TÜVRheinland®
Electronic Products and Services (EPS) B.V.

Test Report No.:	**13080601.fcc01**	*Page 1 of 83*	
Client:	**Intel Mobile Communications SA** 100 Center Point Circle Suite 200 Columbia, SC 29210 USA		
Test Item:	**Bluetooth 2.1 + EDR solution** **Wireless Bluetooth Module**		
Identification:	**PBA31309**	*MAC address:*	**--**
Project No.:	**13080601**	*Date of Receipt:*	**August 26, 2013**
Testing Location:	**TÜV Rheinland EPS B.V.** Eiberkamp 10 9351VT Leek		
Test Specification:	**FCC 47 CFR Part 15, Subpart C, Section 15.209 and15.247 (10-1-12 Edition)** **ANSI C63.10-2009**		
Test Result:	*The test item **passed** the test specification(s).*		
Testing Laboratory:	**TÜV Rheinland EPS B.V.** Eiberkamp 10 9351 VT Leek		

Tested by:			*Reviewed by:*		
2013-09-03	O. Hoekstra / Reviewer / Inspector		2013-09-04	M.C. Edwards van Muyen / 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

5.1.1 VOLTAGE REQUIREMENTS
RESULT: PASS

5.1.2 ANTENNA REQUIREMENTS
RESULT: PASS

5.2.1 CONDUCTED MEASUREMENTS AT ANTENNA PORT
RESULT: PASS

5.2.2 20DB AND 99% BANDWIDTH
RESULT: PASS

5.2.3 NUMBER OF CHANNELS AND OCCUPANCY TIME
RESULT: PASS

5.2.4 CARRIER FREQUENCY SEPARATION
RESULT: PASS

5.2.5 BAND EDGE CONDUCTED EMISSIONS
RESULT: Pass

5.2.6 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER
RESULT: PASS

5.2.7 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER IN RESTRICTED BANDS
RESULT: PASS

5.4.1 AC POWER LINE CONDUCTED EMISSION OF TRANSMITTER
RESULT: PASS

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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 EPS 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	FSP40	99538	11/2012	11/2013
Temperature-Humiditymeter	Extech	SD500	99857	02/2012	02/2014
Spectrum Analyzer	Rohde & Schwarz	FSV	99733	05/2013	05/2014
For Radiated Emission					
Measurement Receiver	Rohde & Schwarz	ESCI	99699	03/2013	03/2014
RF Cable S-AR	Gigalink	APG0500	99858	02/2013	02/2014
Controller	Maturo	SCU/088/ 8090811	99861	N/A	N/A
Controller	EMCS	DOC202	99608	N/A	N/A
Controller	Heinrich Deisel	4630-100	99107	N/A	N/A
Test fascility	Comtest	FCC listed: 90828	99580	12/2011	12/2014
Spectrum Analyzer	Rohde & Schwarz	FSP40	99538	11/2012	11/2013
Controller	EMCS	DOC202	99608	N/A	N/A
Antenna mast	EMCS	AP-4702C	99609	N/A	N/A
Temperature-Humiditymeter	Extech	SD500	99855	02/2012	02/2014
Guidehorn 1-18 GHz	EMCO	3115	12484	04/2013	04/2014
Guidehorn 18-40 GHz	EMCO	RA42-K-F-4B-C	12488	04/2013	04/2014
Biconilog Testantenna	Chase	CBL 6111B	15633	01/2013	01/2014
2.4 GHz bandreject filter	BSC	XN-1783	14450	N/A	N/A
Bandpass filter 4-10 GHz	Reactel	7AS-7G-6G-511	99076	N/A	N/A
Bandpass filter 10-26 GHz	Reactel	9HS-10G/26.5G-S11	99136	N/A	N/A
Preamplifier 0.5 - 18 GHz	Miteq	AMF-5D-005180-28-13p	99596	N/A	N/A
Filterbox	EMCS	RFS06S	99606	10/2013	10/2014

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
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 Intel model PBA31309, hereafter referred to as EUT, is a complete Bluetooth 2.1 + EDR solution. It implements a single point-to-point data link to other SPP capable Bluetooth devices. The module has an integrated antenna

Brand	Model Number	Description	FCC/IC IDs
Intel	PBA31309	Bluetooth 2.1 + EDR module with integrated antenna	PD9PBA31309

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	:	Wireless Bluetooth module
Manufacturer	:	Intel Mobile Communications SA
Brand	:	Intel
Model(s)	:	PBA31309
MAC address (BT)	:	--
Voltage input rating	:	+2.9 – 4.1 V
Voltage output rating	:	--
Current input rating	:	--
Antenna	:	Integrated antenna, Murata, Type LDA21xxx, 0.9 dBi
Operating frequency	:	2402 – 2480 MHz
Modulation	:	GFSK, PSK
Remarks	:	n.a.

Table 3: Interfaces present on the EUT

No.	Port	From	To	Remarks
1.	Mains	Mains	Laptop (AUX1)	Through a AC/DC power supply
2.	USB	Laptop	Test jig	--

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 (DSS).

The test methods, which have been used, are based on ANSI C63.10-2009.

For details, see under each test item.

4.2 Operation Modes

Modulation	Duty cycle	Antenna		Test frequencies (MHz)				
			Lowest	Power control setting	Middle	Power control setting	Highest	Power control setting
DH5	0.77	1	2402	nominal	2441	nominal	2480	nominal
2DH5	0.77	1	2402	nominal	2441	nominal	2480	nominal
3DH5	0.77	1	2402	nominal	2441	nominal	2480	nominal

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, 2 Mb/s and 3Mb/s data rates
The module has an integrated antenna. For conducted measurements, this antenna was replaced by a connector.

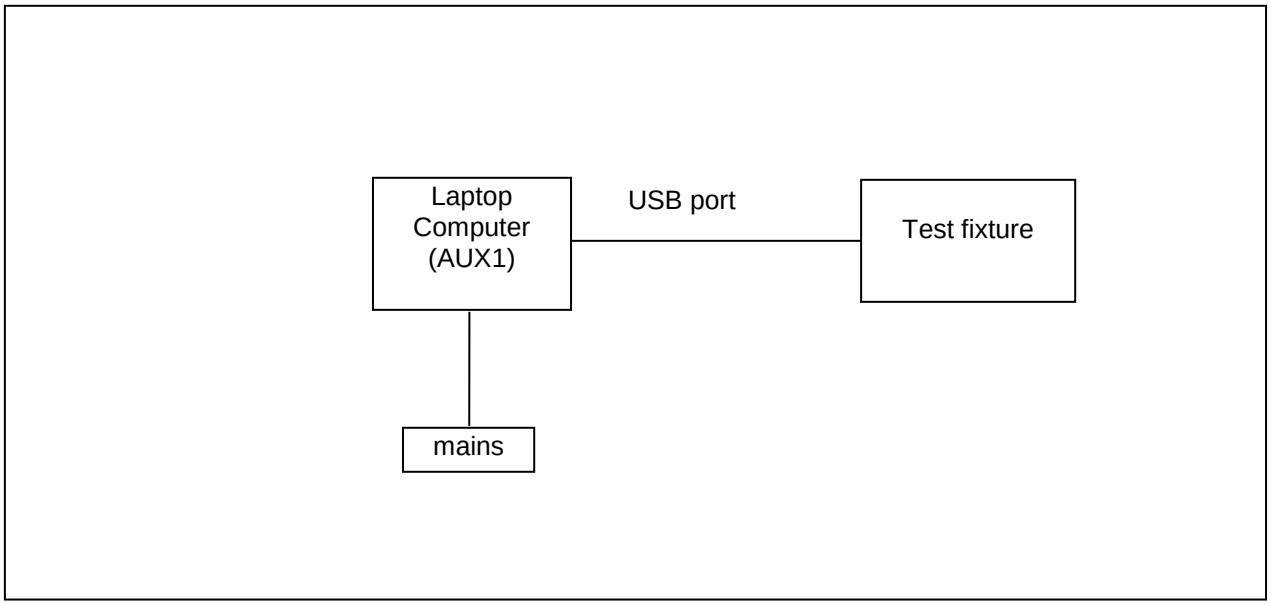
4.3 Physical Configuration for Testing

The EUT was installed on a test-fixture that interfaced to the USB port of a laptop computer. The laptop computer was used to configure the EUT to continuously transmit at a specified output power and channel or continuously receive on the channel as specified in the testdata. See section 4.5 for Auxiliary details.

The EUT was tested on a stand-alone basis (only attached to the test fixture) and the test system was configured in a typical fashion (as a customer would normally use it).

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.

4.4 Test Software

The operation modes could be initiated by using test software as supplied by Intel Mobile Communications SA. 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, as supplied by Intel Corporation and used during all tests is:

Test software : HCI_Lite_v3.04

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:	Dell
Model:	Latitude E5420
Serial Number:	CN-OD80Y4-75900-155-0580-A00
Remark:	property of applicant

5. Test Results

5.1 Technical Requirements

5.1.1 Voltage Requirements

RESULT: PASS

Requirements:

FCC 15.31(e)

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Verdict:

The EUT has an internal voltage regulator to supply the RF circuit. Hence it complies with the power supply requirements.

5.1.2 Antenna Requirements

RESULT: PASS

Requirements:

FCC 15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Verdict:

The EUT has an integrated antenna.

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5.2 Conducted Measurements at Antenna Port

5.2.1 Conducted Output Power

RESULT: PASS

Date of testing: 2013-08-28 & 2013-08-30

Requirements:

FCC 15.247(b)(3)

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:

ANSI C63.10-2009 and KDB 558074 D01.

The Peak Conducted Output Power was measured using the channel integration method according to option 2 in KDB 558074 D01.

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: 0.9 dBi.
The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

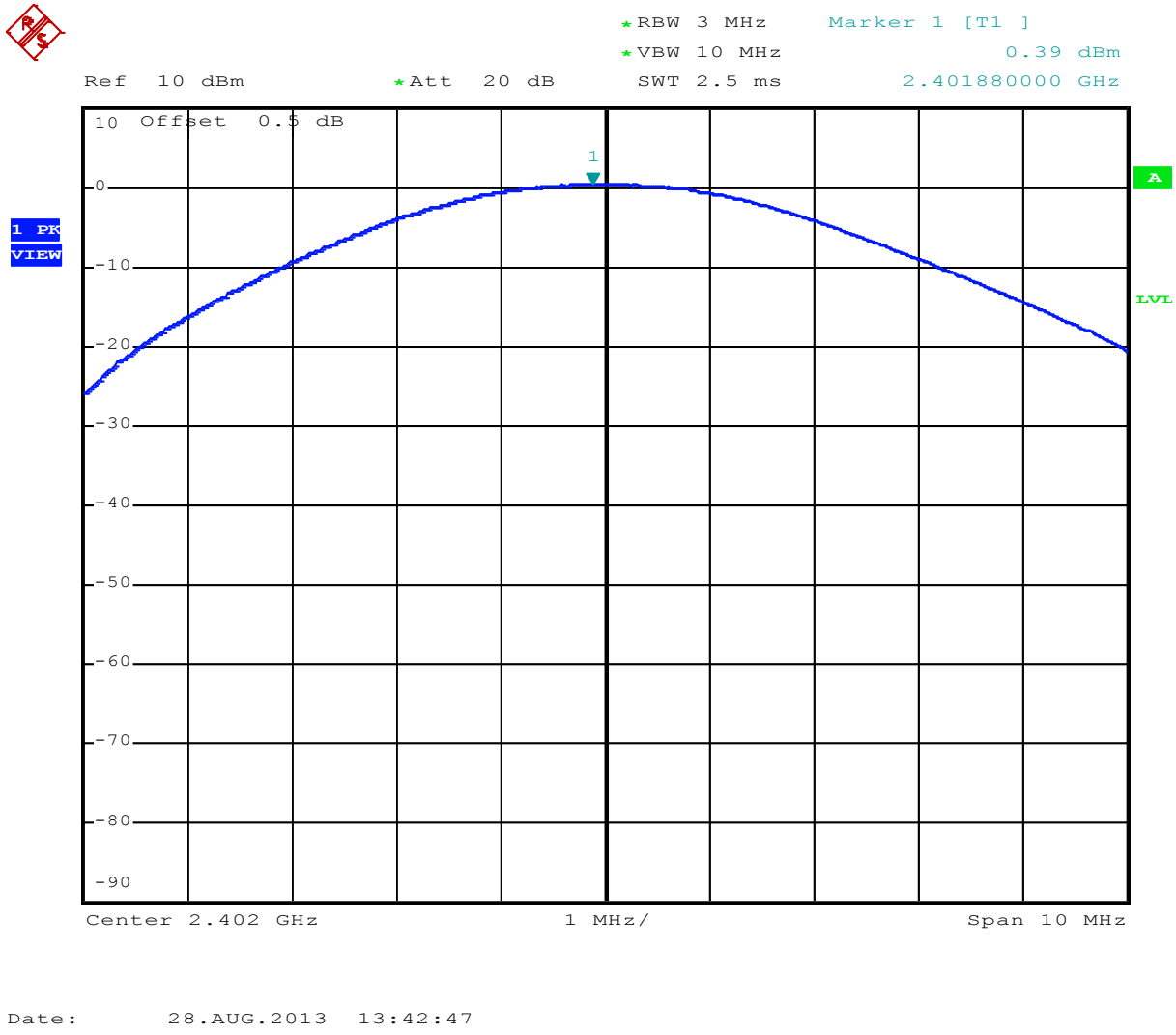
Notes: mW = 10 ^ (dBm/10)
dBm = 10 x log(mW)

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

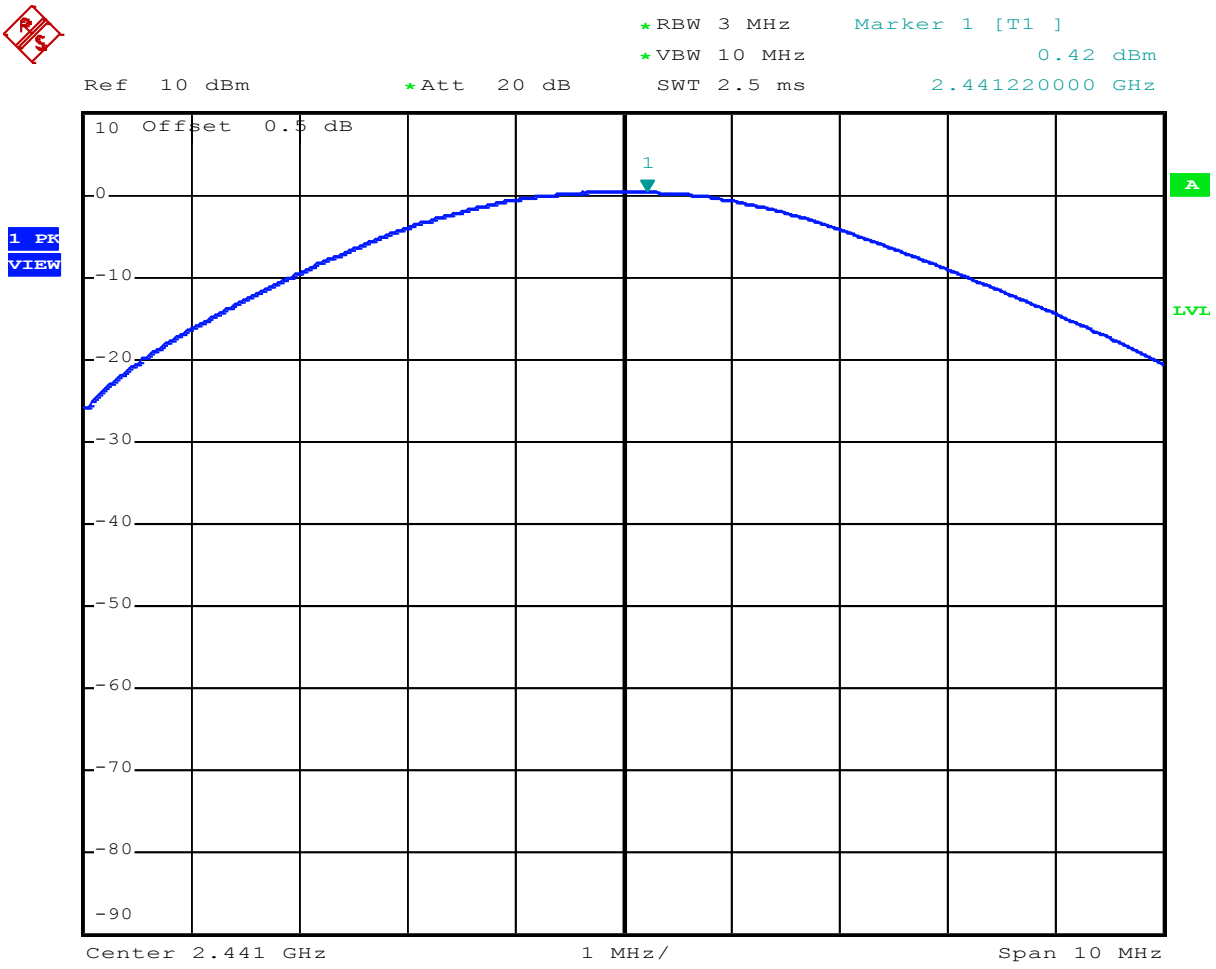
Table 4: Conducted Output Power

Operation mode: DH5

Frequency [MHz]	Gain control setting (dB)	Output Power [dBm]	Limit [dBm]	Limit [mW]	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Plot number
2402	nominal	+0.39	+30	1000	+1.29	1.35	1a
2440	nominal	+0.42	+30	1000	+1.32	1.36	1b
2480	nominal	+0.29	+30	1000	+1.19	1.32	1c

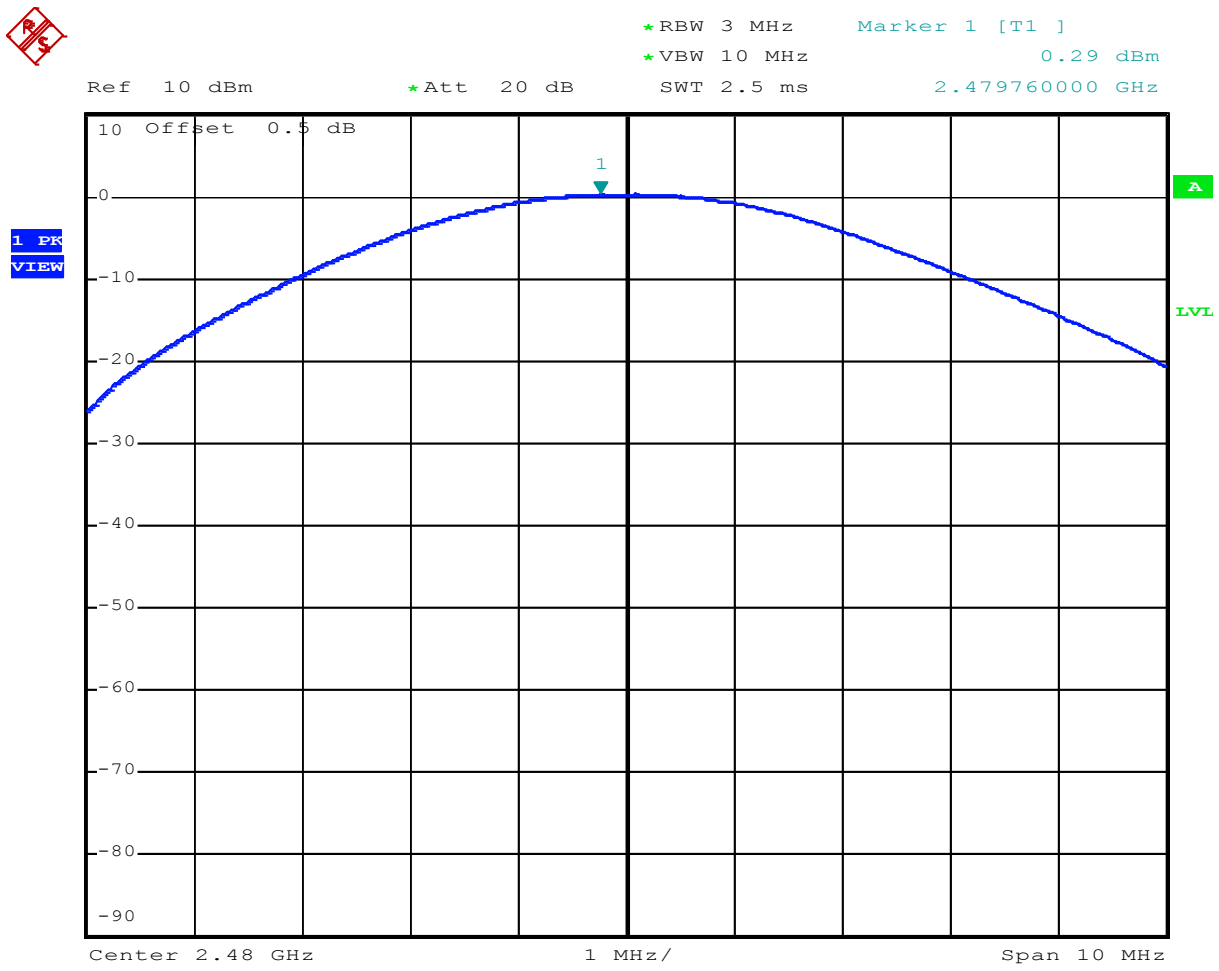


Plot 1a



Date: 28.AUG.2013 13:43:40

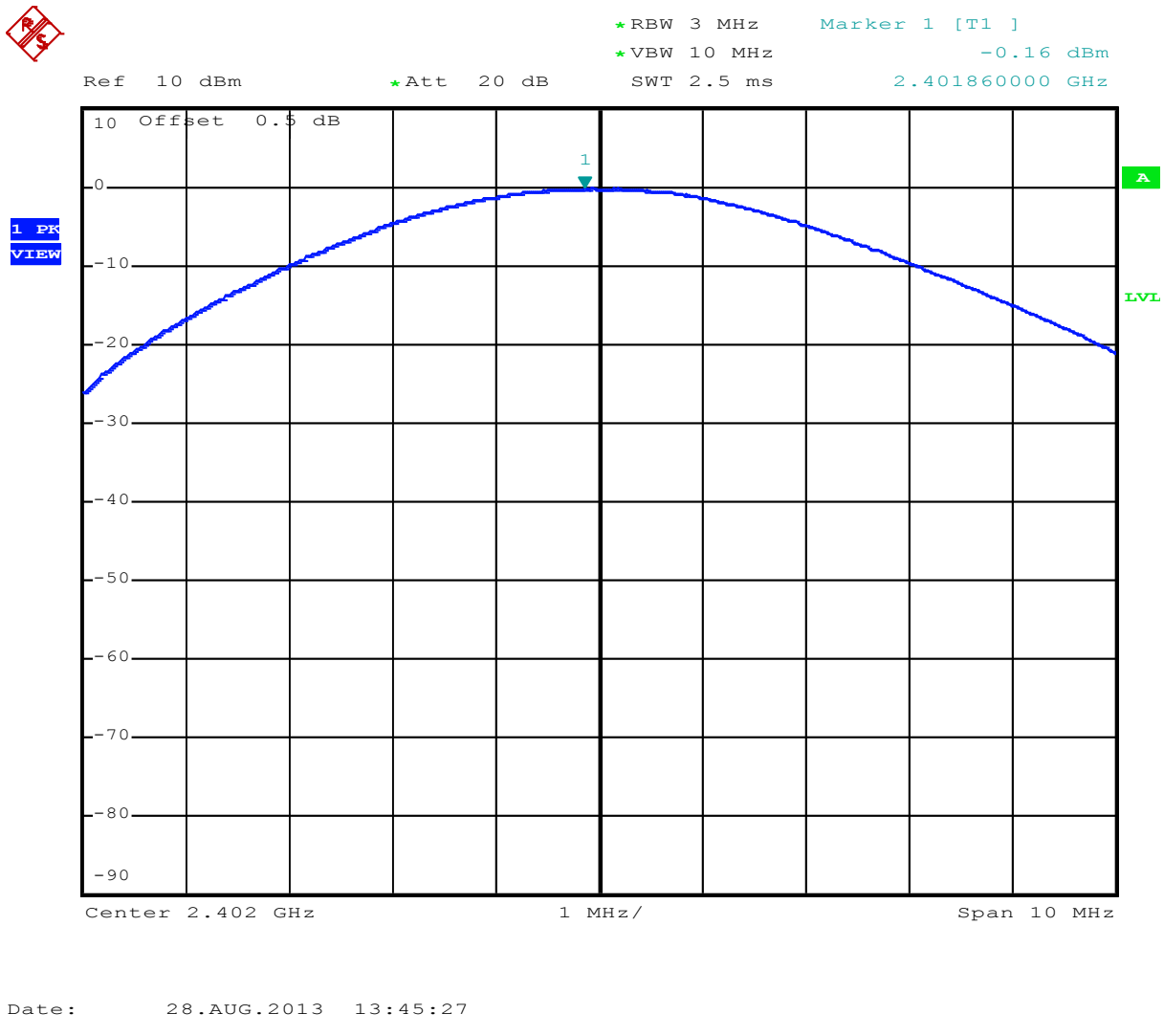
Plot 1b


*RBW 3 MHz
*VBW 10 MHz
Marker 1 [T1]
0.29 dBm
2.479760000 GHz
Ref 10 dBm
*Att 20 dB
SWT 2.5 ms
10 Offset 0.5 dB
1
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
VIEW
A
LVL
Center 2.48 GHz
1 MHz/
Span 10 MHz
Date: 28.AUG.2013 13:44:28

