TÜVRheinland®

Produkte
Products

Prüfbericht - Nr.: *Test Report No.:*	**50036571 002**	**Seite 1 von 80** *Page 1 of 80*
Auftraggeber: *Client:*	**Kpnetworks Ltd.** 4-5-11 10F Shiba Minato-ku, Tokyo 108-0014, Japan	
Gegenstand der Prüfung: *Test Item:*	**Gateway Board**	
Bezeichnung: *Identification:*	**ISH-1101-003**	**Serien-Nr.:** *Serial No.:* **001, 002**
Wareneingangs-Nr.: *Receipt No.:*	**A000310587**	**Eingangsdatum:** *Date of Receipt:* **2016-01-12**
Zustand des Prüfgegenstandes bei Anlieferung: *Condition of Test Item at Delivery:*	**Good**	
Prüfort: *Testing Location:*	**TÜV Rheinland Japan Ltd. – Global Technology Assessment Center** 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan	
Prüfgrundlage: *Test Specification:*	**FCC 47 CFR Part 15, Subpart C, Section 15.247 (October 1, 2015)** **RSS-247 (Issue 1): 2015** **RSS-Gen (Issue 4): 2014** ANSI C63.10-2013	
Prüfergebnis: *Test Result:*	**Der Prüfgegenstand entspricht oben genannter Prüfgrundlage(n).** *The test item passed the test specification(s).*	
Prüflaboratorium: *Testing Laboratory:*	**TÜV Rheinland Japan Ltd. – Global Technology Assessment Center** 4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan	

geprüft/ *tested by:*			**kontrolliert/** *reviewed by:*		
2016-03-10	A. Abe / Inspector		2016-03-10	R. Meiranke / Reviewer	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges / *Other Aspects:*

This test report covers only aspects related to 2.4GHz Bluetooth function of the EUT.

Abkürzungen:				*Abbreviations:*			
P(ass)	=	*entspricht Prüfgrundlage*		*P(ass)*	=	*passed*	
F(ail)	=	*entspricht nicht Prüfgrundlage*		*F(ail)*	=	*failed*	
N/A	=	*nicht anwendbar*		*N/A*	=	*not applicable*	
N/T	=	*nicht getestet*		*N/T*	=	*not tested*	

TEST SUMMARY

5.1.1 SUPPLY VOLTAGE REQUIREMENTS
RESULT: PASS

5.1.2 ANTENNA REQUIREMENTS
RESULT: PASS

5.1.3 RESTRICTED BANDS OF OPERATION
RESULT: PASS

5.2.1 CONDUCTED OUTPUT POWER
RESULT: PASS

5.2.2 CARRIER FREQUENCY SEPARATION
RESULT: PASS

5.2.3 20DB BANDWIDTH

5.2.4 99% BANDWIDTH

5.2.5 NUMBER OF HOPPING FREQUENCIES
RESULT: PASS

5.2.6 AVERAGE TIME OF OCCUPANCY
RESULT: PASS

5.2.7 CONDUCTED SPURIOUS EMISSIONS
RESULT: PASS

5.3.1 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER
RESULT: PASS

5.4.1 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

TÜV Rheinland Japan Ltd. – Global Technology Assessment Center
4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The Federal Communications Commission has reviewed the technical characteristics of the radiated and conducted emission facilities and has found these test sites to be in compliance with the requirements of section 2.948 of the FCC rules. The description of the test facility is listed under FCC registration number 299054.

The Industry Canada has reviewed the technical characteristics of the radiated and conducted emission facilities and has found these test sites to be in compliance with Canadian requirements. The description of the test facility is listed under OATS filing number 3466B-1.

The test facility is accredited by VLAC (member of ILAC) under number VLAC-017 according to ISO/IEC 17025:2005.

ilac-MRA VLAC Lab Accreditation VLAC-017

TÜV Rheinland Japan Ltd. is accredited by the Federal Communications Commission as a Conformity Assessment Body under Designation Number JP0017 and Test Firm Registration Number 386498.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equipment ID	Calibrated until
For Antenna Port Conducted Emission					
Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	2016-03
RF Power Meter	Agilent	N1911A	MY45101737	RF-0393	2016-10
RF Peak Power Sensor	Agilent	N1921A	MY45242228	RF-0394	2016-10
For AC Power Line Conducted Emission					
Conducted Emission Measurement Software	Toyo Corporation	EP5/CE	Ver. 5.0.20	RF-0025	2016-01
Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	2016-03
LISN	Rohde & Schwarz	ENV216	100276	RF-0016	2016-05
LISN	Rohde & Schwarz	ENV216	101958	RF-0708	2016-09
For Radiated Emission					
Radiated Emission Measurement Soft-ware (below 30MHz)	Toyo Corporation	EP5/ME	Ver. 5.0.10	RF-0172	2017-02
Radiated Emission Measurement Soft-ware (above 30MHz)	Toyo Corporation	EP7/RE	Ver. 5.0.2	RF-0026	2017-02
Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	2016-08
Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	2016-03
RF Selector (10m Chamber)	Toyo Corporation	NS4900	0703-182	RF-0029	2017-02
Loop Antenna with Amplifier, 9kHz-30MHz	Rohde & Schwarz	HFH2-Z2	100139	RF-0048	2016-05
Trilog Antenna No. 2, 30-1000MHz	Schwarzbeck	VULB9168	9168-475	RF-0462	2016-10
Biconical Antenna, 30-300MHz	EMCO	3110B	9603-2379	RF-0207	2016-08
10dB Attenuator	Hewlett Packard	8491A 10dB	58354	RF-0314	2017-01
Low Noise Preamplifier, 9kHz-1GHz	TSJ	MLA-10K01-B01-35	1370750	RF-0253	2017-02
Low Pass Filter, DC-1GHz	R&K	LP1000CH3	12104001	RF-0515	2017-02
Horn Antenna, 1-8GHz	Schwarzbeck	BBHA9120D	1059	RF-0553	2016-06
Microwave Preamplifier, 1-8GHz	Toyo Corporation	TPA0108-40	0634	RF-0052	2017-02
Band Reject Filter, 1-8GHz	Nitsuki	NF-49BT	027	RF-0131	2017-02
Horn Antenna with Preamplifier, 8-18GHz	Toyo Corporation	HAP06-18W	00000025	RF-0065	2016-07

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equipment ID	Calibrated until
High Pass Filter, 8-18GHz	Micro-Tronics	HPM50107	006	RF-0334	2016-07
Horn Antenna with Preamplifier, 18-26.5GHz	Toyo Corporation	HAP18-26N	00000010	RF-0070	2016-07
Constant Voltage Constant Frequency Stabilizers and Power Accessories					
CVCF (Shielded Room)	NF Corporation	ES2000S	9075612	RF-0210	N/A
CVCF Booster (Shielded Room)	NF Corporation	ES2000B	9074403	RF-0211	N/A
CVCF (10m Chamber)	NF Corporation	ES2000U	9067307	RF-0212	N/A
CVCF Booster (10m Chamber)	NF Corporation	ES2000B	9074408	RF-0213	N/A
True RMS Multimeter	Fluke	87V	97680445	RF-0281	2017-02

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
AC Power Line Conducted Emission	150kHz - 30MHz	±2.0dB
Antenna Port Conducted Emission	20Hz - 40GHz	±1.5dB
Radiated Emission	150kHz - 30MHz	±4.7dB
	30MHz - 1GHz	±4.7dB
	> 1GHz	±4.7dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT (Equipment Under Test) is a printed circuit board that has two types of unlicensed transmitters 2.4GHz Wireless LAN and Bluetooth. In additions, the EUT incorporates one certified M2M module. Consequently, 3G communication and GPS receiving functions are also available. Since the EUT will be incorporated into other host equipment, the EUT does not have any enclosure **(*)**. These hosts are used in an industrial environment such as monitoring system for photovoltaic panels at outdoor environment.

Note:

(*) The Wi-Fi and Bluetooth transmitters of this EUT do **not** have their own shielding.

