band. The EUT is intended to be used as wireless controller for light, sound and steam for Grohe's bathroom F-digital deluxe appliances. The EUT uses an APM 8262 Bluetooth module which is fully compliant to Bluetooth V2.1+EDR and has an integrated PCB mounted antenna.

The content of this report and measurement results have not been changed other than the way of presenting the data.

3.2 System Details

Details and an overview of the system and all of its components, as it has been tested, may be found below.

EUT	:	Spread Spectrum Transmitter (DSS), BT-Module Class 2
Manufacturer	:	Grohe AG
Brand	:	Grohe
Model	:	BT01A
Serial number	:	Engineering sample
Voltage input rating	:	3.3 Vdc
Voltage output rating	:	--
Current input rating	:	--
Antenna	:	Integral antenna, Gain = -3.1 dBi
Operating frequency	:	2402-2480 MHz
Modulation	:	FHSS (GFSK / π/4-DQPSK / 8DPSK)
Spreading technique	:	FHSS

Photograph of the tested sample.

Table 3: Interfaces present on the EUT

No.	Port	From	To	Remarks
1.	Mains	Mains	AUX2	Unshielded cable <3m
2.	12Vdc	AUX2	AUX3	Shielded cable <3m
3.	Power In	AUX3	EUT DC in 12V	Shielded cable <3m
4.	Power Out	EUT DC out 12V/1A	AUX7	Shielded cable <3m
5.	Power and control	AUX3	AUX4	Shielded cable >3m
6.	Power and control	AUX3	AUX5	Shielded cable >3m
7.	Power and control	AUX3	AUX8	Shielded cable >3m
8.	Power and control	AUX3	AUX9	Shielded cable >3m
9.	Data	AUX3	EUT	Shielded cable <3m
10.	Data	EUT	AUX7	Shielded cable <3m

See page 11 for a photograph

3.3 Countermeasures to achieve EMC Compliance

No additional measures were employed to achieve compliance.

4. Test Set-up and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.207, 15.209, 15.247, RSS-Gen and RSS-210.

The test methods, which have been used, are based on
FCC Public Notice DA 00-705 (March 30, 2000).

For details, see under each test item.

4.2 Operation Modes

Modulation		**Test frequencies (MHz)**				
	Lowest	**Power control setting (Ext, Int)**	**Middle**	**Power control setting (Ext, Int)**	**Highest**	**Power control setting (Ext, Int)**
DH5 (GFSK)	2402 (Ch 1)	255 , 63	2441 (Ch 40)	255 , 63	2480 (Ch 79)	255 , 63
2-DH3 (π/4-DQPSK)	2402 (Ch 1)	255 , 63	2441 (Ch 40)	255 , 63	2480 (Ch 79)	255 , 63
3-DH5 (8DPSK)	2402 (Ch 1)	255 , 63	2441 (Ch 40)	255 , 63	2480 (Ch 79)	255 , 63

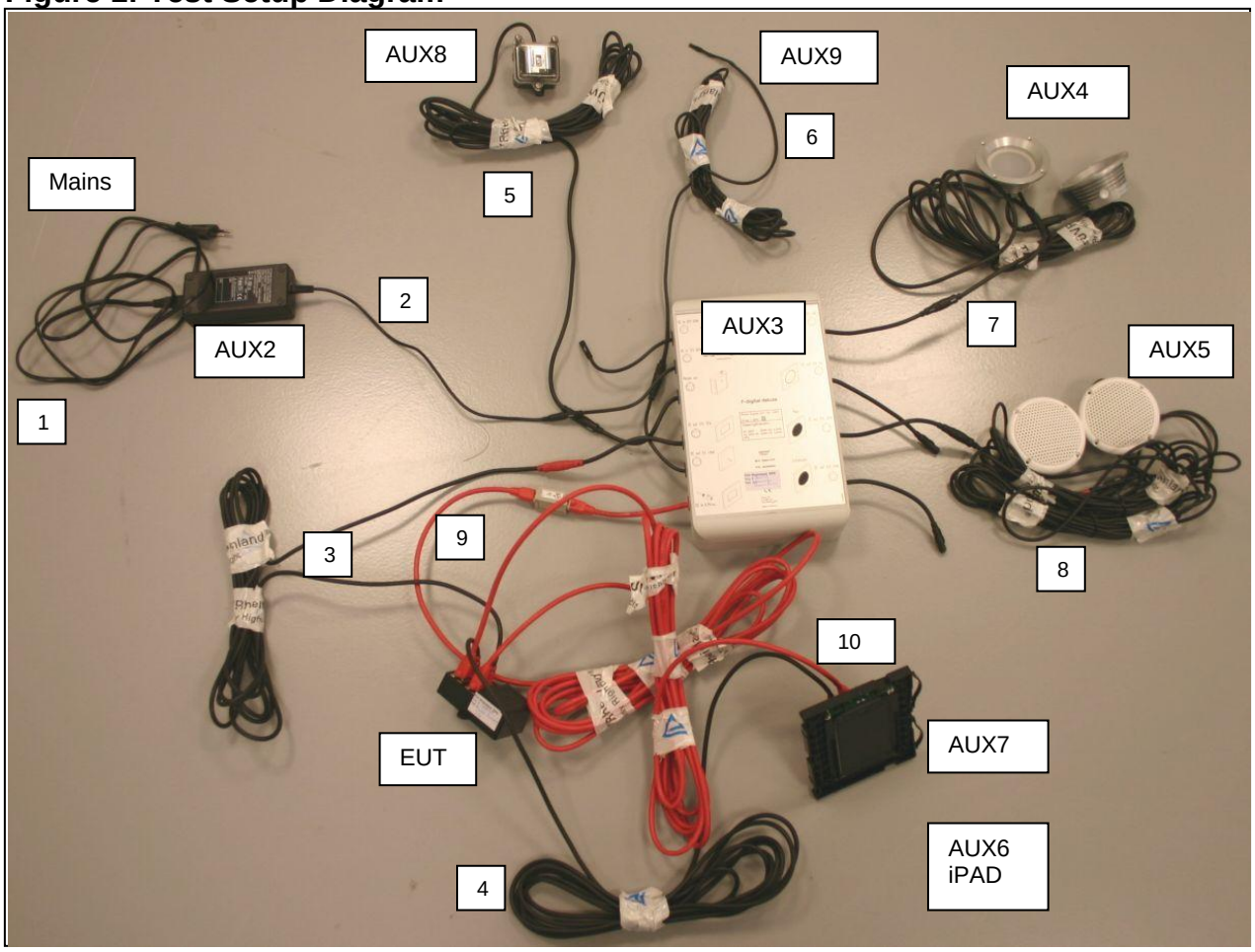
Testing was performed at the lowest operating frequency, at the operating frequency in the middle of the specified frequency band and at the highest operating frequency. These operation modes were selected after review of the capabilities and characteristics of the EUT. Bluetooth operation was evaluated at 1Mb/s and 3Mb/s data rates.
The module has an integrated antenna. For conducted measurements, this antenna was replaced by a connector.

4.3 Physical Configuration for Testing

The EUT was configured in a typical fashion (as a customer would normally use it). The laptop computer was used to configure the EUT to continuously transmit at a specified output power and channel as specified in the testdata. See section 4.5 for Auxiliary details.

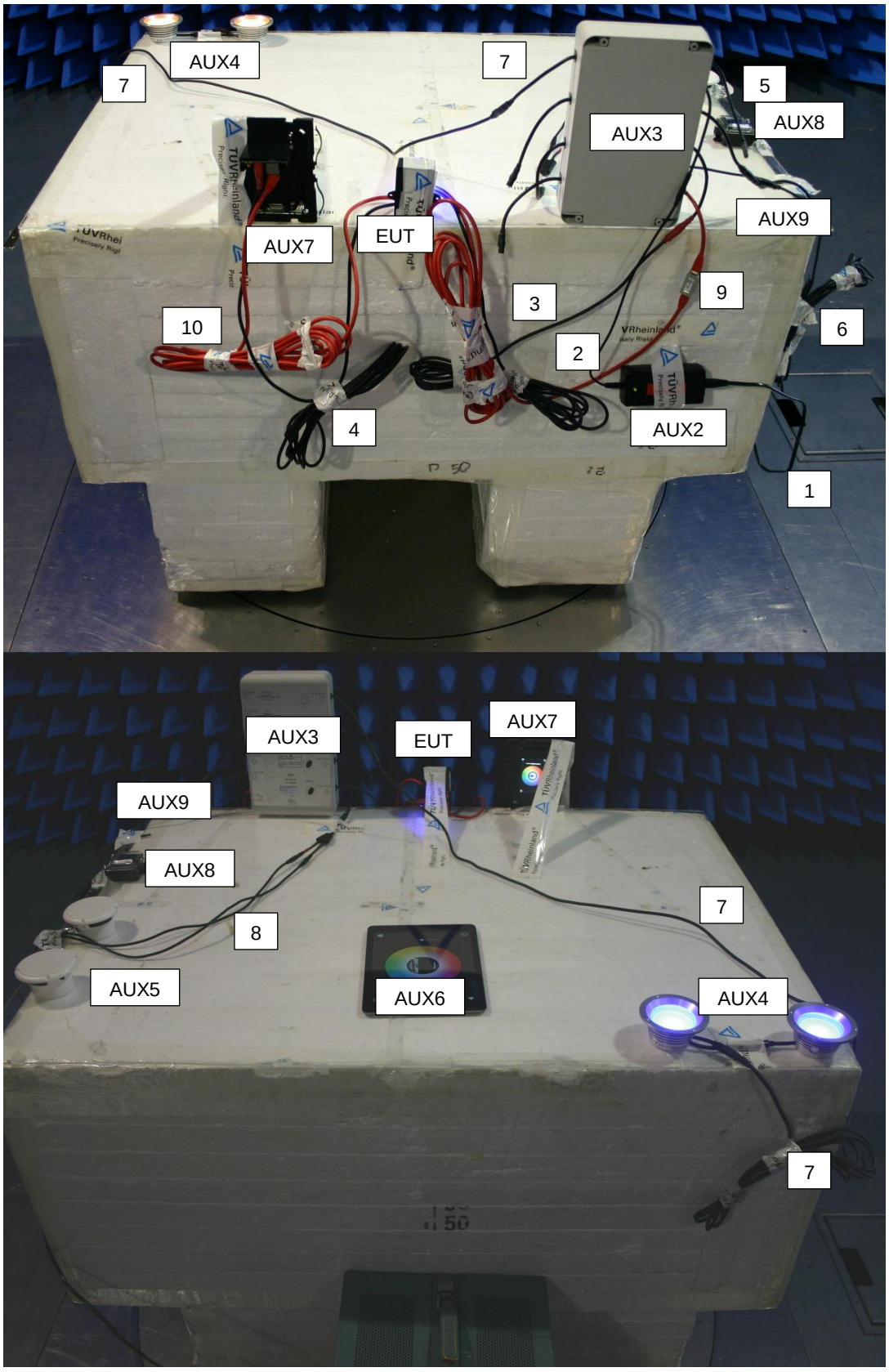
The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.4:2009.

Figure 1: Test Setup Diagram



Notes:

For more details, refer to the document: Test Set-Up Photographs document.


AUX4
7
7
5
AUX8
AUX3
AUX9
AUX7
EUT
3
9
6
10
2
4
AUX2
1
AUX3
EUT
AUX7
AUX9
AUX8
7
8
AUX5
AUX6
AUX4
7

4.4 Test Software

The operation modes could be initiated by using test software as supplied by the applicant. The test software was used to define various different operational modes of the EUT for the purpose of compliance testing. The version of the test software used during all tests is:

Test software : Blue Test3

This software was running on a laptop computer (AUX1). It was used to enable the test operation modes listed in section 4.2 as appropriate.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. AUX1
   Product: Notebook PC (Intel property)
   Brand: HP
   Model: Compaq 610
   Serial Number: CNU94710W B
   Remark: property testlab, host for testsoftware, used only for making settings not used during the tests.

2. AUX2
   Product: Power Supply AC/DC Adapter
   Brand: --
   Model: FW7405M/12
   Serial Number: --
   Voltage input range 100 – 240 Vac 50-60 Hz
   Voltage output range 12 Vdc (3.8A)
   Remark: --

3. AUX3
   Product: Base-Unit
   Brand: Grohe
   Model: Base-Unit
   Serial Number: --
   Remark: Steam generator F-digital deluxe

4. AUX4
   Product: LED lights
   Brand: Grohe
   Model: 403349031
   Serial Number: Z0900160D1701 and Z0900160D3C00
   Remark: --

5. AUX5
   Product: Speaker set
   Brand: Grohe
   Model: 403243031
   Serial Number: --
   Remark: 8 Ω / 15W

6. AUX6
   - Product: LED lights controller
   - Brand: Apple
   - Model: iPAD (A1367)
   - Serial Number: DMPLRQ1NK10
   - FCC ID: BCGA1474
   - IC 597C-A1474
   - Remark: with app for controlling the lights, sounds and steam

7. AUX7
   - Product: Media Player
   - Brand: Apple
   - Model: iPOD model A1367 + dockingstation
   - Serial Number: C3TFQMHDDCP7
   - FCC ID: BCG-E2407
   - IC 597C-E2407
   - Remark: with app for controlling the lights, sounds and steam

8. AUX8
   - Product: Steam cabine simulator
   - Brand: --
   - Model: --
   - Serial Number: --
   - Remark: used as a typical load emulation of a steam cabine

9. AUX9
   - Product: Temperature sensor / simulator
   - Brand: --
   - Model: --
   - Serial Number: --
   - Remark: used to simulate a temperature of around 43°C

5. Test Results

5.1 Conducted Measurements at Antenna Port

5.1.1 Conducted Output Power

RESULT: PASS

Date of testing: 2014-04-03 and 2014-11-03

Requirements:

FCC 15.247(b)(3) and RSS-210 A8.4.

For systems using frequency hopping using at least 15 channels in the 2400-2483.5MHz band, the maximum peak output power is 1W (+30dBm).

Test procedure:

FCC Public Notice DA 00-705 (March 30, 2000).

The maximum peak output power (conducted) was measured at the antenna connector with a spectrum analyzer. The final measurement takes into account the loss generated by all the involved cables.
Declared maximum antenna gain: -3.1 dBi.
The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

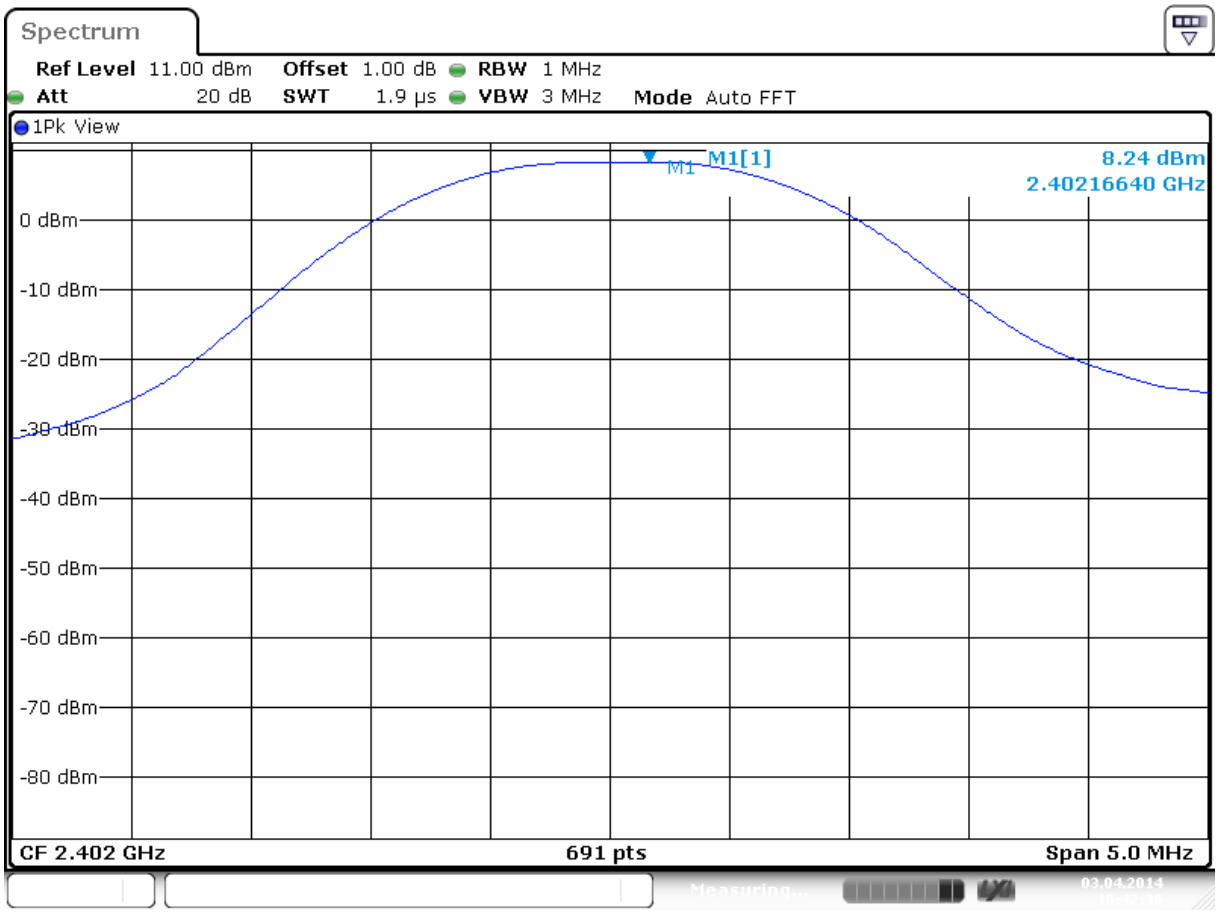
Notes: mW = 10 ^ (dBm/10)
dBm = 10 x log(mW)

plots : Peak power plots,
Plots of the Peak Power outputs are given on the next pages, correction factors included in the reading.

Conducted Output Power

Operation mode: DH5

Frequency [MHz]	Output Power [dBm]	Limit [dBm]	Limit [mW]	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Plot number
2402	8.24	+30	1000	5.14	3.3	1a
2440	8.31	+30	1000	5.21	3.3	1b
2480	7.60	+30	1000	4.50	2.8	1c



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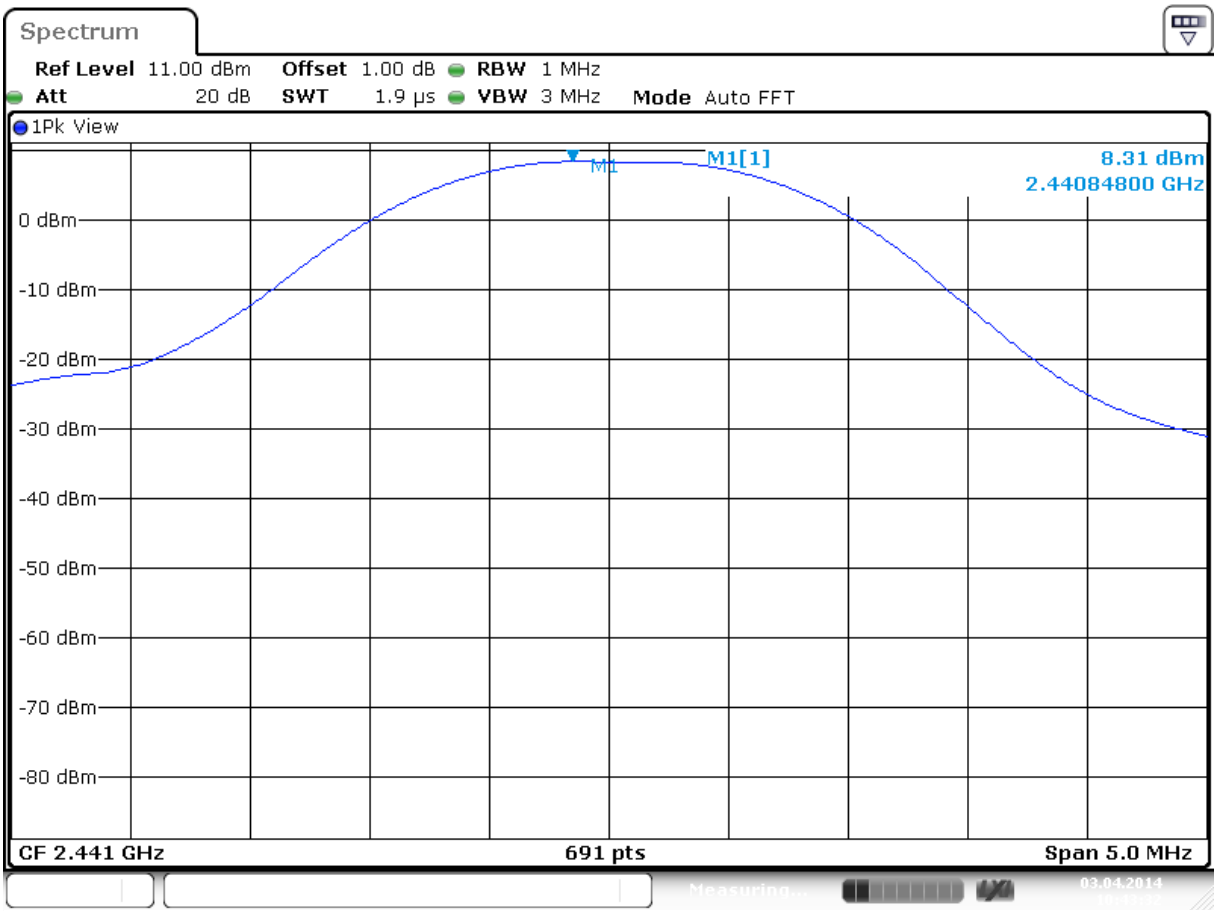
Plot 1a