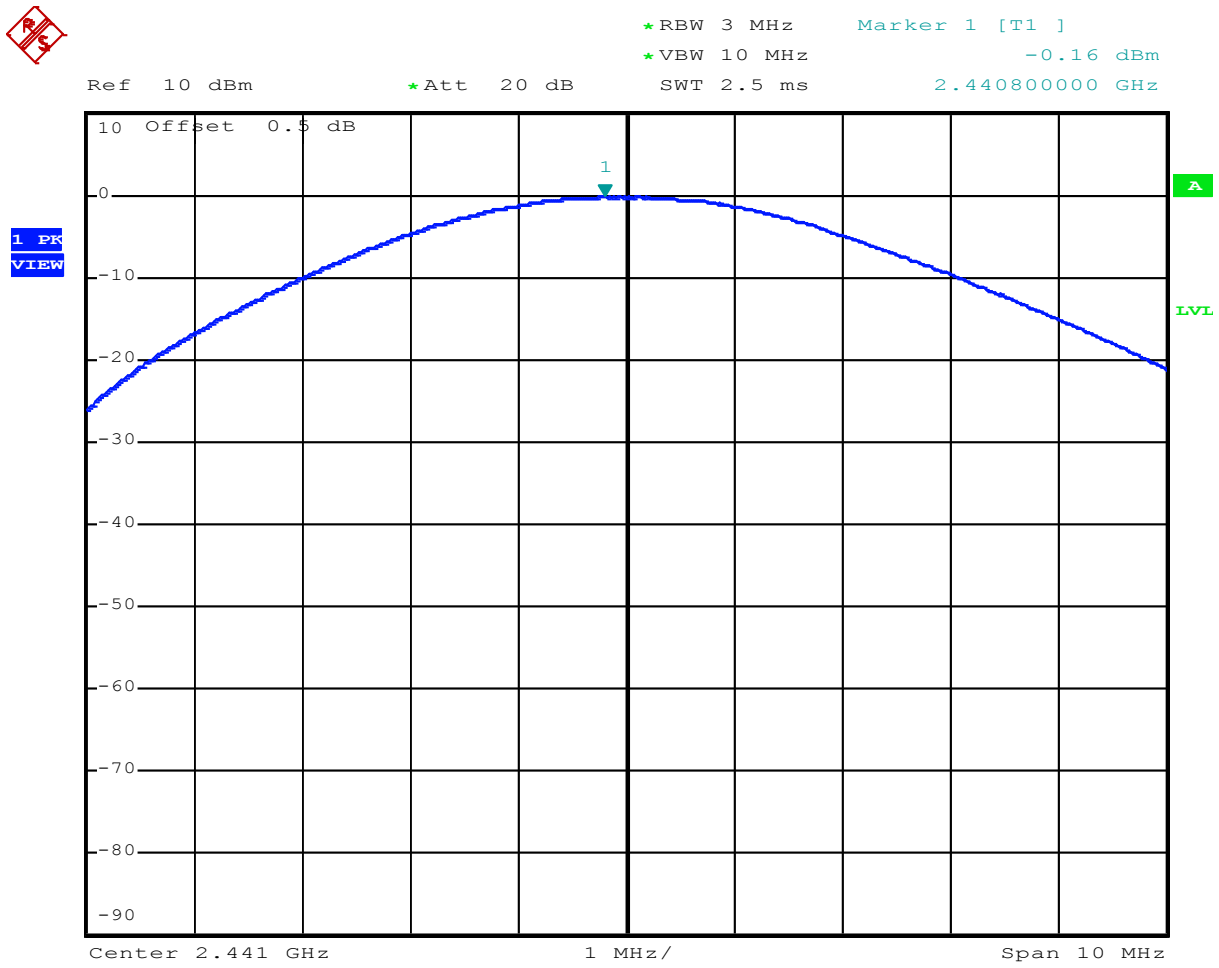
Plot 1c

Operation mode: 2DH5

Frequency [MHz]	Gain control setting (dB)	Output Power [dBm]	Limit [dBm]	Limit [mW]	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Plot number
2402	nominal	-0.16	+30	1000	+0.74	1.19	2a
2440	nominal	-0.16	+30	1000	+0.74	1.19	2b
2480	nominal	-0.32	+30	1000	+0.58	1.14	2c

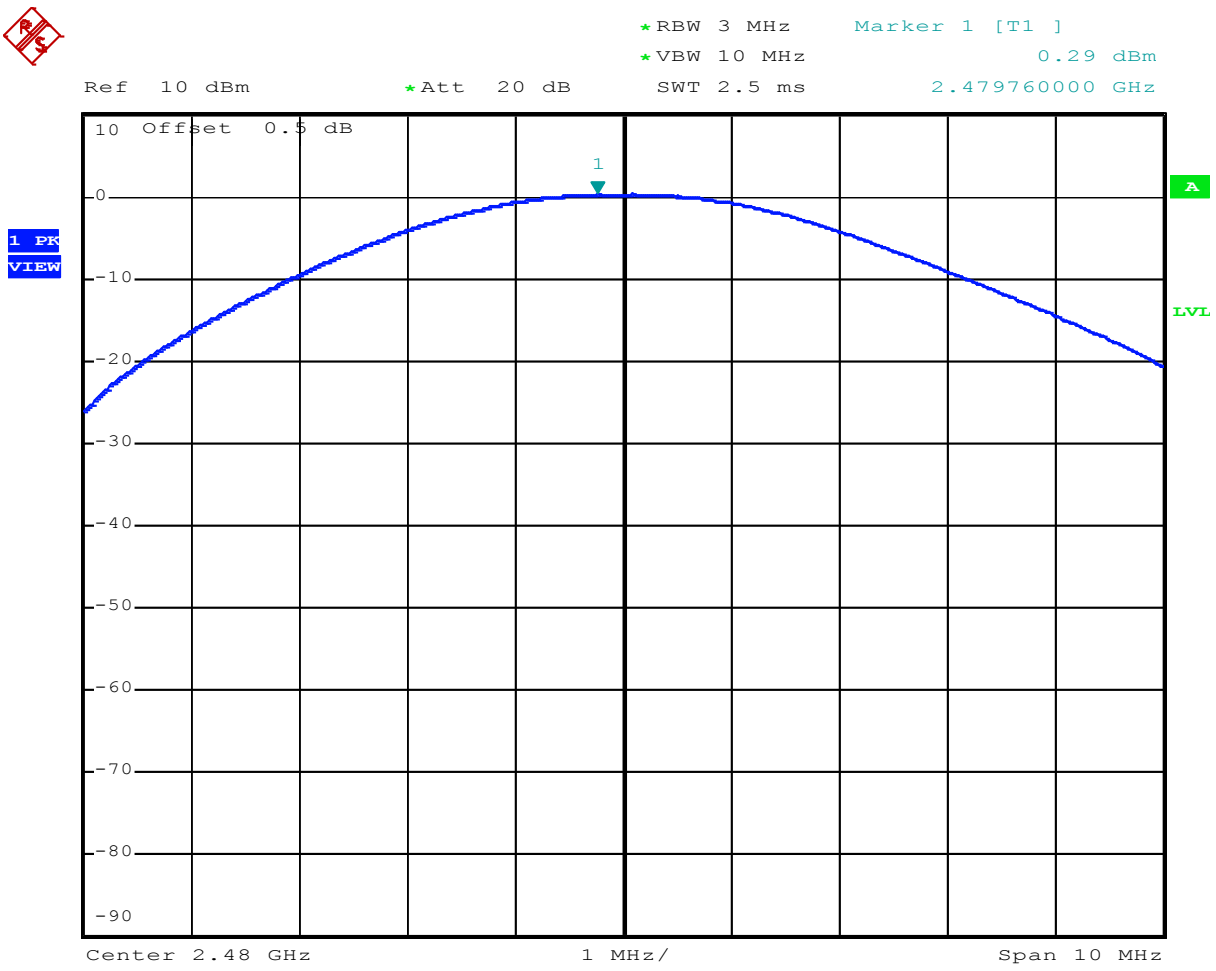


Plot 2a



Date: 28.AUG.2013 13:46:10

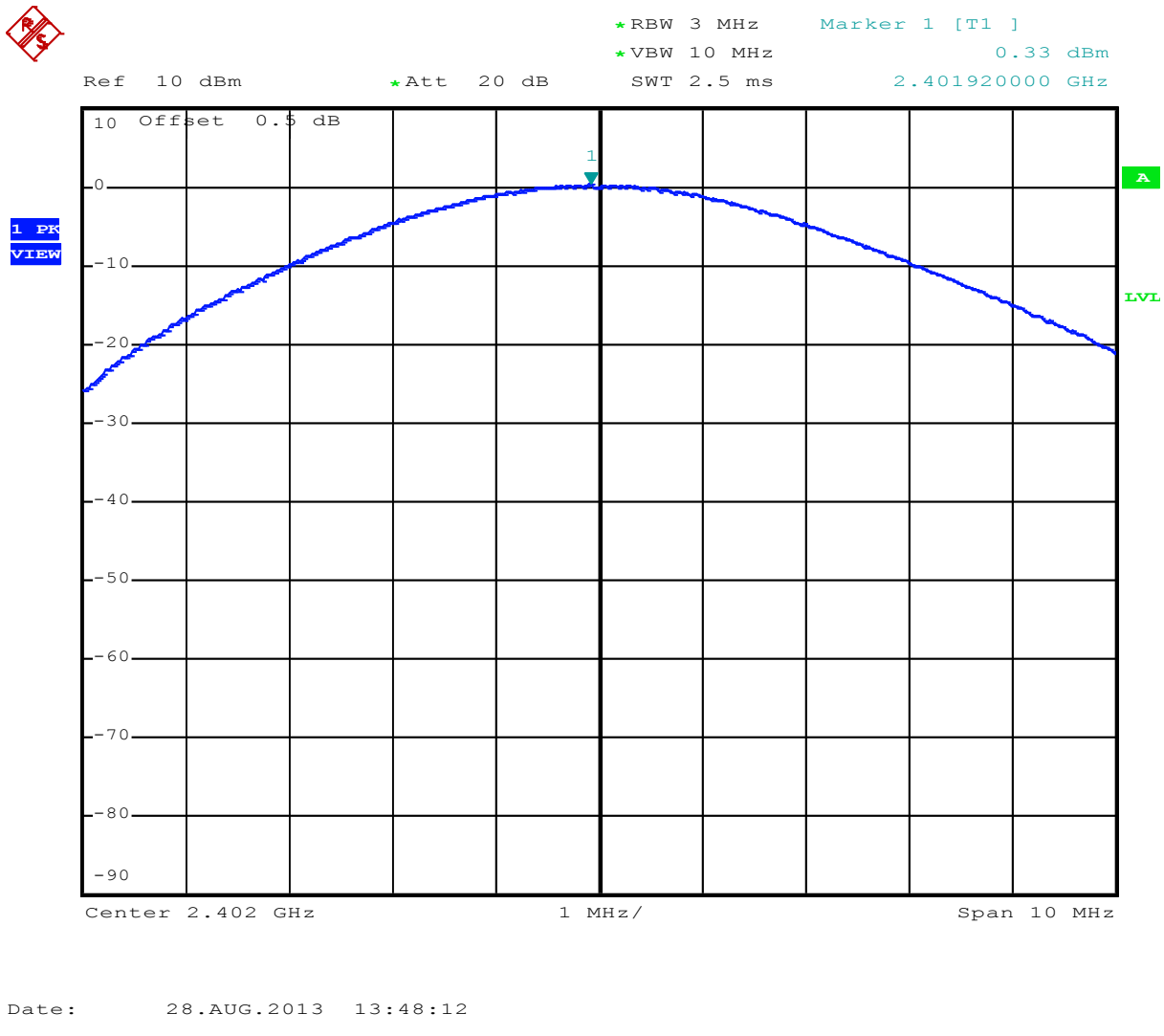
Plot 2b


*RBW 3 MHz
*VBW 10 MHz
Marker 1 [T1]
0.29 dBm
2.479760000 GHz
Ref 10 dBm
*Att 20 dB
SWT 2.5 ms
10 Offset 0.5 dB
1
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
VIEW
A
LVL
Center 2.48 GHz
1 MHz/
Span 10 MHz
Date: 28.AUG.2013 13:44:28

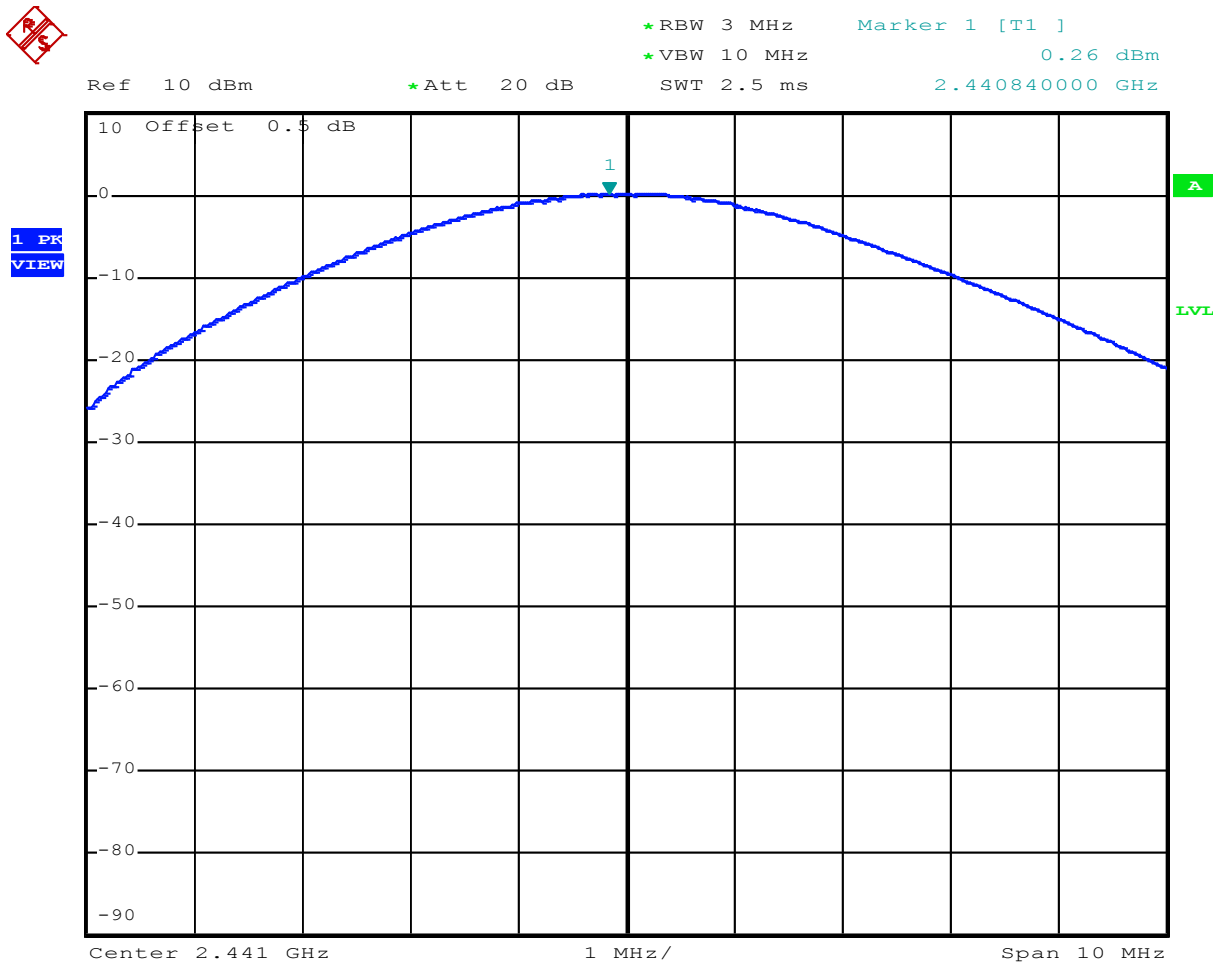
Plot 2c

Operation mode: 3DH5

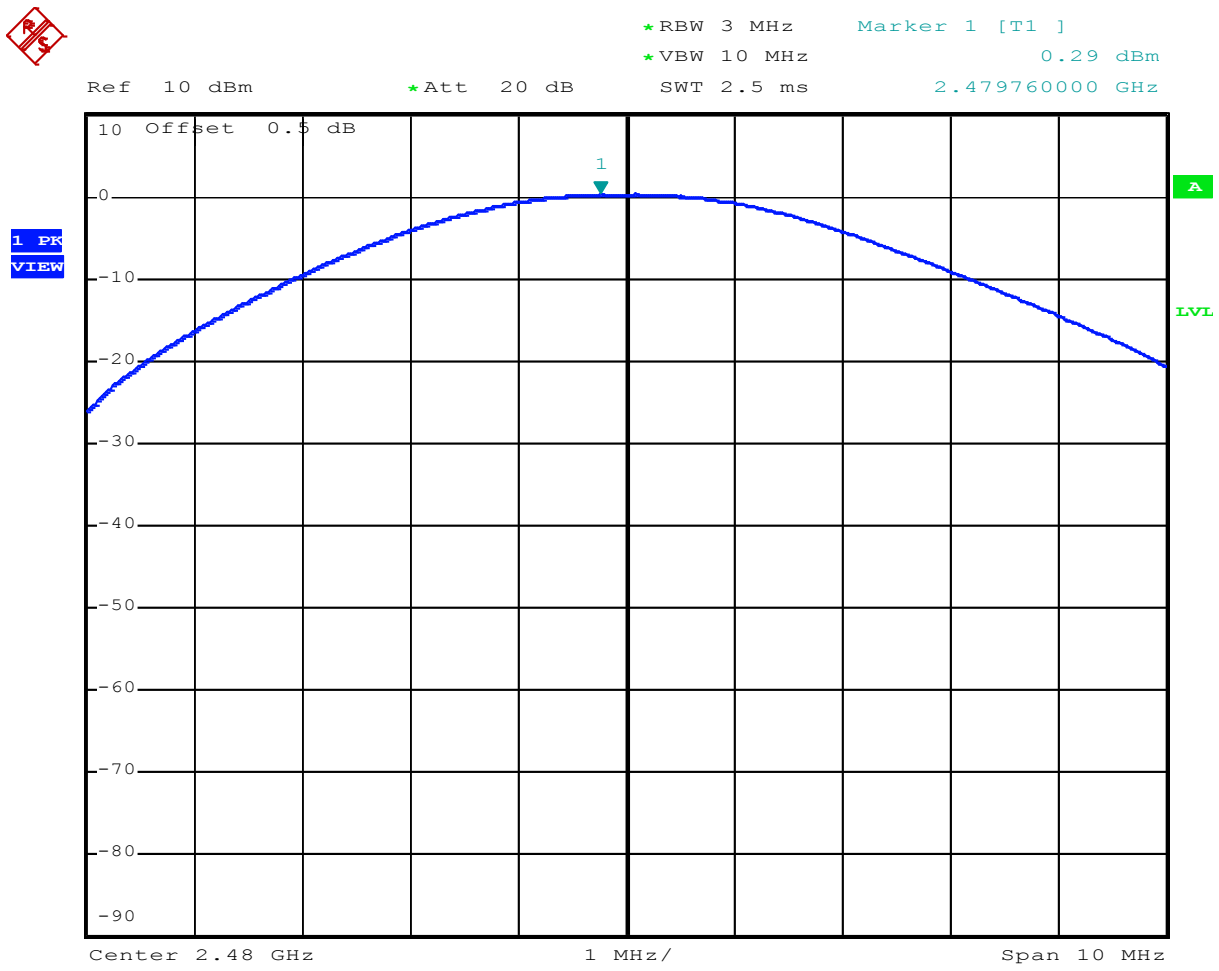
Frequency [MHz]	Gain control setting (dB)	Output Power [dBm]	Limit [dBm]	Limit [mW]	Maximum EIRP Power (dBm)	Maximum EIRP Power (mW)	Plot number
2402	nominal	+0.33	+30	1000	+1.23	1.33	3a
2440	nominal	+0.26	+30	1000	+1.16	1.31	3b
2480	nominal	+0.20	+30	1000	+1.10	1.29	3c



Plot 3a


RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
0.26 dBm
2.440840000 GHz
Ref 10 dBm
Att 20 dB
10 Offset 0.5 dB
1 PK VIEW
A
LVL
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.441 GHz
1 MHz/
Span 10 MHz
Date: 28.AUG.2013 13:49:02

Plot 3b


*RBW 3 MHz
*VBW 10 MHz
Marker 1 [T1]
0.29 dBm
2.479760000 GHz
Ref 10 dBm
*Att 20 dB
SWT 2.5 ms
10 Offset 0.5 dB
1
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1 PK
VIEW
A
LVL
Center 2.48 GHz
1 MHz/
Span 10 MHz
Date: 28.AUG.2013 13:44:28

Plot 3c

5.2.2 20dB Bandwidth

RESULT: PASS

Date of testing: 2013-08-28

Requirements:

FCC 15.247(a)(2)
For systems using hopping technology in the 2400-2483.5MHz band, the 20dB bandwidth is not limited.

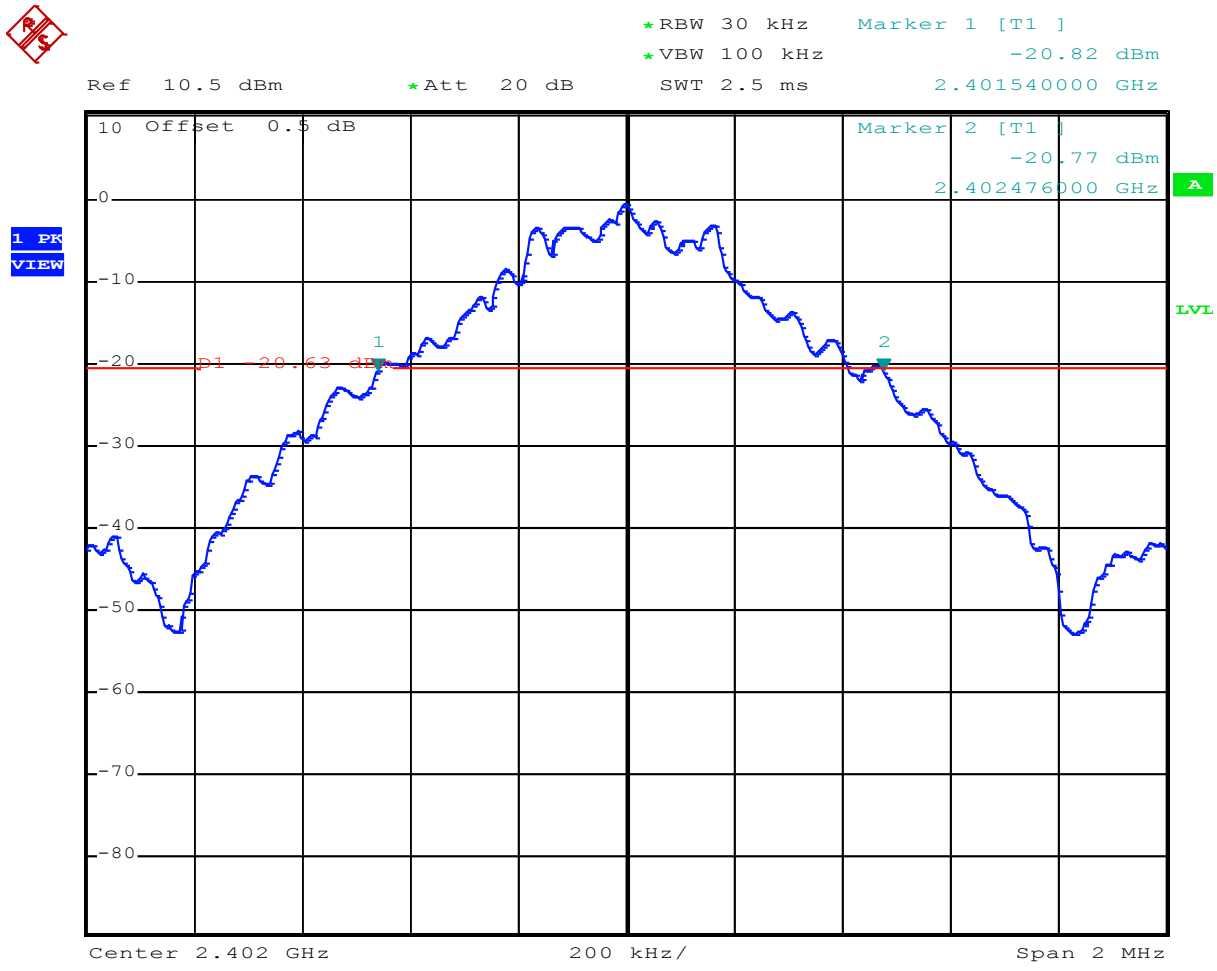
Test procedure 20dB bandwidth: ANSI C63.10-2009

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.