3.2 System Details

Radio standard:	Bluetooth Ver. 4.0 **(*)**
Output power:	-0.82dBm at Peak
Antenna gain:	2.1dBi **(**)**
Antenna type:	Chip Antenna
Antenna mounting type:	On board
Frequency range:	2402 - 2480MHz
Number of channels:	79
Channel spacing:	1MHz
Modulation type:	FHSS coupled with GFSK (1Mbps), π/4-DQPSK (2Mbps) and 8DPSK (3Mbps)
FCC classification:	DSS (Spread Spectrum Transmitter)
IC classification:	Bluetooth Device
Emission designator:	F1D (GFSK) and G1D (π/4-DQPSK & 8DPSK)
Rated voltage:	DC 5V
Rated current:	Maximum 2.15A
Protection class:	III
Test voltage:	AC 120V (representative AC/DC adapter)
Test frequency:	60Hz

Note:

(*) The EUT does **not** support Bluetooth Low Energy by the specifications.

(**) The chip antenna is shared by wireless LAN and Bluetooth communications. However, wireless LAN and Bluetooth do not transmit simultaneously by the specifications.

3.3 Clock Frequencies

The highest frequency generated or used by the EUT is 800MHz for the digital interface.

3.4 Noise Suppressing Parts

Refer to schematics.

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.

The test methods, which have been used, are based on ANSI C63.10-2013 and RSS-Gen (Issue 4).

For details, see under each test item.

4.2 Operation Modes

Testing was performed at the lowest operating frequency (2402MHz), at the operating frequency in the middle of the specified frequency band (2440MHz) and at the highest operating frequency (2480MHz).

The basic operation modes used for testing are:

A. EUT transmits (TX mode), with full power, at lowest channel (2402MHz), a continuous modulated signal streaming with highest duty cycle.

B. EUT transmits (TX mode), with full power, at middle channel (2440MHz), a continuous modulated signal streaming with highest duty cycle.

C. EUT transmits (TX mode), with full power, at highest channel (2480MHz), a continuous modulated signal streaming with highest duty cycle.

D. EUT transmits on pseudo-random sequence on all channels (hopping mode).

Following configurations were tested.

1: BDR - 1Mbps data rate (modulation: GFSK)
2: EDR - worst case of following data rate:
2a: 2Mbps data rate (modulation: π/4-DQPSK)
2b: 3Mbps data rate (modulation: 8DPSK)

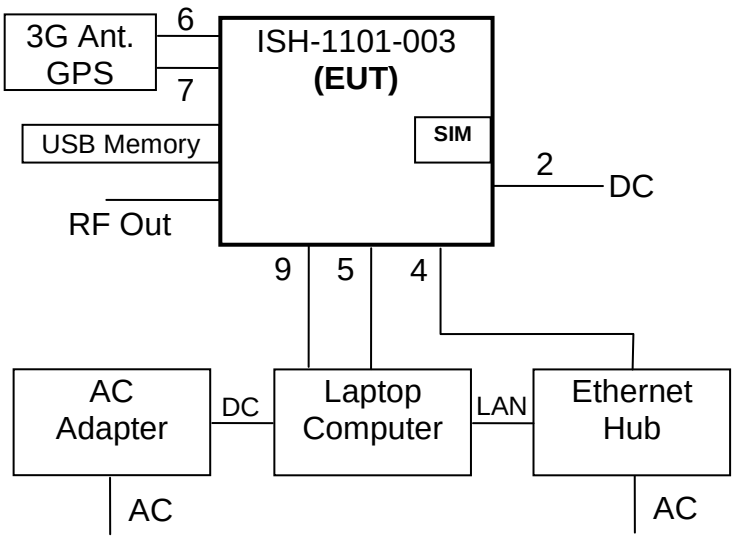
4.3 Physical Configuration for Testing

The test system was configured in a typical fashion (as a customer would normally use it).

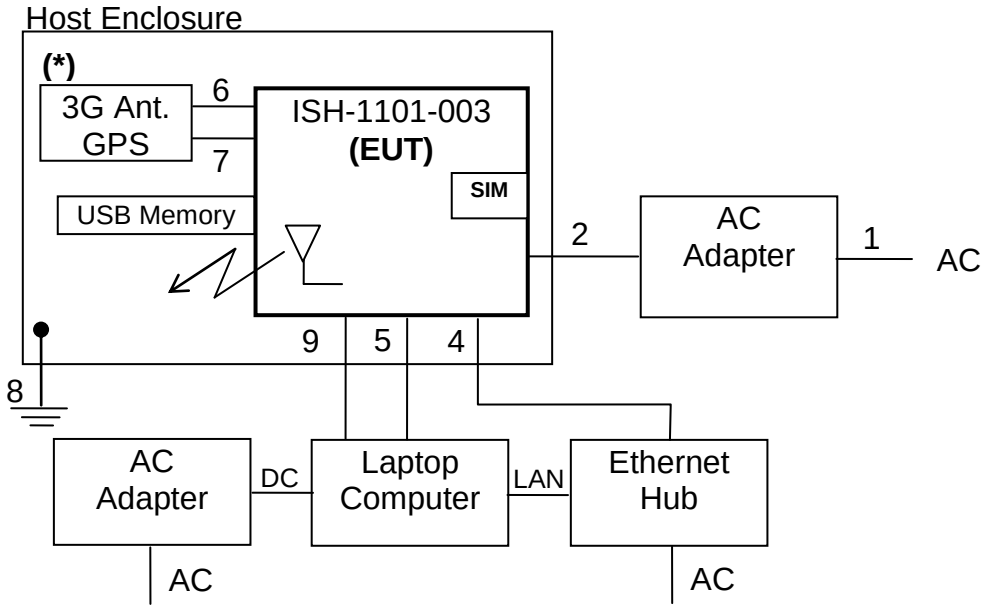
The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.10-2013.

Figure 1: Block Diagram

1) Test Setup of Conducted Radio testing



2) Test Setup of Radiated Radio testing



Note:

(*) Representative host enclosure was used for this test set up.

Table 3: Interfaces present on the EUT

No.	Interface	Cable Length for Testing, Shielding	Interface Classification
1.	AC Mains	1.8m, Un-shielded	AC Power Line
2.	DC Input	2m, Un-shielded	DC Power Line
3.	USB	Direct plug-in **(**)**	Signal and DC Power Line
4.	Ethernet (Cat. 5)	1.4m, Un-shielded	Telecommunication Line
5.	RS-485 #1	1.35m, Un-shielded	Signal Line
6.	3G Antenna	0.2m, Un-shielded	Signal Line
7.	GPS Antenna	0.2m, Un-shielded	Signal Line
8.	Frame Ground	1.4m, Un-shielded	Signal Line
9.	UART	2.2m, Un-shielded	Signal Line
10.	Digital I/O **(*)**	-/-	Signal Line
11.	Analog Input **(*)**	-/-	Signal Line
12.	RS-485 #2 **(*)**	-/-	Signal Line

Note:

(*) Interfaces Digital I/O, Analog Input and RS-485 #2 on the EUT are not used by the end user. Therefore, these ports were not connected during testing.

(**) USB I/F is specified as direct plugged-in type by the customer, no need extension cable for testing.

Two test samples were available. Sample No. 001 was used for antenna conducted measurements and sample No. 002 was used for AC power line conducted measurement and for radiated measurements.

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

4.4 Test Software

The EUT was provided by the manufacturer with suitable software to allow operation in all the required modes.