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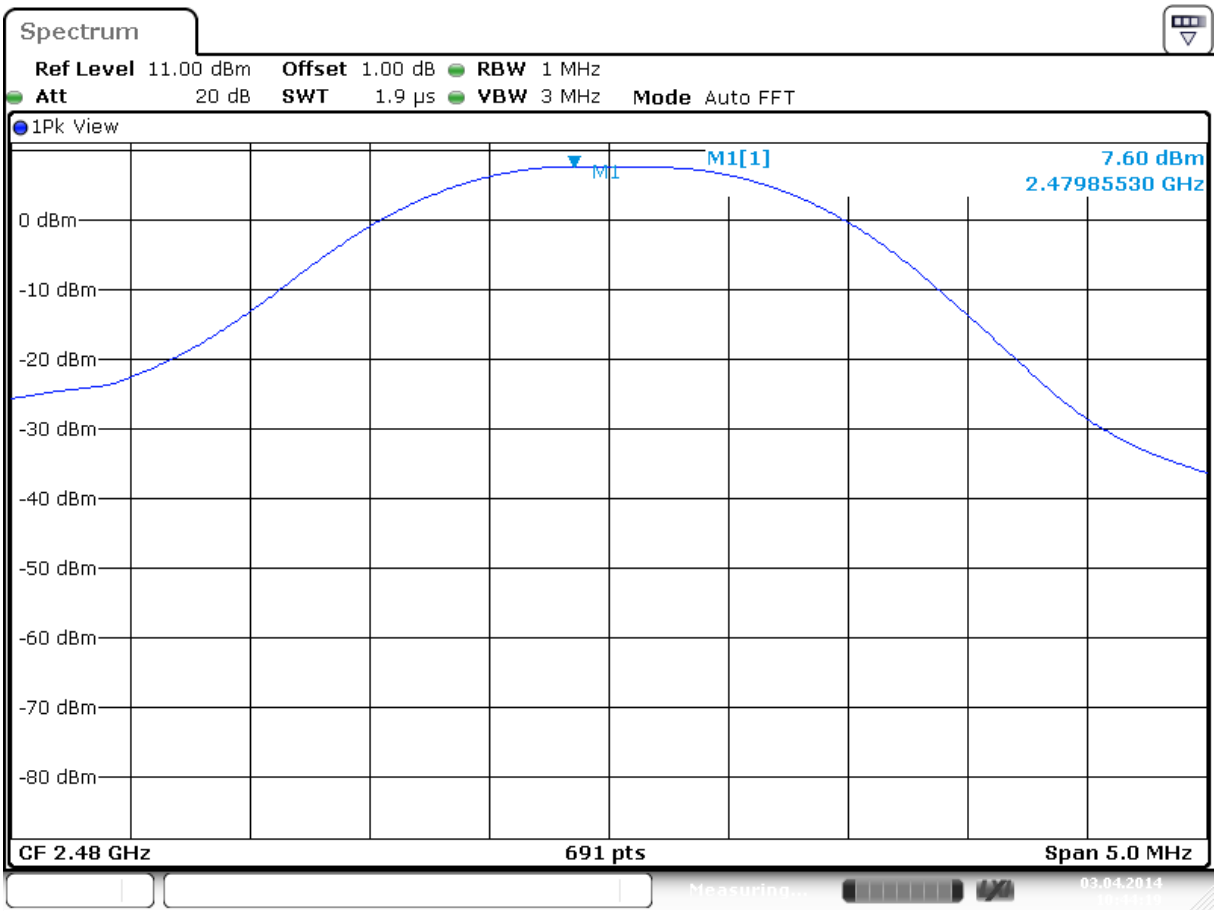
Plot 1b

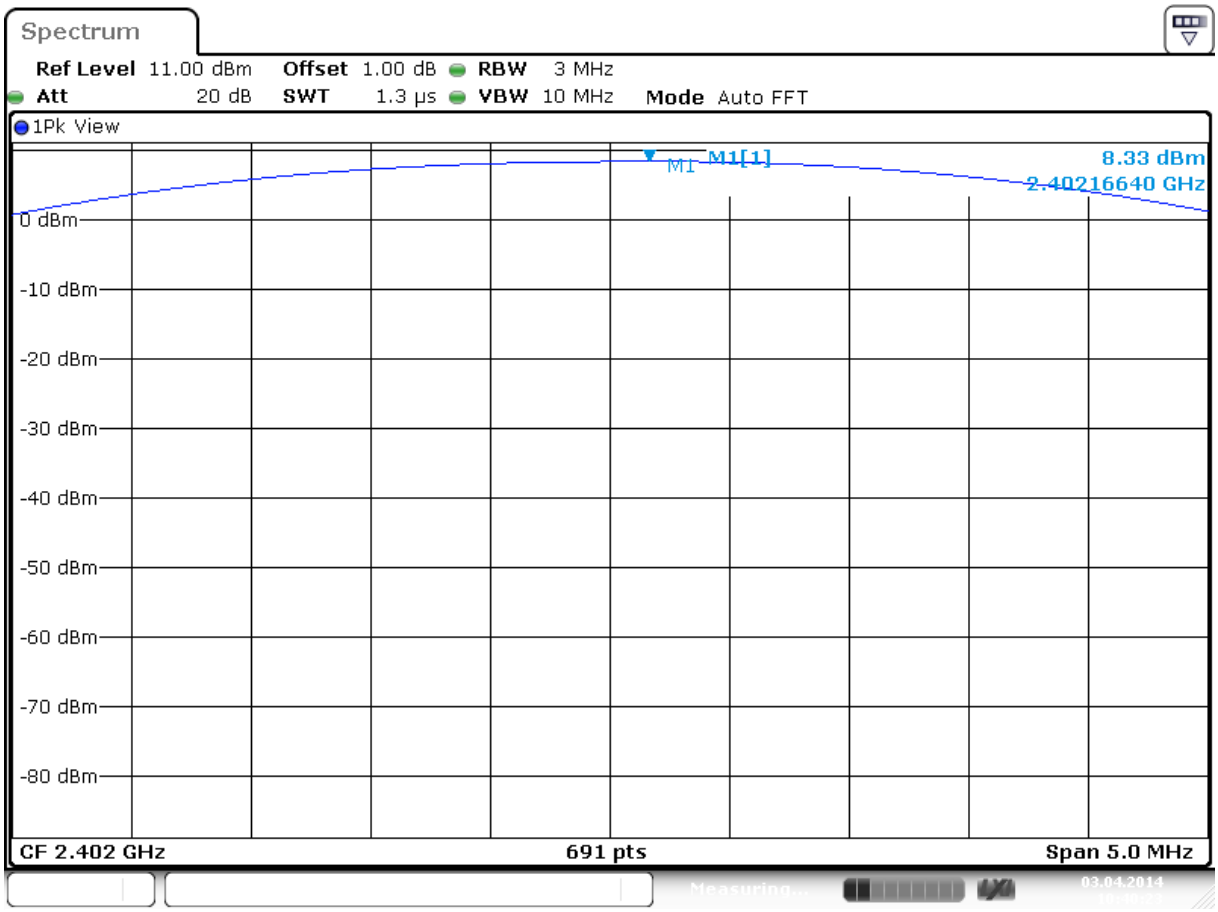


Date: 3.APR.2014 10:44:19

Plot 1c

Operation mode: 2-DH3

Frequency [MHz]	Output Power [dBm]	Limit [dBm]	Limit [mW]	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Plot number
2402	8.33	+30	1000	5.23	3.3	2a
2440	8.25	+30	1000	5.15	3.3	2b
2480	7.72	+30	1000	4.62	2.9	2c



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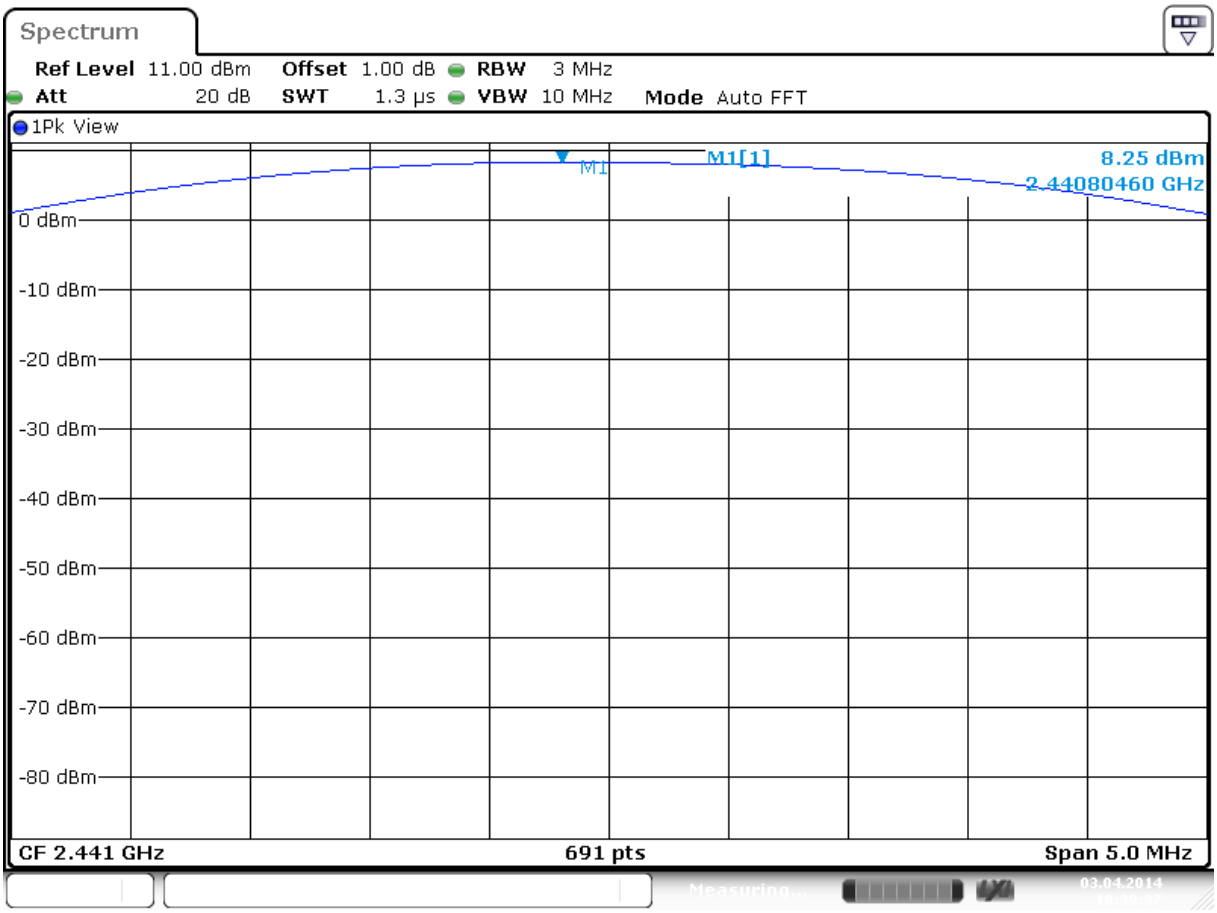
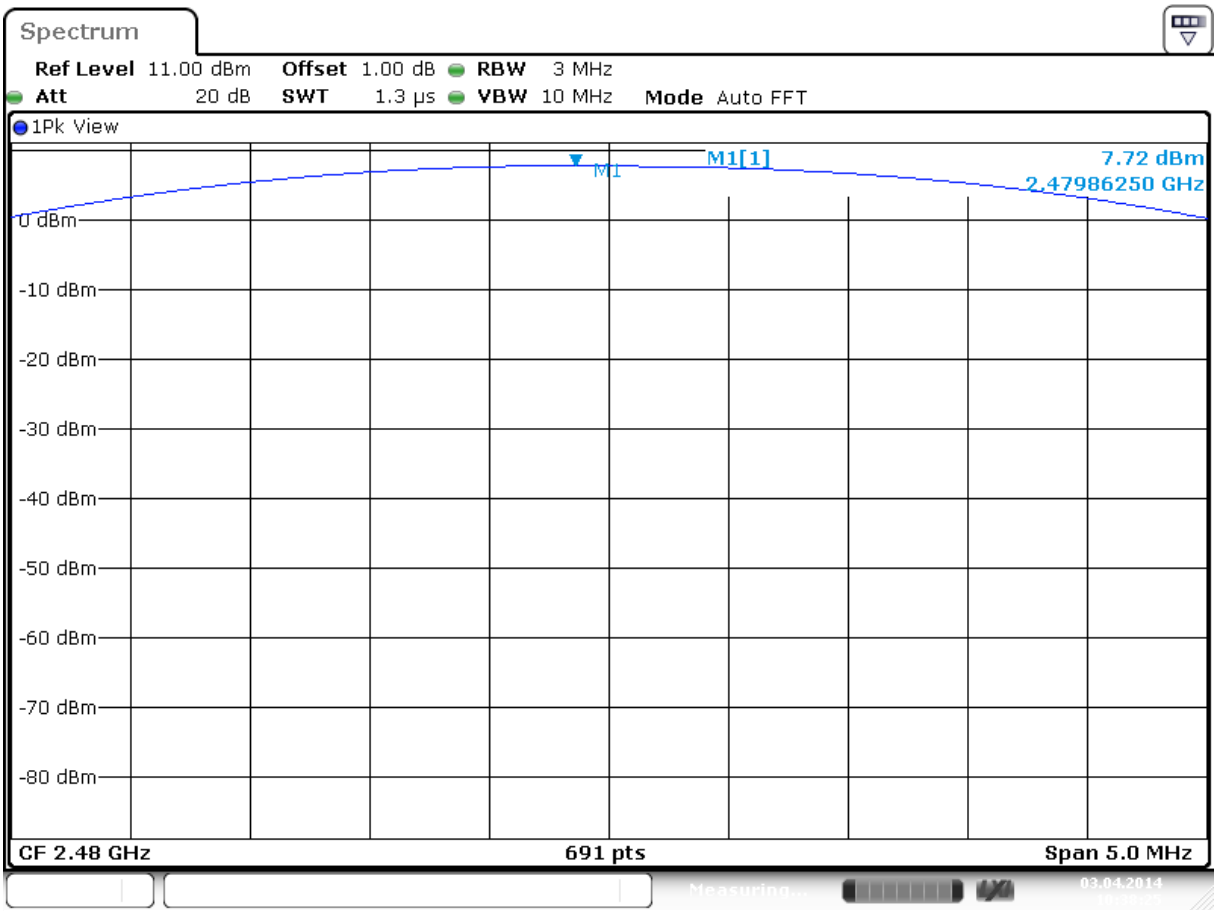
Plot 2a



Date: 3.APR.2014 10:39:37

Plot 2b

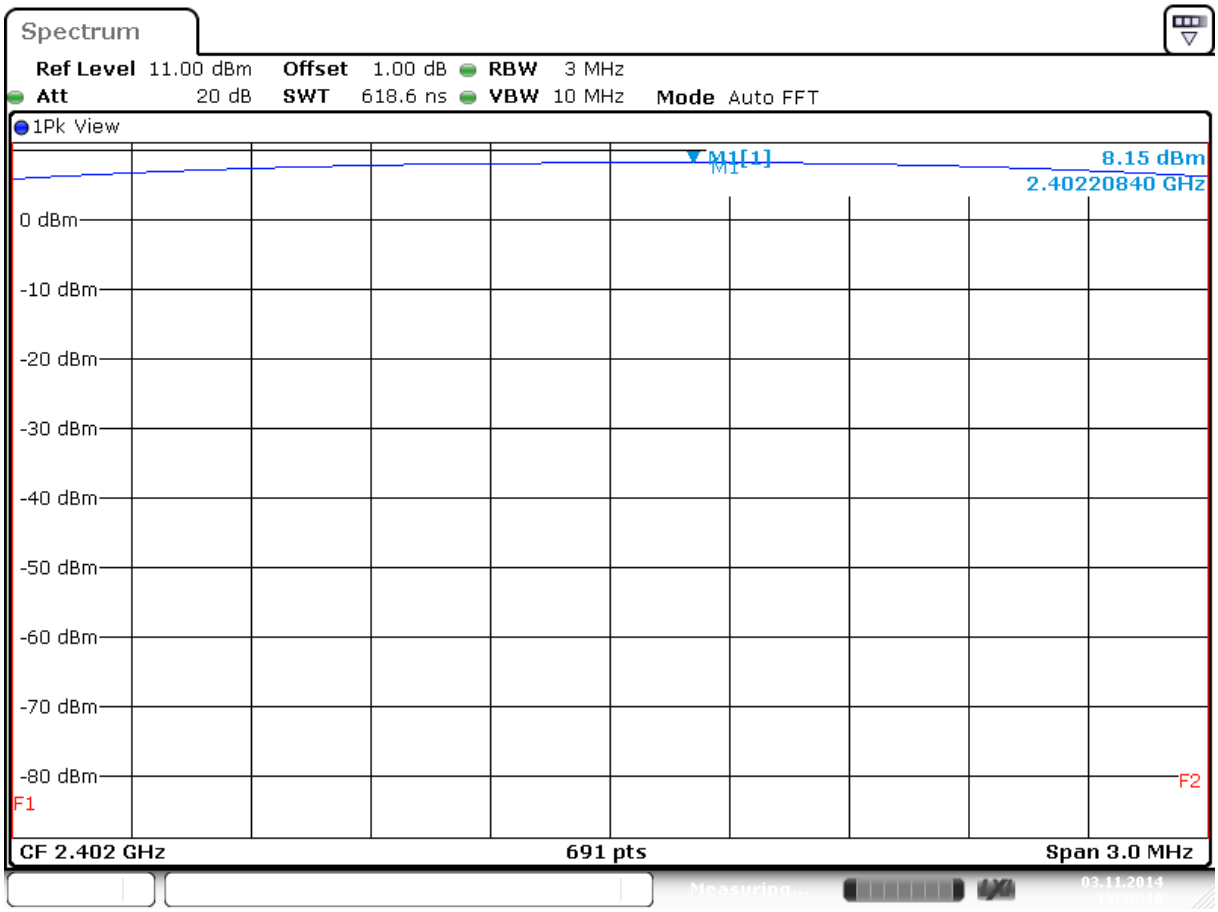


Date: 3.APR.2014 10:38:25

Plot 2c

Operation mode: 3-DH5

Frequency [MHz]	Output Power [dBm]	Limit [dBm]	Limit [mW]	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Plot number
2402	8.15	+30	1000	5.05	3.2	3a
2440	8.05	+30	1000	4.95	3.1	3b
2480	7.49	+30	1000	4.39	2.7	3c



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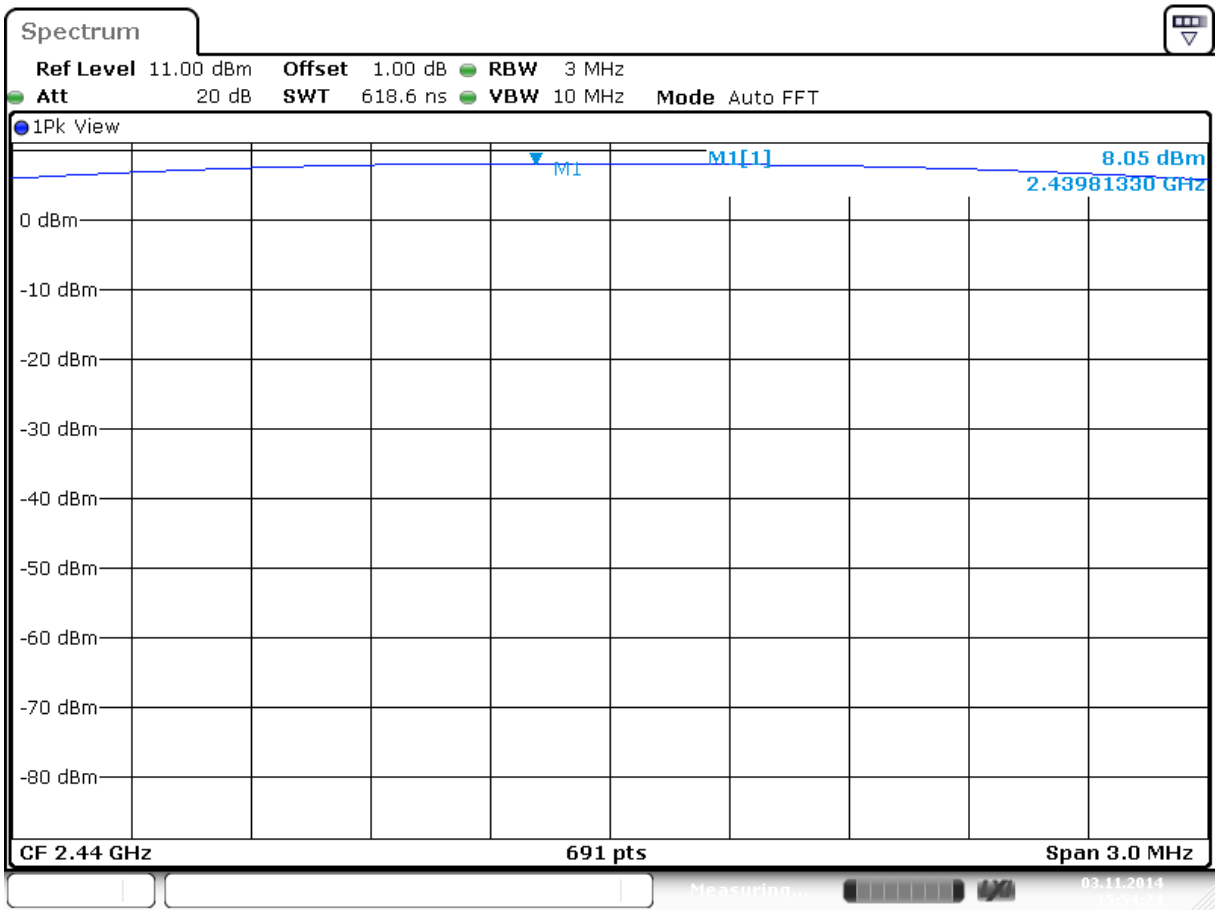
Plot 3a



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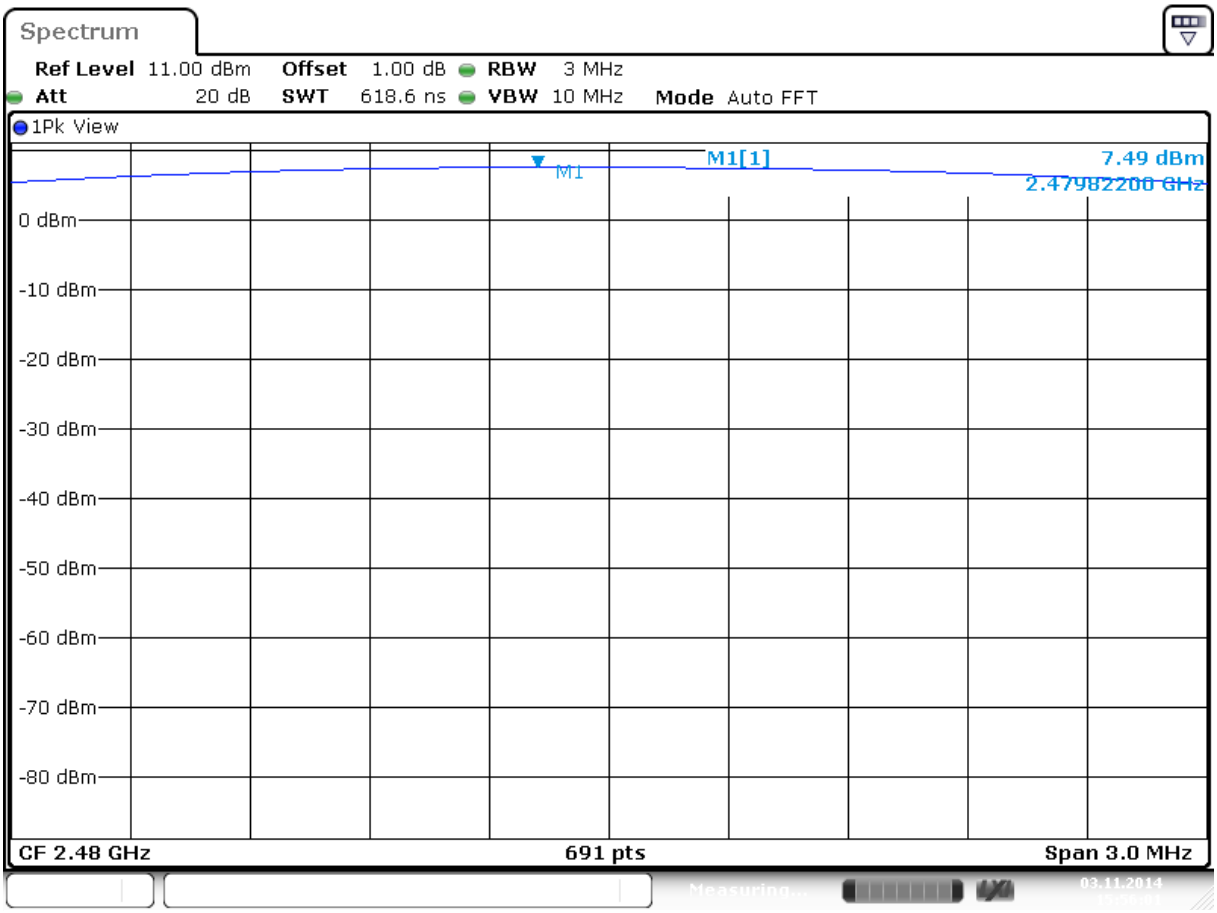
Plot 3b



Date: 3.NOV.2014 15:56:01

Plot 3c

5.1.2 20dB Bandwidth and 99% Bandwidth

RESULT: PASS

Date of testing: 2014-04-03 and 2014-05-12

Requirements:

FCC 15.247(a)(2), RSS-Gen Section 4.6 and RSS-210 Section A8.1 (a) en (b).
For systems using hopping technology in the 2400-2483.5MHz band, the 20dB bandwidth is not limited.