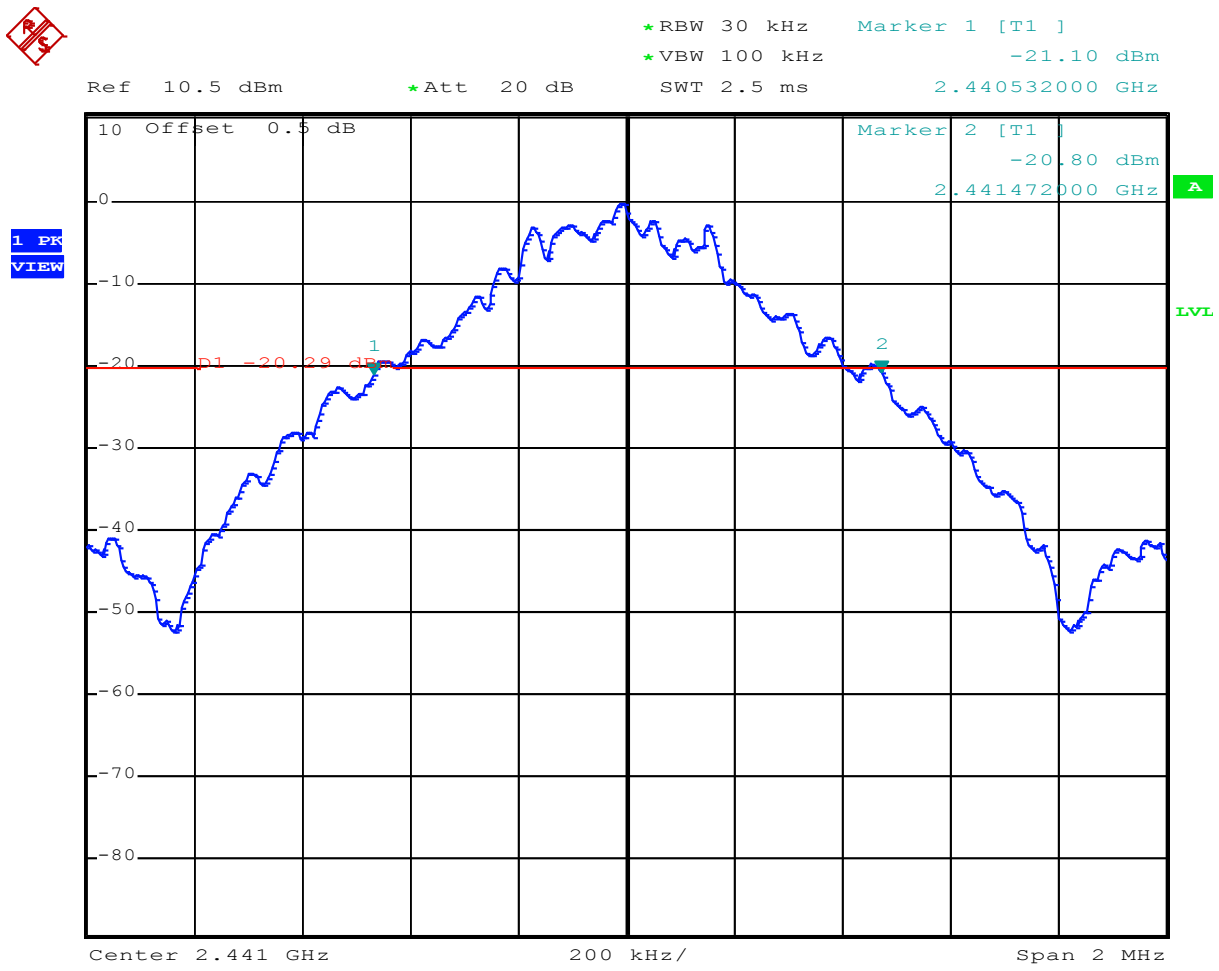
Table 5: 20dB Bandwidth

Operation mode: DH5

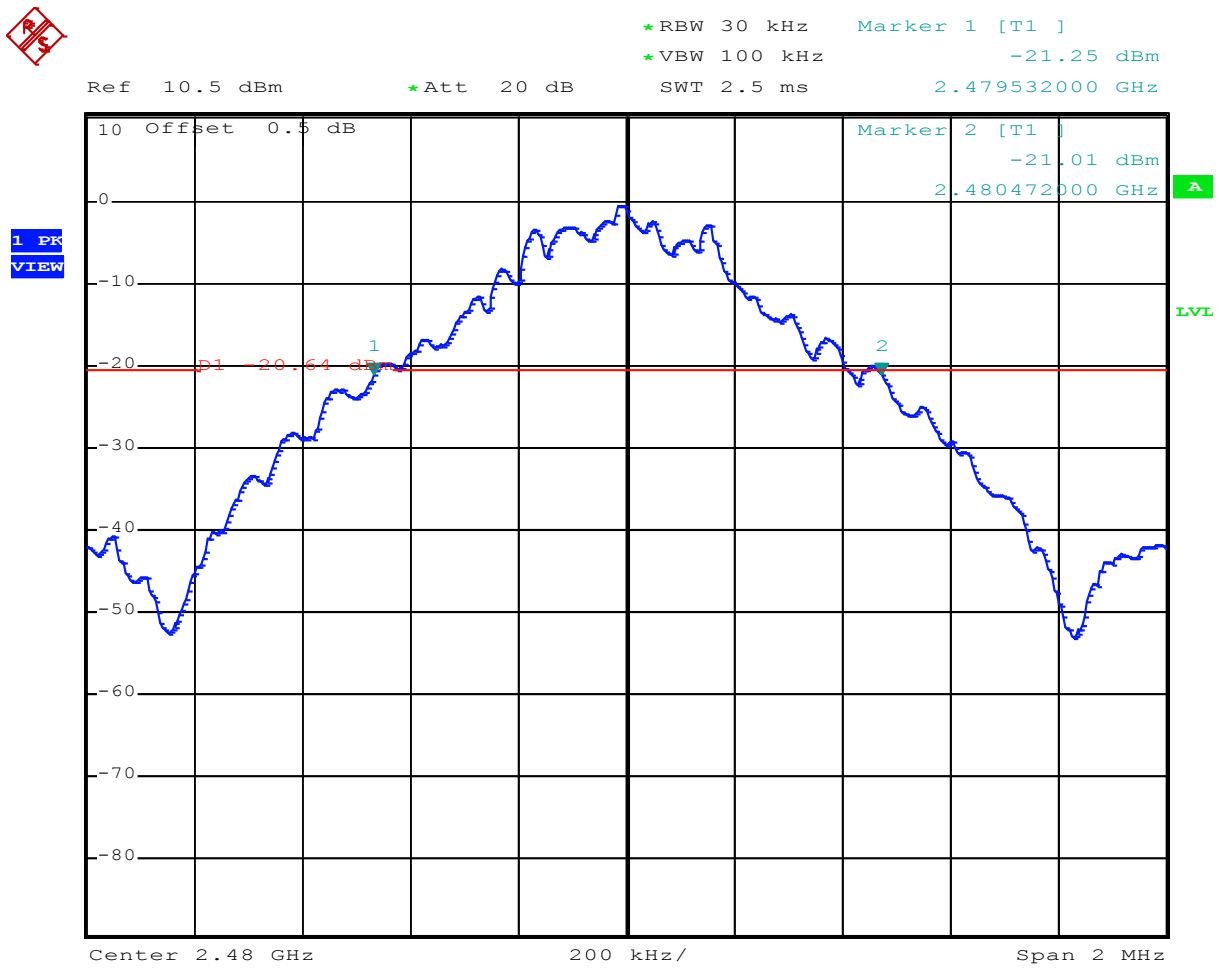
Operating Frequency [MHz]	20dB Bandwidth [kHz]	Limit [kHz]	Plot number
2402	936	Not applicable	4a
2441	940	Not applicable	4b
2480	940	Not applicable	4c



Plot 4a


RBW 30 kHz
VBW 100 kHz
Marker 1 [T1]
-21.10 dBm
2.440532000 GHz
Ref 10.5 dBm
Att 20 dB
SWT 2.5 ms
10 Offset 0.5 dB
Marker 2 [T1]
-20.80 dBm
2.441472000 GHz
1 PK
VIEW
A
LVL
D1 -20.29 dBm
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.441 GHz
200 kHz/
Span 2 MHz
Date: 28.AUG.2013 11:12:48

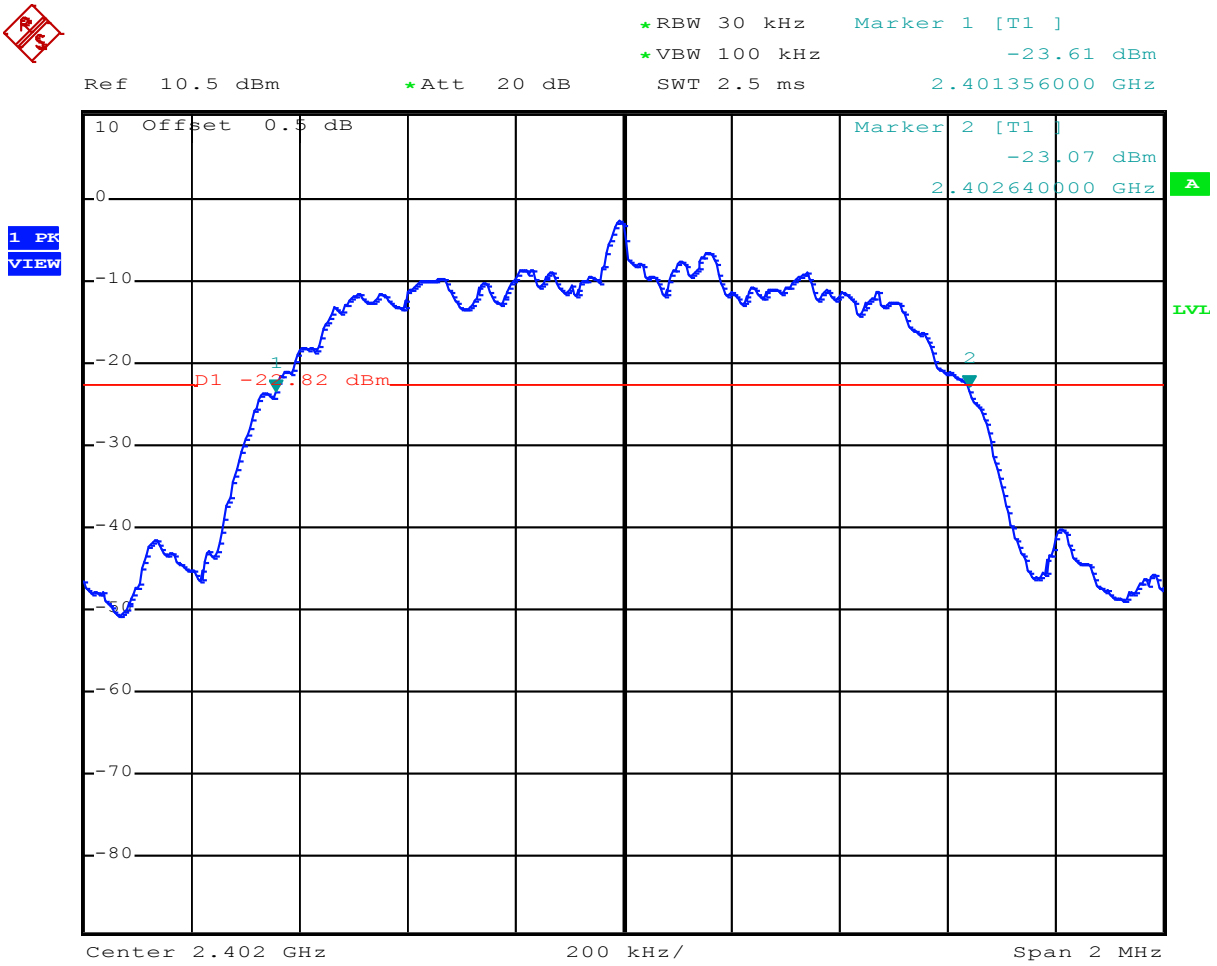
Plot 4b


*RBW 30 kHz
*VBW 100 kHz
Ref 10.5 dBm
*Att 20 dB
SWT 2.5 ms
Marker 1 [T1]
-21.25 dBm
2.479532000 GHz
Marker 2 [T1]
-21.01 dBm
2.480472000 GHz
10 Offset 0.5 dB
D1 -20.64 dBm
1 PK
VIEW
A
LVL
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 2.48 GHz
200 kHz/
Span 2 MHz
Date: 28.AUG.2013 11:16:02

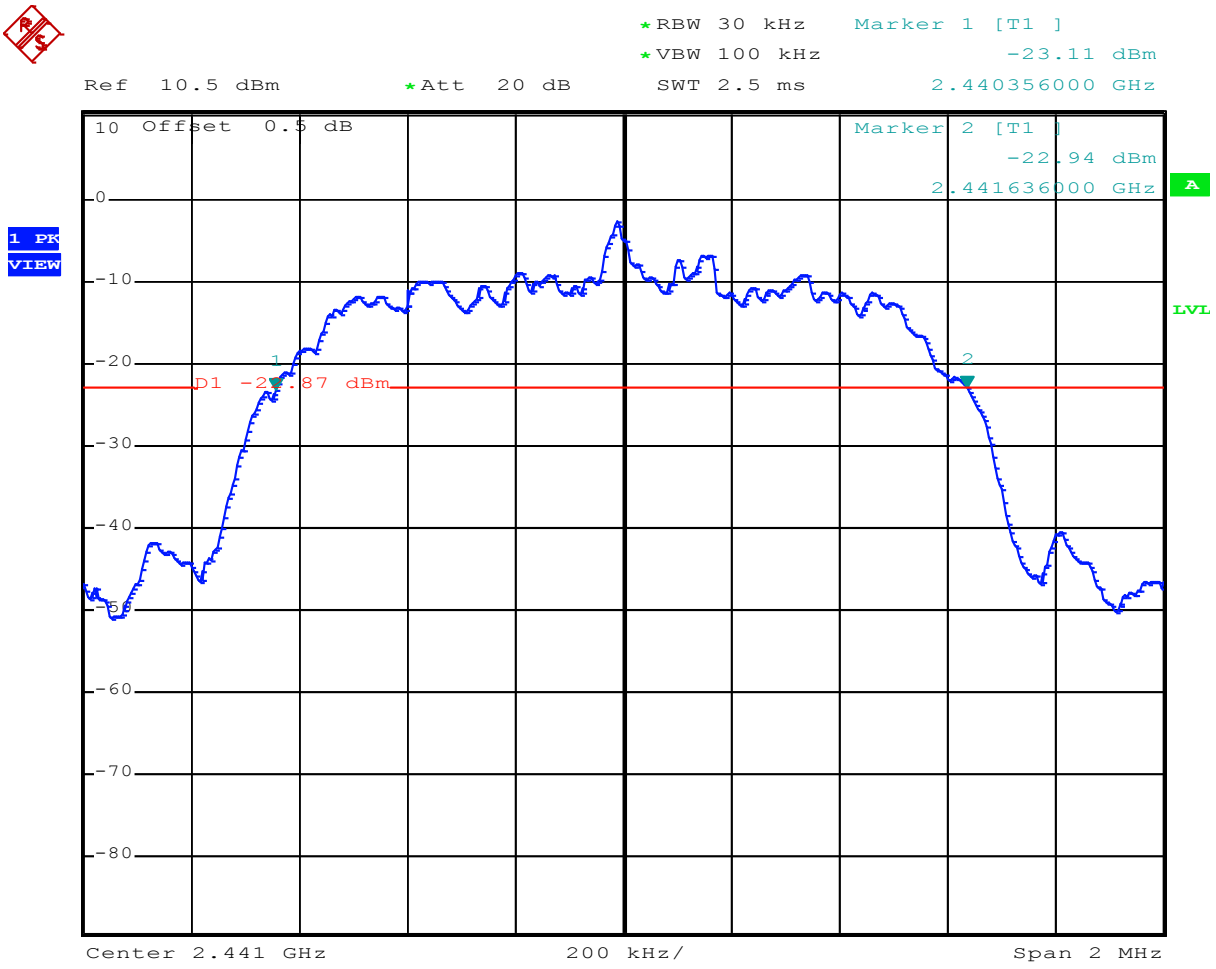
Plot 4c

Operation mode: 2DH5

Operating Frequency [MHz]	20dB Bandwidth [kHz]	Limit [kHz]	Plot number
2402	1284	Not applicable	5a
2441	1280	Not applicable	5b
2480	1284	Not applicable	5c

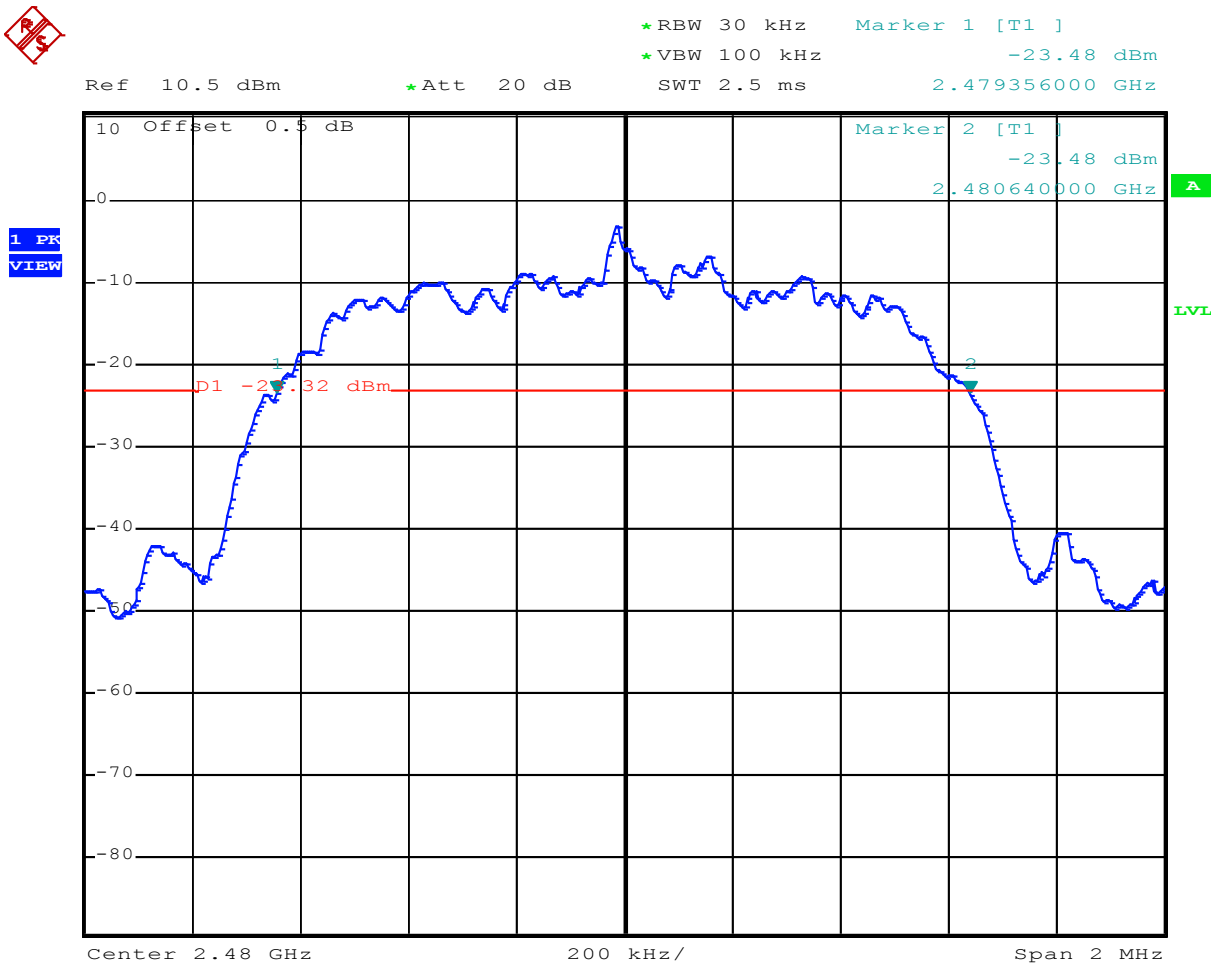


Plot 5a



Date: 28.AUG.2013 11:13:44

Plot 5b

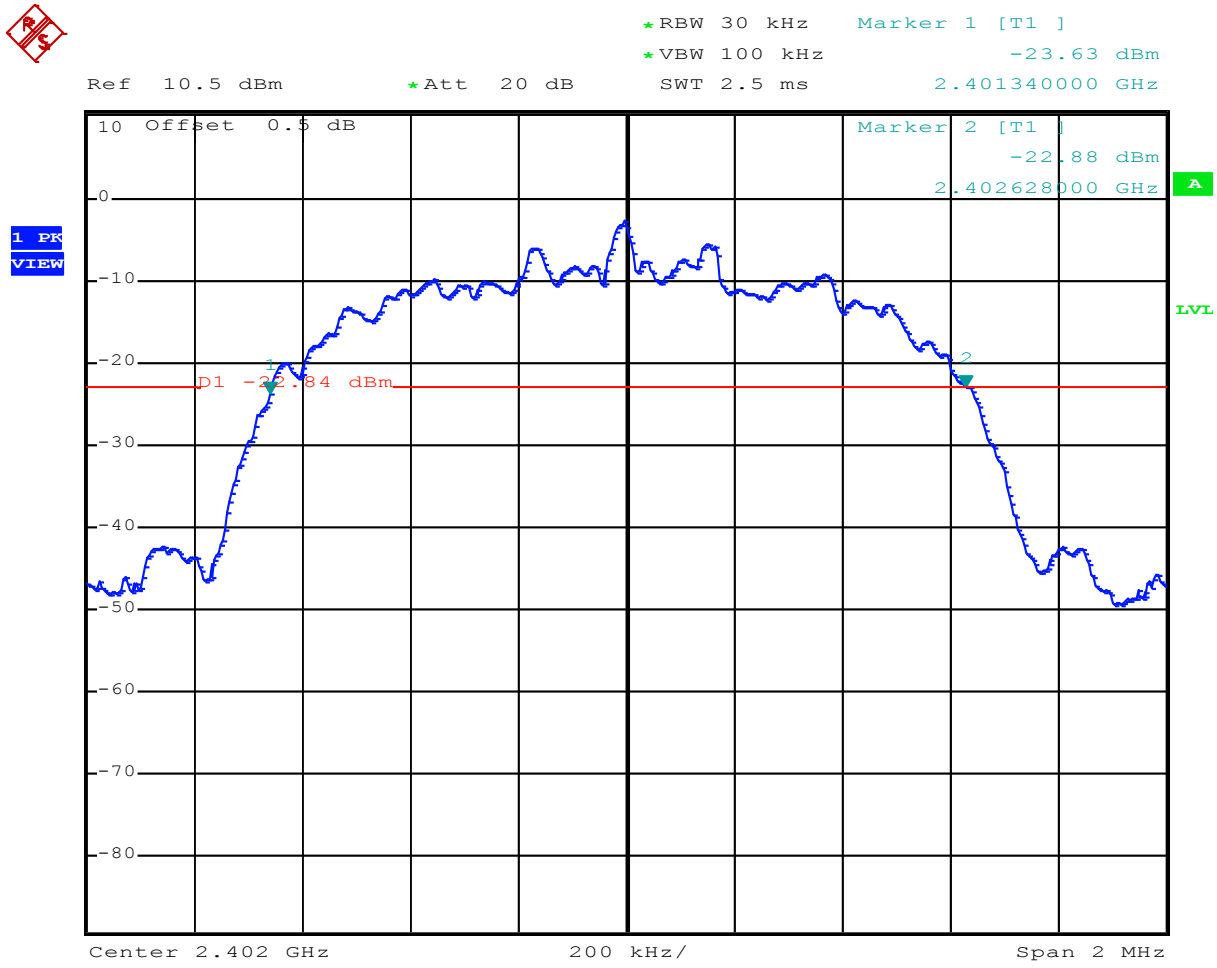


Date: 28.AUG.2013 11:17:01

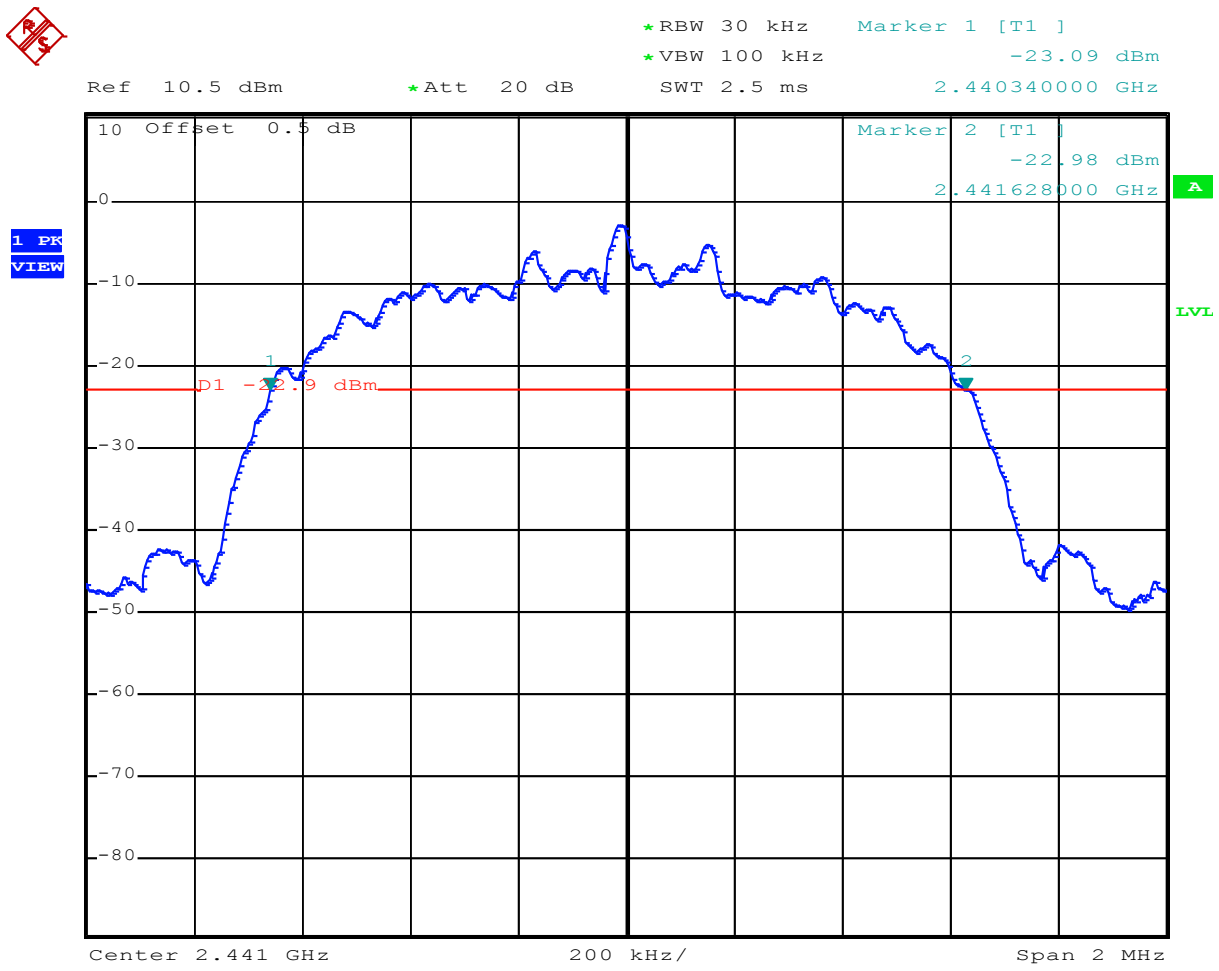
Plot 5c

Operation mode: 3DH5

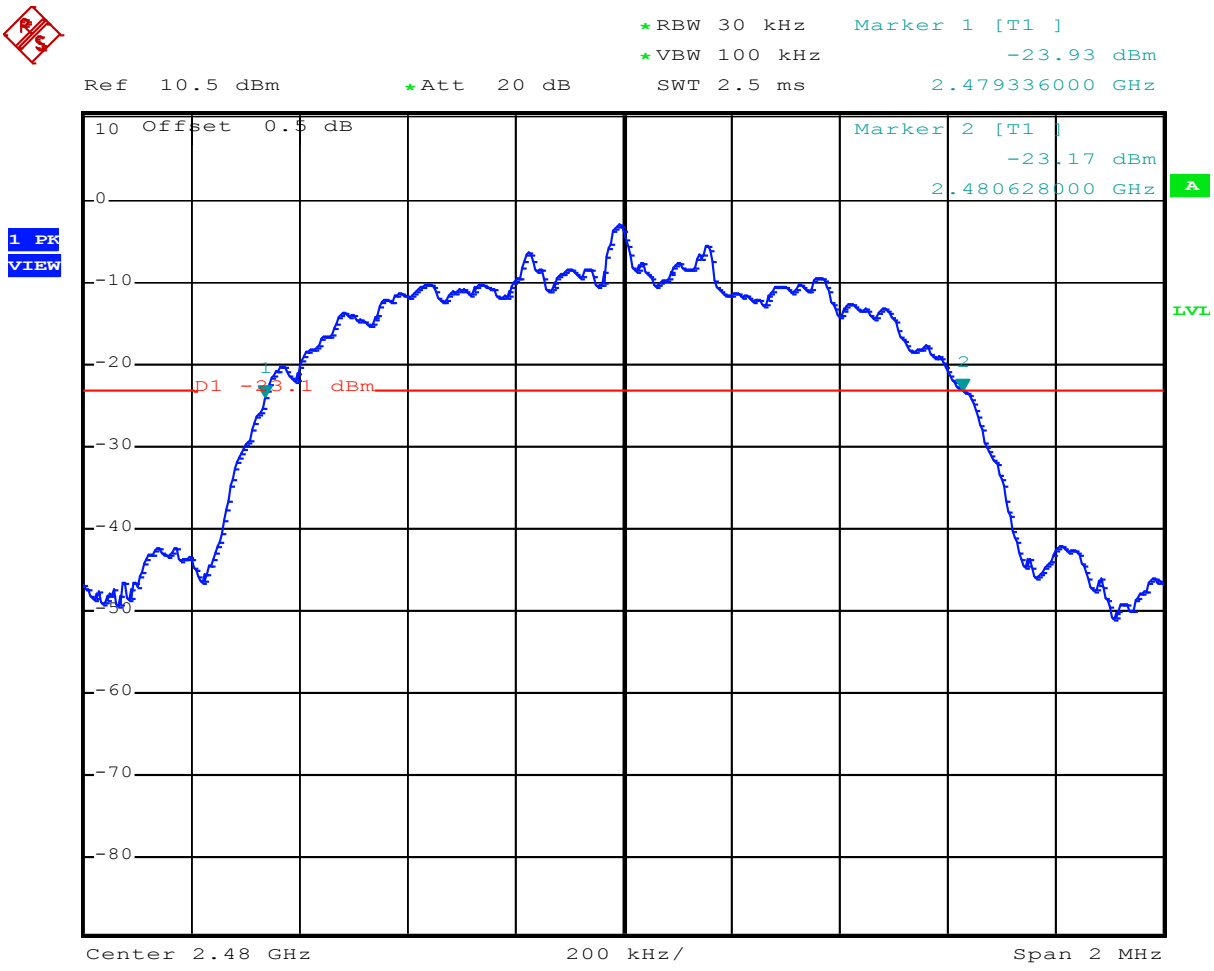
Operating Frequency [MHz]	20dB Bandwidth [kHz]	Limit [kHz]	Plot number
2402	1288	Not applicable	6a
2441	1288	Not applicable	6b
2480	1292	Not applicable	6c