Software used for testing:

Tera Term version 4.89 by Tera Term project (to initiate Wireless LAN or Bluetooth mode)

Real Time Tuning Tool version 2.0.0.55 by EFC (to set up EUT mode when in Wireless LAN mode)

HCI Tester version 3.0.0.35 (to set up EUT mode when in Bluetooth mode)

These softwares were running on the laptop computer connected to the EUT. They were 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. Product: AC Adapter for EUT
   Manufacturer: Unifive
   Model: UI318-05
   Rated Voltage: AC 100-240V
   Input Current: 0.4A
   Frequency: 50/60Hz
   Protection Class: II
   Serial Number: F02-0093765

2. Product: Laptop Computer
   Manufacturer: Dell
   Model: Latitude E6400
   Rated Voltage: DC 19.5V
   Protection Class: III
   Serial Number: 39161719725

3. Product: AC Adaptor for Laptop Computer
   Manufacturer: Dell
   Model: FA90PE0-00
   Rated Voltage: AC 100-240V
   Input Current: 1.5A
   Frequency: 50-60Hz
   Protection Class: II
   Serial Number: CN-0NY512-73245-919-2877-A00

4. Product: Ethernet Switch
   Manufacturer: Allied Telesis
   Model: Center COM GS908XL
   Rated Voltage: AC 100-240V
   Input Current: 0.2A
   Frequency: 50/60Hz
   Protection Class: I
   Serial Number: 007613G125000804E1

5. Product: USB Memory
   Manufacturer: Buffalo
   Model: RUF2-K16GR F
   Rated Voltage: DC 5V (USB Bus-powered)
   Protection Class: III
   Serial Number: I31001

4.6 Countermeasures to achieve Compliance

No additional measures were employed to achieve compliance.

5. Test Results RADIO

5.1 Technical Requirements

5.1.1 Supply 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 supply voltage 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 internal antenna which is not user accessible. Hence it complies with the antenna requirements.

5.1.3 Restricted Bands of Operation

RESULT: **PASS**

Requirements:

FCC 15.205 and RSS-Gen 8.10

Only spurious emissions are permitted in any of the restricted frequency bands, unless otherwise specified.

Verdict:

The EUT operation frequency range is 2402-2480MHz. Therefore only spurious emissions may be found in the restricted bands of operation and the EUT complies with the restricted frequency band requirement.

5.2 Conducted Measurements at Antenna Port

5.2.1 Conducted Output Power

RESULT: **PASS**

Date of testing: 2016-01-14

Ambient temperature: 23°C
Relative humidity: 24%
Atmospheric pressure: 1006hPa

Requirements:

FCC 15.247(b)(1) and RSS-247 §5.4(2)

For frequency hopping systems operating in the 2400-2483.5MHz band employing at least 75 non-overlapping hopping channels, the maximum peak output power shall be 1W (30dBm). For other hopping systems operating in the 2400-2483.5MHz band, the maximum peak output power shall be 0.125W (20.97dBm).

Test procedure:

ANSI C63.10-2013 §7.8.5 and RSS-Gen 6.12.

The maximum peak output power (conducted) was measured at the antenna connector with a power meter. The final result takes into account the loss generated by all the involved cables.

The measurement was performed at all the available transmit speeds (data rates) and packet types (DH) in order to identify the configurations producing the highest output power.

The results given here below indicate the worst case configurations. All other measurements described in this test report for the evaluation of the radio properties of the EUT have been performed using these configurations.

Table 4: Conducted Output Power, Mode A (2402MHz), all Data Rates

Frequency [MHz]	Configuration and Data Rate	Output Power [dBm]	Limit [dBm]	Margin [dB]
2402	BDR: 1Mbps - DH1	-0.83	30.00	30.83
2402	BDR: 1Mbps - DH3	-0.83	30.00	30.83
2402	BDR: 1Mbps - DH5	-0.82	30.00	30.82
2402	EDR: 2Mbps - DH1	-4.29	20.97	25.26
2402	EDR: 2Mbps - DH3	-4.28	20.97	25.25
2402	EDR: 2Mbps - DH5	-4.30	20.97	25.27
2402	EDR: 3Mbps - DH1	-3.95	20.97	24.92
2402	EDR: 3Mbps - DH3	-3.74	20.97	24.71
2402	EDR: 3Mbps - DH5	-3.73	20.97	24.70

Notes: Output power = Reading + Correction factor
mW = 10 ^ (dBm/10)
dBm = 10 x log(mW)

Grey shading areas show the highest power in the corresponding modulation, used for other tests.

Table 5: Conducted Output Power, Mode B (2440MHz), all Data Rates

Frequency [MHz]	Configuration and Data Rate	Output Power [dBm]	Limit [dBm]	Margin [dB]
2440	BDR: 1Mbps - DH1	-1.29	30.00	31.29
2440	BDR: 1Mbps - DH3	-1.29	30.00	31.29
2440	BDR: 1Mbps - DH5	-1.29	30.00	31.29
2440	EDR: 2Mbps - DH1	-4.78	20.97	25.75
2440	EDR: 2Mbps - DH3	-4.76	20.97	25.73
2440	EDR: 2Mbps - DH5	-4.80	20.97	25.77
2440	EDR: 3Mbps - DH1	-4.40	20.97	25.37
2440	EDR: 3Mbps - DH3	-4.23	20.97	25.20
2440	EDR: 3Mbps - DH5	-4.23	20.97	25.20

Notes: Output power = Reading + Correction factor
mW = 10 ^ (dBm/10)
dBm = 10 x log(mW)

Grey shading areas show the highest power in the corresponding modulation, used for other tests.

Table 6: Conducted Output Power, Mode C (2480MHz), all Data Rates

Frequency [MHz]	Configuration and Data Rate	Output Power [dBm]	Limit [dBm]	Margin [dB]
2480	BDR: 1Mbps - DH1	-2.27	30.00	32.27
2480	BDR: 1Mbps - DH3	-2.26	30.00	32.26
2480	BDR: 1Mbps - DH5	-2.26	30.00	32.26
2480	EDR: 2Mbps - DH1	-5.77	20.97	26.74
2480	EDR: 2Mbps - DH3	-5.77	20.97	26.74
2480	EDR: 2Mbps - DH5	-5.80	20.97	26.77
2480	EDR: 3Mbps - DH1	-5.42	20.97	26.39
2480	EDR: 3Mbps - DH3	-5.21	20.97	26.18
2480	EDR: 3Mbps - DH5	-5.20	20.97	26.17

Notes: Output power = Reading + Correction factor
mW = 10 ^ (dBm/10)
dBm = 10 x log(mW)

Grey shading areas show the highest power in the corresponding modulation, used for other tests.

5.2.2 Carrier Frequency Separation

RESULT: **PASS**

Date of testing: 2016-01-15

Ambient temperature: 24°C
Relative humidity: 24%
Atmospheric pressure: 1012hPa

Requirements:

FCC 15.247(a)(1) and RSS-247 §5.1 (2)

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 C63.10-2013 §7.8.2

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth was set to 30kHz and the video bandwidth to 100kHz. The Delta Marker function was used to determine the separation between the peaks of two adjacent channels.

Table 7: Carrier Frequency Separation

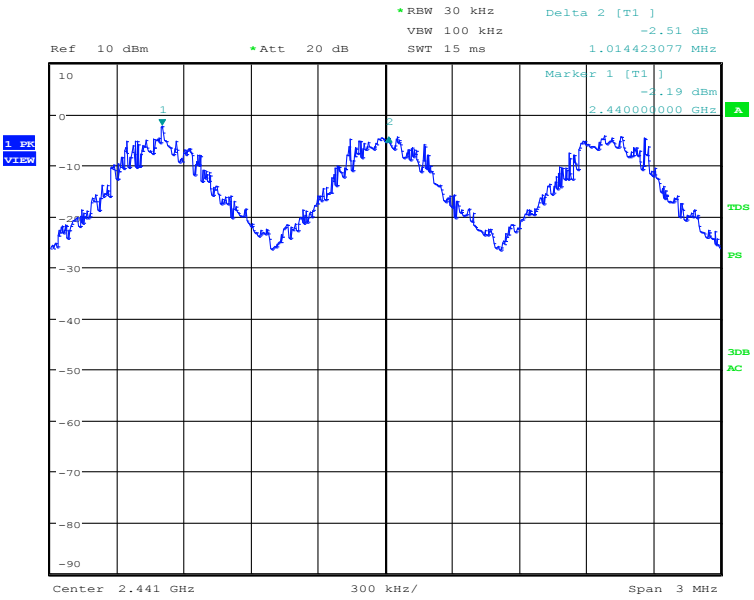
Configuration	Channel Separation [kHz]	Maximum 20dB Bandwidth [kHz]	Limit [kHz] (*)
BDR (GFSK)	1014.42	875.00	875.00
EDR (8DPSK)	1000.00	1293.27	862.18

Note (*):

For BDR, the limit is equal to the 20dB bandwidth, since the applied power limit was 1W.