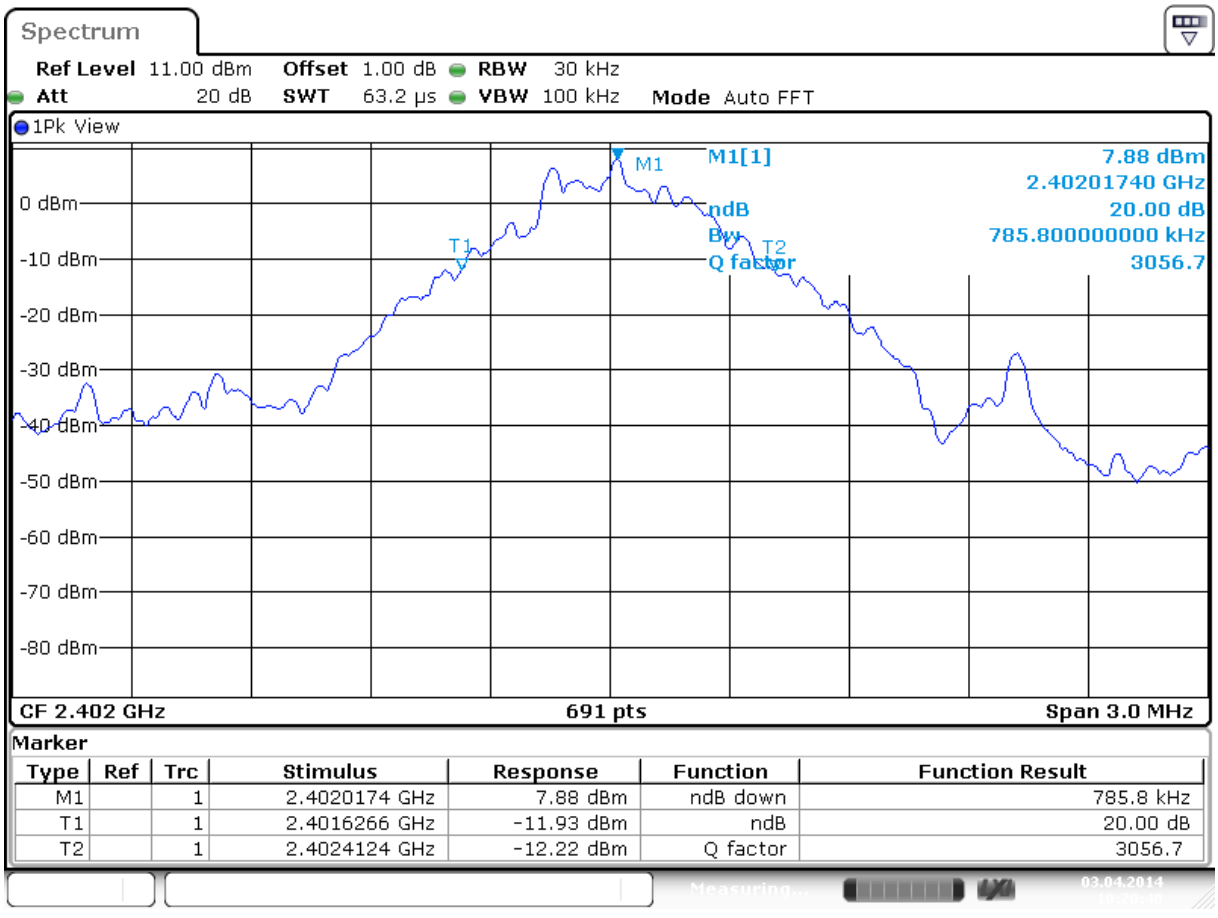
Test procedure: FCC Public Notice DA 00-705 (March 30, 2000).

A spectrum analyzer was connected to the antenna port of the EUT. The spectrum analyzer resolution bandwidth was set to 100kHz, video bandwidth to 300kHz and the span wide enough to capture the modulated carrier.

20dB Bandwidth

Operation mode: DH5

Operating Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]	Limit [kHz]	Plot number
2402	785.8	846.6	Not applicable	4a
2441	781.5	837.9	Not applicable	4b
2480	781.5	833.6	Not applicable	4c



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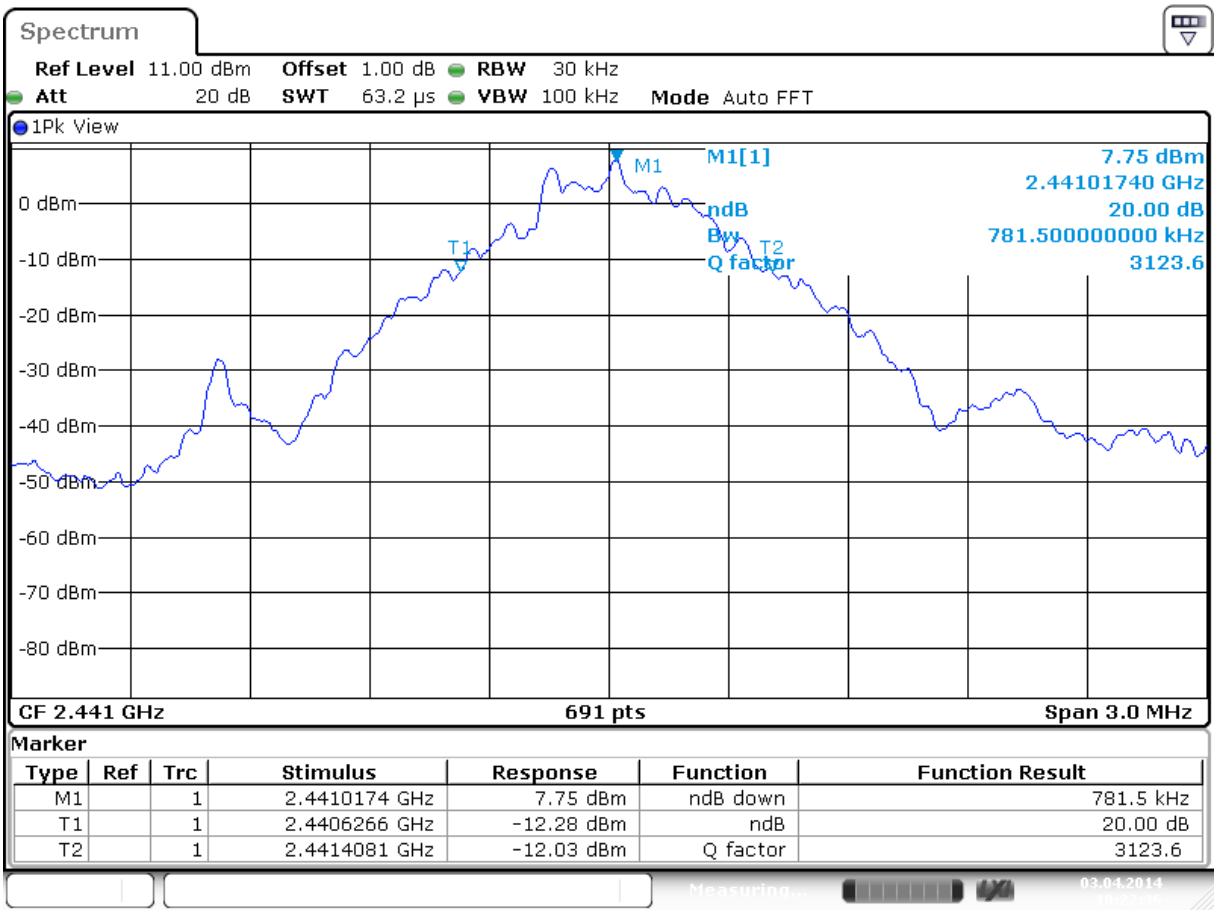
Plot 4a



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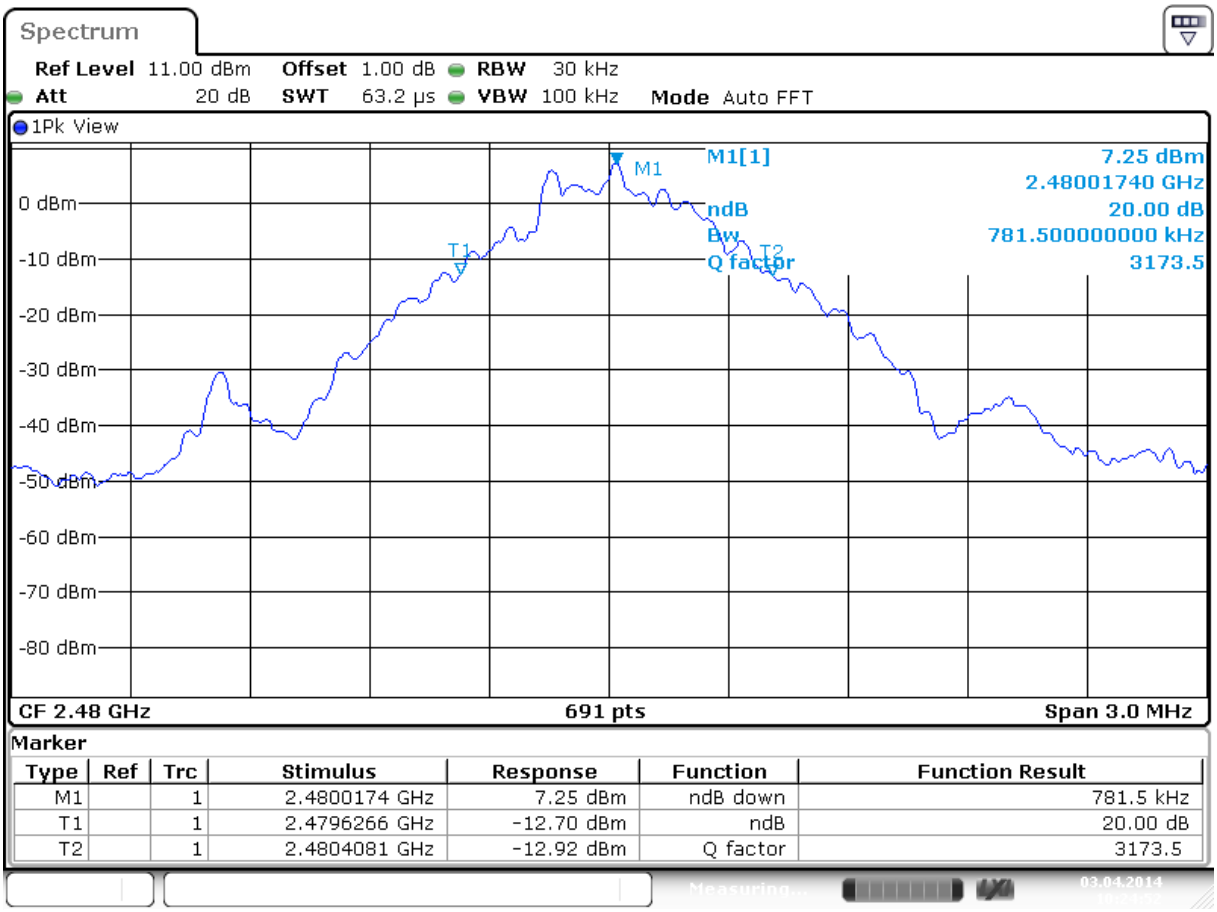
Plot 4b

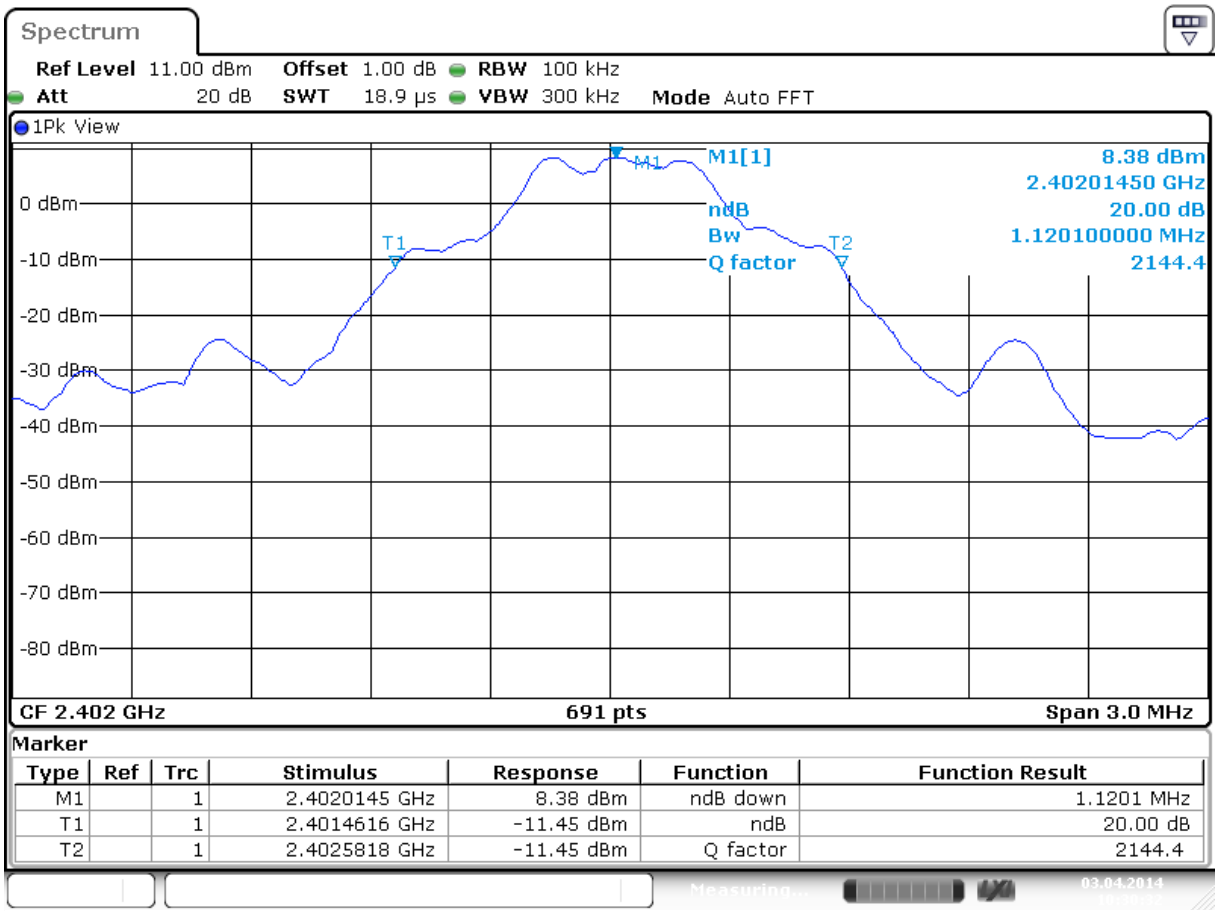


Date: 3.APR.2014 10:24:51

Plot 4c

Operation mode: 2-DH3

Operating Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]	Limit [kHz]	Plot number
2402	1120.1	981.2	Not applicable	5a
2441	1124.5	985.5	Not applicable	5b
2480	1124.5	985.5	Not applicable	5c



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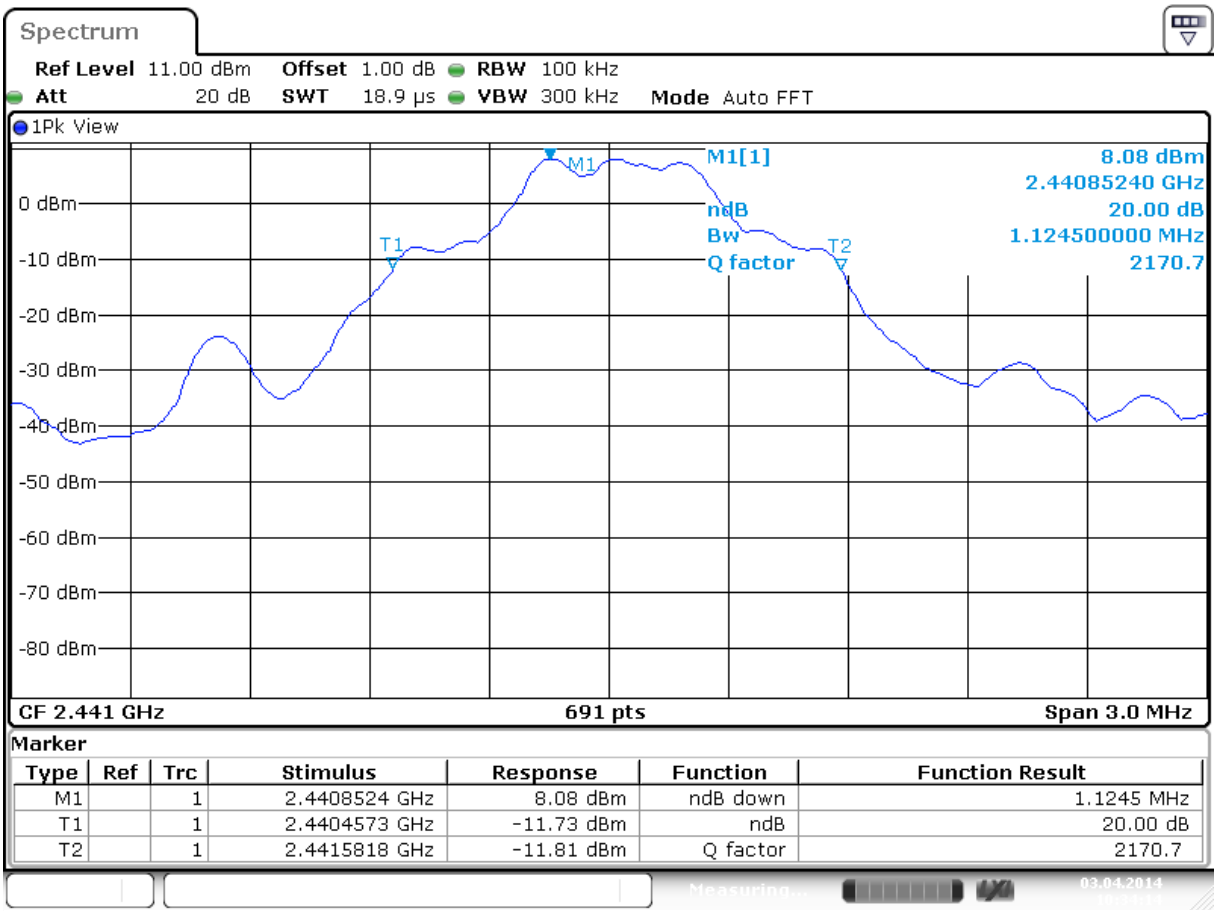
Plot 5a



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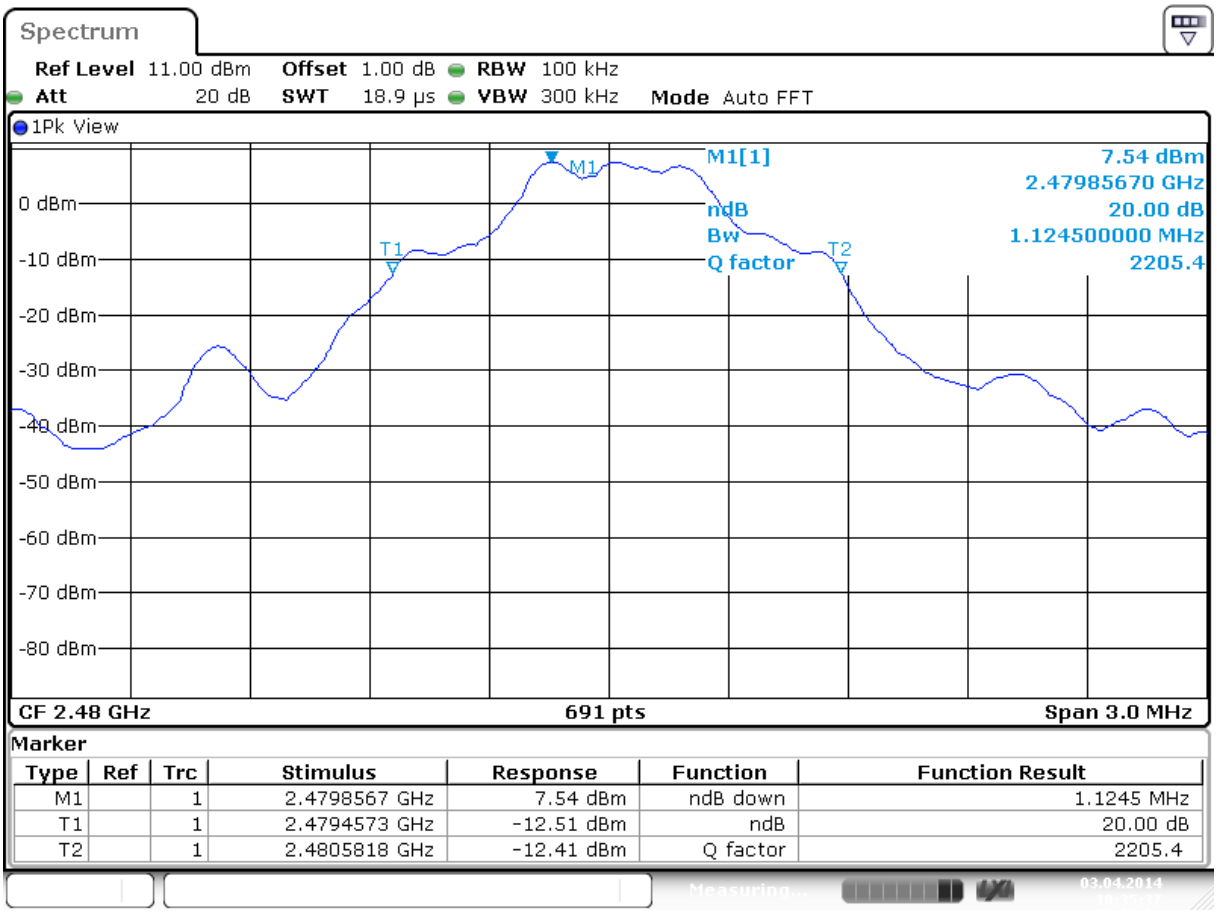
Plot 5b