Plot 6a


RBW 30 kHz
VBW 100 kHz
SWT 2.5 ms
Marker 1 [T1]
-23.09 dBm
2.440340000 GHz
Ref 10.5 dBm
Att 20 dB
10 Offset 0.5 dB
Marker 2 [T1]
-22.98 dBm
2.441628000 GHz
1 PK
VIEW
A
LVL
D1 -22.9 dBm
Center 2.441 GHz
200 kHz/
Span 2 MHz
Date: 28.AUG.2013 11:14:48

Plot 6b


RBW 30 kHz
VBW 100 kHz
SWT 2.5 ms
Marker 1 [T1]
-23.93 dBm
2.479336000 GHz
Ref 10.5 dBm
Att 20 dB
10 Offset 0.5 dB
Marker 2 [T1]
-23.17 dBm
2.480628000 GHz
1 PK
VIEW
A
LVL
0
-10
-20
-30
-40
-50
-60
-70
-80
D1 -23.1 dBm
Center 2.48 GHz
200 kHz/
Span 2 MHz
Date: 28.AUG.2013 11:17:54

Plot 6c

5.2.3 Number of hopping channels and Channel Occupancy

RESULT: PASS

Date of testing: 2013-08-28

Requirements:

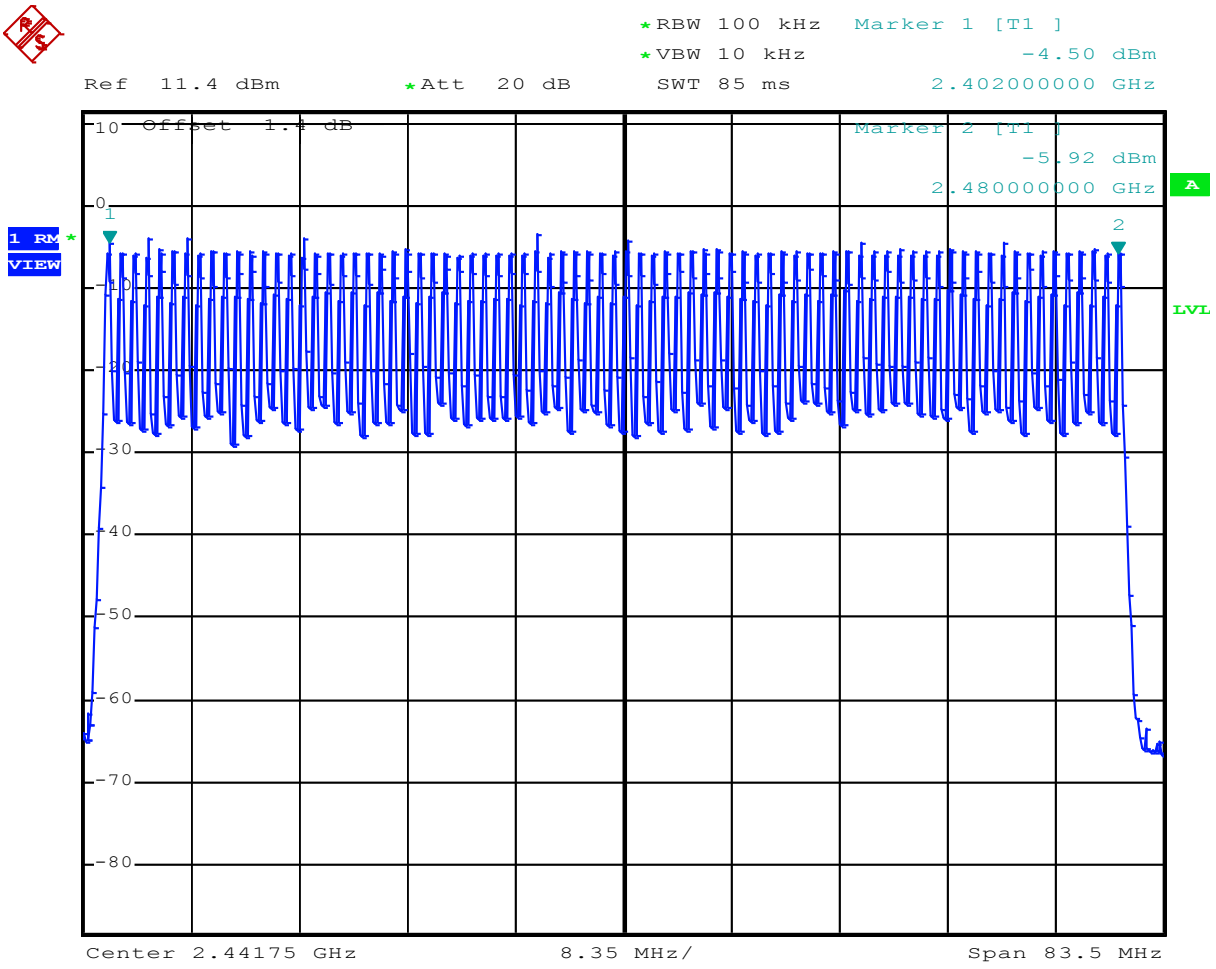
FCC 15.247(a)(1)(iii)

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.

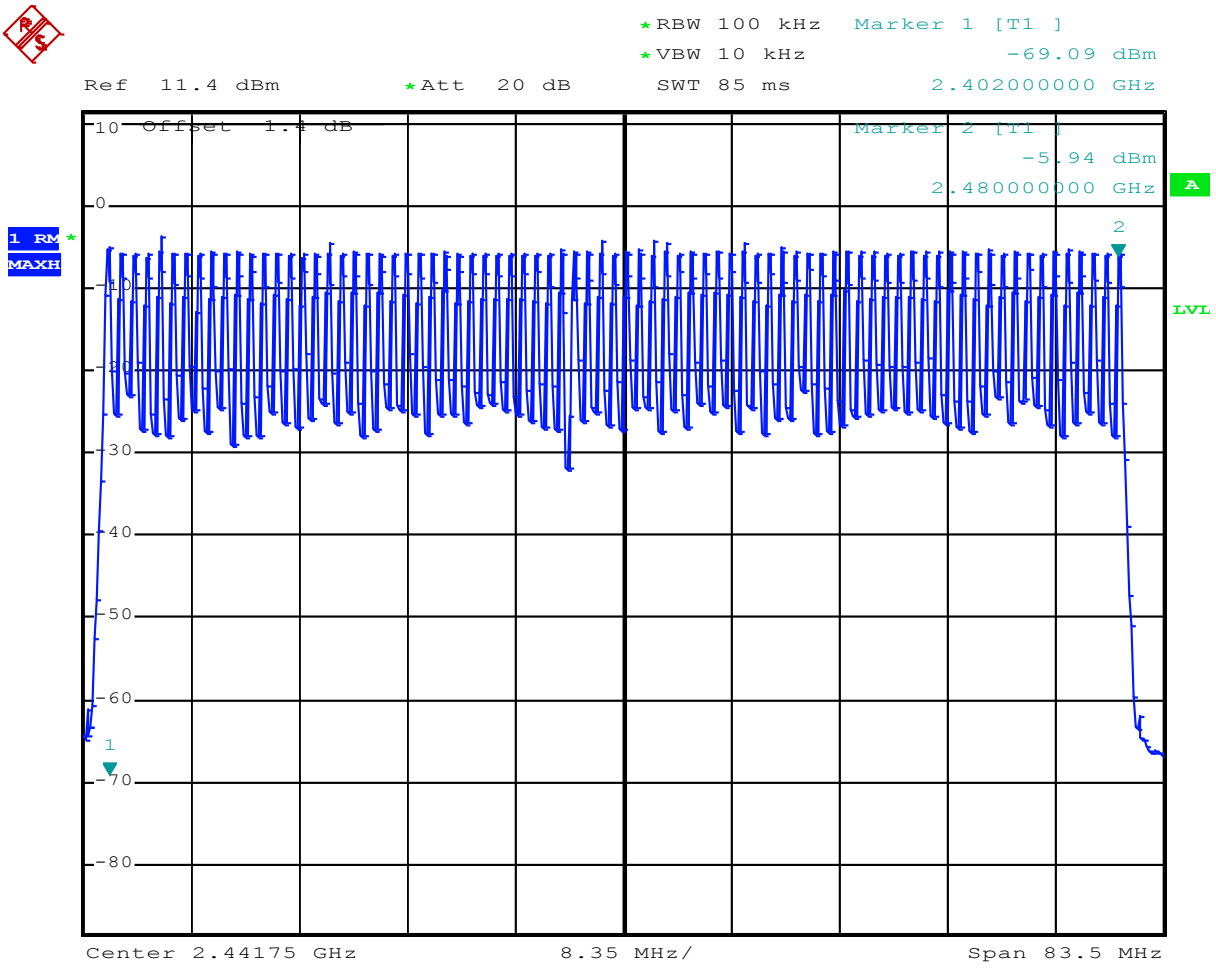
Test procedure: ANSI C63.10-2009.

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.

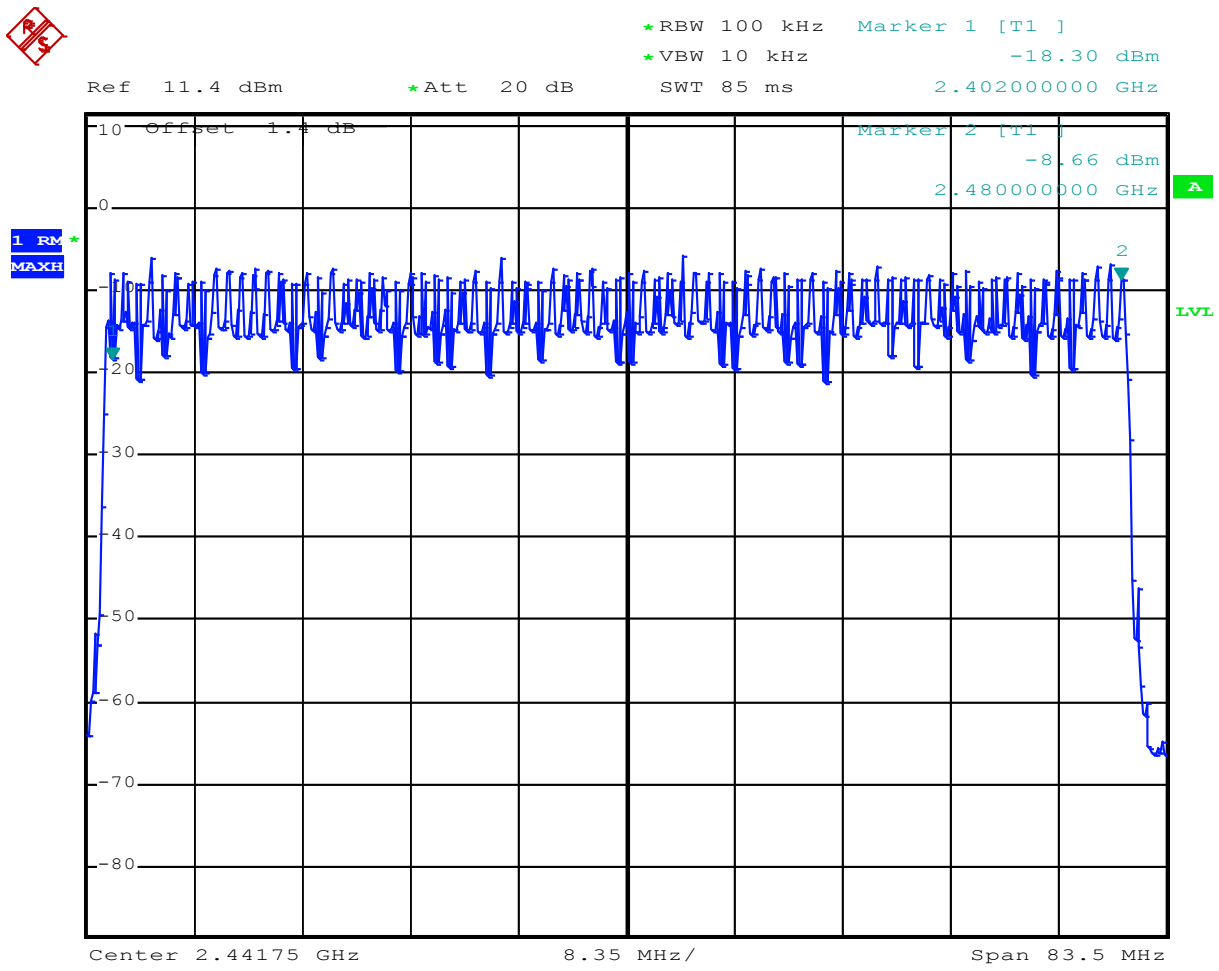
Number of hopping channels



Plot 7a: DH5 number of hopping channels is 79



Plot 7b: 2DH5 number of hopping channels is 79



Plot 7c: 3DH5 number of hopping channels is 79

Channel Occupancy

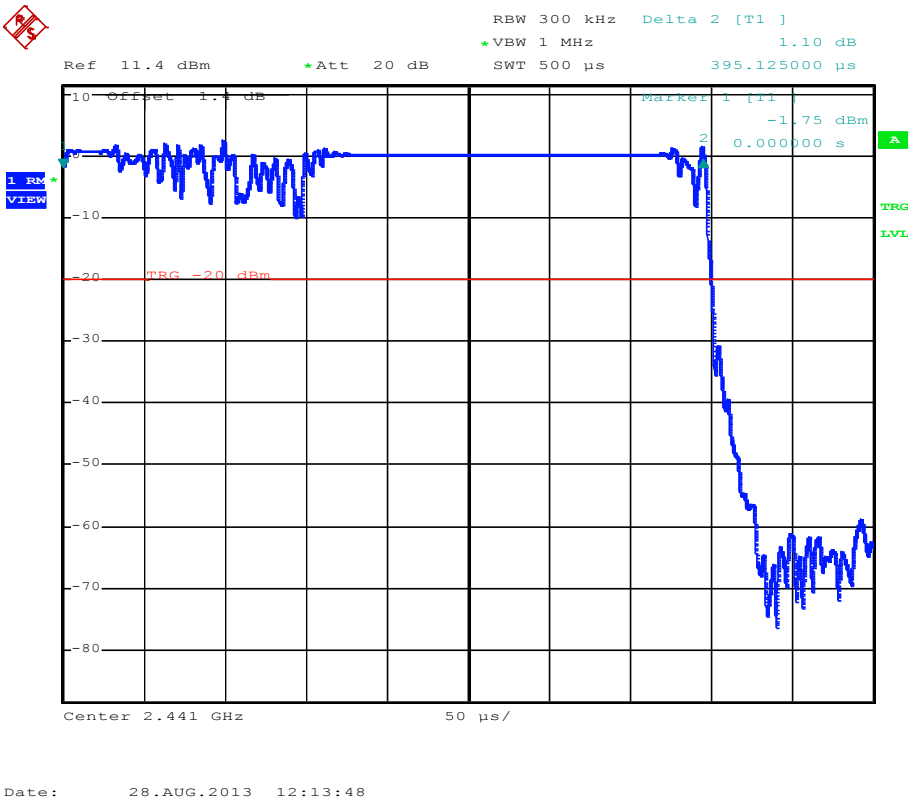
Specification

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

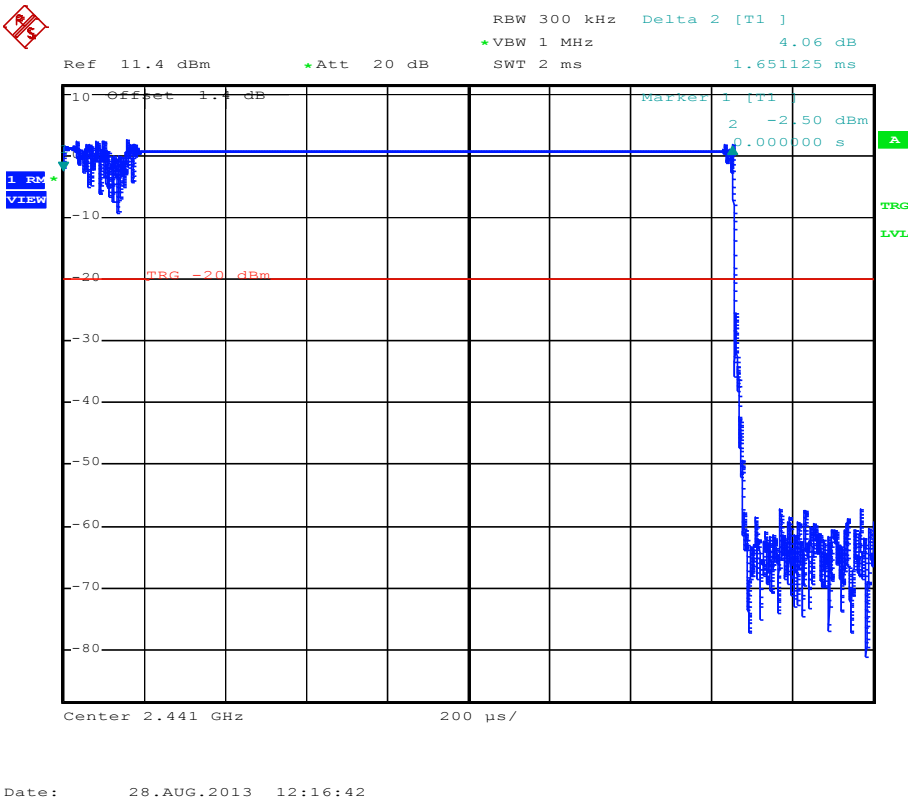
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH1.

The system makes worst case 1600 hops per second or 1 time slot has a length of 625us with 79 channels. A DH1 Packet needs 1 time slot for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. So you have each channel 800/79 = 10.127 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 10.127 x 31.6 = 320 times of appearance.
Each Tx-time per appearance is 0.3951 ms (see next plot).
So we have 320 x 0.3951 ms = 126.432 ms per 31.6 seconds.



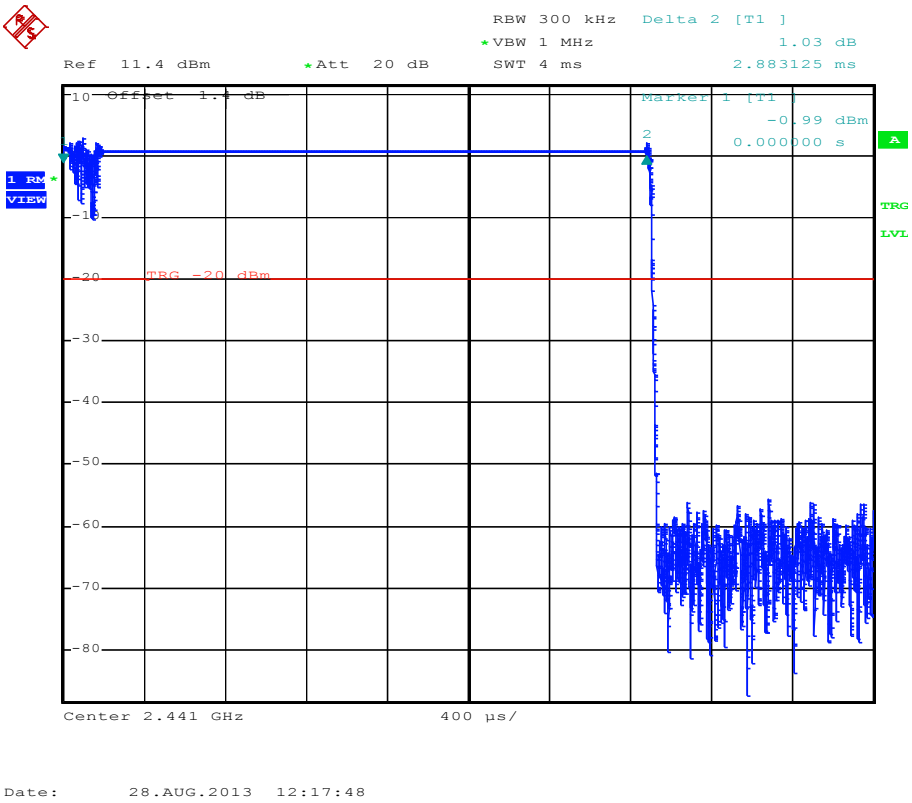
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH3.

A 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 =5.063 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.0638 x 31.6 = 160 times of appearance.
Each Tx-time per appearance is 1.651 ms (see next plot).
So we have 160 x 1.651 ms = 264.161 ms per 31.6 seconds.



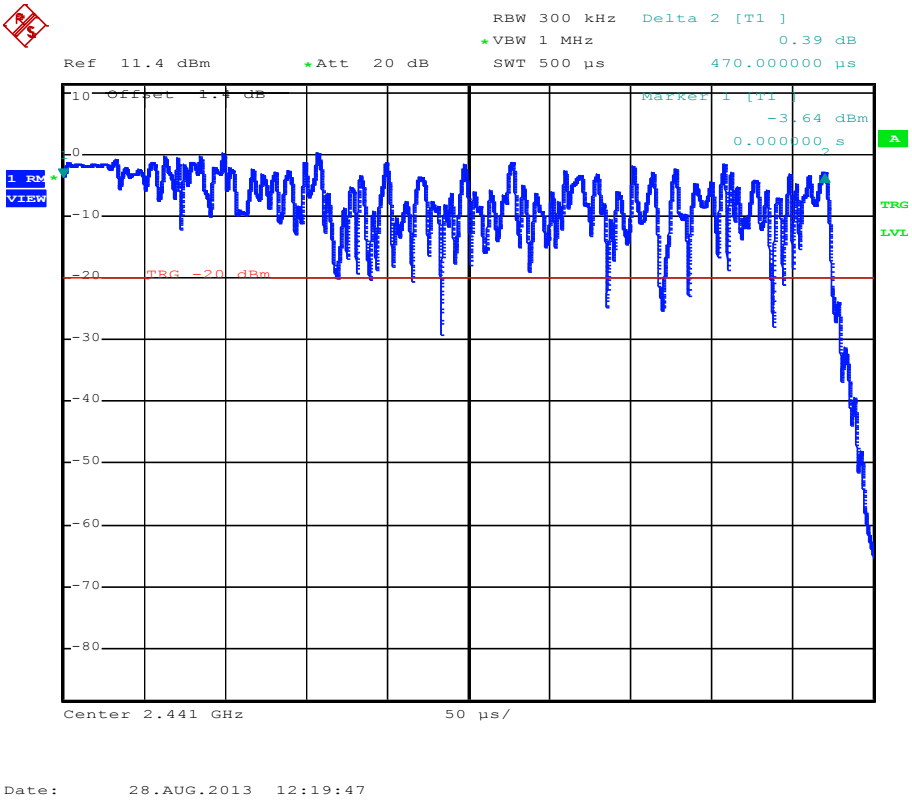
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE DH5.

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 2.883 ms (see next plot).
So we have 106.67 x 2.883 ms = 307.52 ms per 31.6 seconds.



TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2DH1.

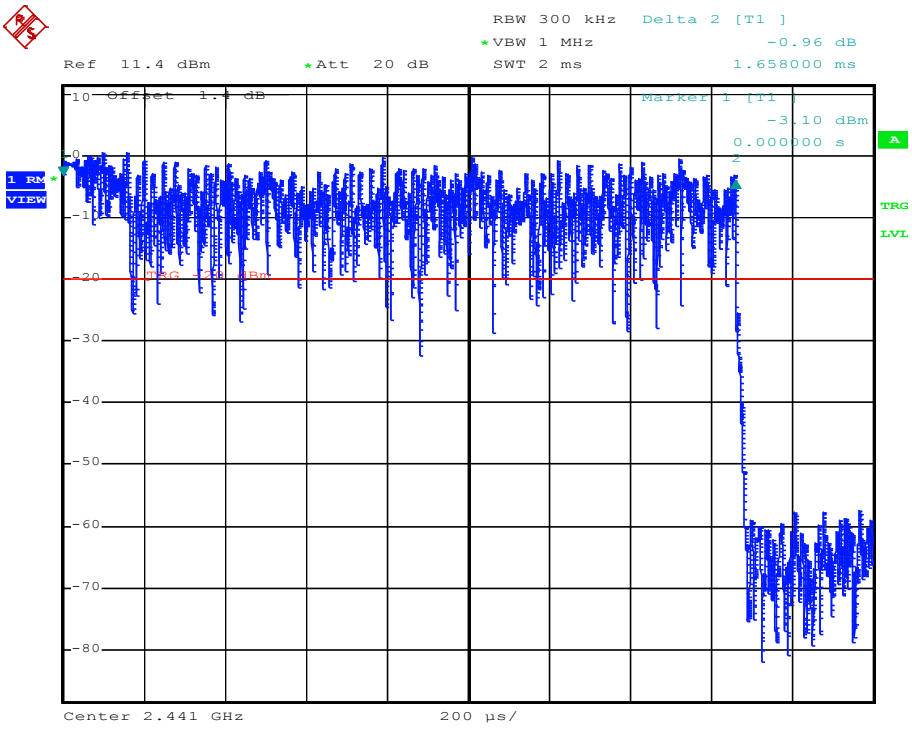
The system makes worst case 1600 hops per second or 1 time slot has a length of 625us with 79 channels. A 2DH1 Packet needs 1 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. So you have each channel 800/79 =10.127 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 10.127 x 31.6 = 320 times of appearance.
Each Tx-time per appearance is 0.4700 ms (see next plot).
So we have 320 x 0.4700 ms = 150.4 ms per 31.6 seconds.