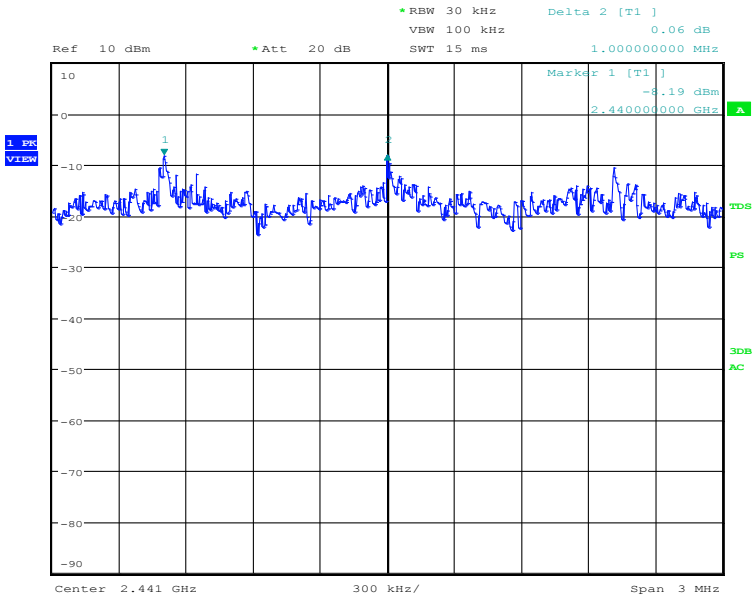
For EDR, the limit is equal to 2/3 x 20dB bandwidth, since the applied power limit was 125mW.

Figure 2: Carrier Frequency Separation, BDR (GFSK)



Carrier Frequency Separation, DH5
Date: 15.JAN.2016 11:18:10

Figure 3: Carrier Frequency Separation, EDR (8DPSK)



Carrier Frequency Separation, 3-DH5
Date: 15.JAN.2016 11:24:24

5.2.3 20dB Bandwidth

Date of testing:	2016-01-15
Ambient temperature:	24°C
Relative humidity:	24%
Atmospheric pressure:	1012hPa

Requirements:

FCC 15.247(a)(1) and RSS-247 §5.1

For frequency hopping systems operating in the 2400-2483.5MHz band, no bandwidth limit is specified. Test data is provided for reference.

Test procedure:

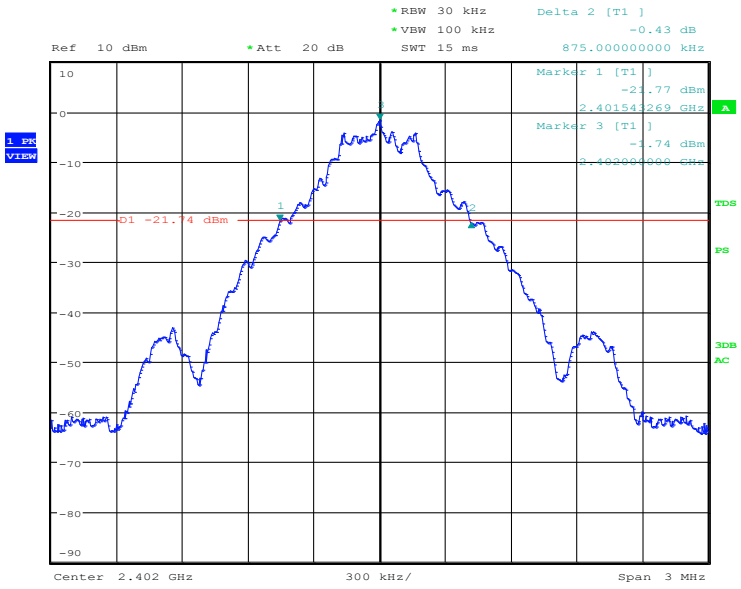
ANSI C63.10-2013 §7.8.7 and RSS-Gen 6.6.

The 20dB bandwidth was measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 30kHz and the video bandwidth to 100kHz. Markers placed at the lowest and highest intersections of the trace with a 20dBc line were used to calculate the emission bandwidth.

Table 8: 20dB Bandwidth

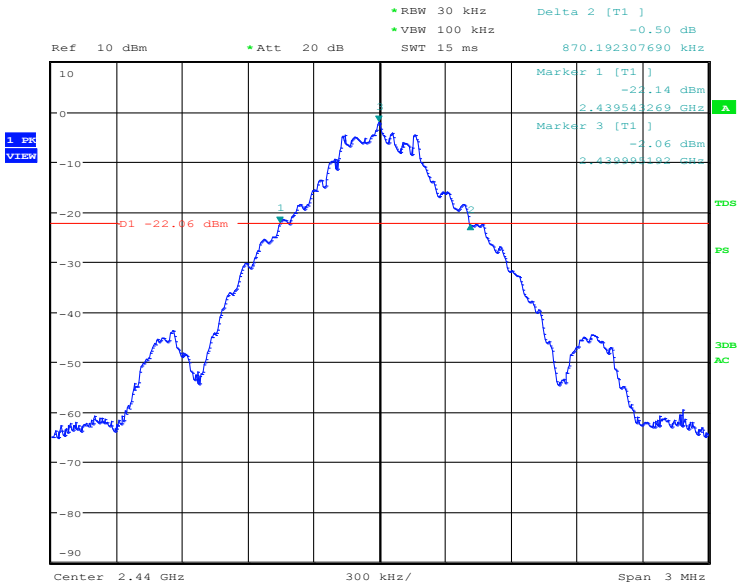
Configuration	Operating Frequency [MHz]	20dB Bandwidth [kHz]
BDR (GFSK)	2402	875.00
	2440	870.19
	2480	870.19
EDR (8DPSK)	2402	1293.27
	2440	1293.27
	2480	1293.27

Figure 4: 20dB Bandwidth, Mode A (2402MHz), BDR (GFSK)



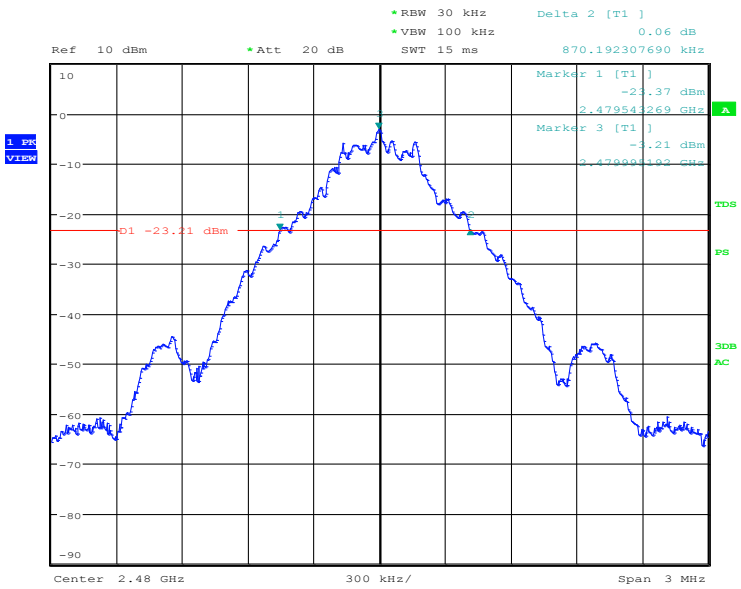
20dB bandwidth, mode DH5, A2
Date: 15.JAN.2016 09:51:22

Figure 5: 20dB Bandwidth, Mode B (2440MHz), BDR (GFSK)