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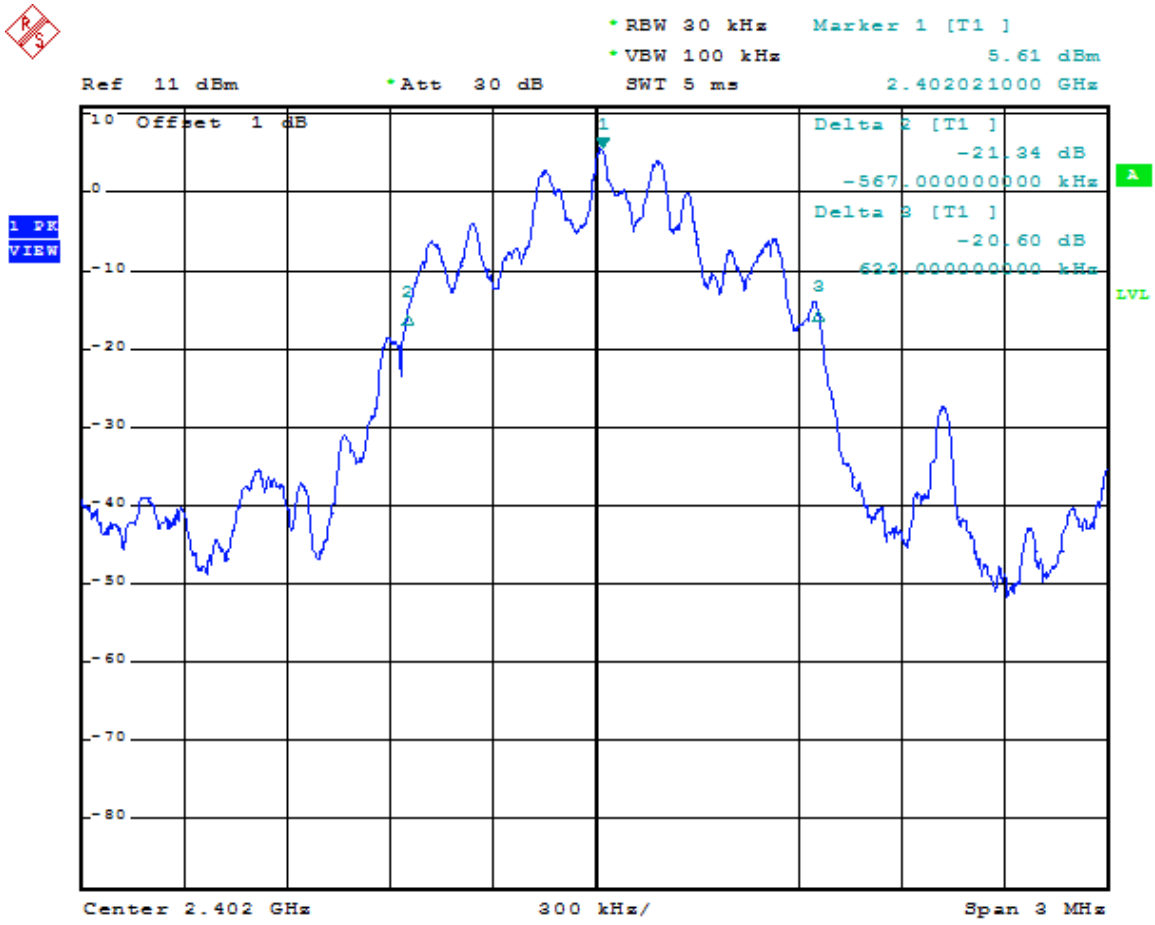
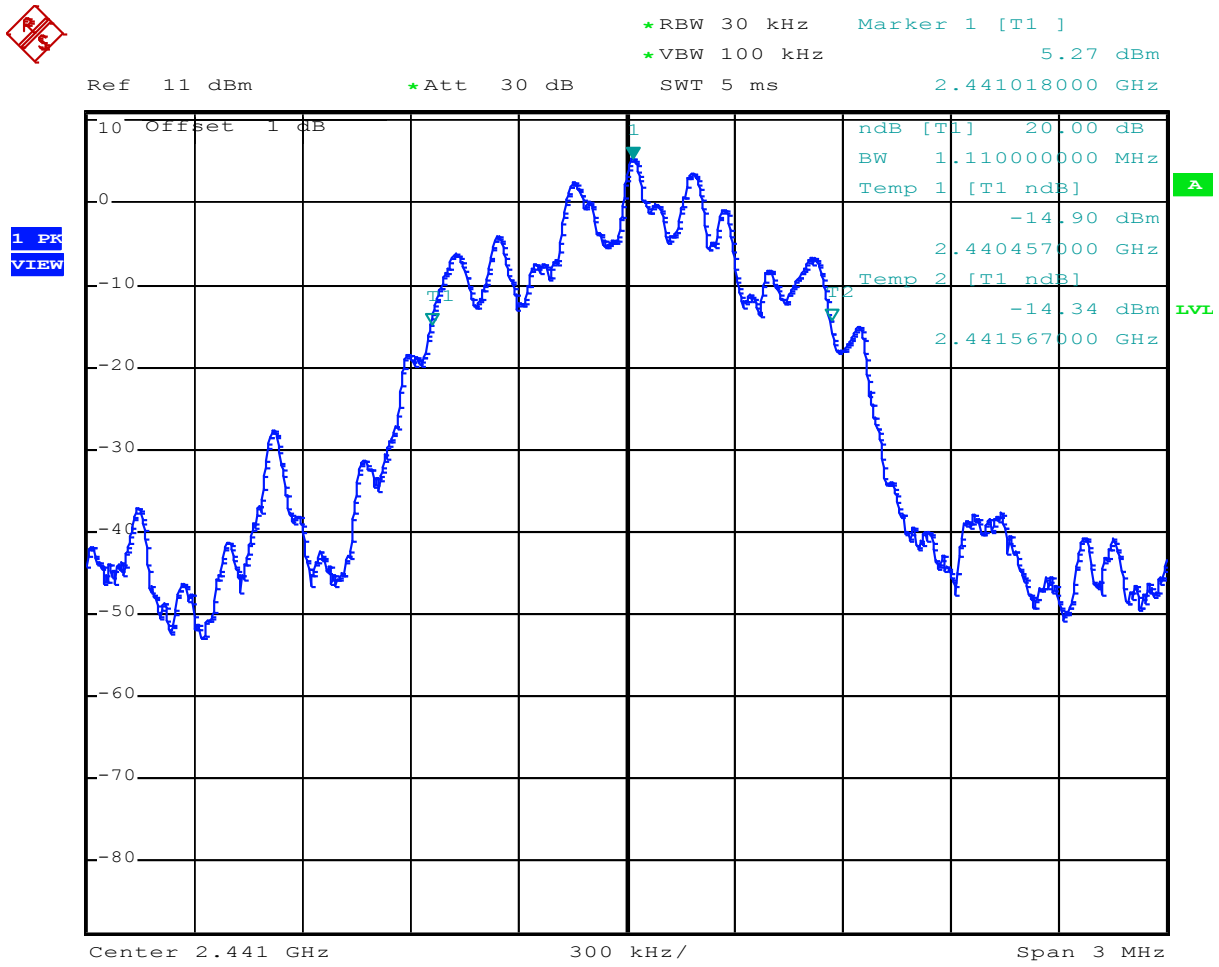
Plot 5c

Operation mode: 3-DH5

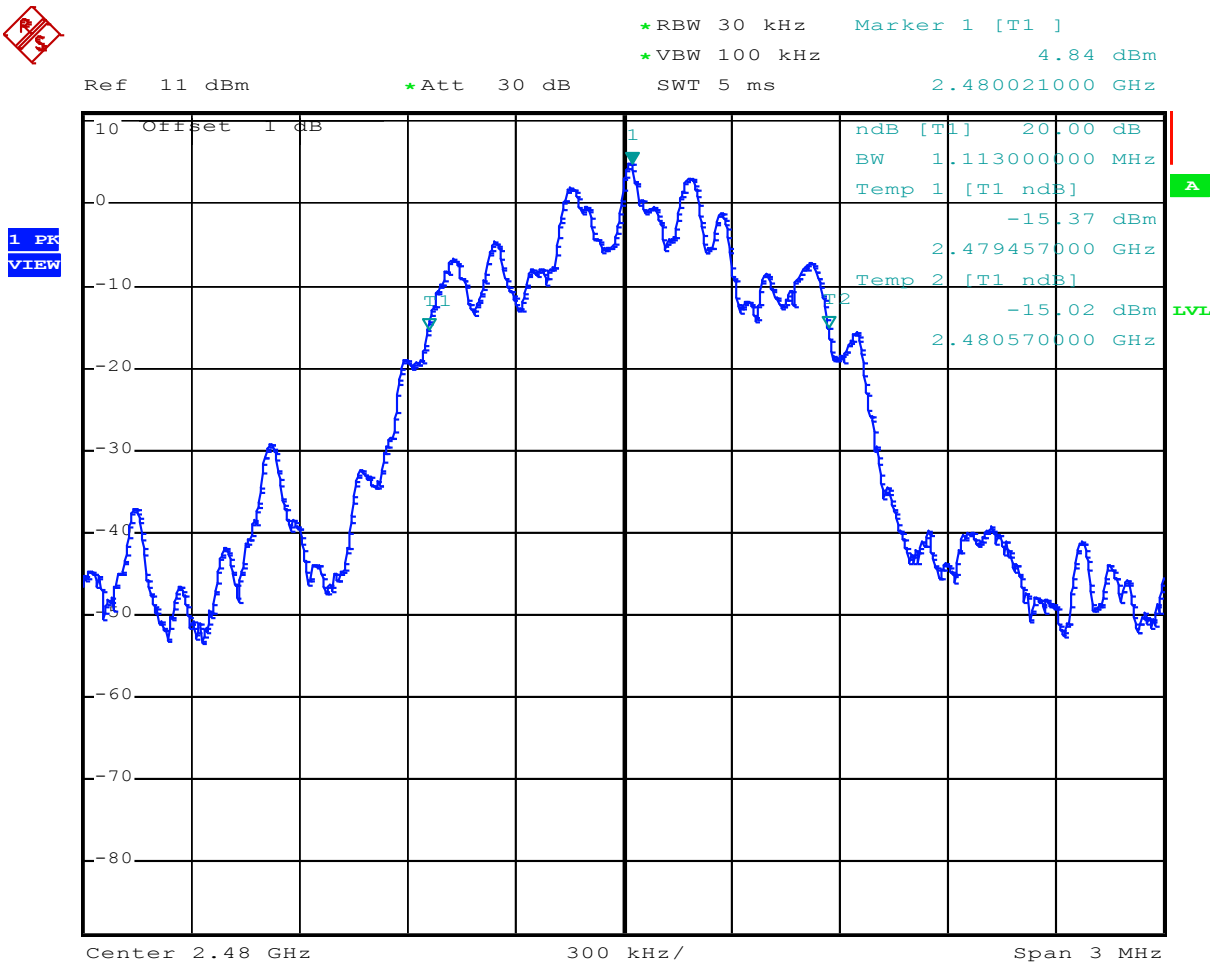
Operating Frequency [MHz]	20dB Bandwidth [kHz]	99% Bandwidth [kHz]	Limit [kHz]	Plot number
2402	1189.0	1074.0	Not applicable	6a
2441	1110.0	1074.0	Not applicable	6b
2480	1113.0	1074.0	Not applicable	6c



Plot 6a


RBW 30 kHz
VBW 100 kHz
Marker 1 [T1]
5.27 dBm
2.441018000 GHz
Ref 11 dBm
Att 30 dB
SWT 5 ms
Offset 1 dB
ndB [T1] 20.00 dB
BW 1.110000000 MHz
Temp 1 [T1 ndB]
-14.90 dBm
2.440457000 GHz
Temp 2 [T1 ndB]
-14.34 dBm
2.441567000 GHz
1 PK VIEW
A
LVL
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.441 GHz
300 kHz/
Span 3 MHz
Date: 12.MAY.2014 12:40:35

Plot 6b



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Plot 6c

5.1.3 Spurious emissions conducted

RESULT: PASS

Date of testing: 2014-04-04

Requirements:

FCC 15.247(d) and RSS-210 A8.1

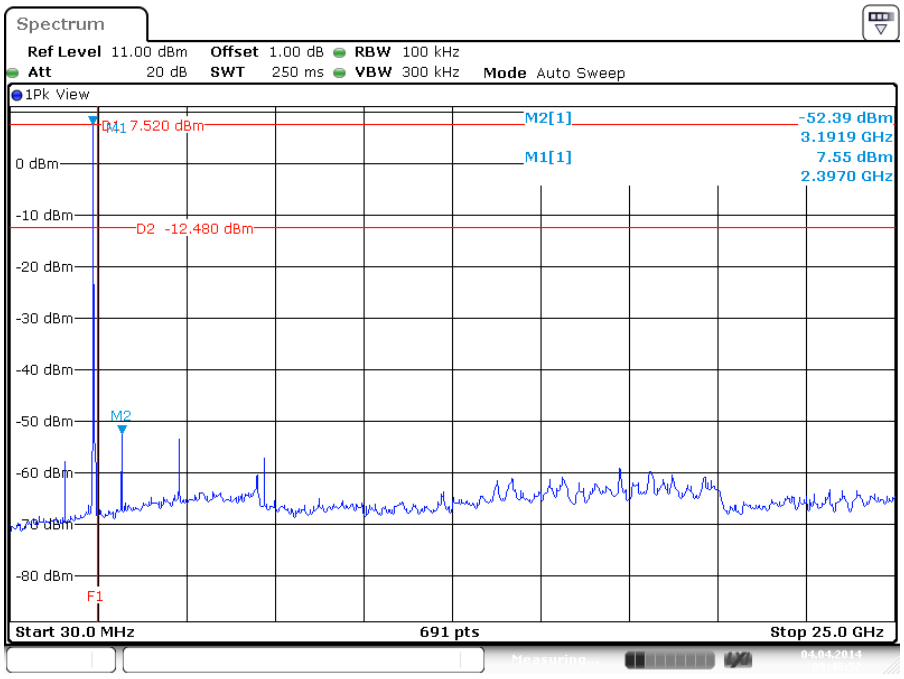
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the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

Test procedure: FCC Public Notice DA 00-705 (March 30, 2000).

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth and the video bandwidth were set to suitable values (RBW=100kHz/ VBW=300kHz). The sweep time was set to auto couple and the trace was allowed to stabilize before making the final measurement.

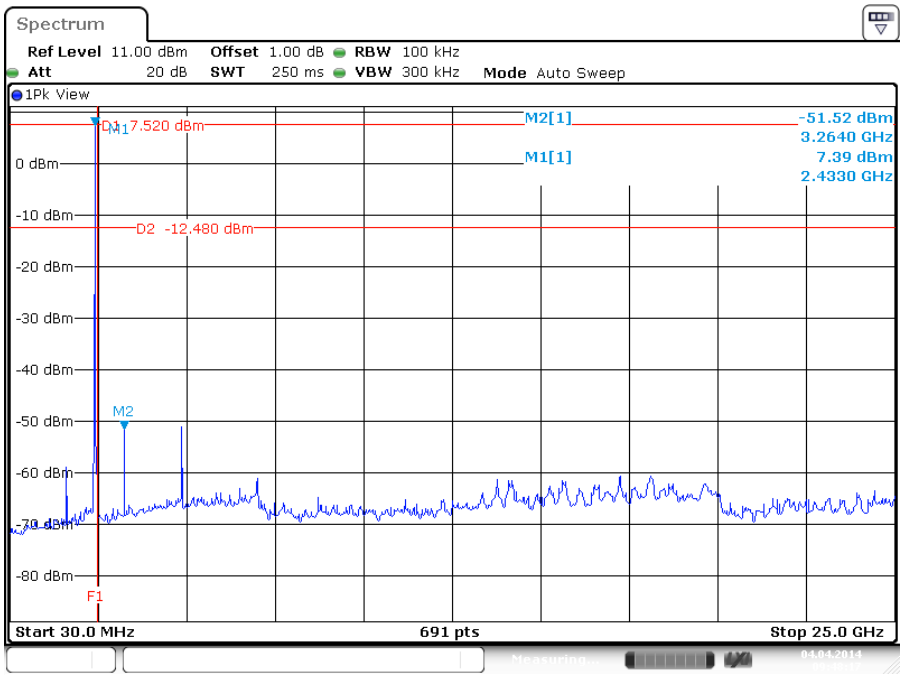
See plots on the next pages.

Spurious emissions conducted, DH5 packet:



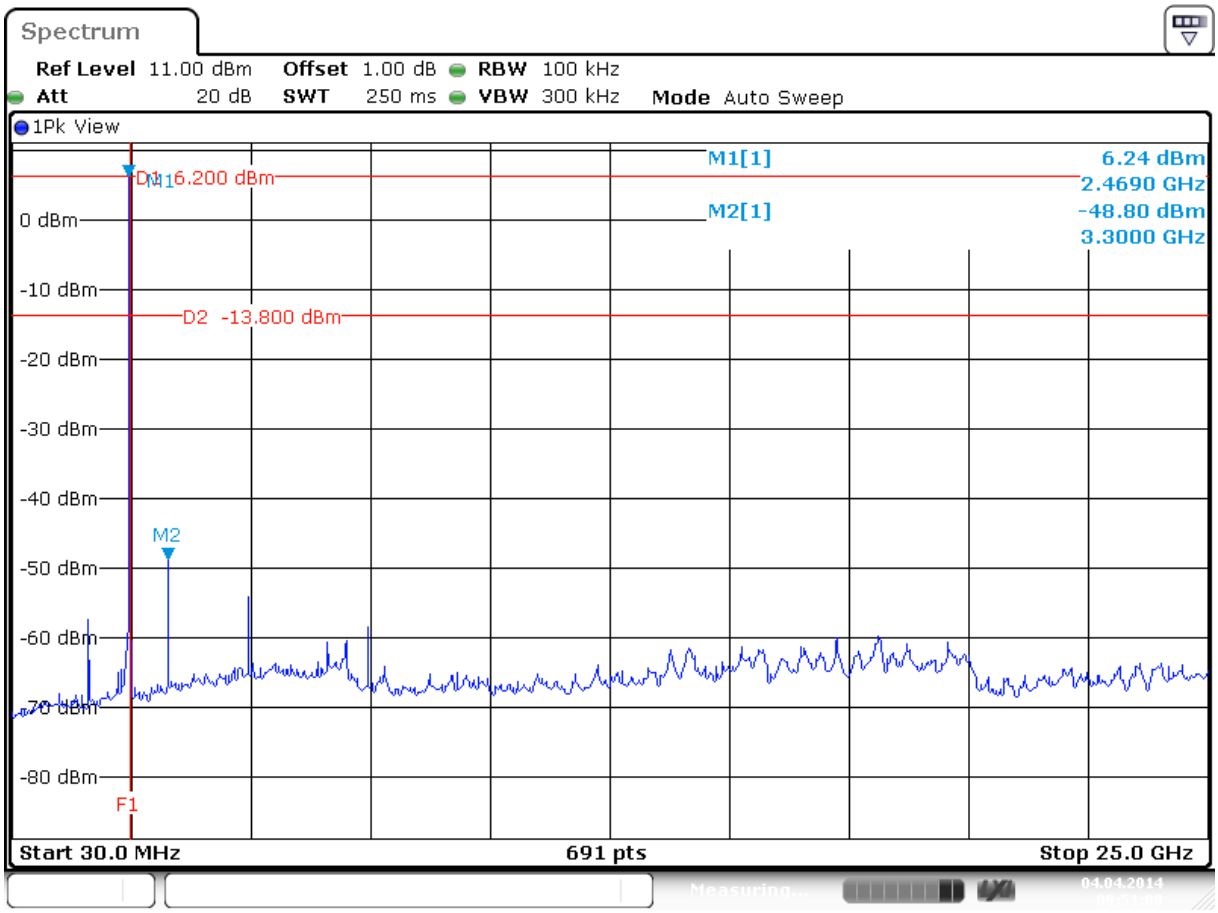
Date: 4.APR.2014 09:46:52

Channel 1



Date: 4.APR.2014 09:48:18

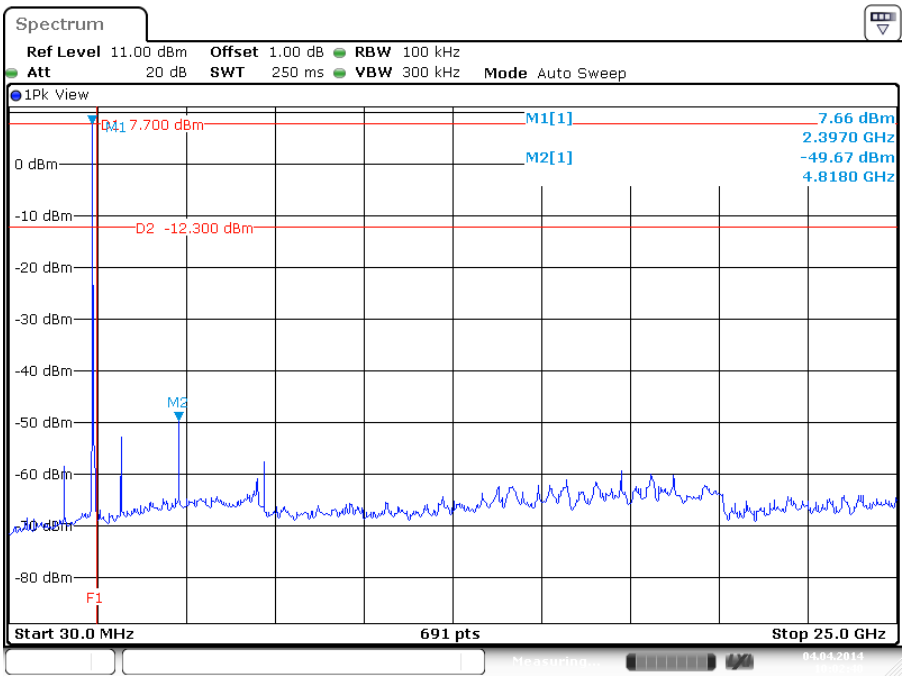
Channel 40



Date: 4.APR.2014 09:51:08

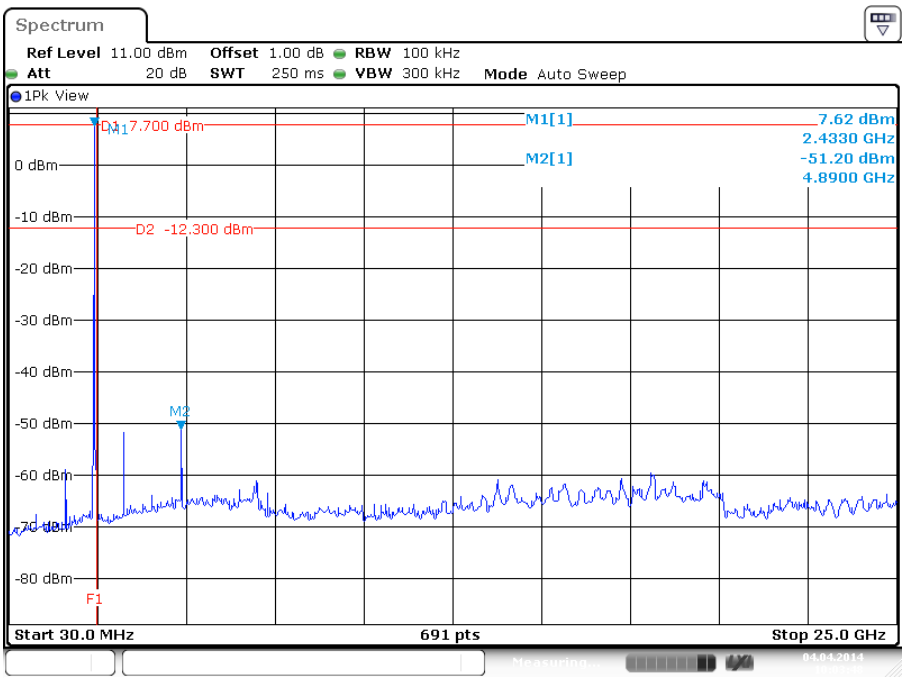
Channel 79

Spurious emissions conducted, 2-DH3 packet:



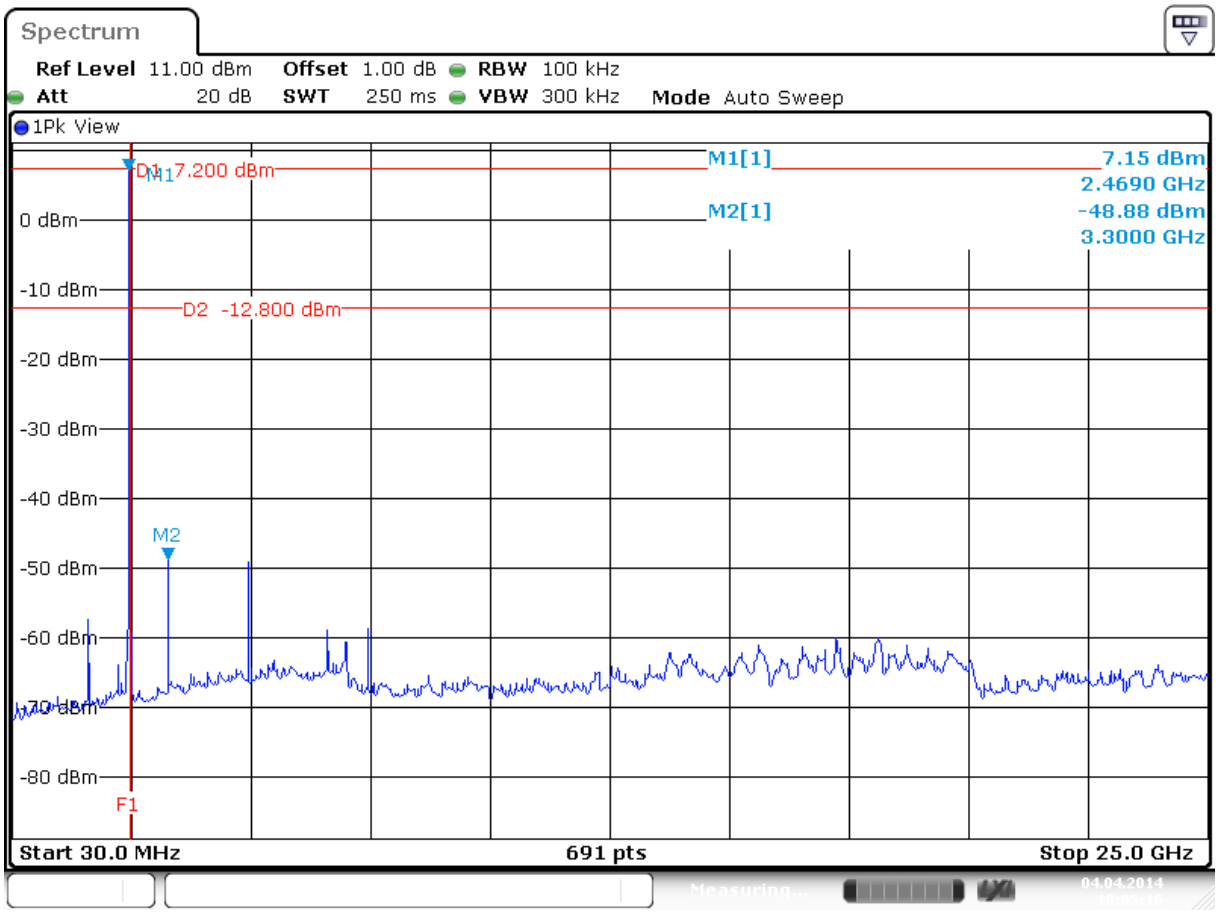
Date: 4.APR.2014 10:02:40

Channel 1



Date: 4.APR.2014 10:03:47

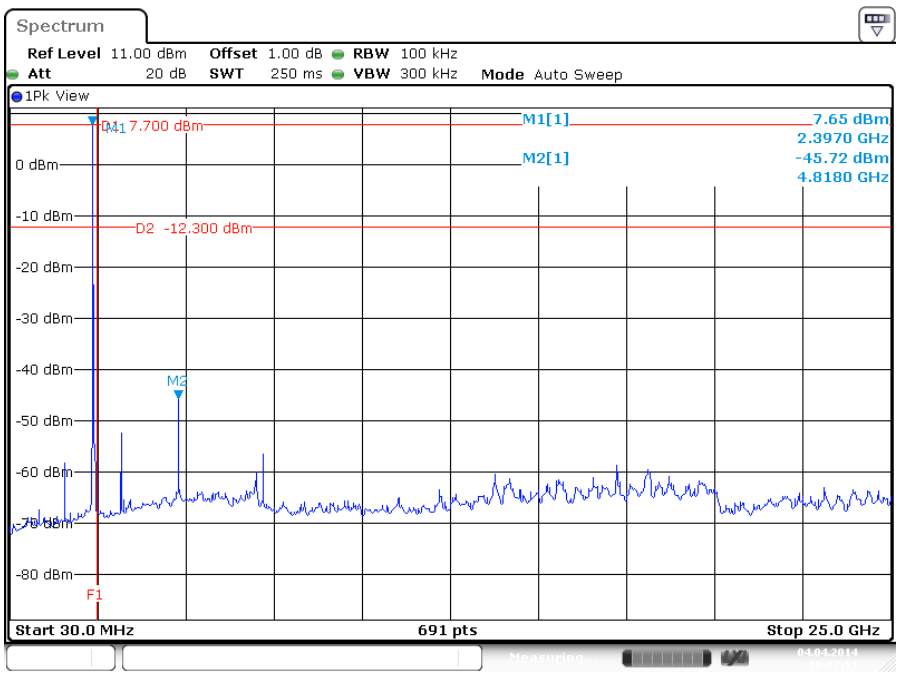
Channel 40



Date: 4.APR.2014 10:05:16

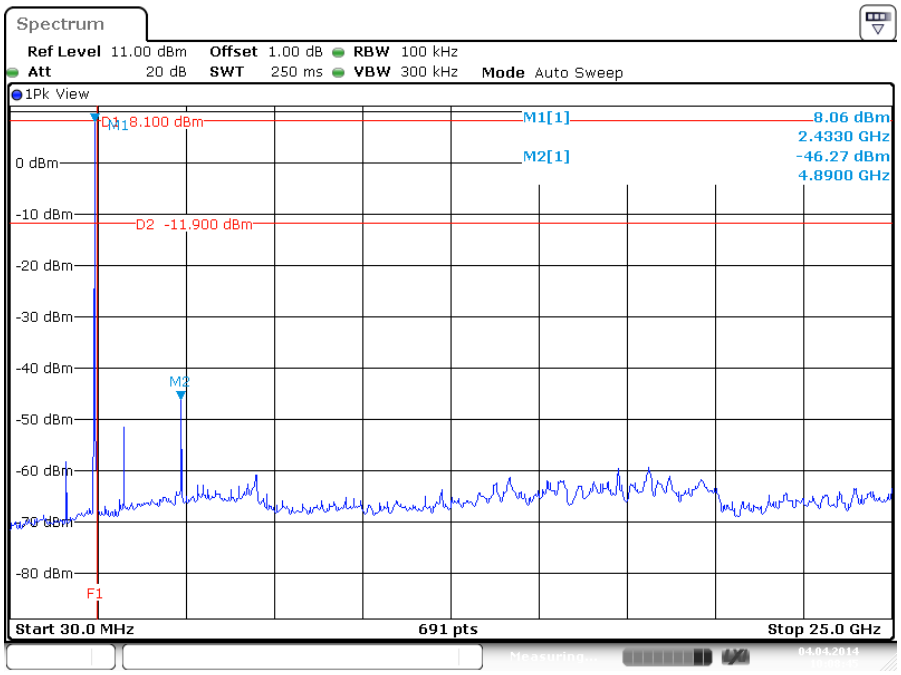
Channel 79

Spurious emissions conducted, 3-DH5 packet:



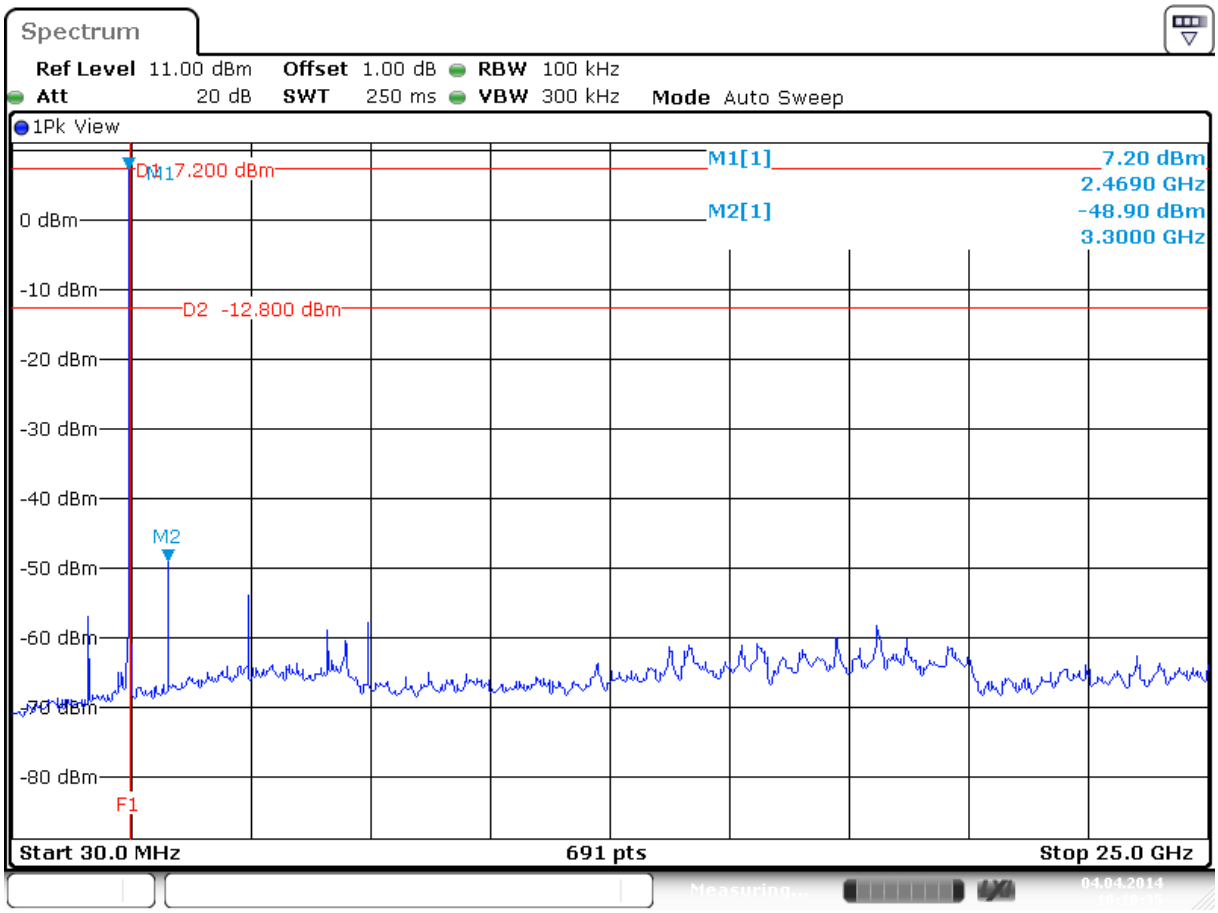
Date: 4.APR.2014 10:07:11

Channel 1



Date: 4.APR.2014 10:08:45

Channel 40



Date: 4.APR.2014 10:10:35

Channel 79

5.1.4 Number of hopping channels and Channel Occupancy

RESULT: PASS

Date of testing: 2014-04-03 and 2014-05-12

Requirements:

FCC 15.247(a)(1)(iii) and RSS-210 A8.1(d)

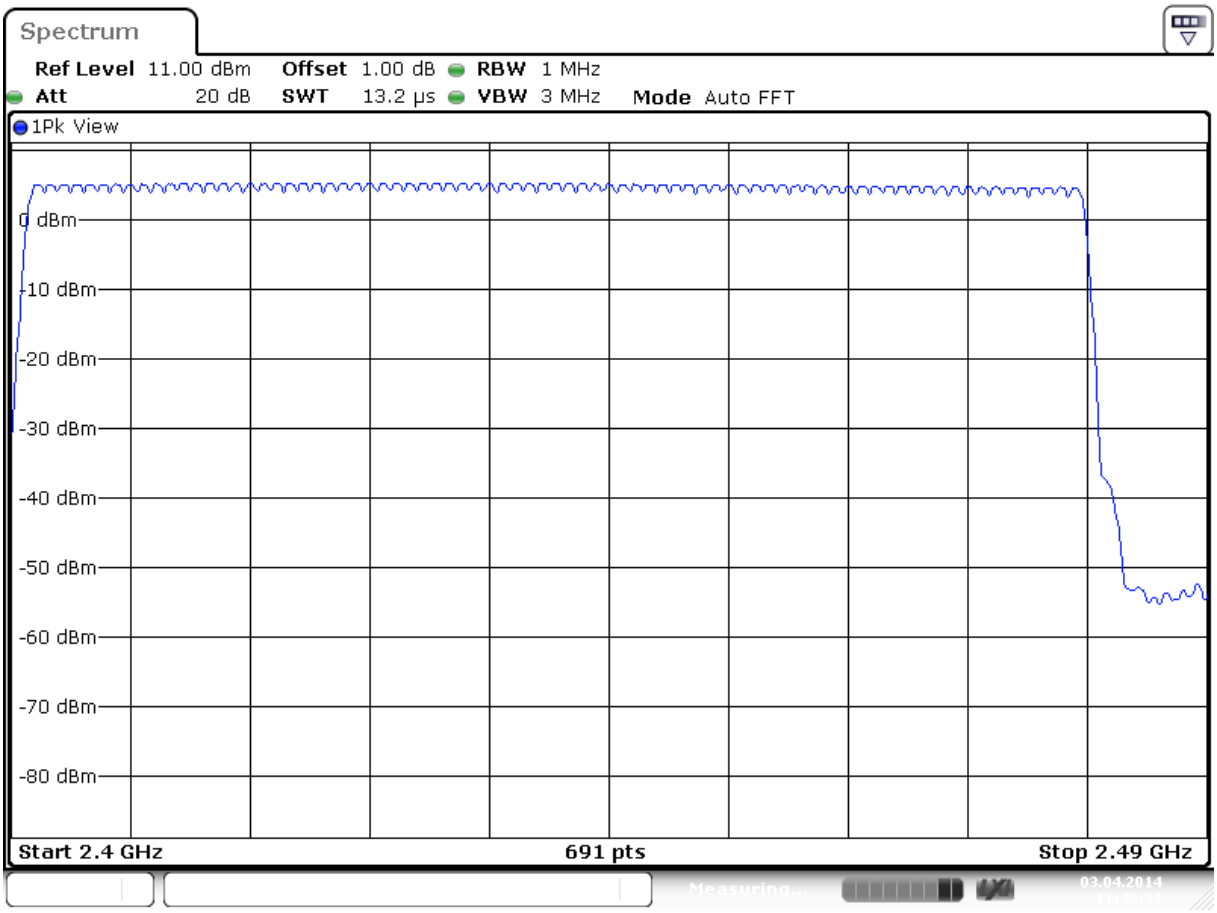
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test procedure: FCC Public Notice DA 00-705 (March 30, 2000).

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth and the video bandwidth were set to suitable values to make the hopping channels visible. The sweep time was set to auto couple and the trace was allowed to stabilize before making the final measurement.

Number of hopping channels

The number of hopping channels is independent of the operating mode, plot 7 below shows that the number of hopping channels is 79. Tested on a spectrum analyzer in operating mode 3-DH5.



Date: 3.APR.2014 11:48:31

Plot 7: (mode 3-DH5) number of hopping channels is 79

Channel Occupancy

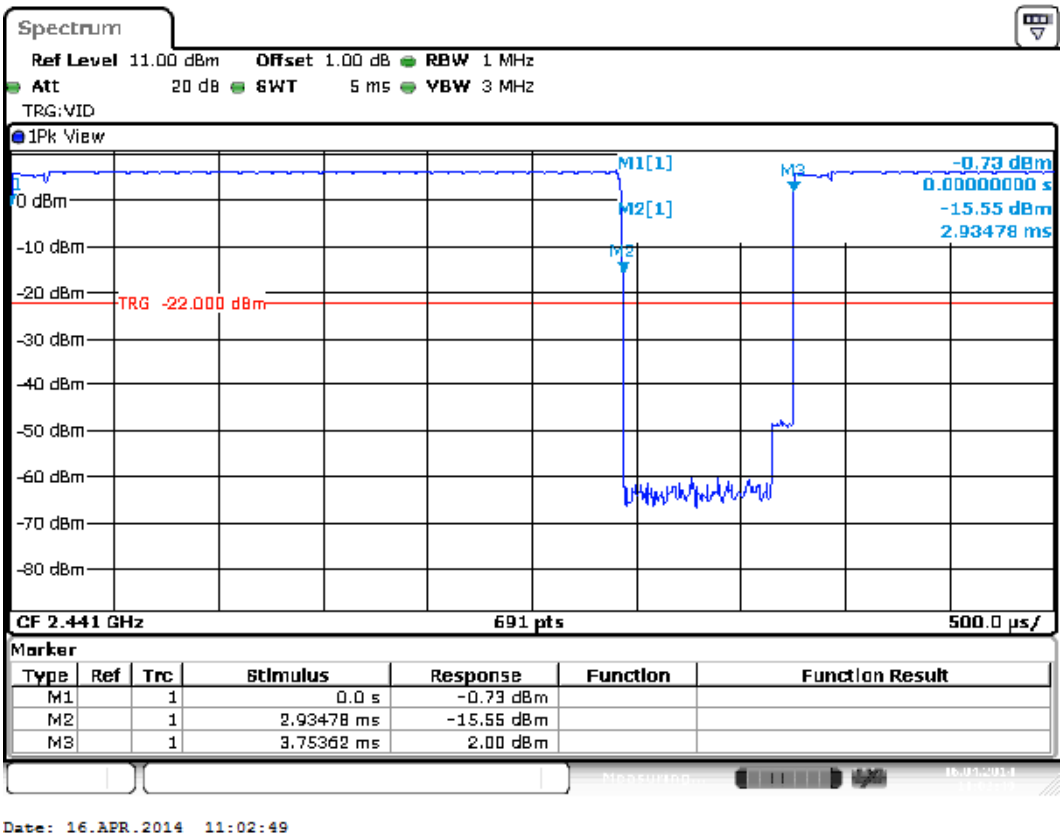
Specification

The average time of occupancy on any channel shall not be greater than 0.4 seconds (400 ms) within a period of 0.4 seconds multiplied by the number of hopping channels employed = 0.4 x 79= 31.6 seconds.

Results

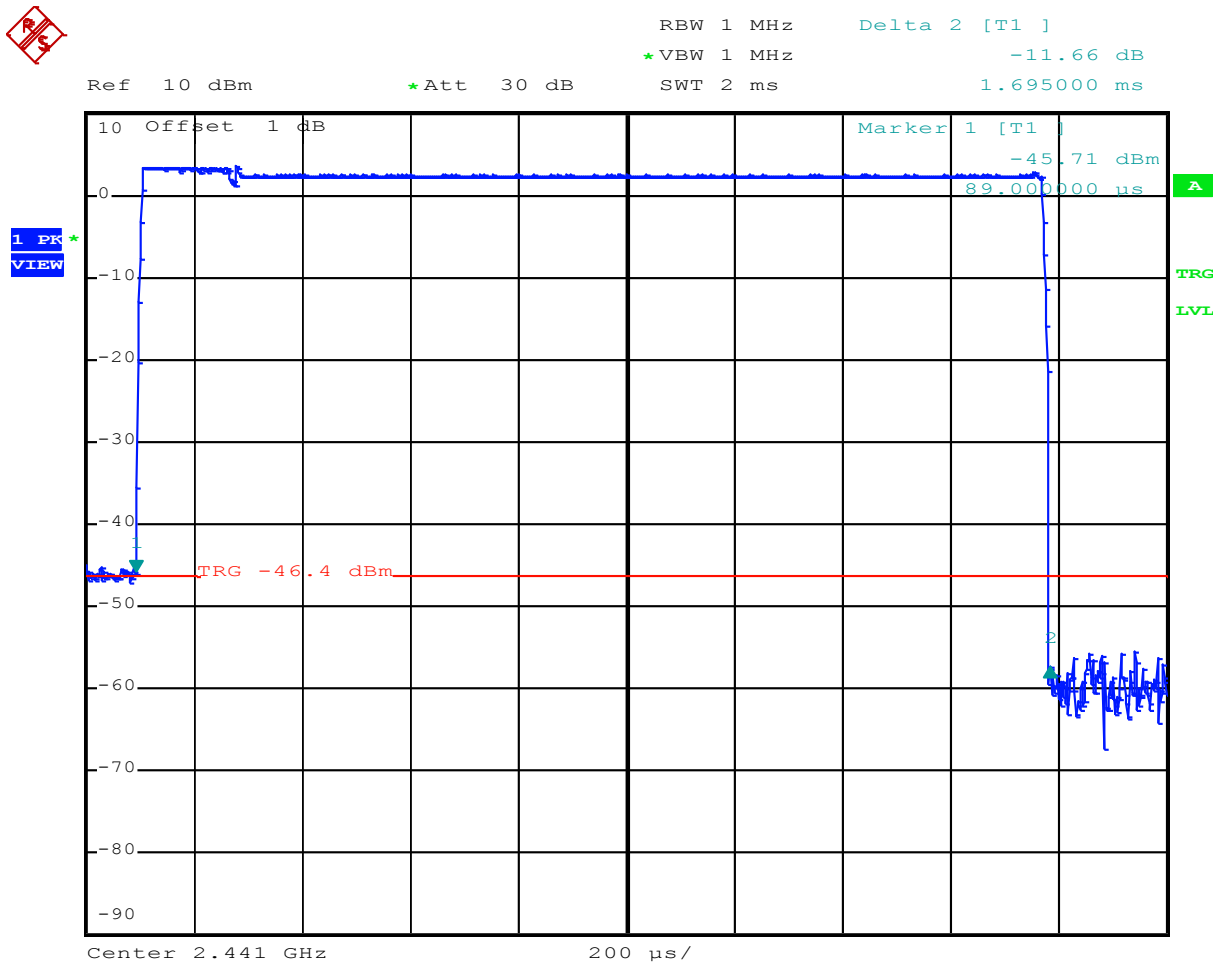
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH5.

A DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/6 = 266.67 hops per second with 79 channels. So you have each channel 266.67/79 =3.376 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 3.376 x 31.6 = 106.67 times of appearance.
Each Tx-time per appearance is 2.935 ms (see next plot).
So we have 106.67 x 2.935 ms = 313.07 ms per 31.6 seconds.



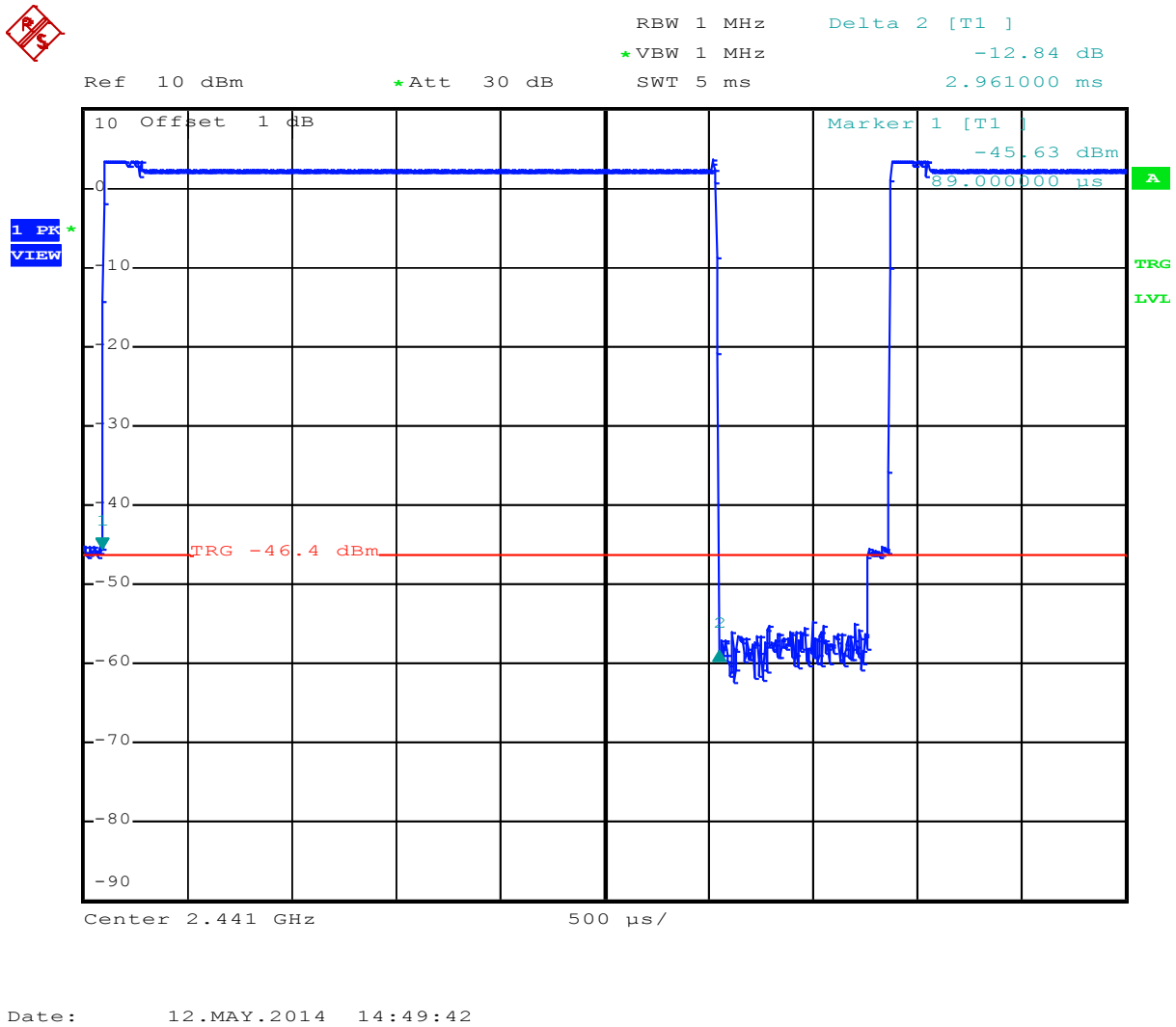
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2-DH3.

A 2-DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/4 = 400 hops per second with 79 channels. So you have each channel 400/79 = 5.06 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.06 x 31.6 = 160 times of appearance.
Each Tx-time per appearance is 1.695 ms (see next plot).
So we have 160 x 1.695 ms = 271.2 ms per 31.6 seconds.



TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 3-DH5.

A 3-DH5 Packet needs 5 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/6 = 266.67 hops per second with 79 channels. So you have each channel 266.67/79 =3.376 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 3.376 x 31.6 = 106.67 times of appearance.
Each Tx-time per appearance is 2.961 ms (see next plot).
So we have 106.67 x 2.961 ms = 315.85 ms per 31.6 seconds.



5.1.5 Carrier Frequency Separation

RESULT: PASS

Date of testing: 2014-05-07

Requirements: FCC 15.247(a)(1) and RSS-210 Section A8.1(b)

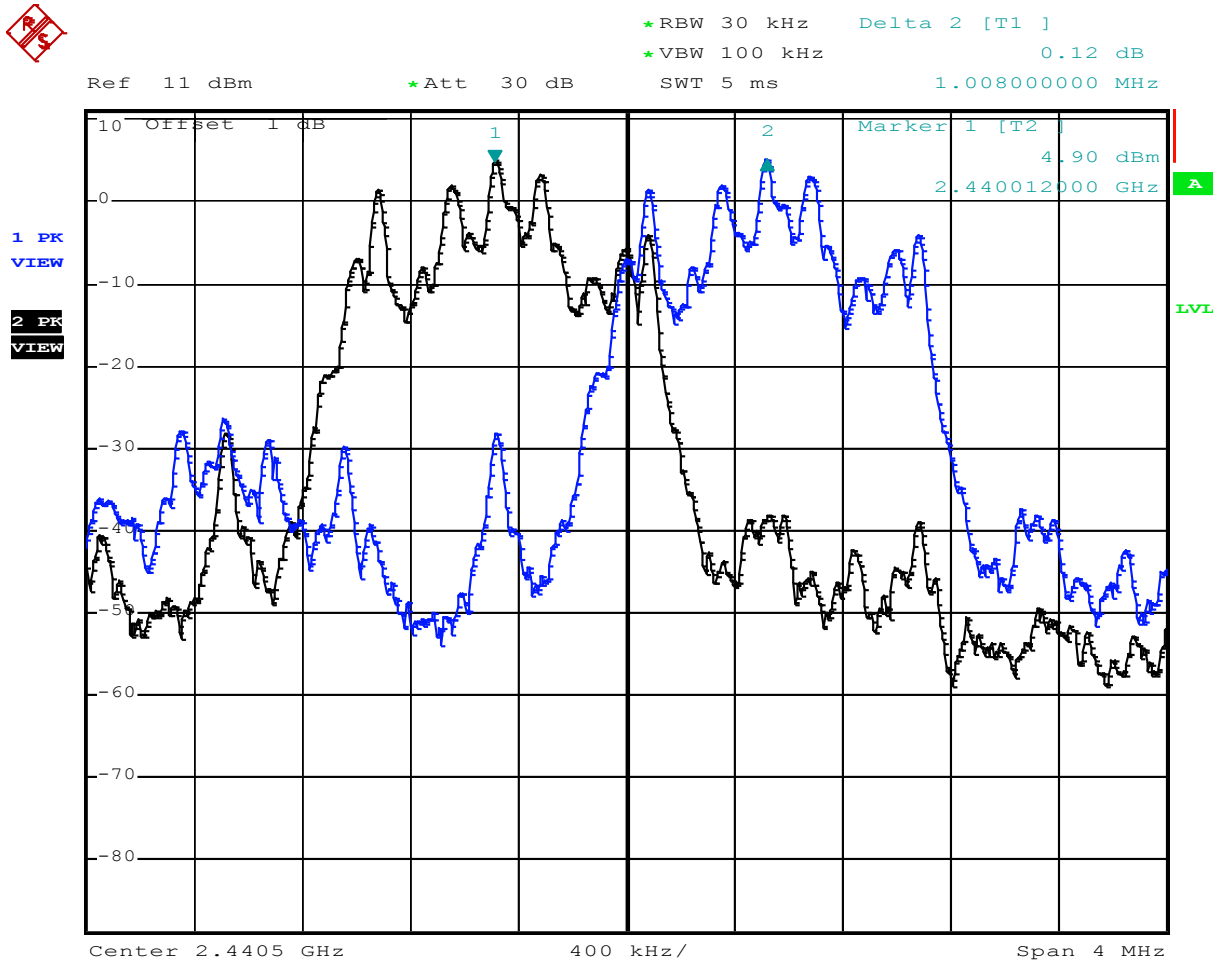
Frequency hopping systems operating in the 2400-2483.5MHz band shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater. In case of an output power less than 125mW, the frequency hopping system may have channels separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater.

Test procedure: FCC Public Notice DA 00-705 (March 30, 2000).

A spectrum analyzer was connected to the antenna port of the EUT. The Delta Marker function was used to determine the separation between the peaks of two adjacent channels.

Result: The nominal channel spacing of the Bluetooth system is 1MHz independent of the operating mode. An example for the channel separation in 3-DH5 mode is given in the plot below. The plot shows a channel separation that is more than 2/3 of the 20dB bandwidth.

Channel	2/3 of 20 dB BW (MHz)	Hopping channels	Channel Separation (MHz)	Limit (MHz)
39/40	0.740	79	1.00	>0.740



Plot showing 3DH5 Carrier Frequency Separation of 1.008 MHz.

5.1.6 Band Edge Conducted Emissions

RESULT: Pass

Date of testing: 2014-04-03

Frequency ranges: 2310.0MHz – 2390MHz (lower band edge)
2483.5MHz – 2500MHz (higher band edge)

Requirements:

FCC 15.205, FCC 15.209, FCC 15.247(d) and RSS-210 Section A8.5

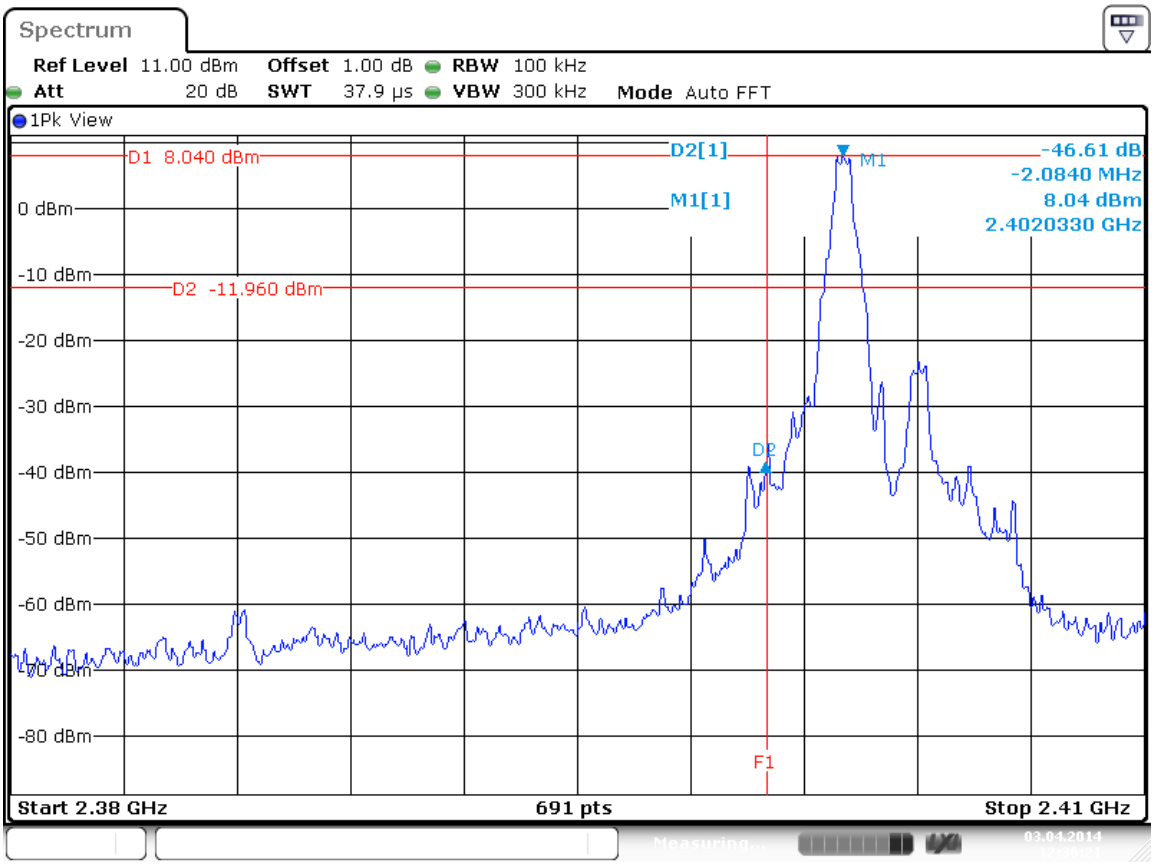
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Test procedure: FCC Public Notice DA 00-705 (March 30, 2000).

A spectrum analyzer was connected to the antenna port of the EUT. Measurements were performed using a spectrum analyzer with a suitable span to encompass the peak of the fundamental and using the following settings:
RBW = 100kHz, VBW = 300kHz.

The highest emission amplitudes relative to the appropriate limit were measured and recorded in this report.

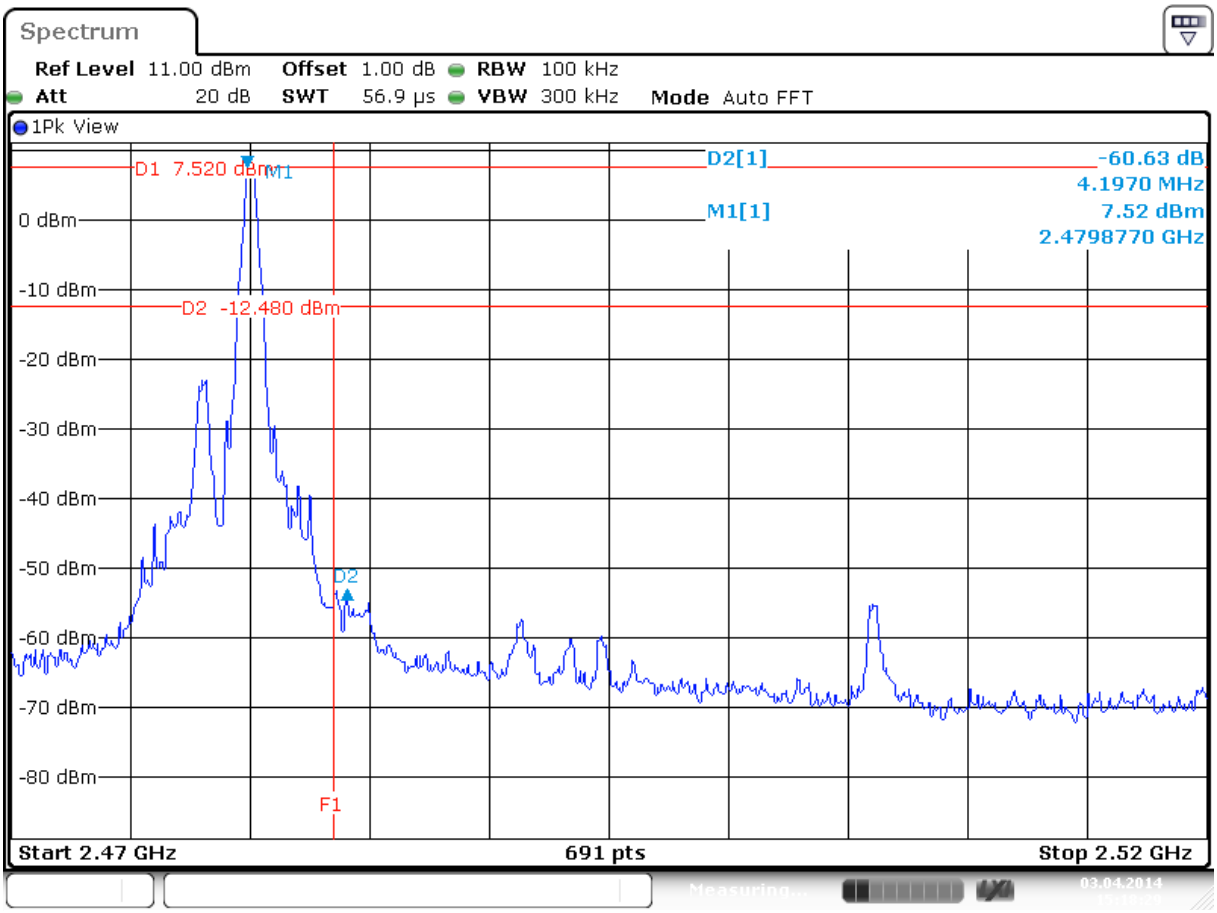
Results: All out of band spurious emissions are more than 20 dB below the fundamental.
See the figures on the following pages.



Date: 3.APR.2014 12:36:22

Band Edge Conducted Emission- Lower band edge 2402 MHz DH5 Packet

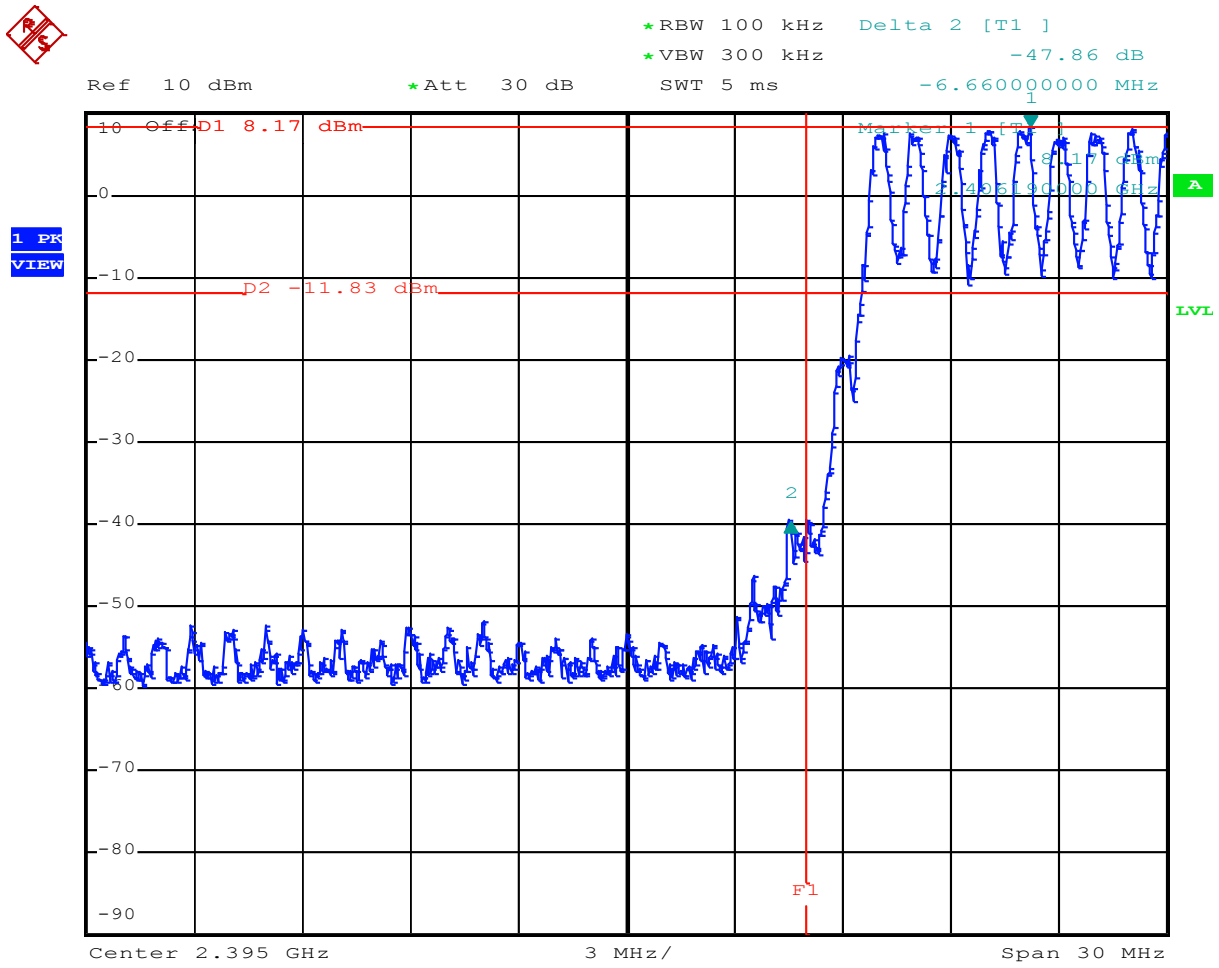
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz.