Date: 28.AUG.2013 12:19:47

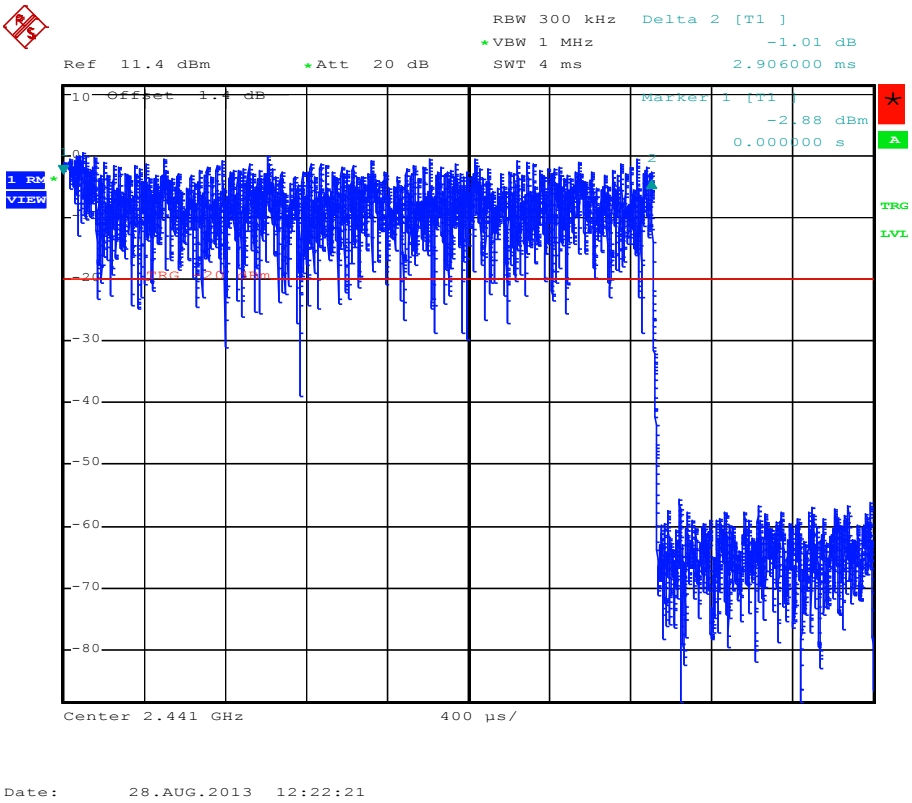
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2DH3.

A 2DH3 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 =5.063 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.0638 x 31.6 = 160 times of appearance.
Each Tx-time per appearance is 1.658 ms (see next plot).
So we have 160 x 1.658 ms = 265.28 ms per 31.6 seconds.



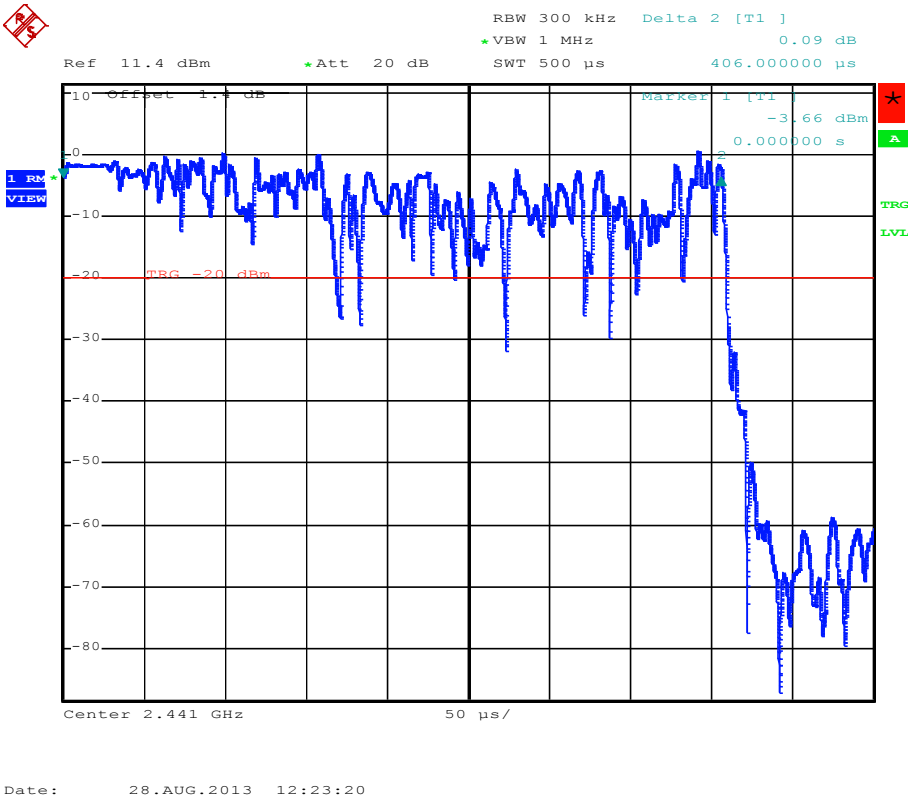
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 2DH5.

A 2DH5 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 2.906 ms (see next plot).
So we have 106.67 x 2.906 ms = 309.97 ms per 31.6 seconds.



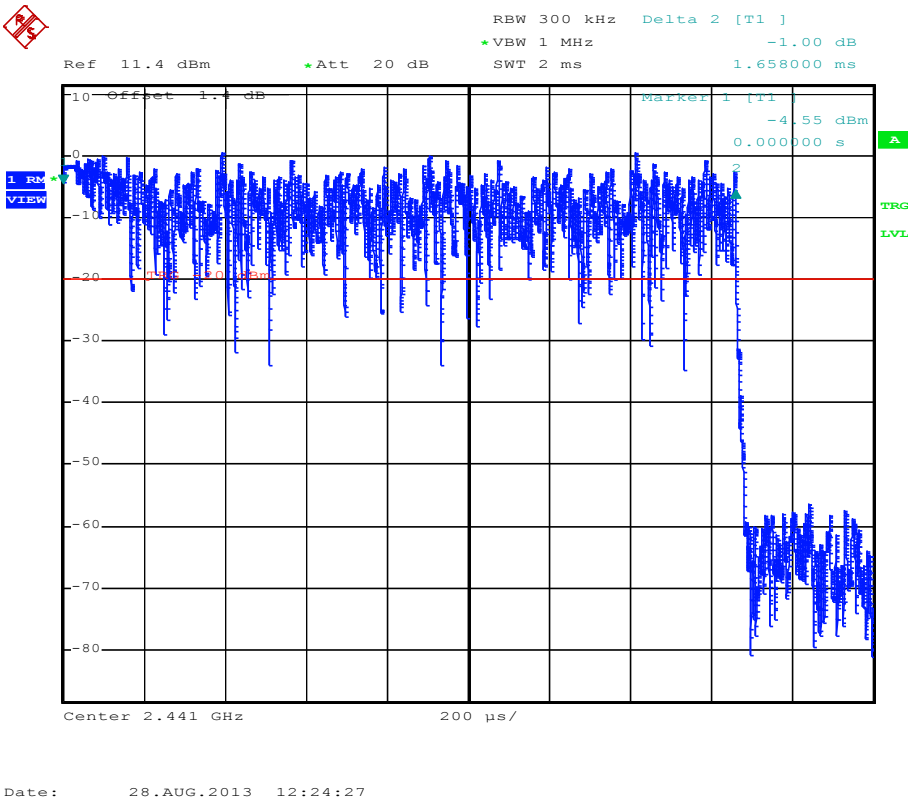
TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 3DH1.

The system makes worst case 1600 hops per second or 1 time slot has a length of 625us with 79 channels. A 3DH1 Packet needs 1 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/2 = 800 hops per second with 79 channels. So you have each channel 800/79 =10.127 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 10.127 x 31.6 = 320 times of appearance.
Each Tx-time per appearance is 0.406 ms (see next plot).
So we have 320 x 0.406 ms = 129.92 ms per 31.6 seconds.



TIME OF OCCUPANCY (DWELL TIME) FOR PACKET TYPE 3DH3.

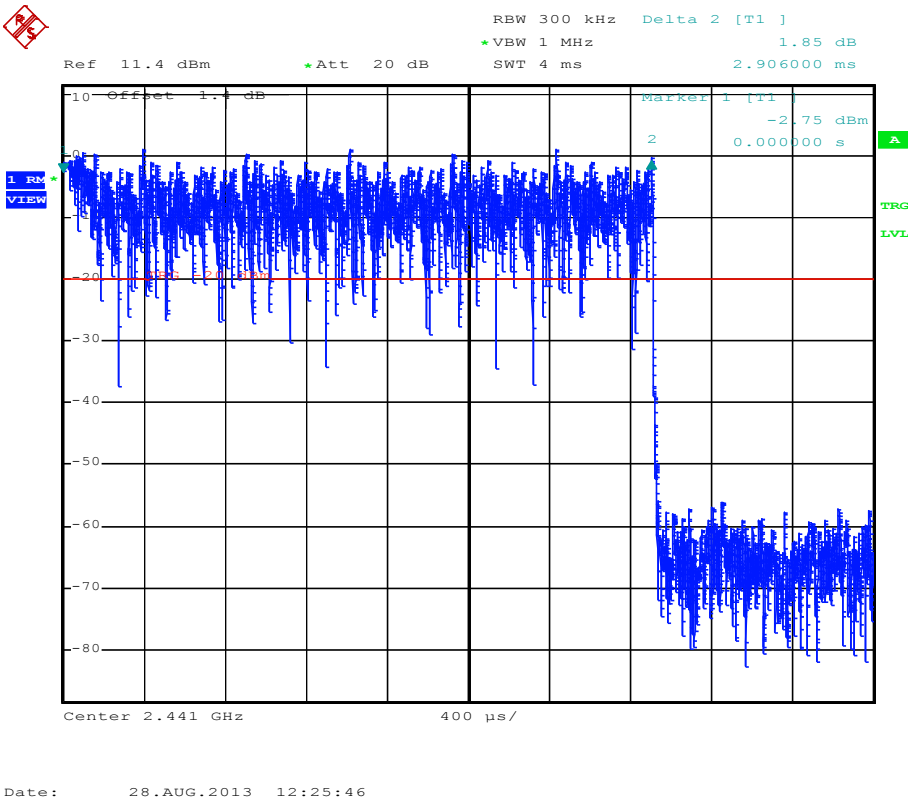
A 3DH3 Packet needs 3 time slots for transmitting and 1 time slot for receiving. Then the system makes worst case 1600/4 = 400 hops per second with 79 channels. So you have each channel 400/79 =5.063 times per second and so for a period of 0.4 x 79 = 31.6 seconds you have 5.0638 x 31.6 = 160 times of appearance.
Each Tx-time per appearance is 1.658 ms (see next plot).
So we have 160 x 1.658 ms = 265.28 ms per 31.6 seconds.



Date: 28.AUG.2013 12:24:27

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

A 3DH5 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 2.906 ms (see next plot).
So we have 106.67 x 2.906 ms = 309.97 ms per 31.6 seconds.



5.2.4 Carrier Frequency Separation

RESULT: PASS

Date of testing: 2013-08-28

Requirements: FCC 15.247(a)(1)

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: ANSI C63.10-2009.

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.

Operation mode: DH5

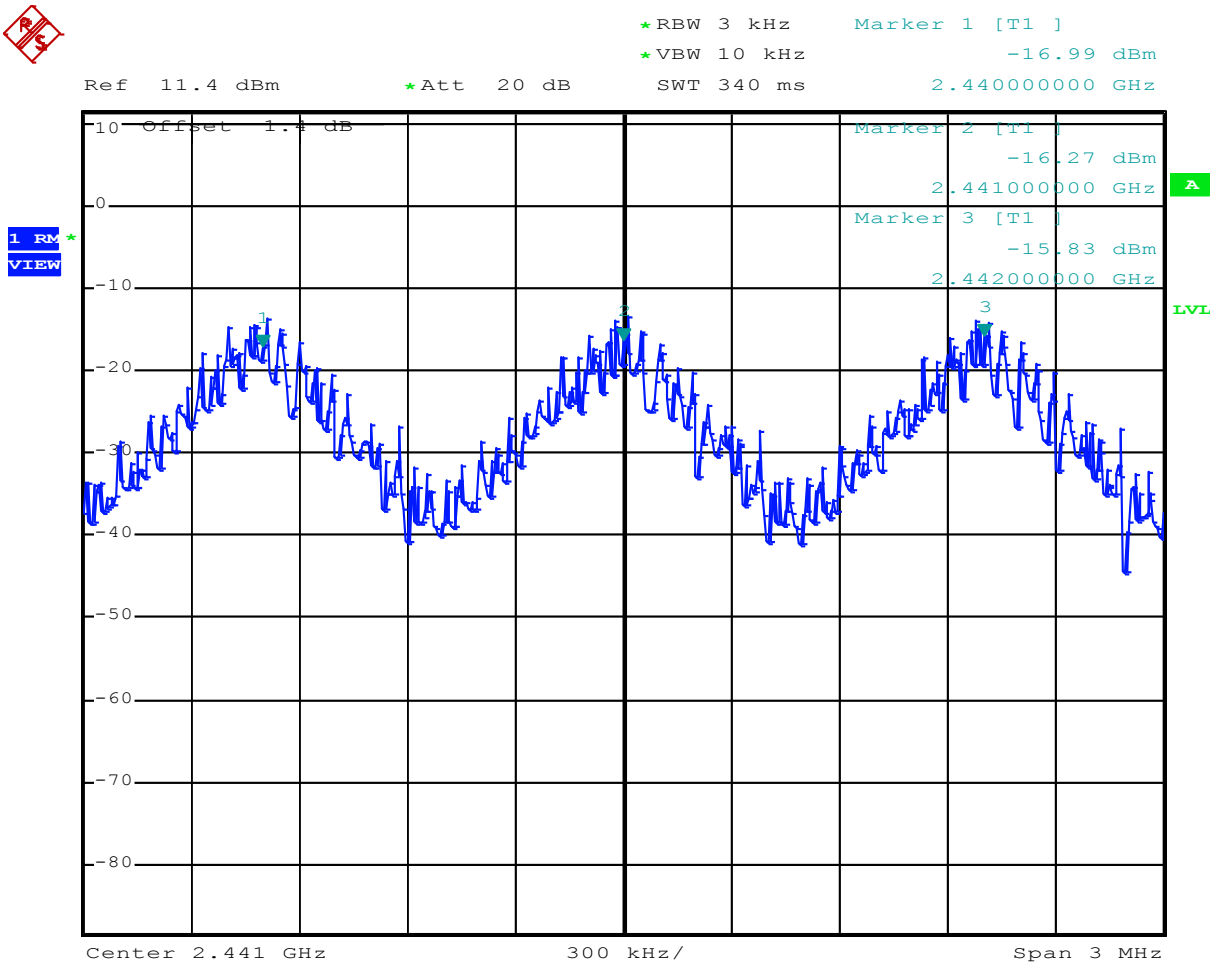
Operating Frequency [MHz]	20dB Bandwidth [kHz]	2/3xBandwidth [kHz]	Limit [kHz]
2402	936	624	1000
2441	940	627	1000
2480	940	627	1000

Operation mode: 2DH5

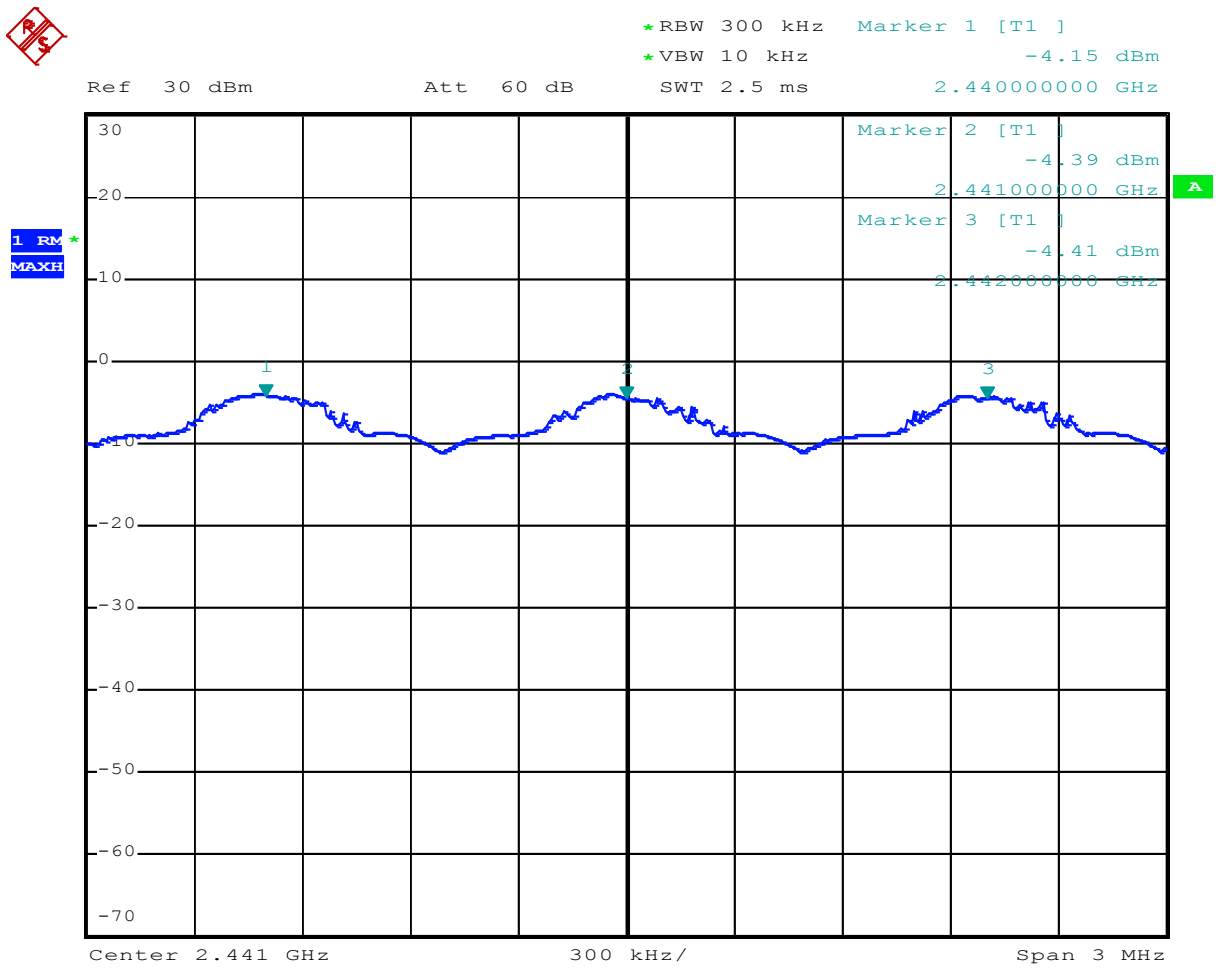
Operating Frequency [MHz]	20dB Bandwidth [kHz]	2/3xBandwidth [kHz]	Limit [kHz]
2402	1284	856	1000
2441	1280	853	1000
2480	1284	856	1000

Operation mode: 3DH5

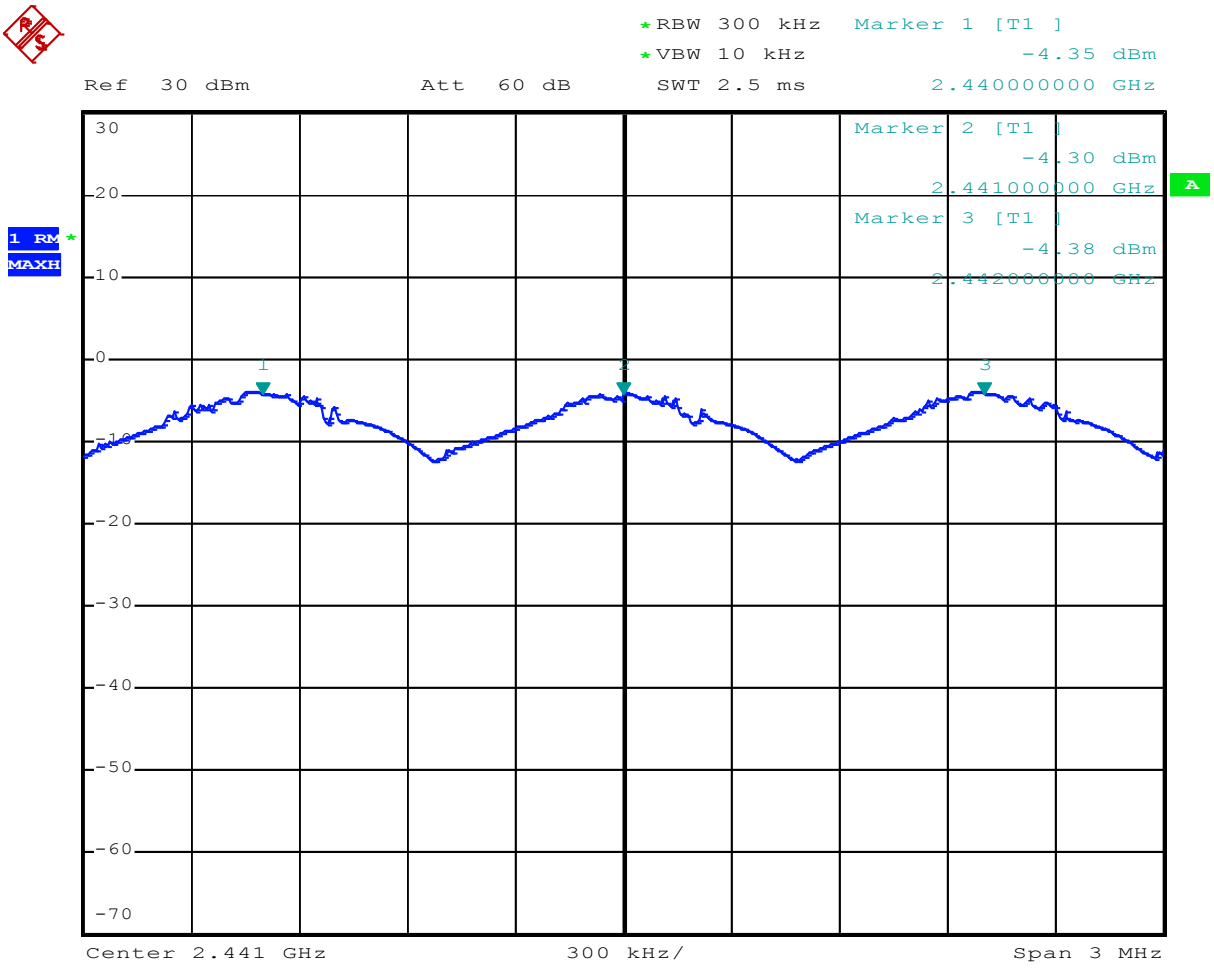
Operating Frequency [MHz]	20dB Bandwidth [kHz]	2/3xBandwidth [kHz]	Limit [kHz]
2402	1288	859	1000
2441	1288	859	1000
2480	1292	861	1000



Plot showing DH5 Carrier Frequency Separation of 1.000 MHz.



Plot showing 2DH5 Carrier Frequency Separation of 1.000 MHz.



Plot showing 3DH5 Carrier Frequency Separation of 1.000 MHz.

5.2.5 Lower Band Edge Conducted Emissions

RESULT: Pass

Date of testing: 2013-08-28

Requirements:

FCC 15.205, FCC 15.209, FCC 15.247(d)

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

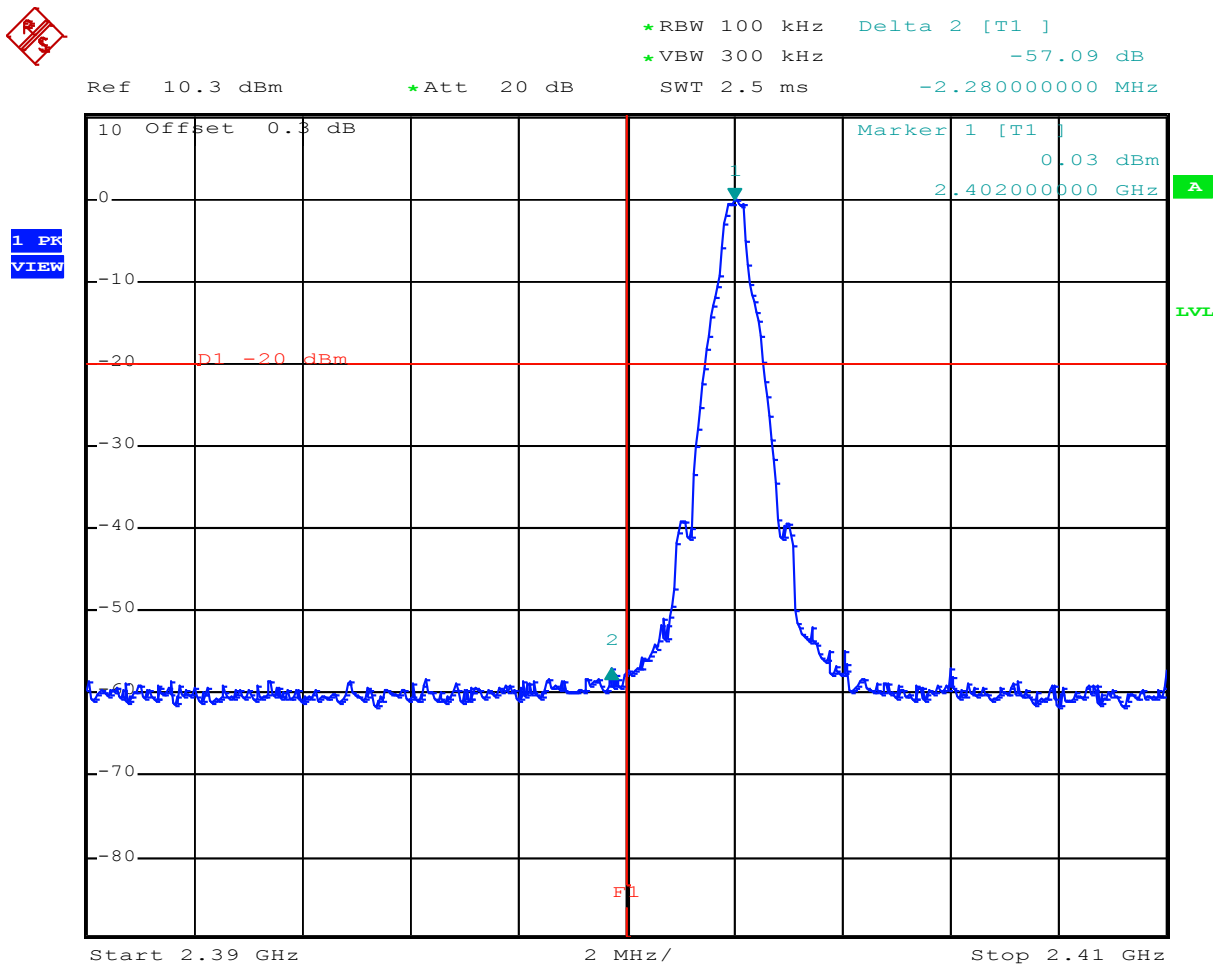
Test procedure: ANSI C63.10-2009

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.