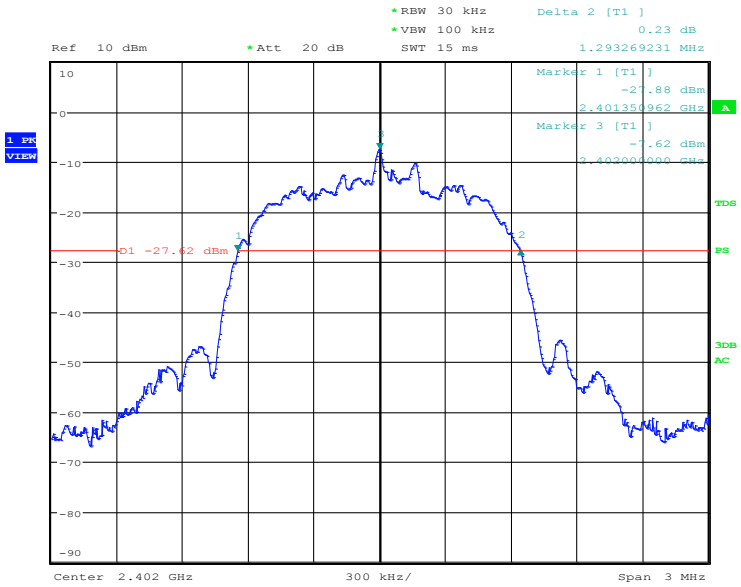
20dB bandwidth, mode DH5, B2
Date: 15.JAN.2016 10:01:20

Figure 6: 20dB Bandwidth, Mode C (2480MHz), BDR (GFSK)



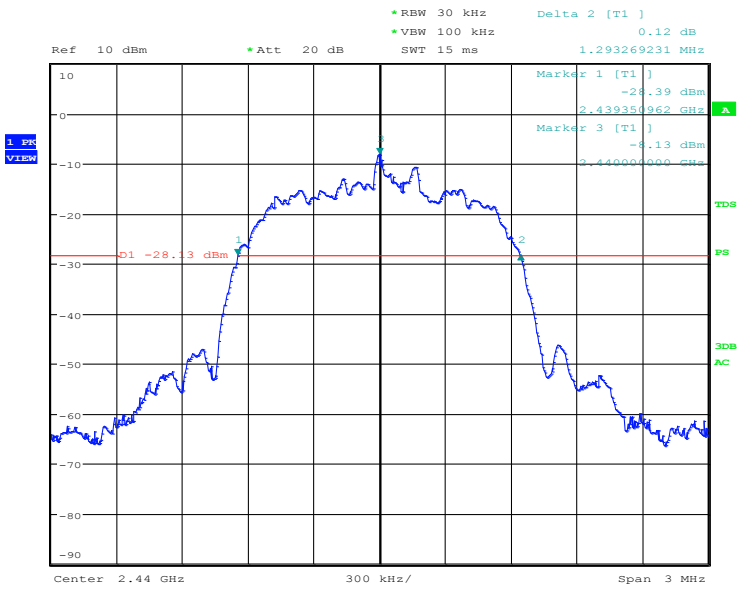
20dB bandwidth, mode DH5, C2
Date: 15.JAN.2016 10:09:32

Figure 7: 20dB Bandwidth, Mode A (2402MHz), EDR (8DPSK)



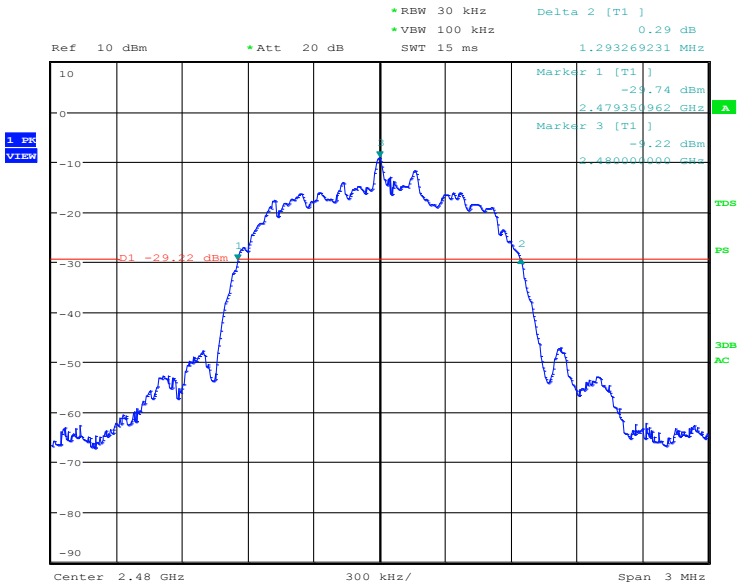
20dB bandwidth, mode 3-DH5, A2
Date: 15.JAN.2016 10:47:26

Figure 8: 20dB Bandwidth, Mode B (2440MHz), EDR (8DPSK)



20dB bandwidth, mode 3-DH5, B2
Date: 15.JAN.2016 10:54:51

Figure 9: 20dB Bandwidth, Mode C (2480MHz), EDR (8DPSK)



20dB bandwidth, mode 3-DH5, C2
Date: 15.JAN.2016 11:03:25

5.2.4 99% Bandwidth

Date of testing:	2016-01-14, 2016-01-15
Ambient temperature:	23, 24°C
Relative humidity:	24, 24%
Atmospheric pressure:	1006, 1012hPa

Requirements:

RSS-Gen 6.6

The 99% bandwidth shall be reported according to RSS-Gen 6.6.

Test procedure:

ANSI C63.10-2013 §6.9.3 and RSS-Gen 6.6

The 99% bandwidth was measured at the antenna port with a spectrum analyzer using a sample detector. The resolution bandwidth was set to 30kHz and the video bandwidth to 100kHz.

The 99% bandwidth was measured by using the OBW function of the analyzer with a 99% coverage setting.

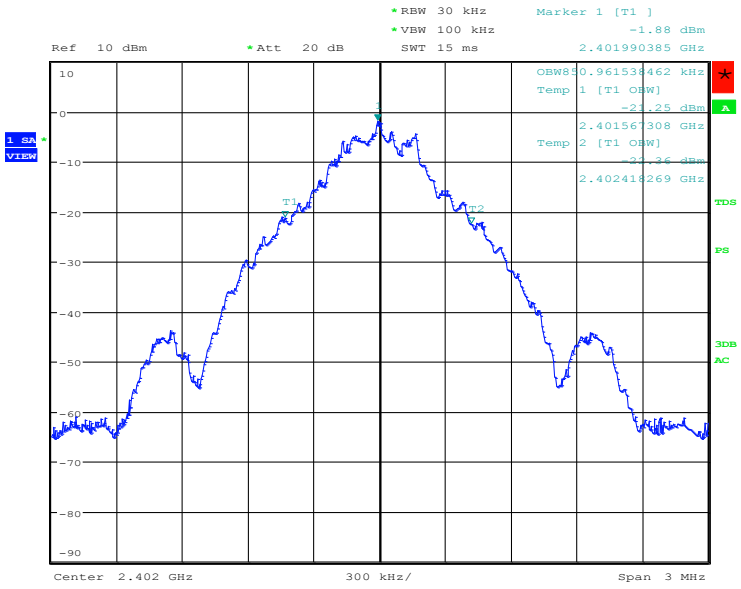
Table 9: 99% Bandwidth

Configuration	Operating Frequency [MHz]	99% Bandwidth [kHz]
BRD (GFSK)	2402	850.962
	2440	850.962
	2480	846.154
EDR (8DPSK)	2402	1182.692
	2440	1182.692
	2480	1177.885

Note: This RBW was set to 3.54% of the OBW for GFSK. (30 kHz / 846.154 kHz) × 100 = 3.54%

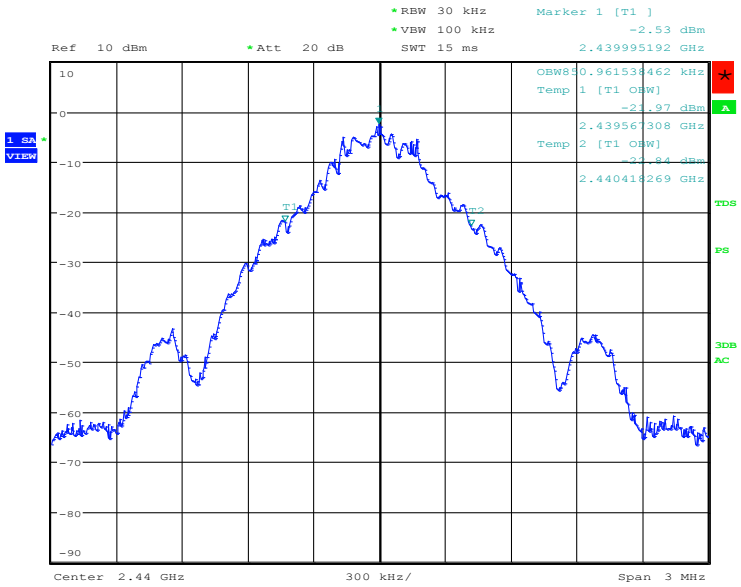
This RBW was set to 2.55% of the OBW for 8DPSK. (30 kHz / 1177.885 kHz) × 100 = 2.55%