Date: 3.APR.2014 15:18:29

Band Edge Conducted Emission- Higher band edge, 2480 MHz DH5 Packet

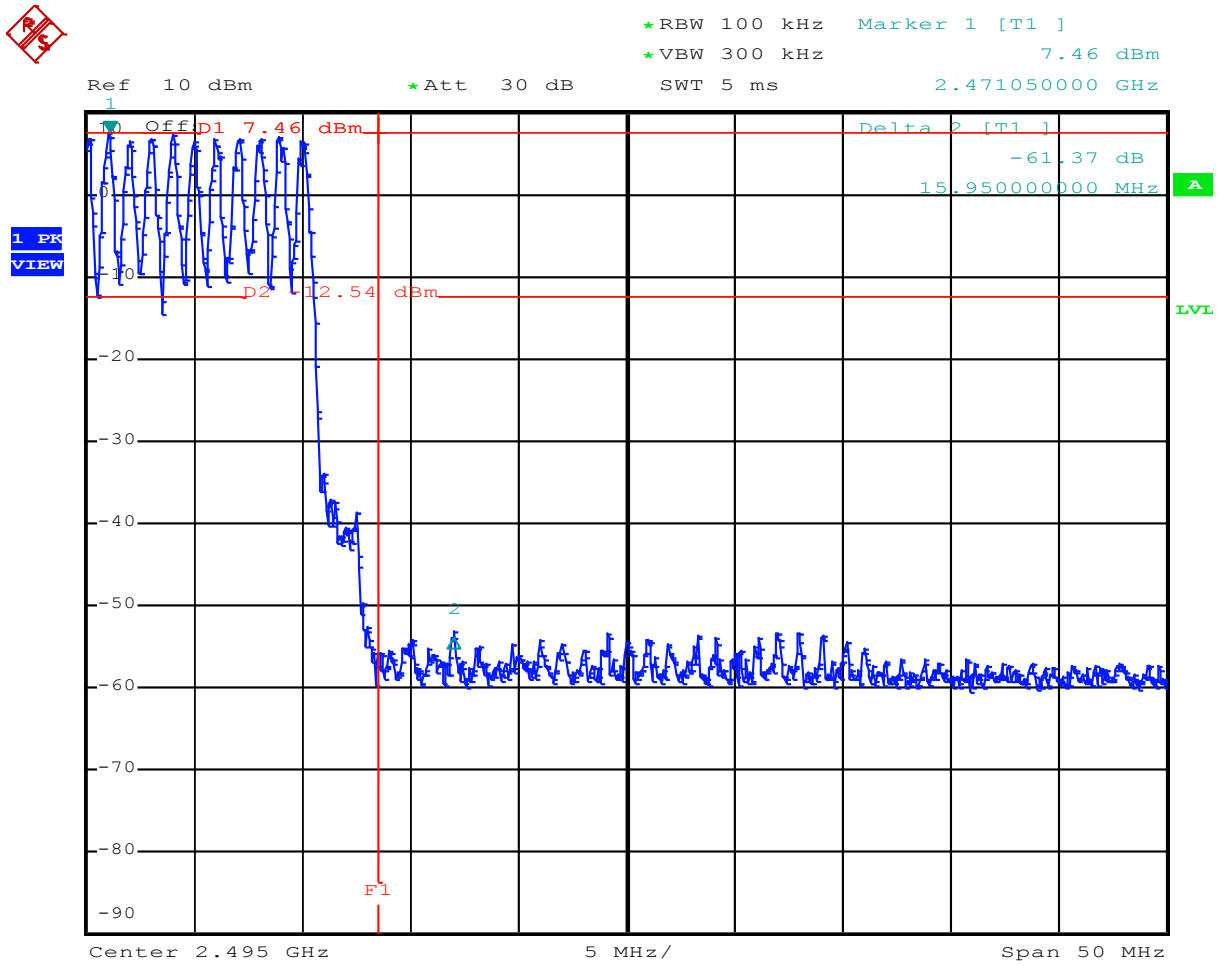
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483.5 MHz.



Date: 3.APR.2014 10:16:20

Band Edge Conducted Emission- Lower band edge, Hopping On DH5

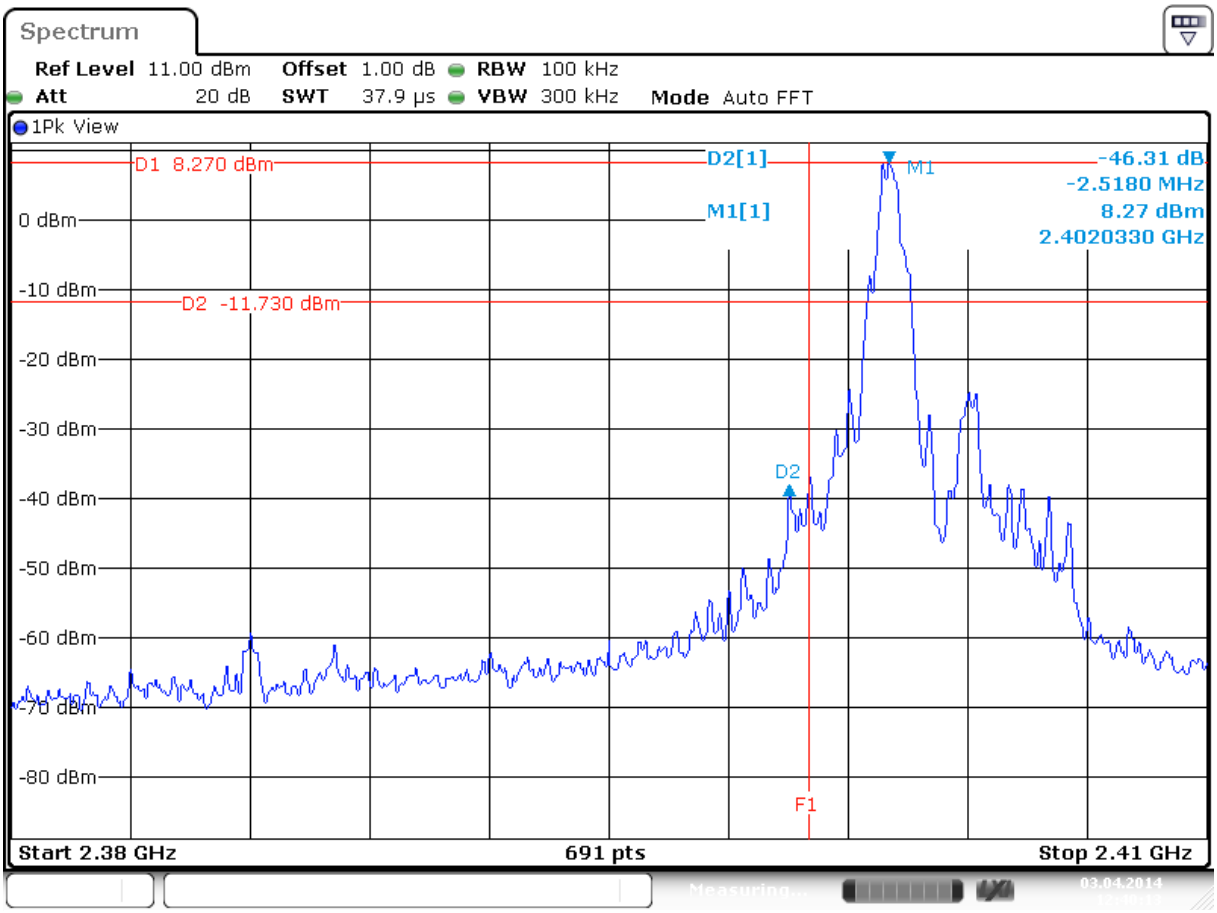
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz



Date: 3.APR.2014 11:18:06

Band Edge Conducted Emission- Higher band edge, Hopping On DH5

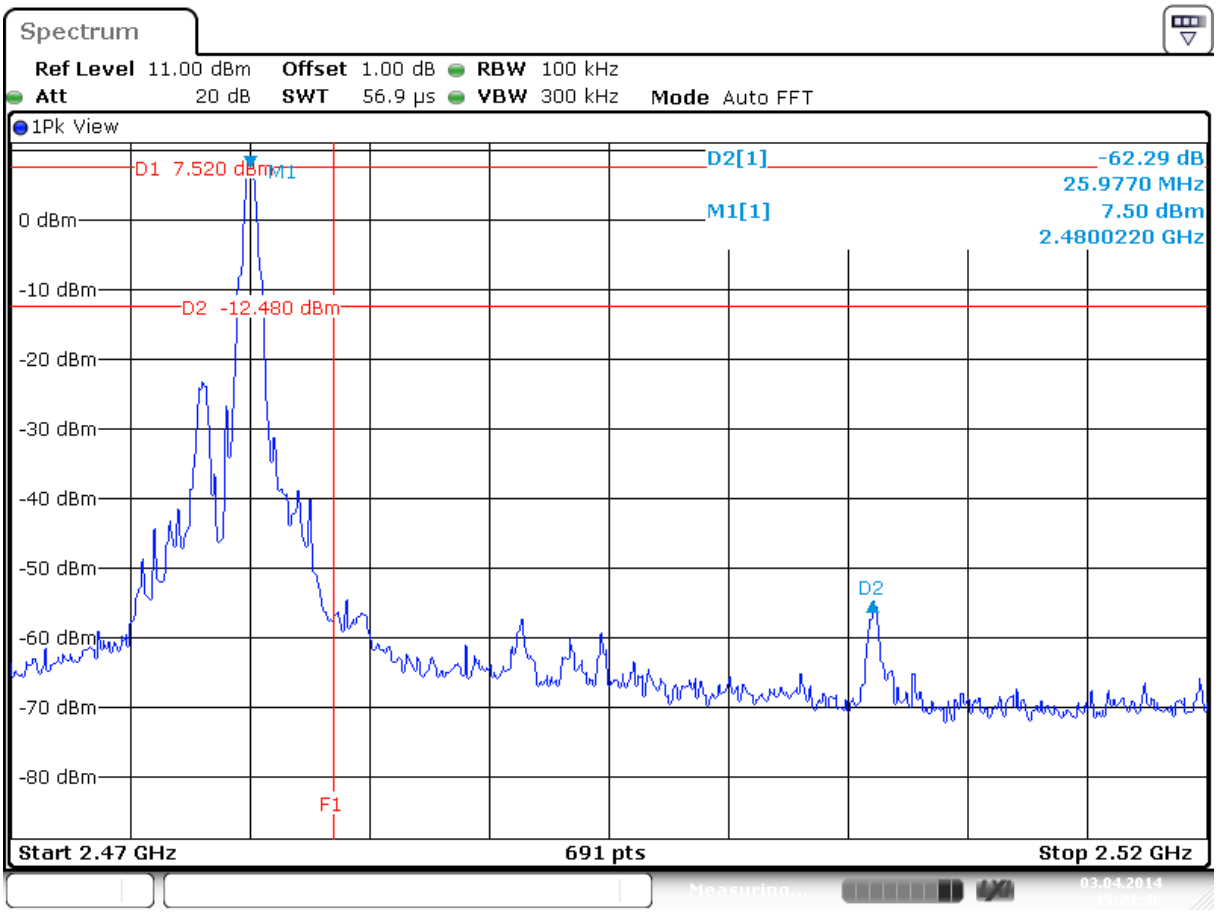
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483.5 MHz



Date: 3.APR.2014 12:40:14

Band Edge Conducted Emission- Lower band edge 2402 MHz 2-DH3

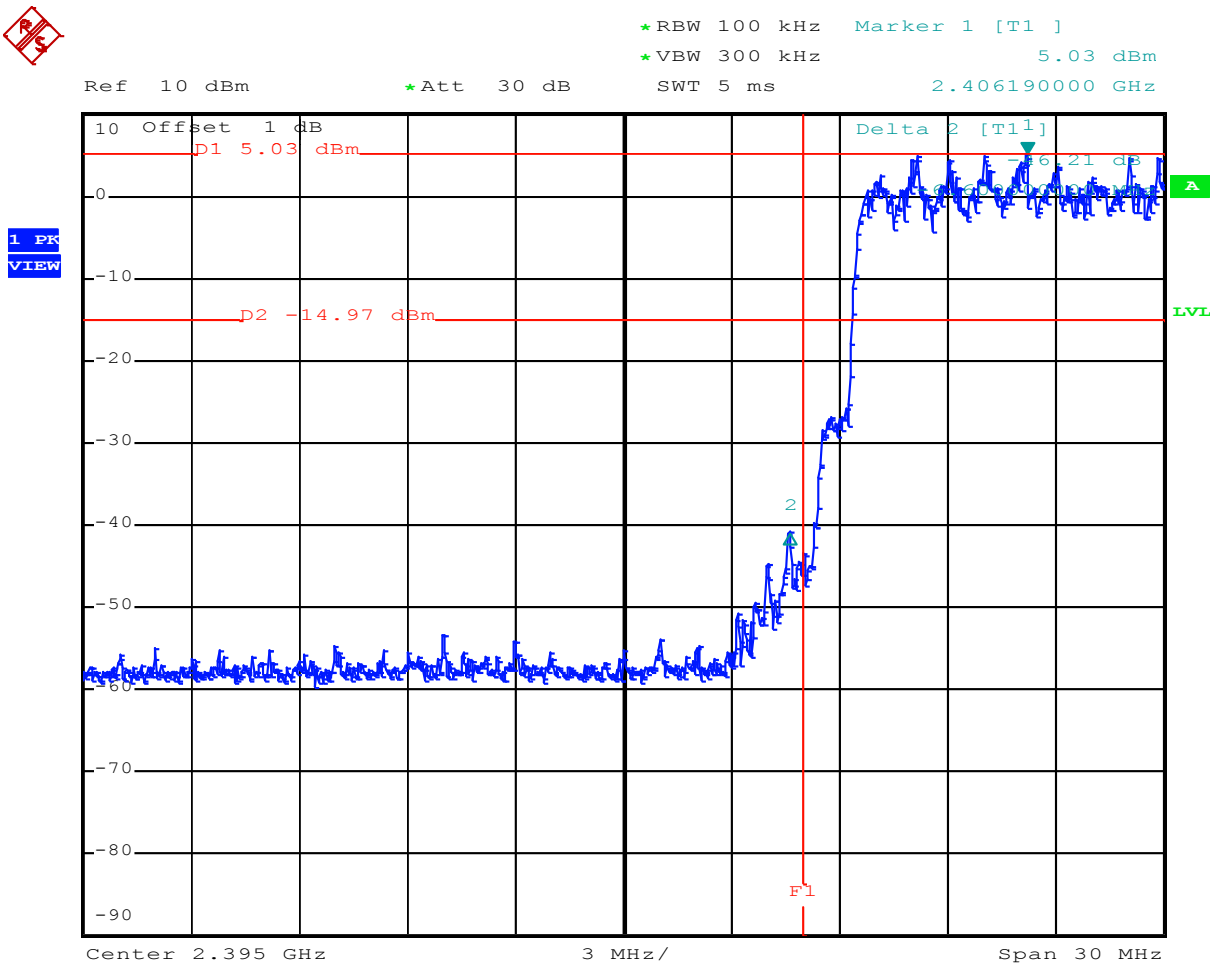
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz



Date: 3.APR.2014 15:21:46

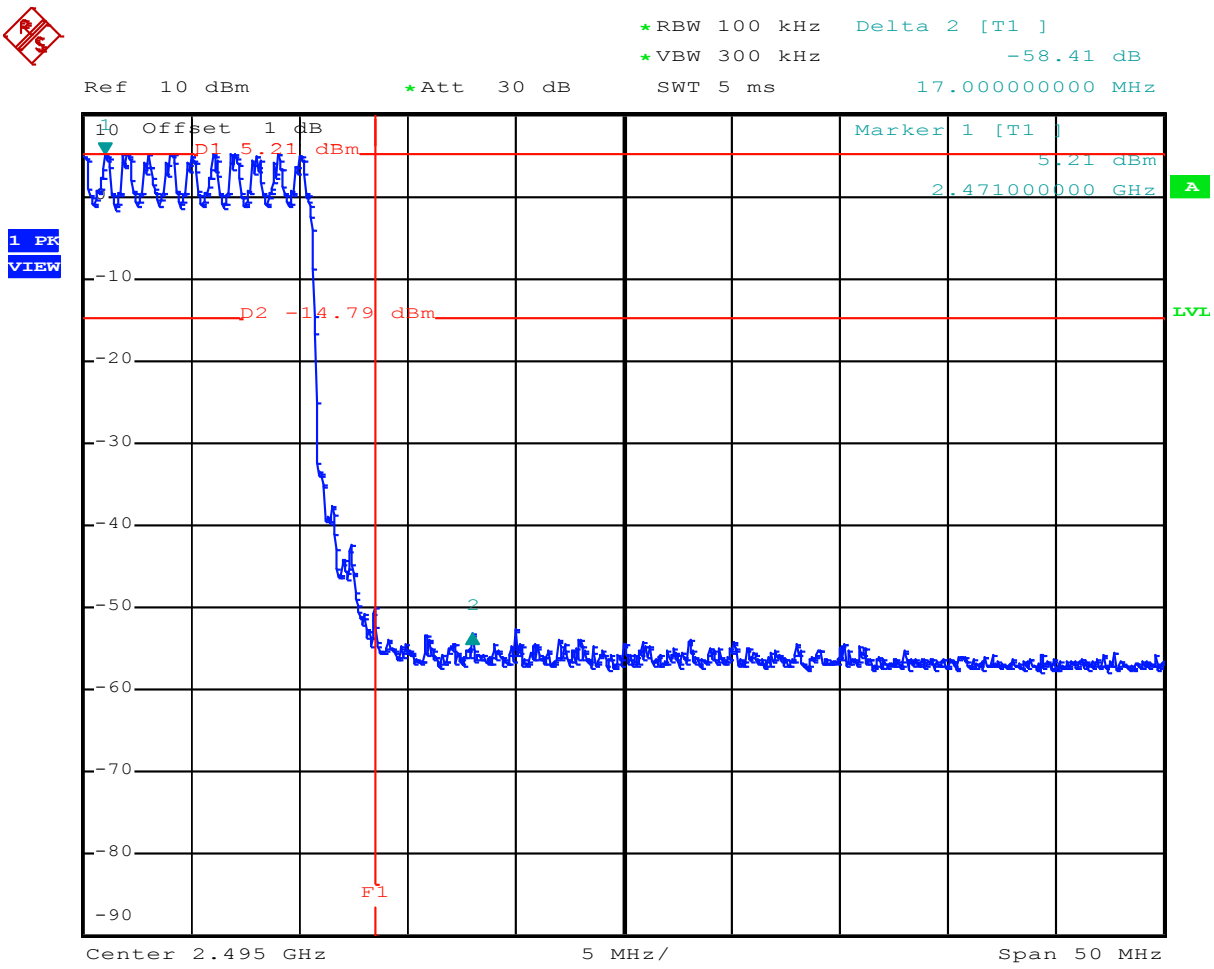
Band Edge Conducted Emission- Higher band edge, 2480 MHz 2-DH3

Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483.5 MHz.



Band Edge Conducted Emission- Lower band edge, Hopping On 2-DH3

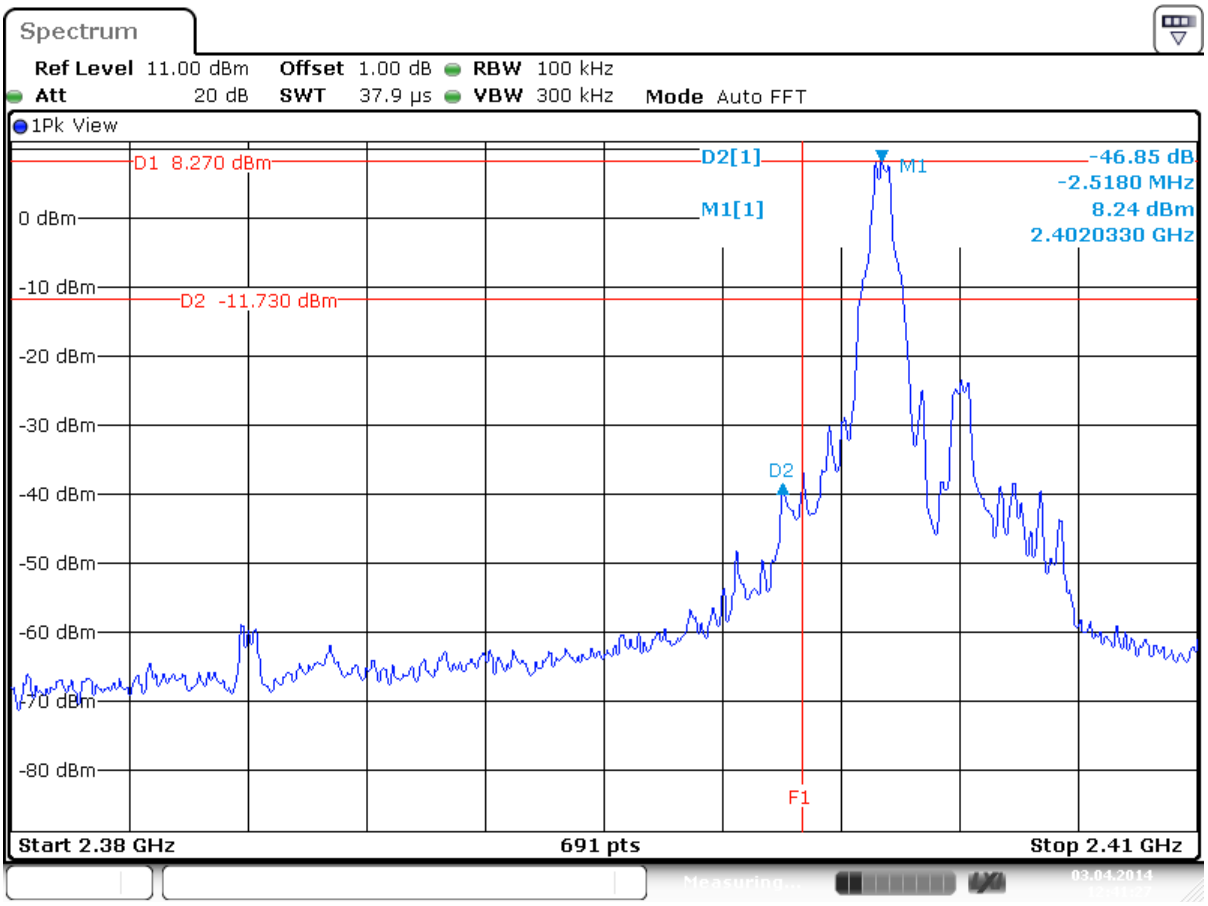
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz



Date: 3.APR.2014 11:15:39

Band Edge Conducted Emission- Higher band edge, Hopping On 2-DH3.