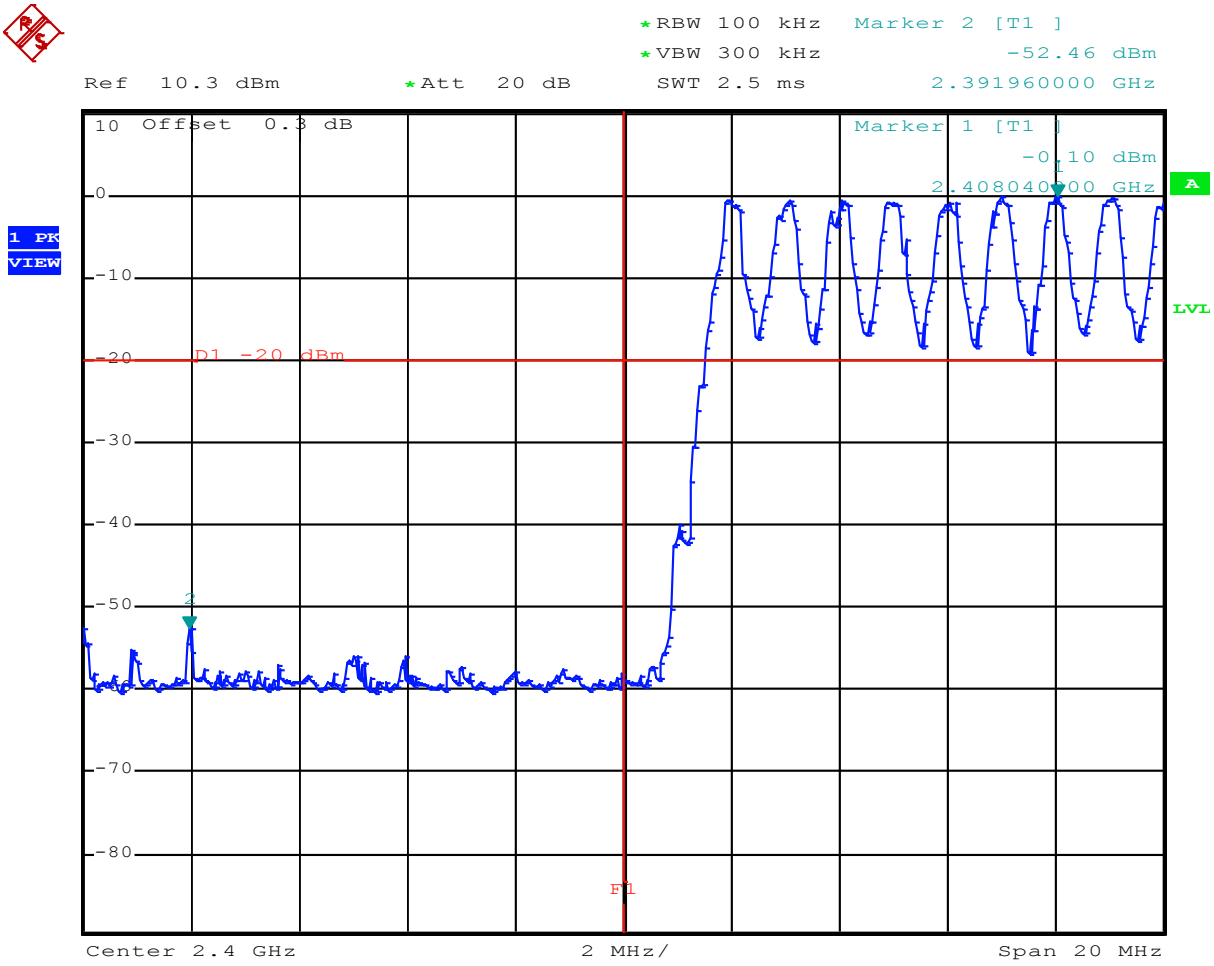
Results: All out of band spurious emissions are more than 20 dB below the fundamental.
See the figures on the following pages.

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



Date: 28.AUG.2013 15:33:22

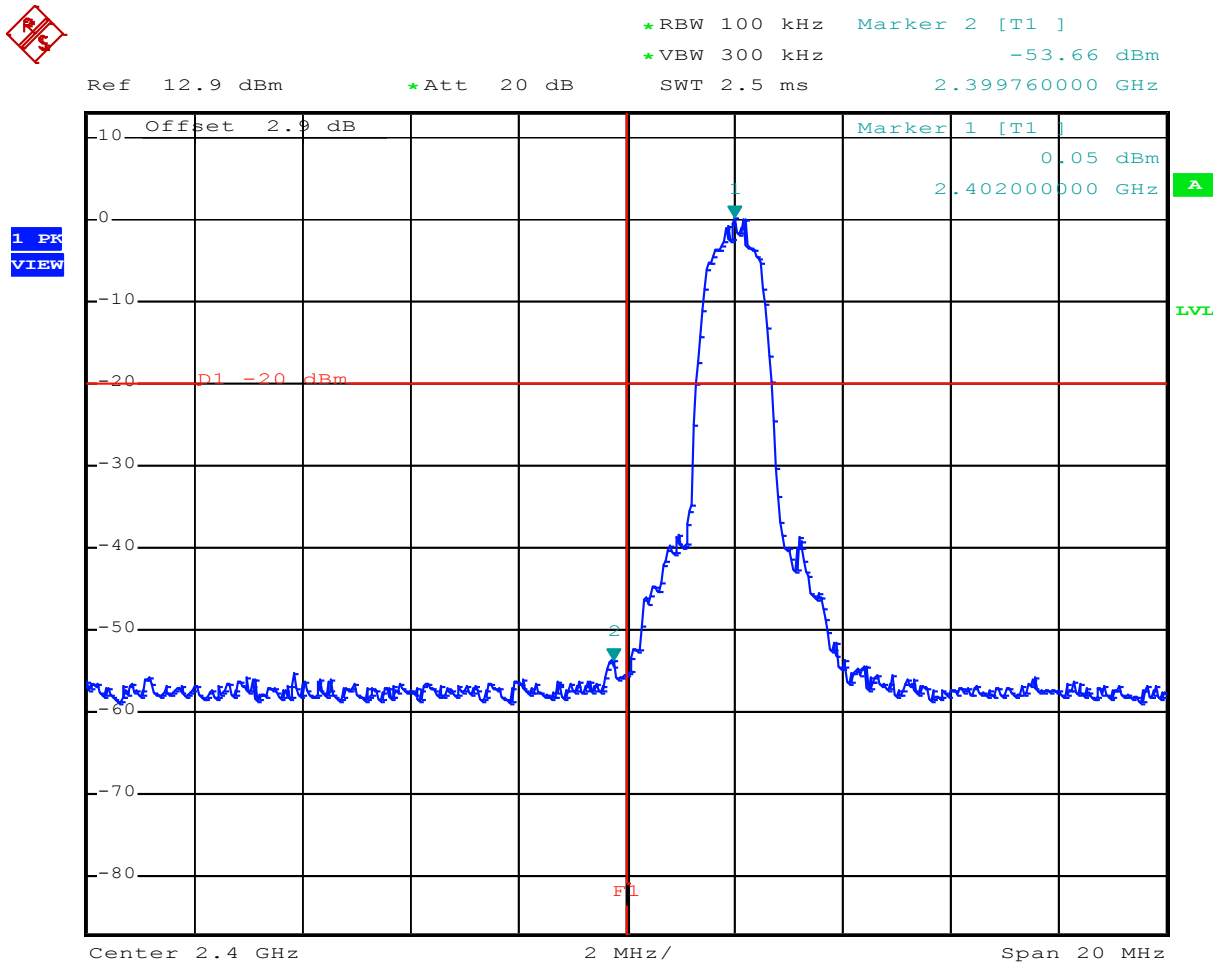
Band Edge Conducted Emission- Lower band edge, Hopping Off 2402 MHz-DH5



Date: 28.AUG.2013 15:37:49

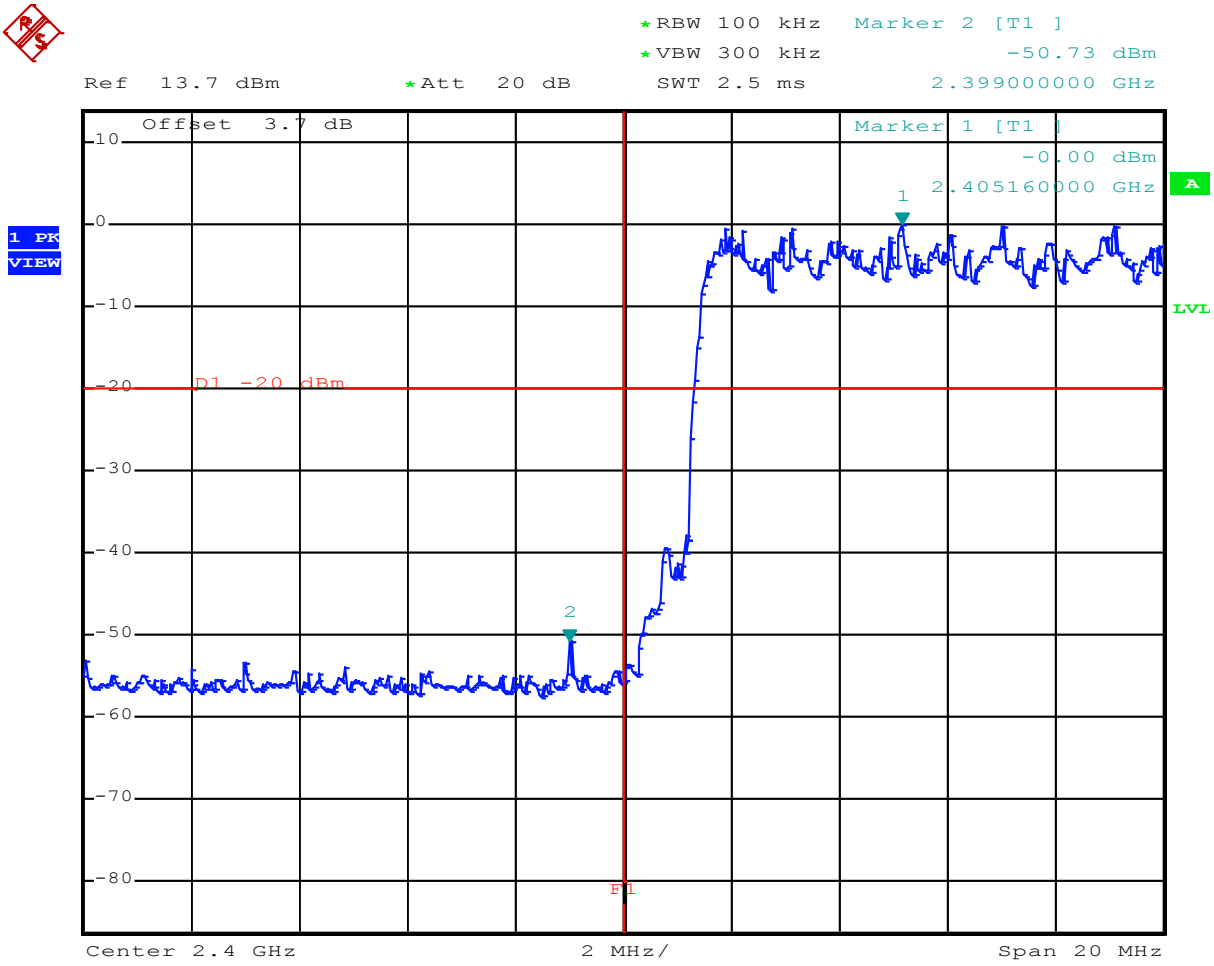
Band Edge Conducted Emission- Lower band edge, Hopping On 2402 MHz-DH5

Band Edge Conducted Emission- Lower band edge 2402 MHz-2DH5



Date: 28.AUG.2013 15:39:35

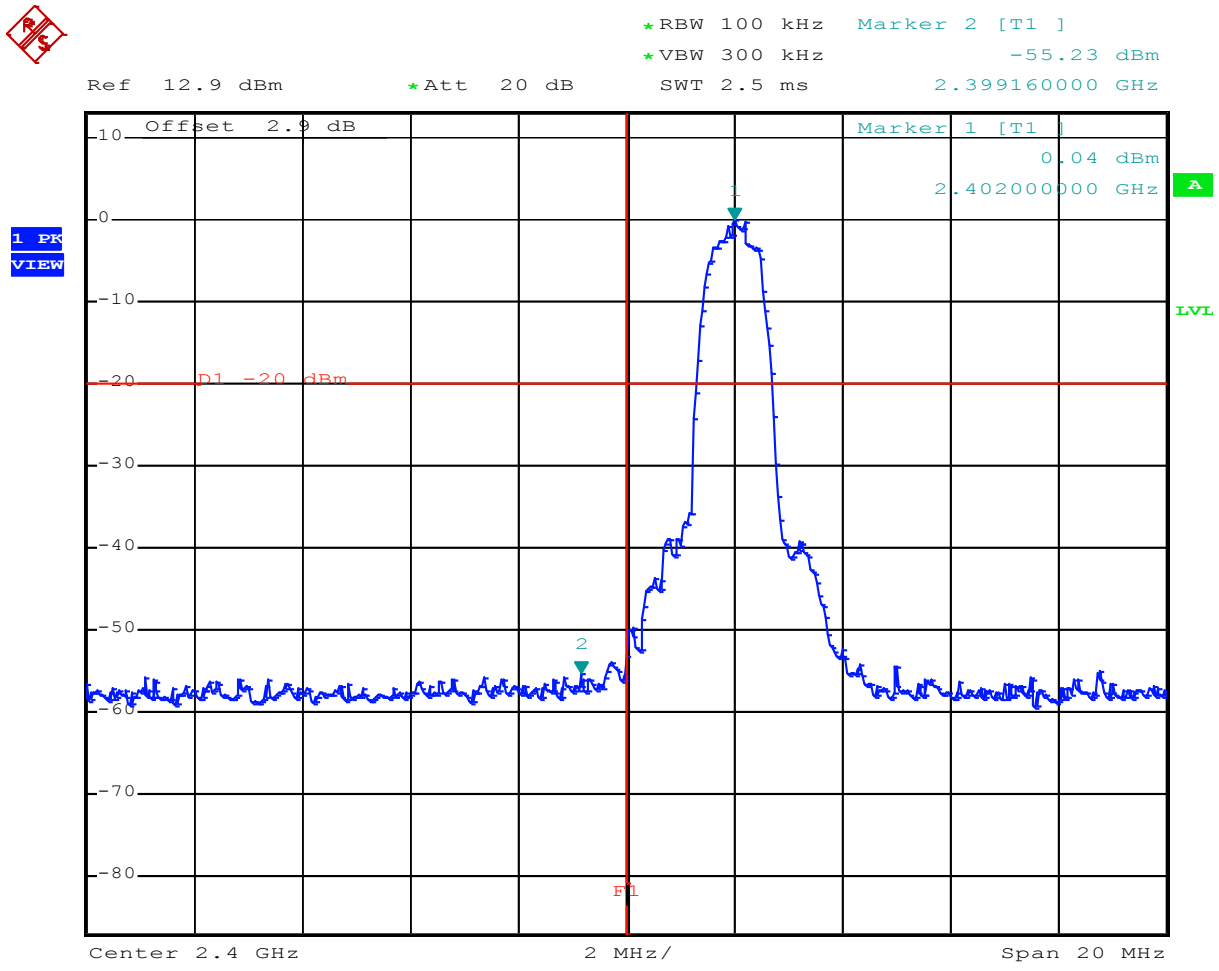
Band Edge Conducted Emission- Lower band edge, Hopping Off 2402 MHz-2DH5



Date: 28.AUG.2013 15:41:49

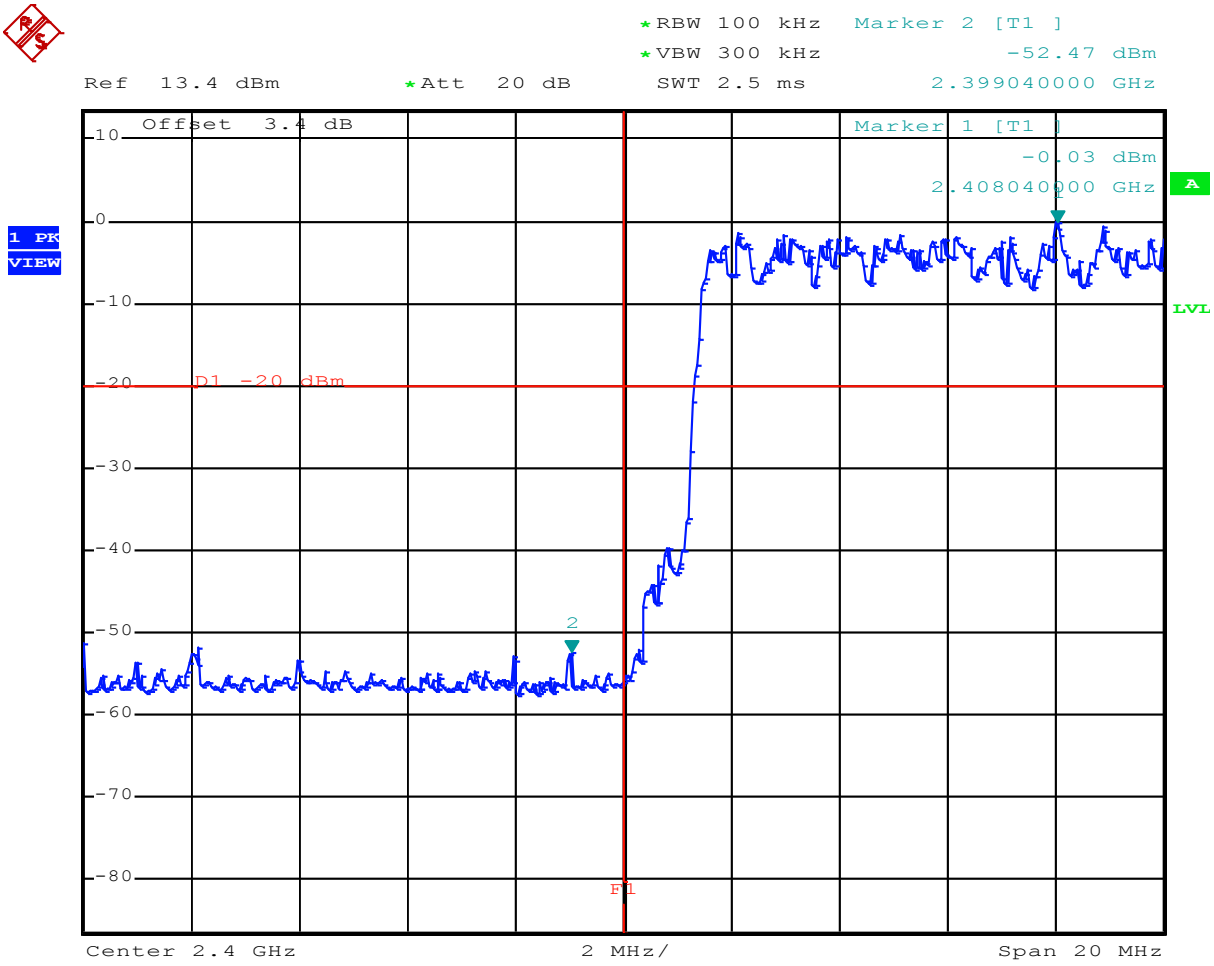
Band Edge Conducted Emission- Lower band edge, Hopping On 2402 MHz-2DH5

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



Date: 28.AUG.2013 15:43:48

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



Date: 28.AUG.2013 15:45:58

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

5.2.6 Band Edge Radiated Emissions in Restricted Bands

RESULT: Pass

Date of testing: 2013-08-28

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

Requirements:

FCC 15.205, FCC 15.209 and FCC 15.247(d)

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

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).

Test procedure: ANSI C63.10-2009.

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.

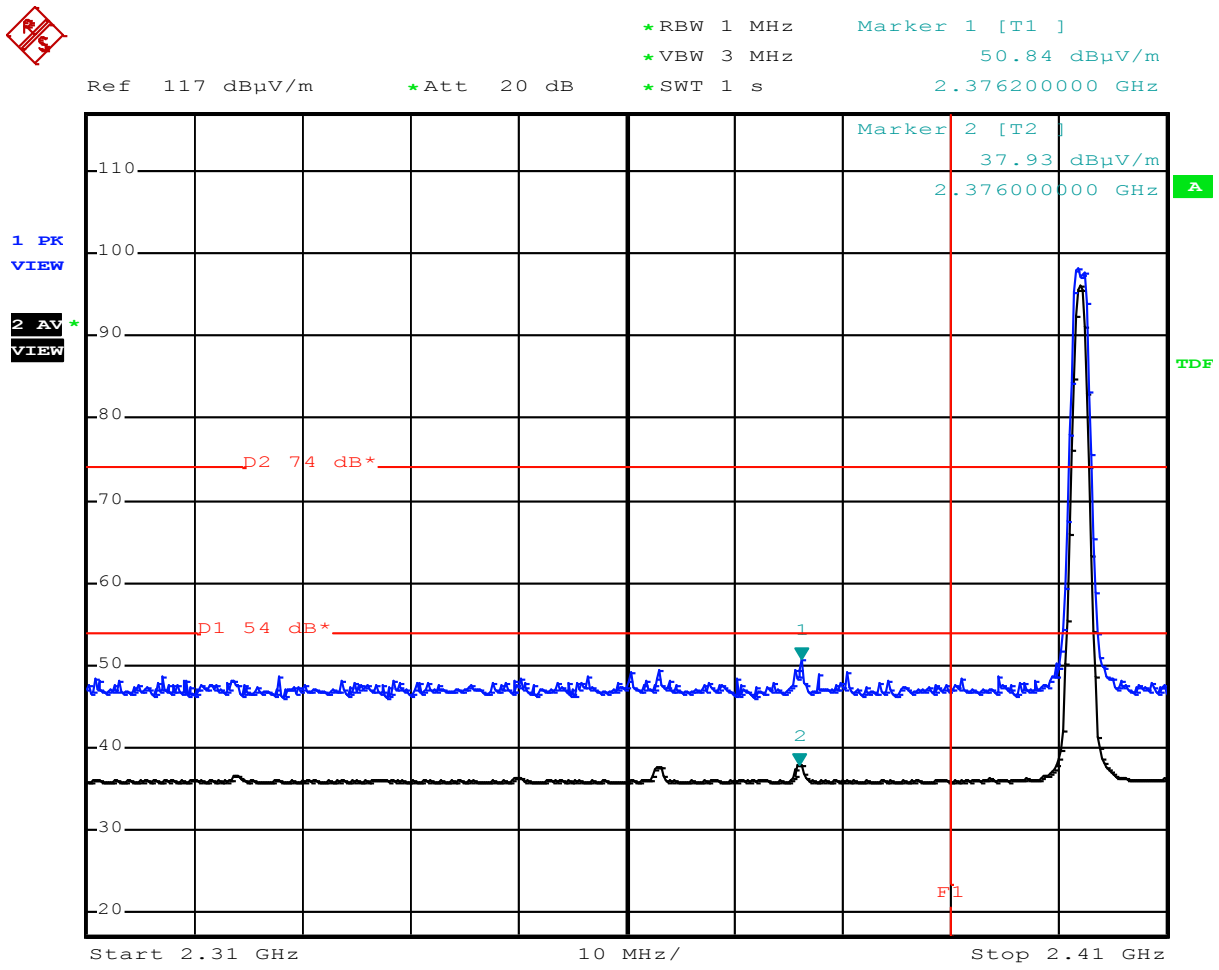
The spectrum was examined from 30MHz to the 10th harmonic of the highest fundamental transmitter frequency (25GHz). Final radiated emission measurements were made at 3m distance.

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.

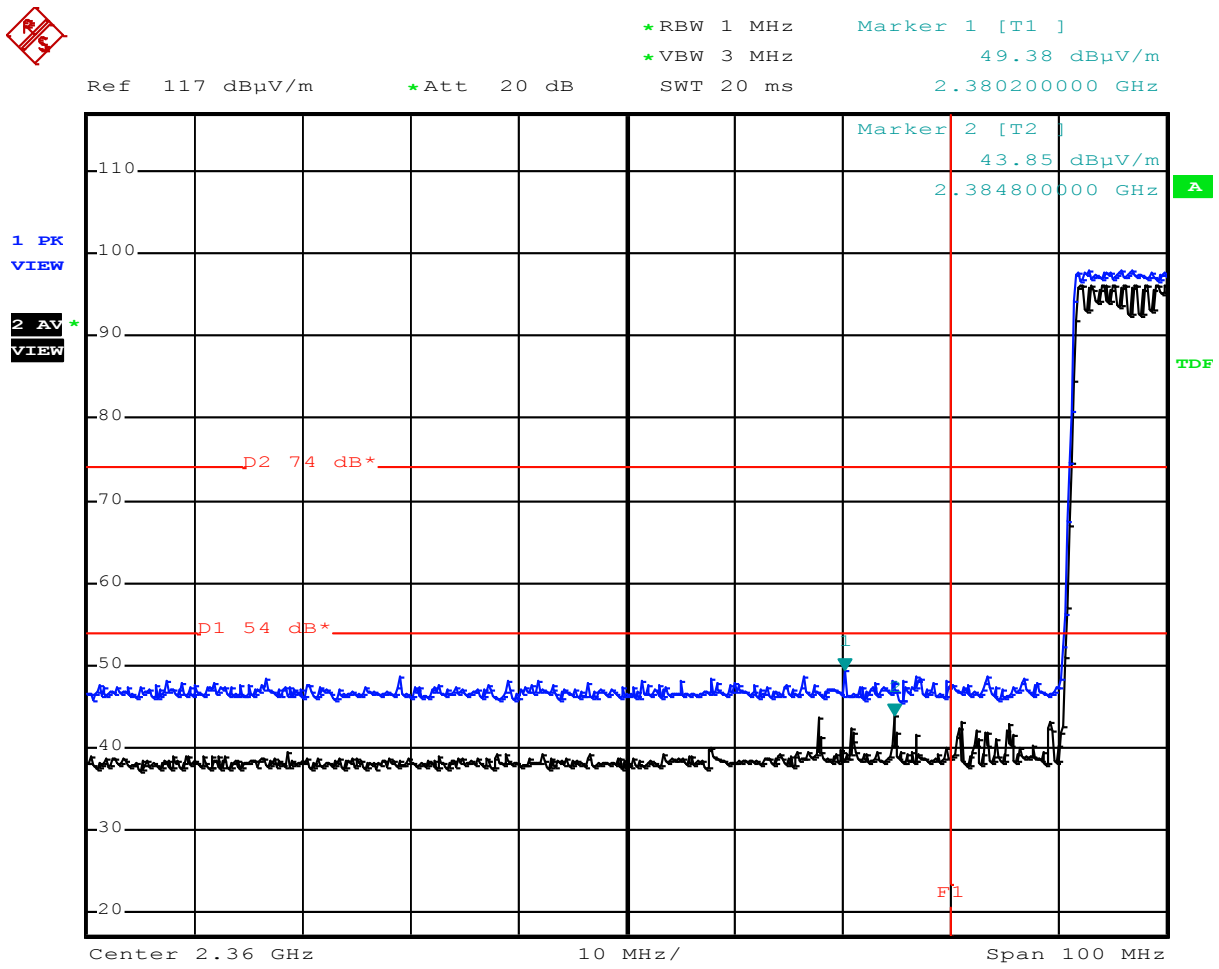
The highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

Correction factors are incorporated in the spectrum analyzers as an automated function.
Refer to section 4.2 for the power settings and modes.
Correction factors includes: antenna factor, cable loss and pre-amplifier gain.