Figure 10: 99% Bandwidth, Mode A (2402MHz), BDR (GFSK)



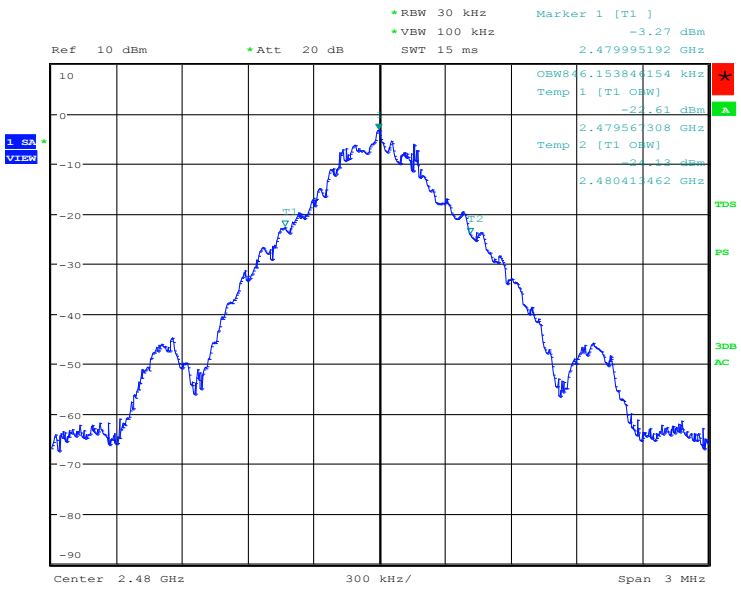
99% bandwidth, mode DH5, A2
Date: 15.JAN.2016 09:51:47

Figure 11: 99% Bandwidth, Mode B (2440MHz), BDR (GFSK)



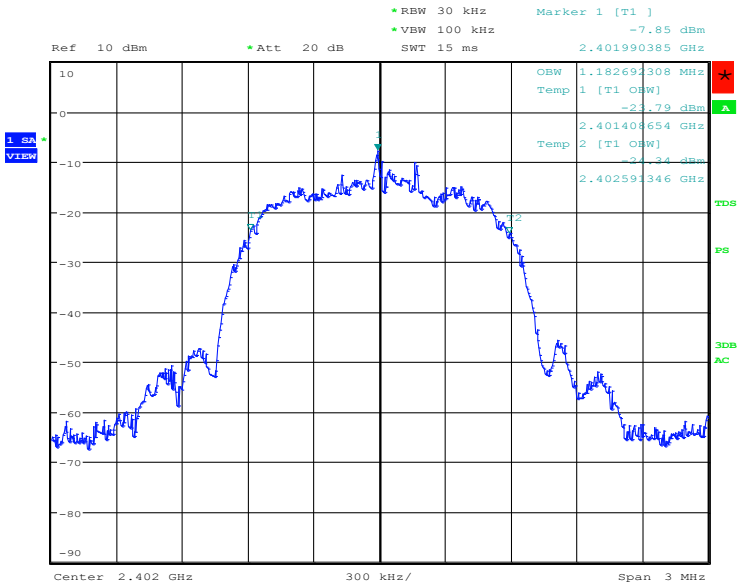
99% bandwidth, mode DH5, B2
Date: 15.JAN.2016 10:01:37

Figure 12: 99% Bandwidth, Mode C (2480MHz), BDR (GFSK)



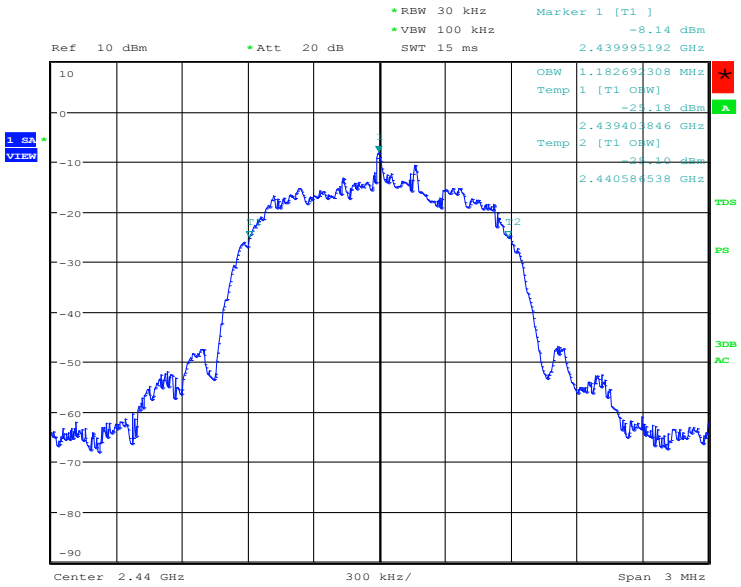
99% bandwidth, mode DH5, C2
Date: 15.JAN.2016 10:09:54

Figure 13: 99% Bandwidth, Mode A (2402MHz), EDR (8DPSK)



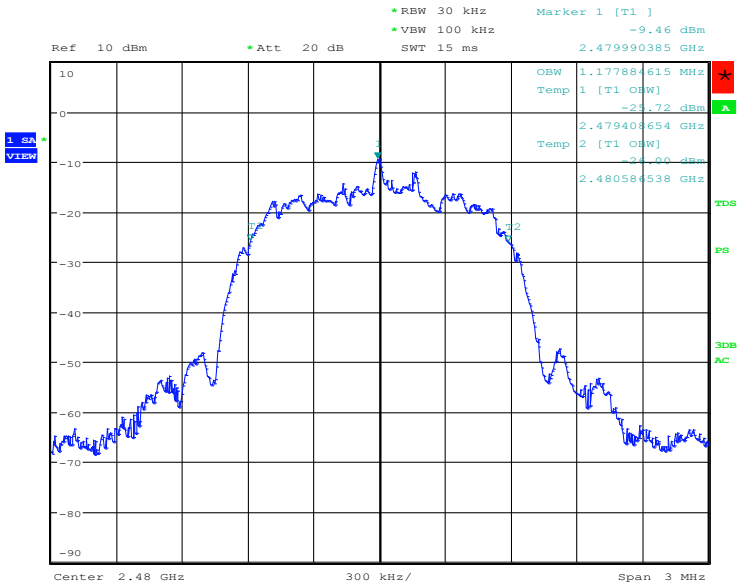
99% bandwidth, mode 3-DH5, A2
Date: 15.JAN.2016 10:47:44

Figure 14: 99% Bandwidth, Mode B (2440MHz), EDR (8DPSK)



99% bandwidth, mode 3-DH5, B2
Date: 15.JAN.2016 10:55:28

Figure 15: 99% Bandwidth, Mode C (2480MHz), EDR (8DPSK)



99% bandwidth, mode 3-DH5, C2
Date: 15.JAN.2016 11:03:45

5.2.5 Number of Hopping Frequencies

RESULT: **PASS**

Date of testing:	2016-03-10
Ambient temperature:	21°C
Relative humidity:	28%
Atmospheric pressure:	1013hPa

Requirements:

FCC 15.247(a)(1)(iii) and RSS-247 §5.1 (4)

Frequency hopping systems operating in the 2400-2483.5MHz band shall use at least 15 channels.