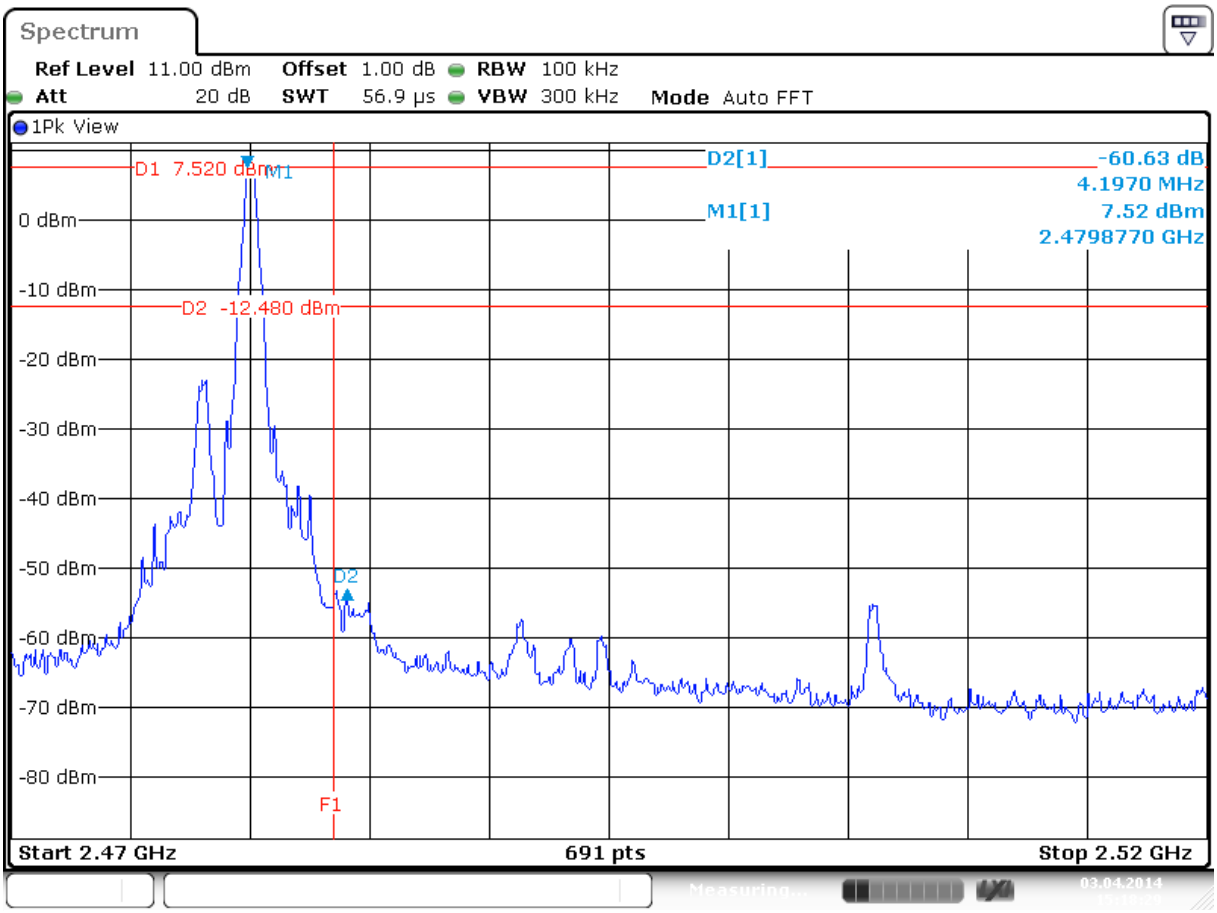
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483.5 MHz.



Date: 3.APR.2014 12:41:27

Band Edge Conducted Emission- Lower band edge 2402 MHz 3-DH5

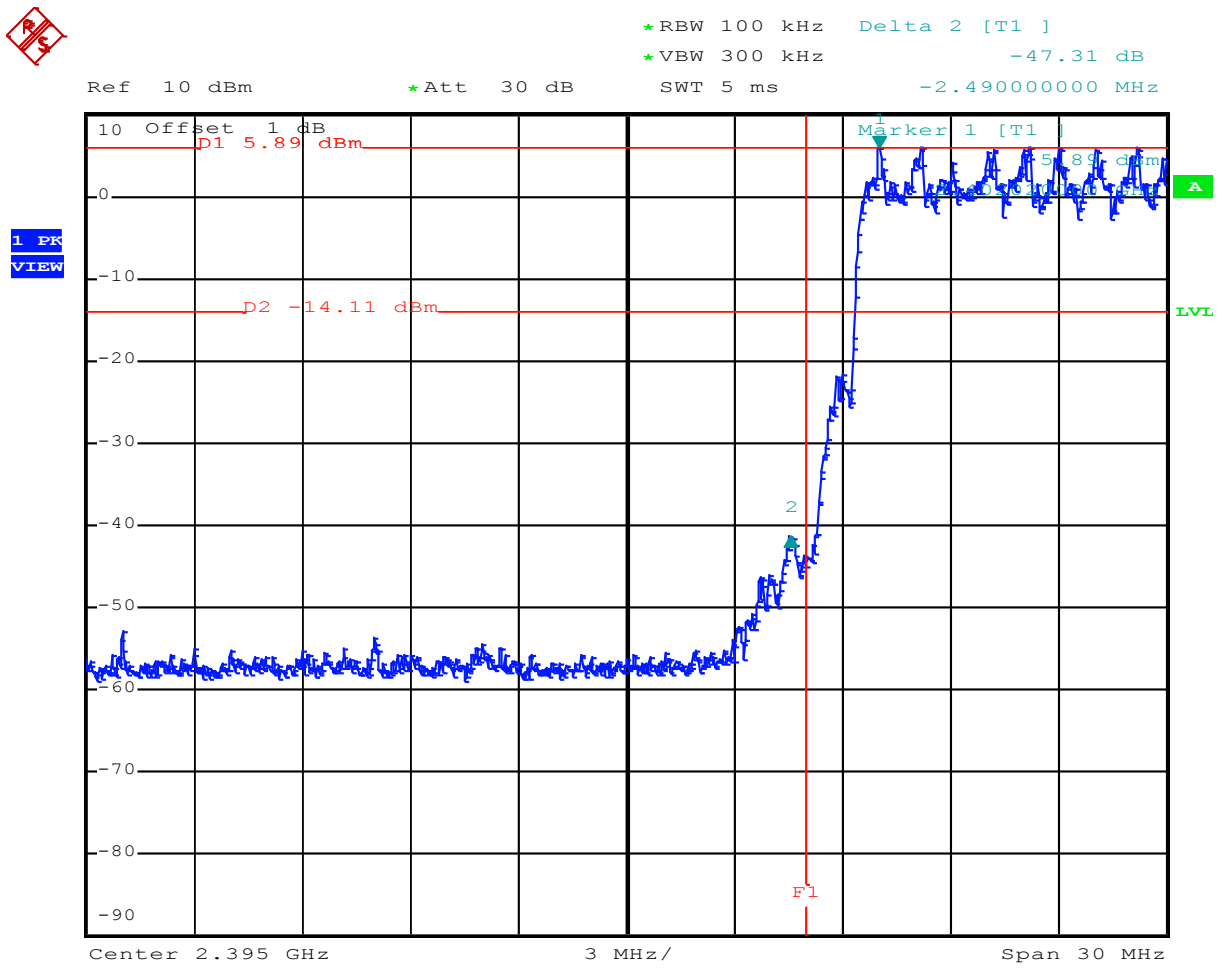
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz



Date: 3.APR.2014 15:18:29

Band Edge Conducted Emission- Higher band edge, 2480 MHz 3-DH5

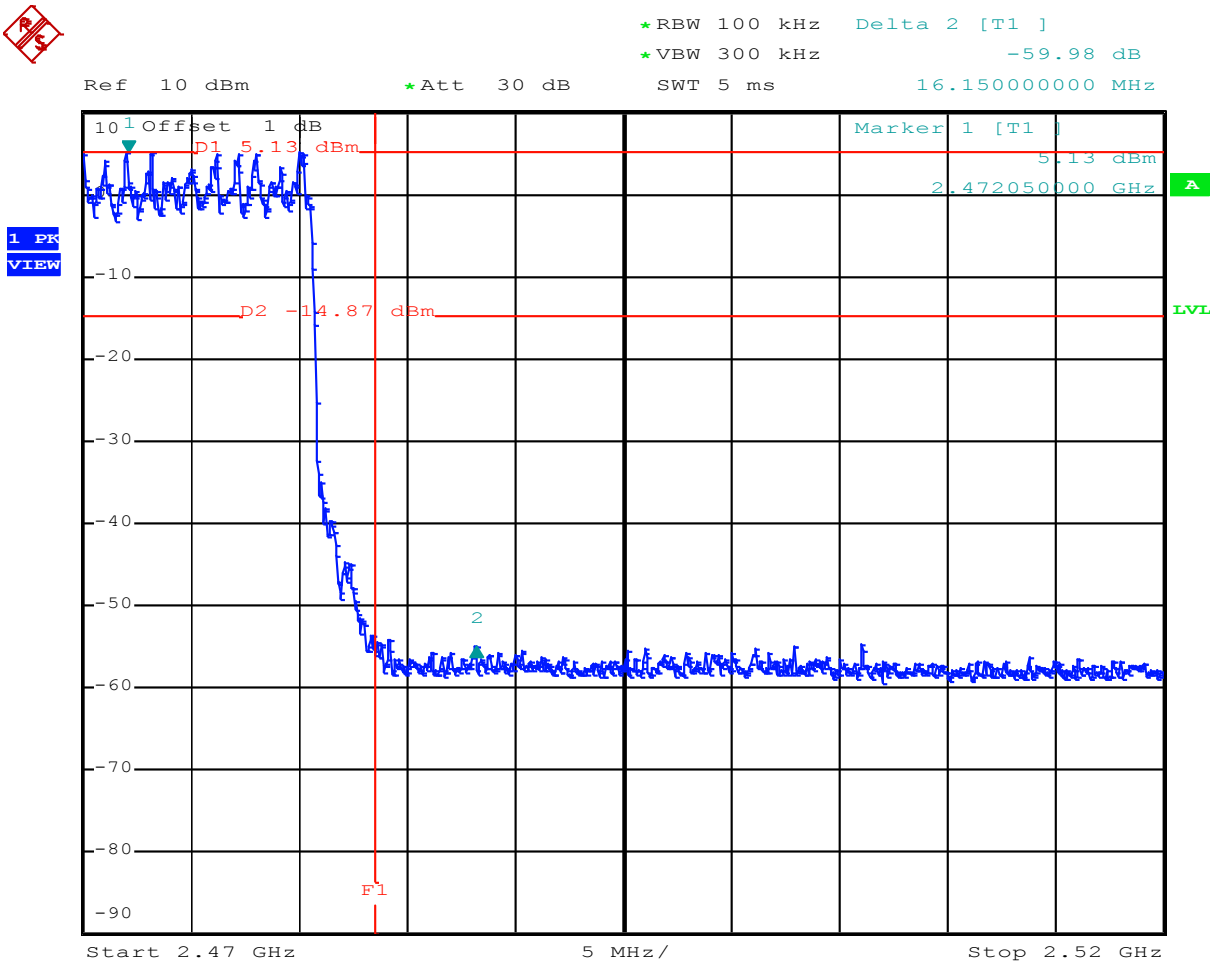
Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483.5 MHz.



Date: 3.APR.2014 10:25:17

Band Edge Conducted Emission- Lower band edge, Hopping On 3-DH5

Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2400 MHz



Date: 3.APR.2014 10:30:44

Band Edge Conducted Emission- Higher band edge, Hopping On 3-DH5

Plot showing more than 20 dB band edge attenuation.
F1 shows the band edge frequency of 2483,5 MHz

6.1 Radiated emissions in restricted bands

RESULT: PASS

Date of testing: 2014-02-

Frequency range: 30MHz - 25GHz

Requirements:

FCC 15.205, FCC 15.209, FCC 15.247(d) and RSS-Gen Section 7.2.2.

Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a) and RSS-Gen Section 7.2.2, must comply with the radiated emission limits specified in FCC 15.209(a) and RSS-Gen.

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Detector	Measurement distance (m)
0.009-0.490	2400/F(kHz)	43.5 > 13.8	Average	300
0.490-1.705	24000/F(kHz)	33.8 > 22.9	Average	300
1.705 - 30.0	30	29.5	Quasi peak	30
30 - 88	100	40.0	Quasi peak	3
88 - 216	150	43.5	Quasi peak	3
216 - 960	200	46.0	Quasi peak	3
960 - 25000	500	54.0	Average	3

Test procedure: FCC Public Notice DA 00-705 (March 30, 2000).

The restricted bands are measured radiated in a Semi-anechoic chamber. The EUT was placed on a nonconductive turntable 0.8m above the ground plane. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling and the EUT orientation (X, Y, Z) were varied in order to ensure that maximum emission amplitudes were attained.

The span of the spectrum analyzer was set wide enough to capture the restricted band and measure the peak level of the emission of the channel operating closest to the band edge, as well as any modulation products which fall outside the authorized band of operation.

The spectrum was examined from 30MHz to the 10th harmonic of the highest fundamental transmitter frequency (25GHz). This range is chosen as worst case from the original certification data. Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° and the antenna was raised and lowered from 1 to 4m in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

A Peak detector was used with a resolution bandwidth of 1 MHz and video bandwidth of 3 MHz, for Average detector a resolution bandwidth of 1 MHz and video bandwidth of 10 Hz was used were applicable. Correction factors for cable loss and antenna factors are incorporated in the measurement equipment.

Results:

From pre-tests the mode 3-DH5 proved to be the worst case and final tests were done using this mode, results as stated in tables below.

Restricted band 2310-2390 MHz, 3-DH5.

Channel number	Frequency [MHz]	Antenna Orientation	Level Peak [dBm eirp] *1	Limit Average [dBm eirp] *1	Limit Peak [dBm eirp] *1	Result
1	2322.0	Vertical	-49.4	-41.2	-21.2	Pass
79	2340.0	Vertical	-49.0	-41.2	-21.2	Pass

Restricted band 2483.5-2500 MHz, 3-DH5.

Channel number	Frequency [MHz]	Antenna Orientation	Level Peak [dBm eirp] *1	Limit Average [dBm eirp] *1	Limit Peak [dBm eirp] *1	Result
1	2485.5	Vertical	-48.8	-41.2	-21.2	Pass
79	2491.7	Vertical	-50.1	-41.2	-21.2	Pass

Restricted band 2655-2900 (Canada), 3-DH5.

Channel number	Frequency [MHz]	Antenna Orientation	Level Peak [dBm eirp] *1	Limit Average [dBm eirp] *1	Limit Peak [dBm eirp] *1	Result
1	2712.0	Vertical	-49.4	-41.2	-21.2	Pass
79	2834.0	Vertical	-50.8	-41.2	-21.2	Pass

Restricted band 4500-5150 MHz, 3-DH5.

Channel number	Frequency [MHz]	Antenna Orientation	Level Peak [dBm eirp] *1	Limit Average [dBm eirp] *1	Limit Peak [dBm eirp] *1	Result
1	4804.1	Vertical	-45.2	-41.2	-21.2	Pass
79	4960.1	Vertical	-47.5	-41.2	-21.2	Pass

Notes:

1. Derived from the expression $EIRP_{dBm} = E_{dB\mu V/m} - 95.2_{dB}$
2. The measuring antenna was varied in horizontal and vertical orientations and also around it's axis and height. The reported value is the worst case found at the reported frequency.
3. Tested with EUT in operation in non hopping mode at lowest and highest frequency of the band in which it operates. Worst case values noted.
4. Peak values already within Average limits, therefor not Average not tested. Except were Peak values is close to or exceeds Average limits.

7. AC Power Line Conducted Measurements

7.1 AC Power Line Conducted Emission of Transmitter

RESULT: Pass

Date of testing: 2014-05-14

Requirements: FCC 15.207 and RSS-Gen Section 7.2.4.

Except when the requirements applicable to a given device state otherwise, for any license-exempt radio communication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the following table. The tighter limit applies at the frequency range boundaries.

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

***Decreases with the logarithm of the frequency.**

The EUT is placed on a test table, raised 80cm above the reference ground plane. The vertical conducting ground plane is located 40cm tot the rear of the table and EUT. The EUT is connected to a Line Impedance Stabilization Network (LISN). Measured AC power line conducted emissions are made across the L1 and L2(Neutral) ports of the LISN.

Frequency (MHz)	Measurement results Line 1 (dBµV)		Measurement results Neutral/Line 2 (dBµV)		Limits (dBµV)		Result
	QP	AV (note 4)	QP	AV (note 4)	QP	AV	
0.271	44.3	--	46.5	--	61.1	51.1	PASS
0.357	40.3	--	43.0	--	58.7	48.7	PASS
0.642	41.9	--	43.0	--	56.0	46.0	PASS
0.728	44.5	--	44.3	--	56.0	46.0	PASS
0.798	39.1	--	41.1	--	56.0	46.0	PASS
23.818	45.4	--	46.5	--	60.0	50.0	PASS

The results of the conducted emission tests, carried out in accordance with 47 CFR Part 15 section 15.207(a) and RSS-Gen Section 7.2.4, at the 120 Volts/ 60 Hz AC mains connection terminals of the power supply (AUX2) of the system, are depicted in the table above. The system is tested as in whole, so with all equipment as shown in Figure 1 in place and functioning. Being the worst case situation. See plots on pages 66 – 67.

Notes:

1. Tests were performed with the EUT in DH5, 2-DH3 and 3-DH5 mode, worst case values noted.
2. Measurement uncertainty is ±3.5dB
3. The resolution bandwidth used was 9 kHz.
4. Qp values are already within Av limits, therefor not retested on Av.

Used test equipment and ancillaries:

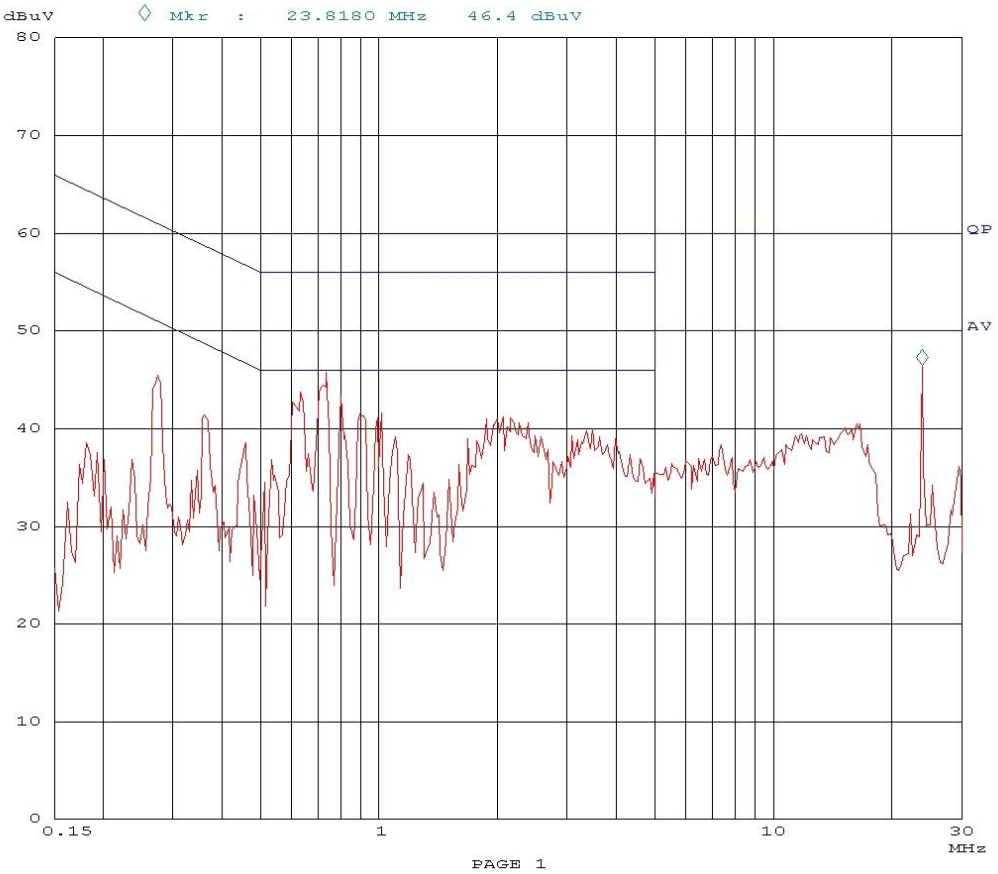
13313	99161	12512	15667	99852	99855	

14. May 14 09:08

Overview Scan Settings (1 Range)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	30M	3.9k	9k	PK	1ms	10dBLN	OFF

Final Measurement: x QP
Meas Time: 1 s
Subranges: 25
Acc Margin: 6dB



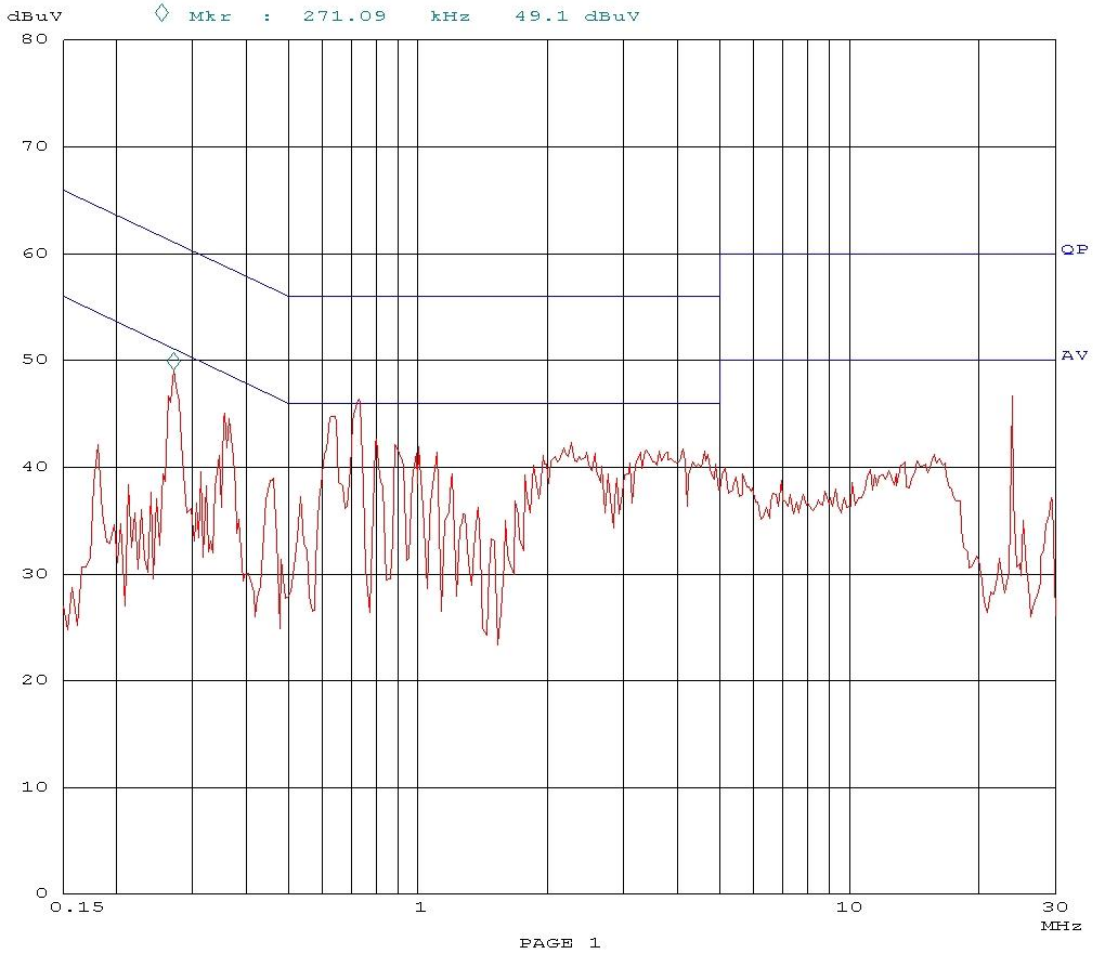
Plot Conducted emissions on L1

14. May 14 09:03

Overview Scan Settings (1 Range)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	30M	3.9k	9k	PK	1ms	10dBLN	OFF

Final Measurement: x QP
Meas Time: 1 s
Subranges: 25
Acc Margin: 6dB



Plot Conducted emissions on L2

End of report