5.2.6.1 Band Edge Radiated Emission- lower band edge 2402 MHz-DH5

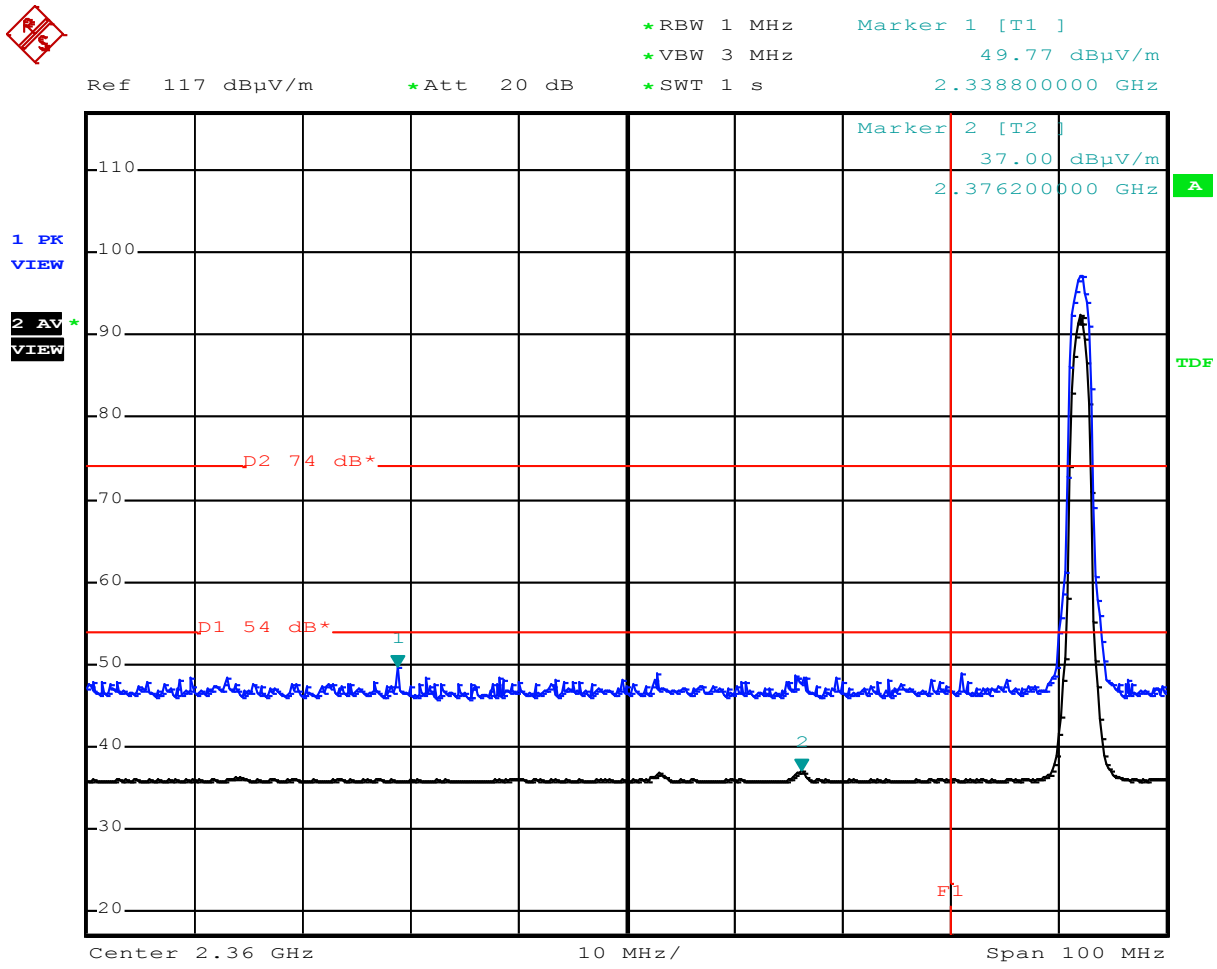


Band Edge Radiated Emission- lower band edge, Hopping Off 2402 MHz-DH5

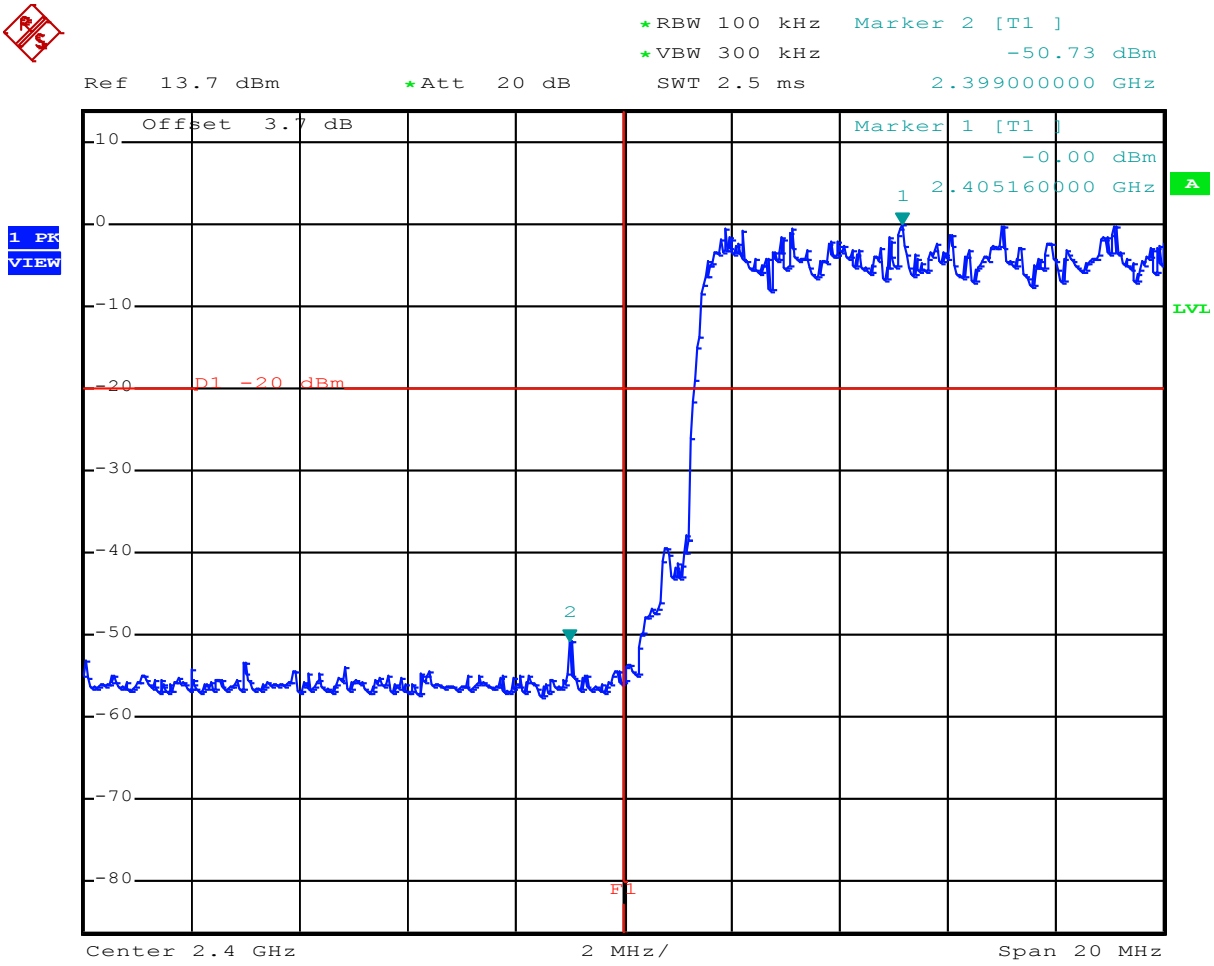


Band Edge Radiated Emission- lower band edge, Hopping On 2402 MHz-DH5

5.2.6.2 Band Edge Radiated Emission- lower band edge 2402 MHz-2DH5



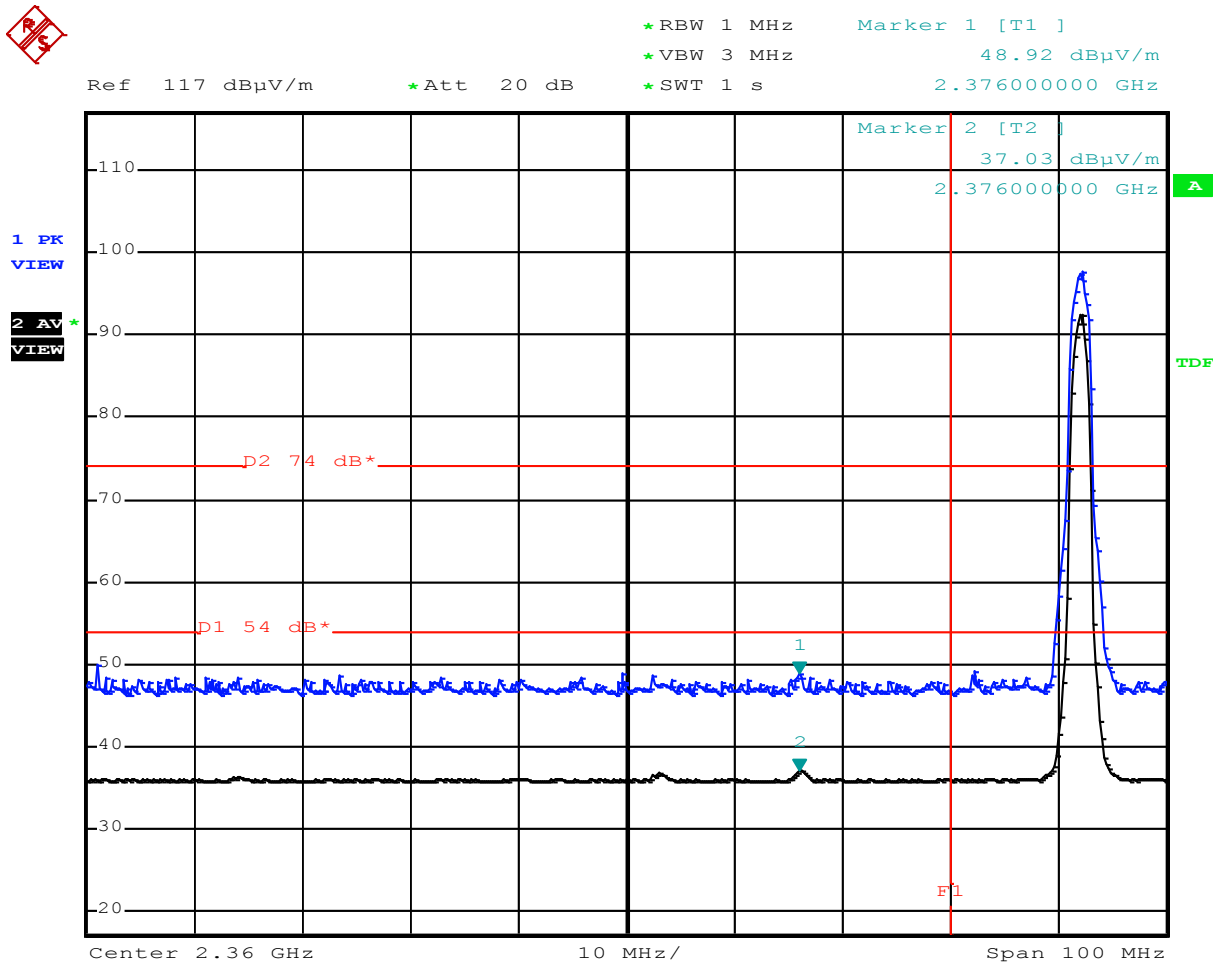
Band Edge Radiated Emission- lower band edge, Hopping Off 2402 MHz-2DH5



Date: 28.AUG.2013 15:41:49

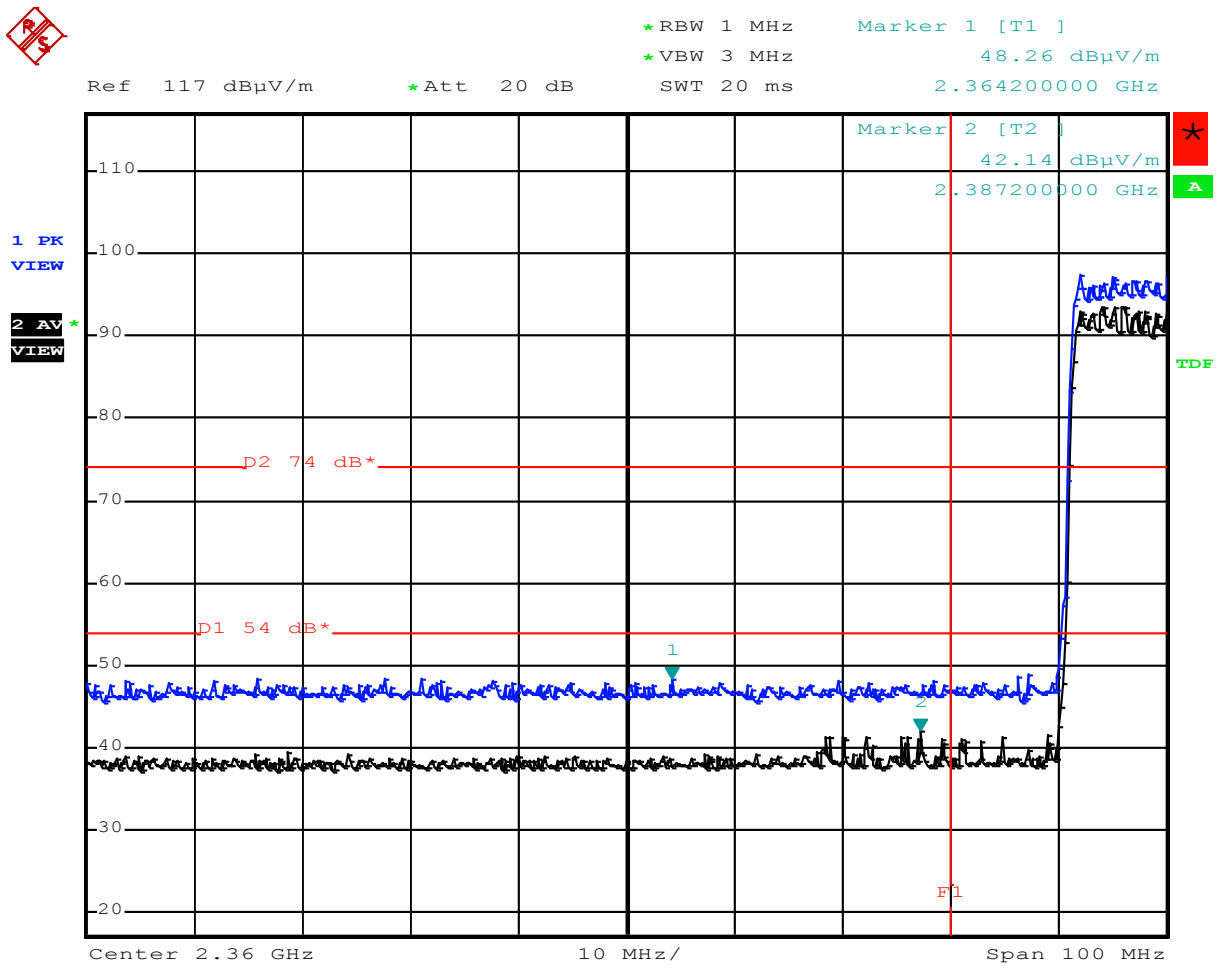
Band Edge Radiated Emission- lower band edge, Hopping On 2402 MHz-2DH5

5.2.6.3 Band Edge Radiated Emission- lower band edge 2402 MHz-3DH5



Date: 28.AUG.2013 14:41:08

Band Edge Radiated Emission- lower band edge, Hopping Off 2402 MHz-3DH5



Band Edge Radiated Emission- lower band edge, Hopping On 2402 MHz-3DH5

1.1 Spurious Emissions of Transmitter outside Restricted bands

RESULT: PASS

Date of testing: 2013-08-29

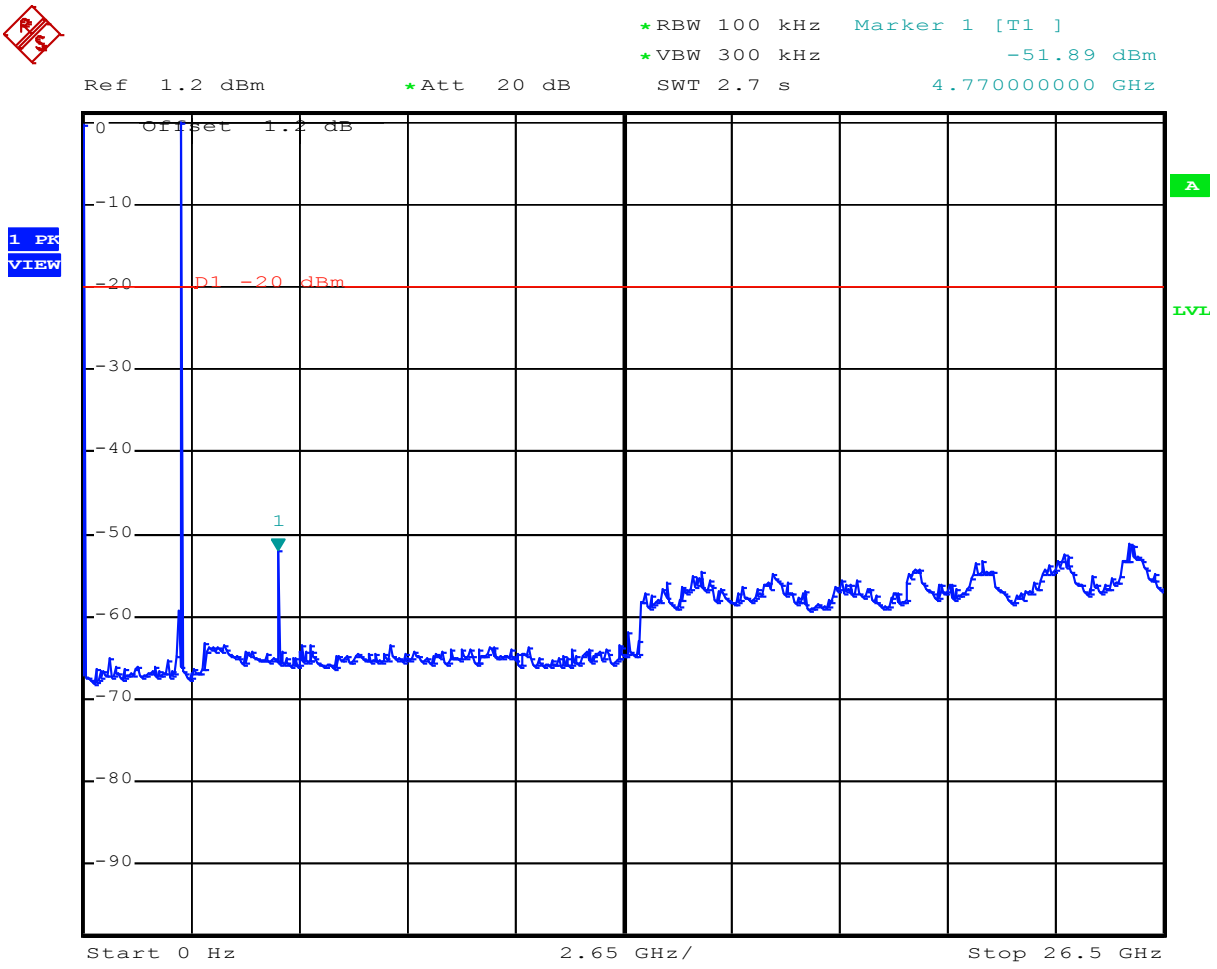
Frequency range: 30MHz - 25GHz

Requirements:

FCC 15.205, FCC 15.209 and FCC 15.247(d)

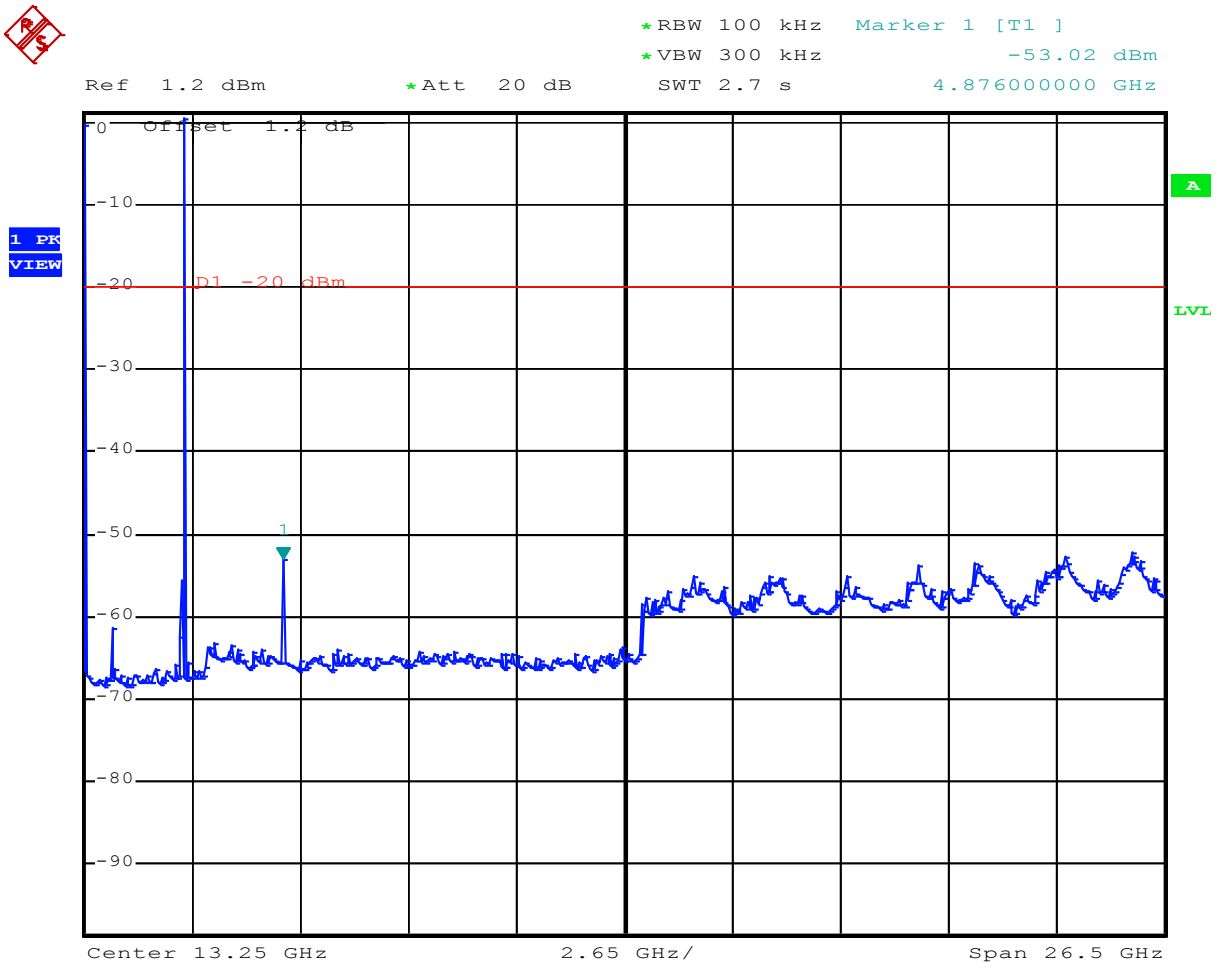
Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).

Test procedure: ANSI C63.10-2009.