Test procedure:

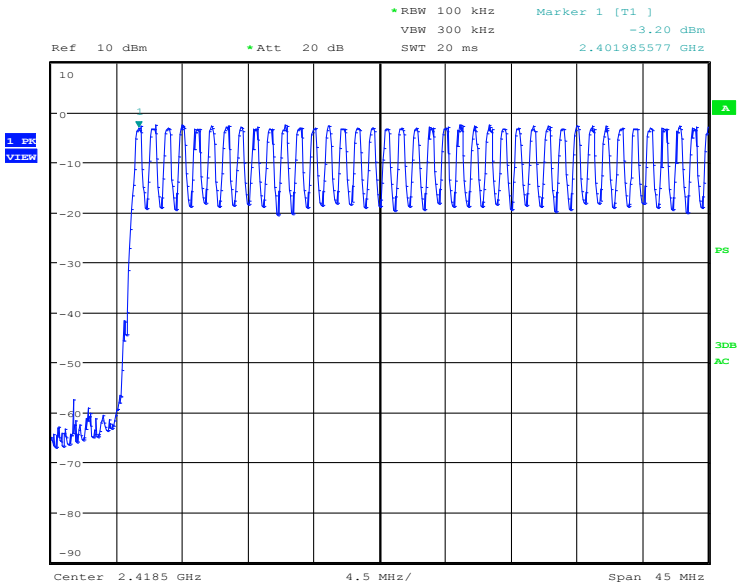
ANSI C63.10-2013 §7.8.3

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. The spectrum was broken in two plots having each a 50MHz span to show all the hopping frequencies.

Table 10: Number of Hopping Frequencies

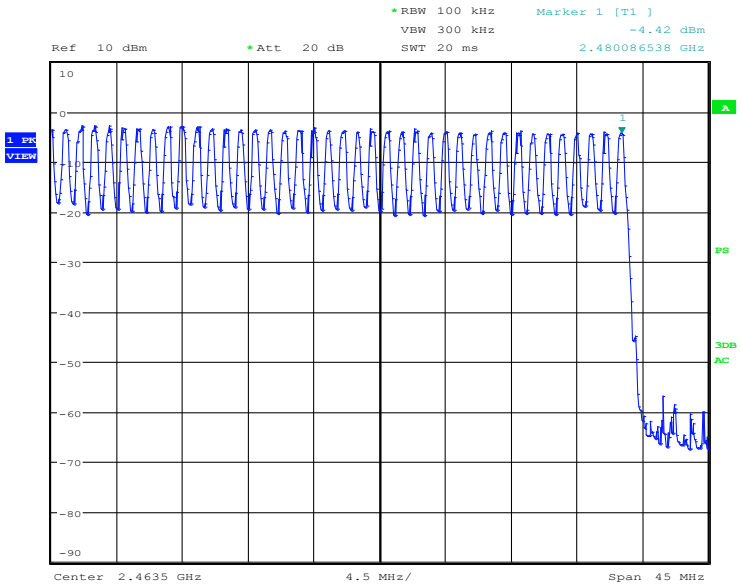
Configuration	Number of Hopping Frequencies	Limit
BDR (GFSK)	79	79
EDR (8DPSK)	79	79

Figure 16: Hopping Frequencies up to 2440MHz, Mode D (Hopping), BDR (GFSK)



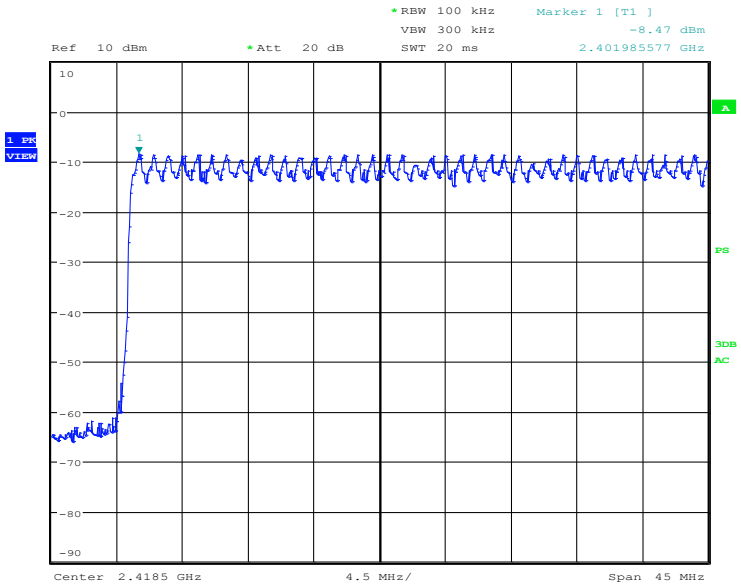
Hopping Sequence, DH5 - 1
Date: 10.MAR.2016 09:17:46

Figure 17: Hopping Frequencies above 2440MHz, Mode D (Hopping), BDR (GFSK)



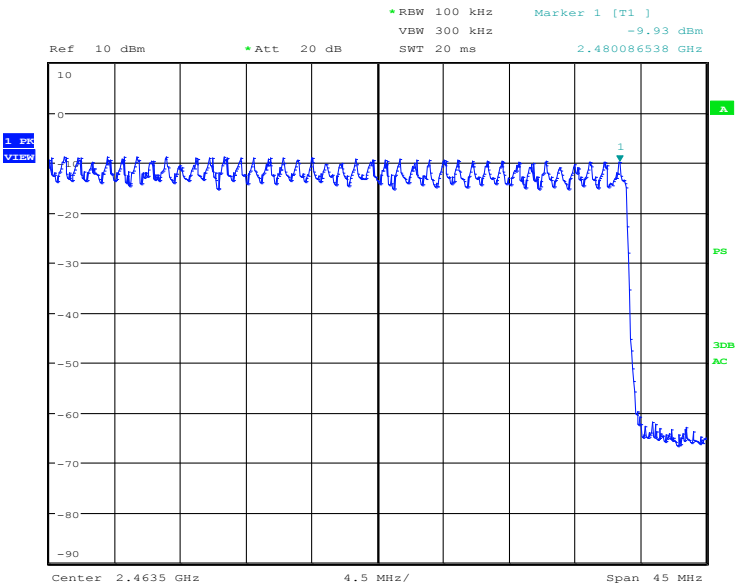
Hopping Sequence, DH5 - 2
Date: 10.MAR.2016 10:24:59

Figure 18: Hopping Frequencies up to 2440MHz, Mode D (Hopping), EDR (8DPSK)



Hopping Sequence, 3-DH5 - 1
Date: 10.MAR.2016 09:51:58

Figure 19: Hopping Frequencies above 2440MHz, Mode D (Hopping), EDR (8DPSK)



Hopping Sequence, 3-DH5 - 2
Date: 10.MAR.2016 10:02:02

5.2.6 Average Time of Occupancy

RESULT: **PASS**

Date of testing: 2016-03-10

Ambient temperature: 21°C
Relative humidity: 28%
Atmospheric pressure: 1013hPa

Requirements:

FCC 15.247(a)(1)(iii) and RSS-247 §5.1(4)

For frequency hopping systems operating in the 2400-2483.5MHz band, the average time of occupancy on any channel shall not be greater than 0.4s within a period of 0.4s multiplied by the number of hopping channels employed.

Test procedure:

ANSI C63.10-2013 §7.8.4

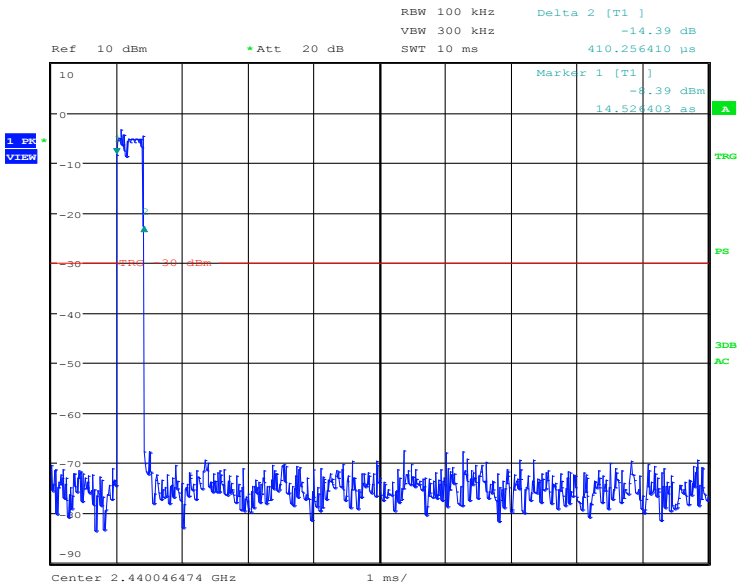
A spectrum analyzer was connected to the antenna port of the EUT. The analyzer was set in zero span mode centered on a hopping channel. The resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. The dwell time of a single packet was measured first with the Delta Marker function. The number of hops per channel in a 10s period was measured next. These measured values were used to calculate the average time of occupancy in a 31.6s period (0.4s times the number of hopping channels).