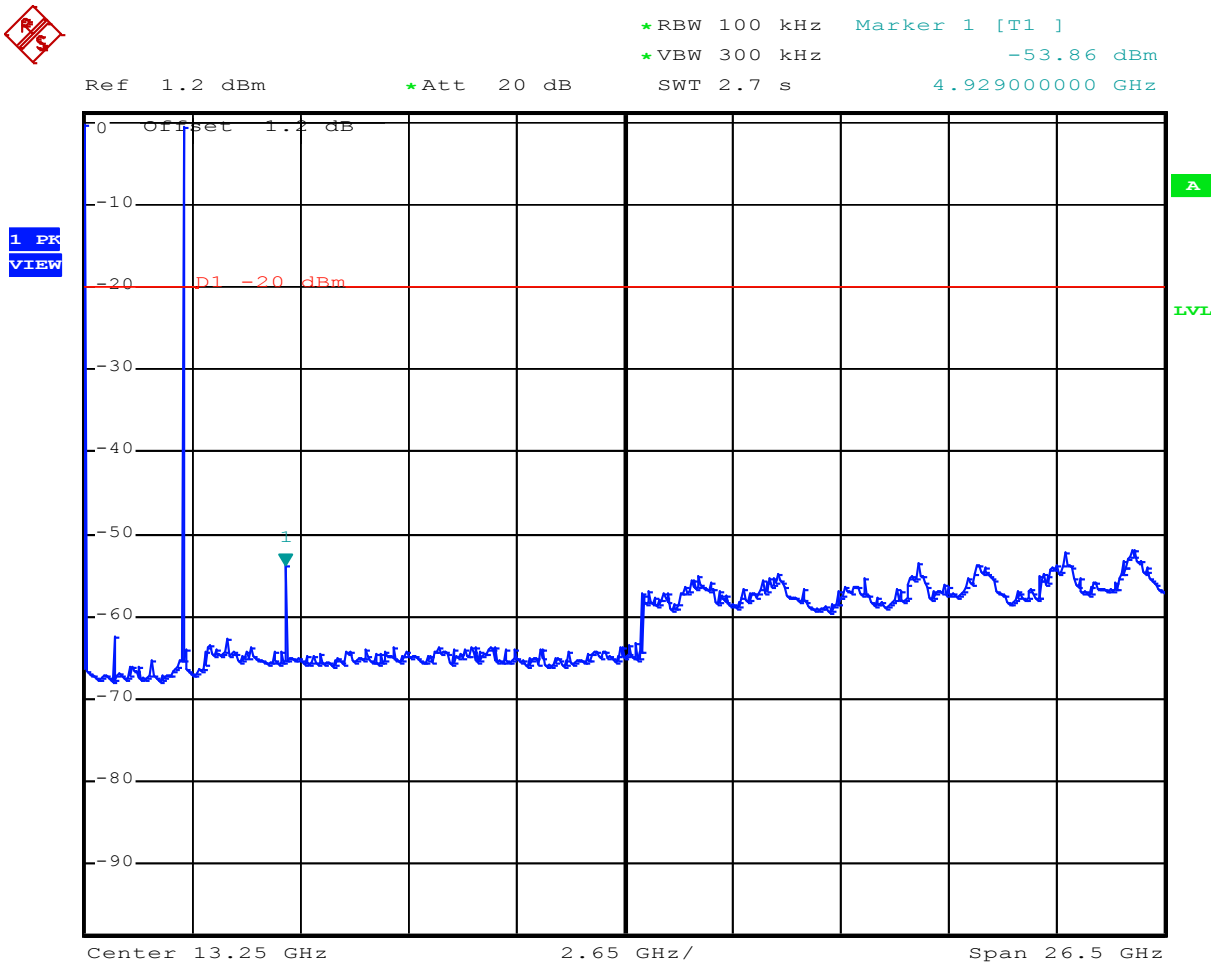


Date: 28.AUG.2013 16:23:23

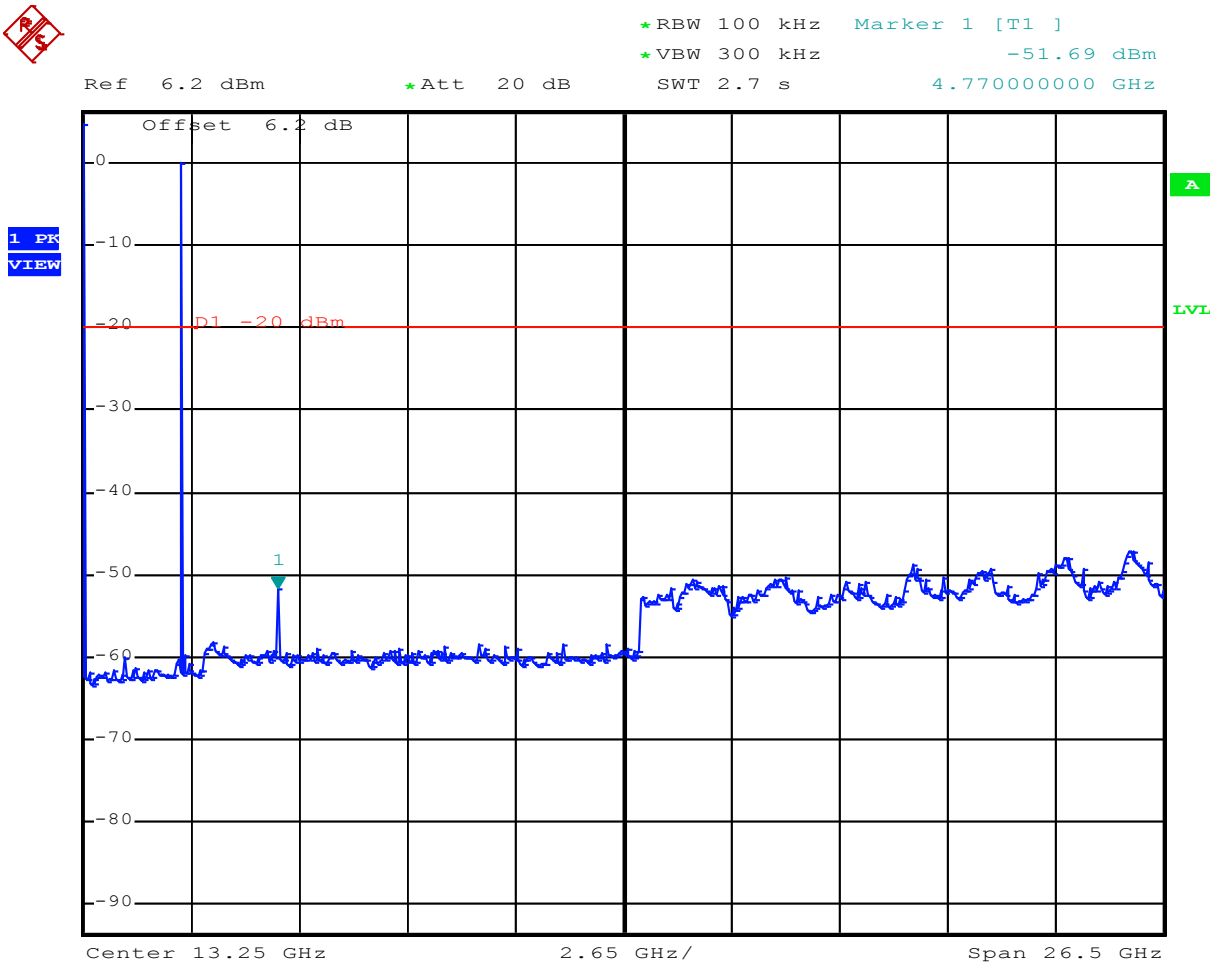
Spurious Emissions, 2402 MHz-DH5



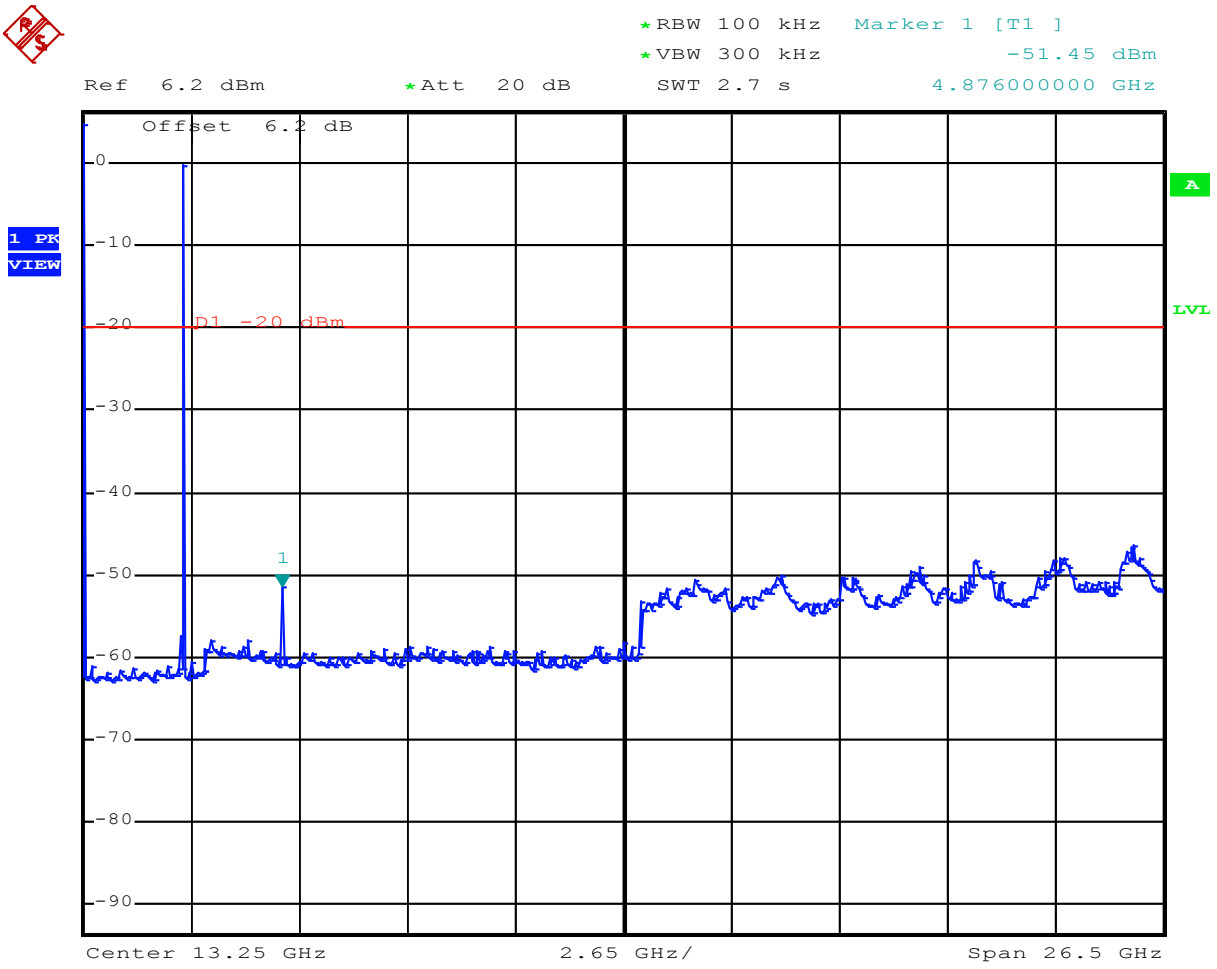
Spurious Emissions, 2441 MHz-DH5



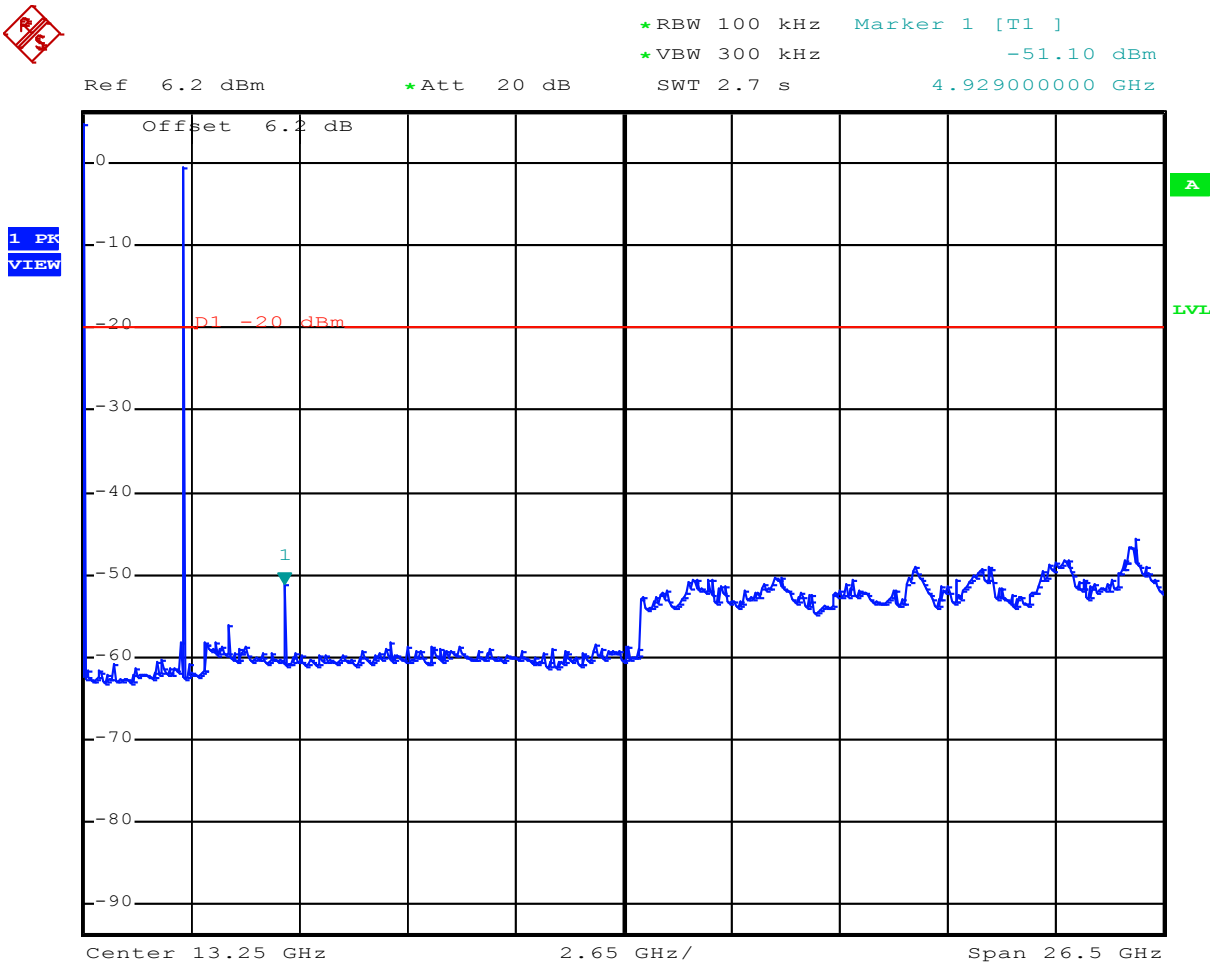
Spurious Emissions, 2480 MHz-DH5



Spurious Emissions, 2402 MHz-2DH5

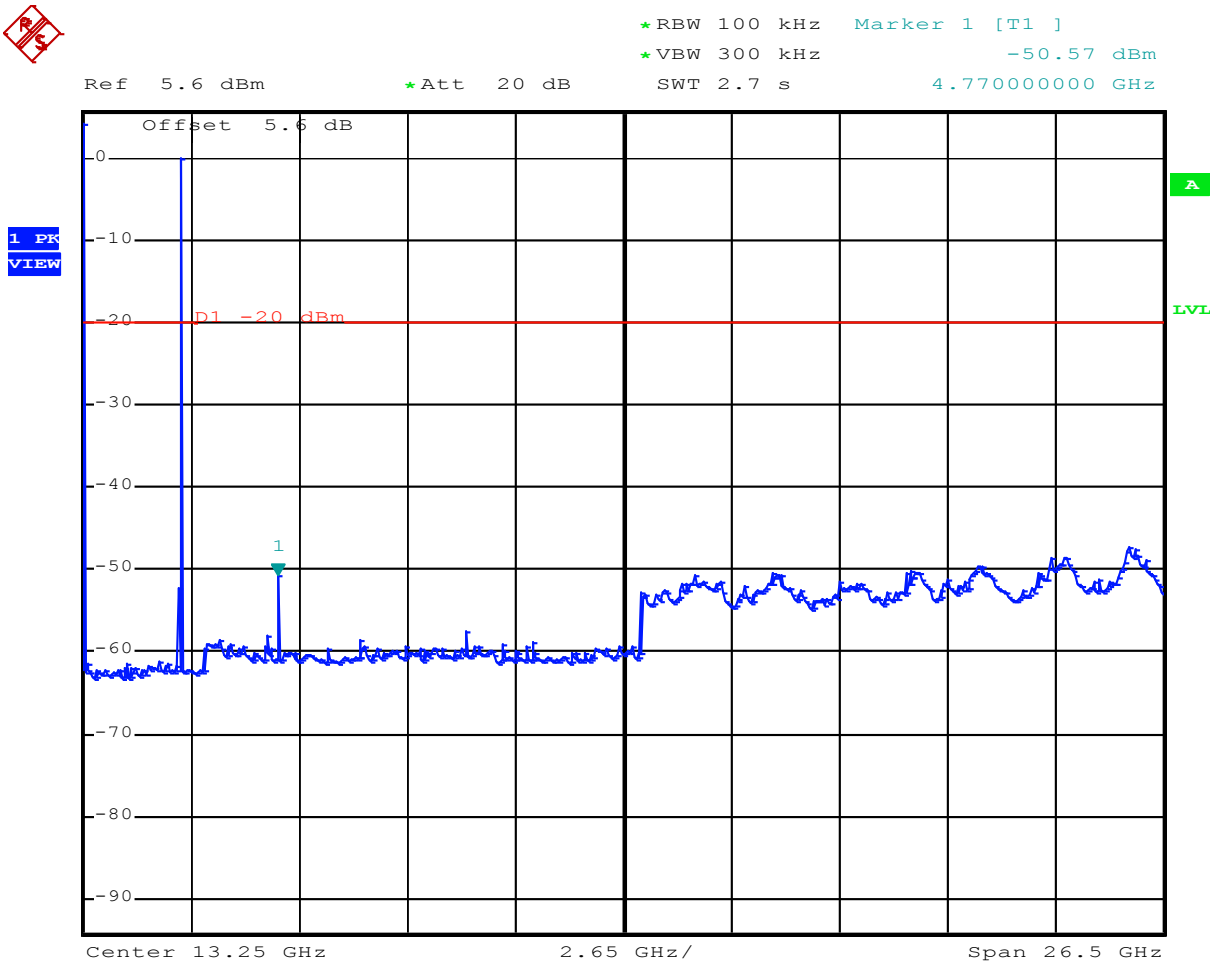


Spurious Emissions, 2441 MHz-2DH5



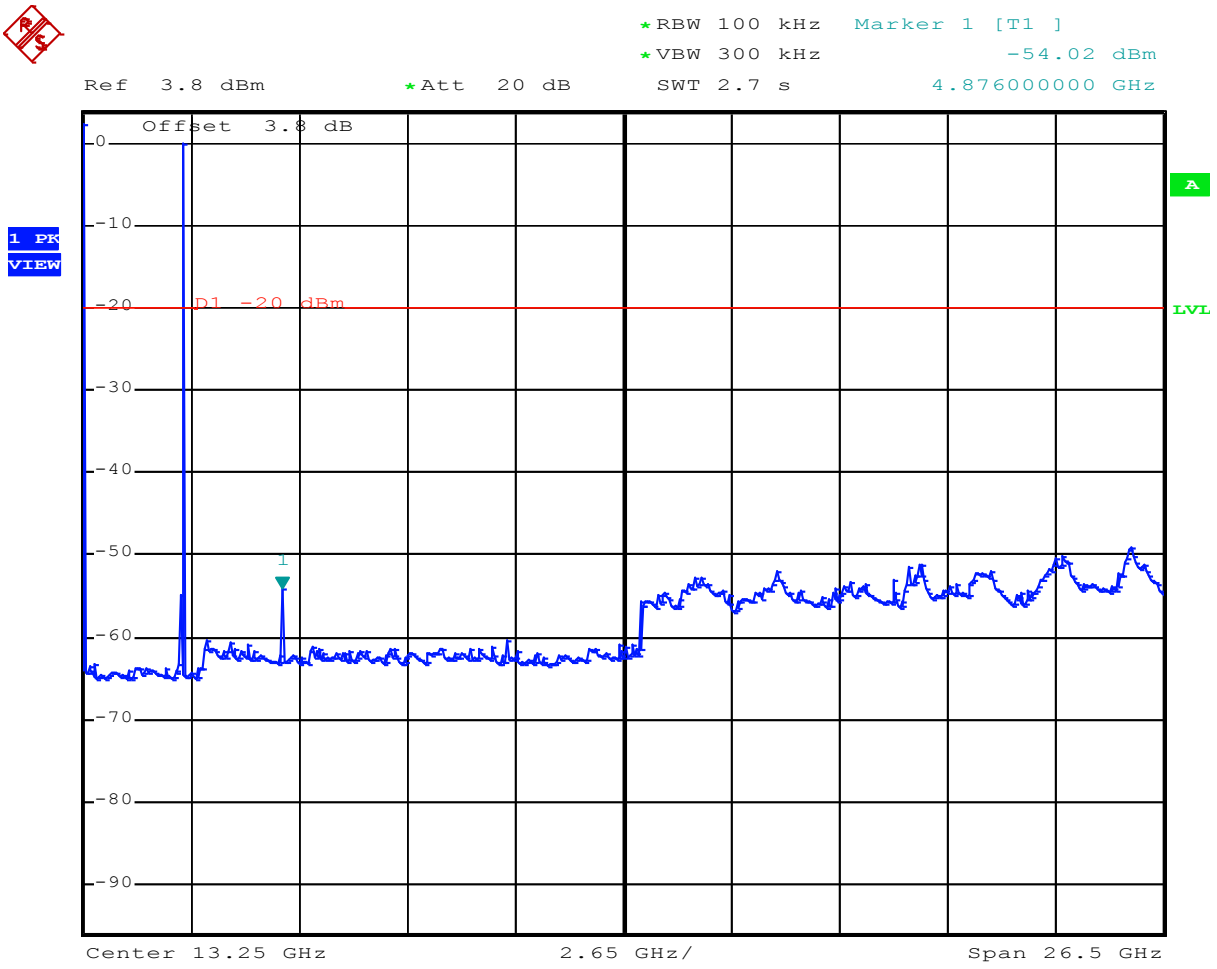
Date: 28.AUG.2013 16:29:43

Spurious Emissions, 2480 MHz-2DH5

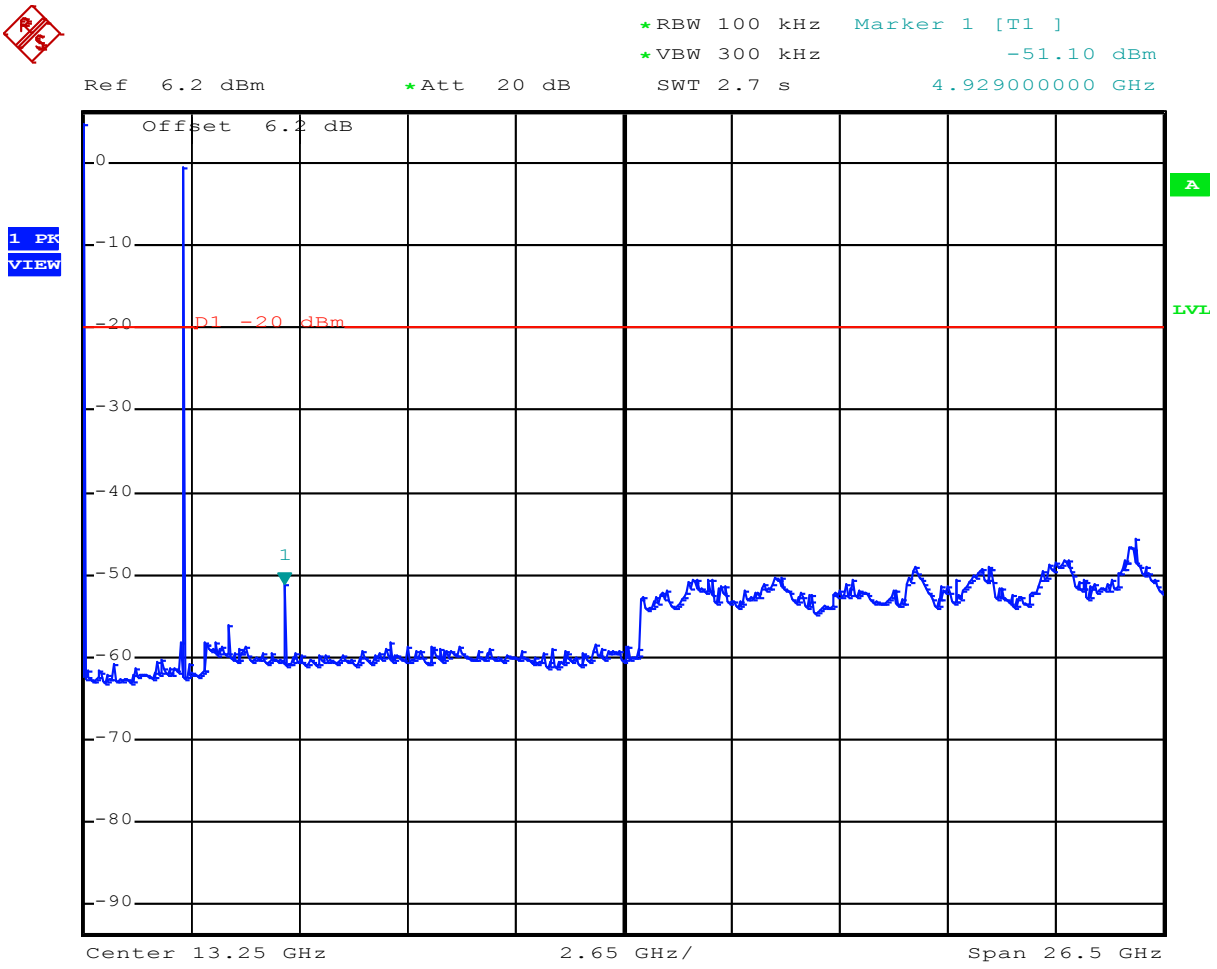


Date: 28.AUG.2013 16:31:48

Spurious Emissions, 2402 MHz-3DH5



Spurious Emissions, 2441 MHz-3DH5



Spurious Emissions, 2480 MHz-3DH5

5.2.7 Radiated Spurious Emissions of Transmitter in restricted bands

RESULT: PASS

Date of testing: 2013-08-29

Requirements:

FCC 15.205, FCC 15.209 and FCC 15.247(d)

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

Test procedure: ANSI C63.10-2009.

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

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 spectrum was examined from 4.5-5.15 GHz and 5.35-5.46 GHz. 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.

Correction factors are incorporated in the spectrum analyzers as an automated function.
Refer to section 4.2 for the power settings and modes.
Correction factors includes: antenna factor, cable loss and pre-amplifier gain.

Radiated Emission, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations

Freq. [MHz]	Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]
41.4	Vertical	16.7	12.9	29.6	40.0	10.4
75.3	Vertical	18.2	6.6	24.8	40.0	15.2
181.4	Horizontal	16.6	9.8	26.4	43.5	17.1
336.0	Vertical	14.1	15.6	29.7	46.0	16.3
432.0	Vertical	12.3	18.7	31.0	46.0	15.0
494.0	Vertical	4.0	20.7	24.7	46.0	21.3
648.0	Vertical	-1.3	22.6	21.0	46.0	25.0

Note: - Level QP = Reading QP + Factor
- Tested in modes as described in section 4.2, highest values noted.
- Quasi Peak detector used with a bandwidth of 120 kHz
- None of the emission components could be related to the EUT

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2402 MHz – DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804	Vertical	Pk	39.5	54.0	-14.5
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz.

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2441 MHz – DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882	Vertical	Pk	40.3	54.0	-13.7
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2480 MHz – DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960	Horizontal	Pk	46.8	54.0	-7.2
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz.

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2402 MHz – 2DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804	Vertical	Pk	38.2	54.0	-15.8
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz.

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2441 MHz – 2DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882	Vertical	Pk	39.8	54.0	-14.2
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2480 MHz – 2DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960	Horizontal	Pk	46.3	54.0	-7.7
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz.

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2402 MHz – 3DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804	Vertical	Pk	38.5	54.0	-15.5
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz.

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2441 MHz – 3DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882	Vertical	Pk	39.1	54.0	-14.9
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz

Radiated Emission, 1 GHz - 25GHz, Horizontal and Vertical Antenna Orientations, 2480 MHz – 3DH5

Freq. [MHz]	Antenna Orientation	Detector	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960	Horizontal	Pk	45.0	54.0	-9.0
0-26500 Others	Horizontal/ Vertical	Pk	<34.0	54.0	<-20.0

Note: - Peak (Pk) value already within Average (Av) limits, therefor Av not retested.
- Peak detector used with a bandwidth of 1 MHz.

5.3 Spurious emissions in receive mode

RESULT: Pass

Date of testing: 2013-08-29

Requirements: FCC 15.109

Radiated emissions from receiver shall not exceed the radiated limits in the table below.

Freq. [MHz]	Detector	Measurement Bandwidth	Limit [dBµV/m]
30 – 88	Qp	120 kHz	40.0
88 – 216	Qp	120 kHz	43.5
216 – 960	Qp	120 kHz	46.0
Above 916	Av	1 MHz	54.0

Test procedure: ANSI C63.10-2009

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 spectrum was examined from 30 MHz to 7500 MHz. 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 6 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.
Correction factors are incorporated in the spectrum analyzers as an automated function.
Correction factors includes: antenna factor, cable loss and pre-amplifier gain.

Results:

Orientations

Freq. [MHz]	Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]
41.4	Vertical	16.7	12.9	29.6	40.0	10.4
75.3	Vertical	18.2	6.6	24.8	40.0	15.2
181.4	Horizontal	16.6	9.8	26.4	43.5	17.1
336.0	Vertical	14.1	15.6	29.7	46.0	16.3
432.0	Vertical	12.3	18.7	31.0	46.0	15.0
494.0	Vertical	4.0	20.7	24.7	46.0	21.3
648.0	Vertical	-1.3	22.6	21.0	46.0	25.0

Note: - Level QP = Reading QP + Factor
- Tested in modes as described in section 4.2, highest values noted.
- Quasi Peak detector used with a bandwidth of 120 kHz
- None of the emission components could be related to the EUT

5.4 AC Power Line Conducted Measurements

5.4.1 AC Power Line Conducted Emission of Transmitter

AC power line conducted emissions are included in the Part 15B testreport. Refer to documentnumber 13080601.fcc02.pdf

End of report