Table 11: Average Time of Occupancy

Configuration	Packet Type	Packet Duration [ms]	Measured Number of Hops per Channel in 10s Period	Calculated Number of Hops per Channel in 31.6s Period	Average Time of Occupancy in 31.6s Period [ms]	Limit [ms]
BDR (GFSK)	DH1	0.4103	68	215	88.2	400
	DH3	1.6603	59	186	308.8	400
	DH5	2.9103	40	126	366.7	400
EDR (8DPSK)	DH1	0.4263	64	202	86.1	400
	DH3	1.2436	51	161	200.2	400
	DH5	2.9423	39	123	361.9	400

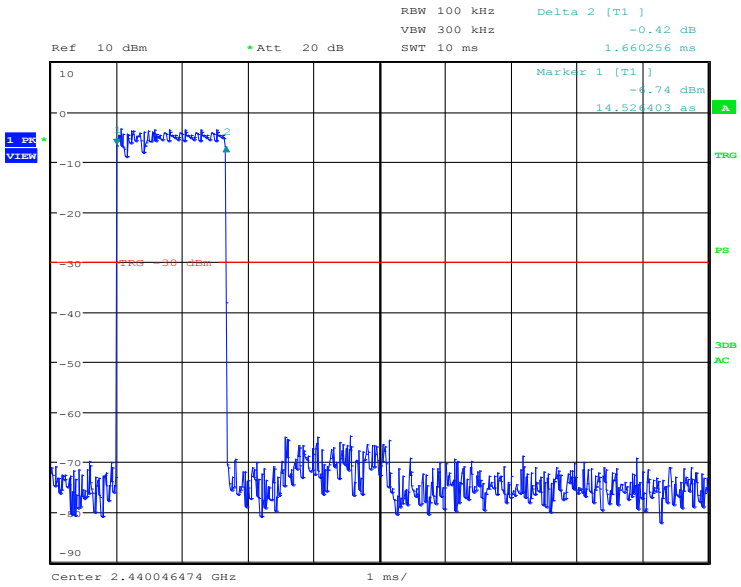
Note: Calculated number of hops per channel in 31.6s period = Measured number of hops per channel in 10s period × (31.6s / 10.0s)
Average time of occupancy in 31.6s period = Packet duration × Calculated number of hops per channel in 31.6s period

Figure 20: Dwell Time, Mode D (Hopping), DH1, BDR (GFSK)



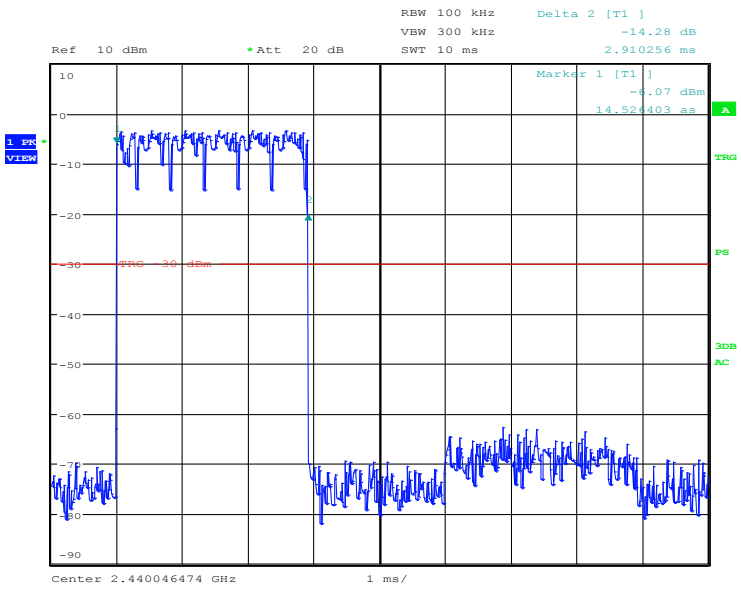
Average Time Of Occupancy, DH1 - Single Burst
Date: 10.MAR.2016 10:46:20

Figure 21: Dwell Time, Mode D (Hopping), DH3, BDR (GFSK)



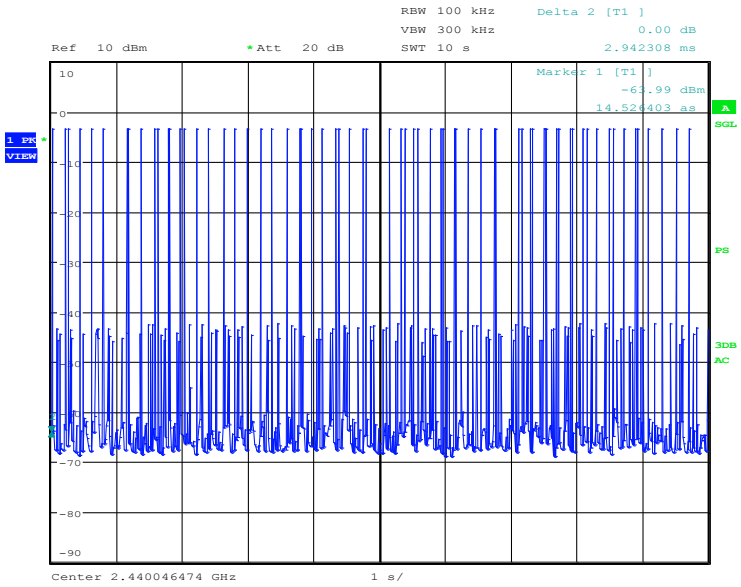
Average Time Of Occupancy, DH3 - Single Burst
Date: 10.MAR.2016 10:38:22

Figure 22: Dwell Time, Mode D (Hopping), DH5, BDR (GFSK)



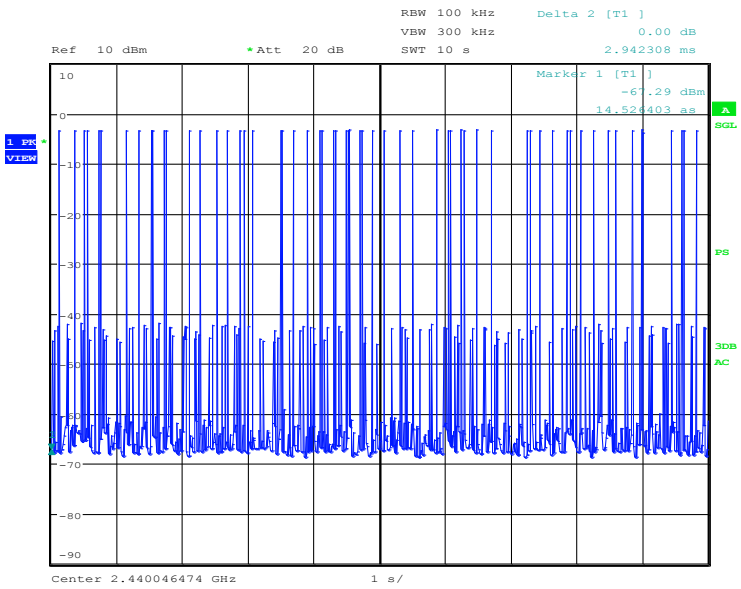
Average Time Of Occupancy, DH5 - Single Burst
Date: 10.MAR.2016 10:39:27

Figure 23: Number of Hops, Mode D (Hopping), DH1, BDR (GFSK)



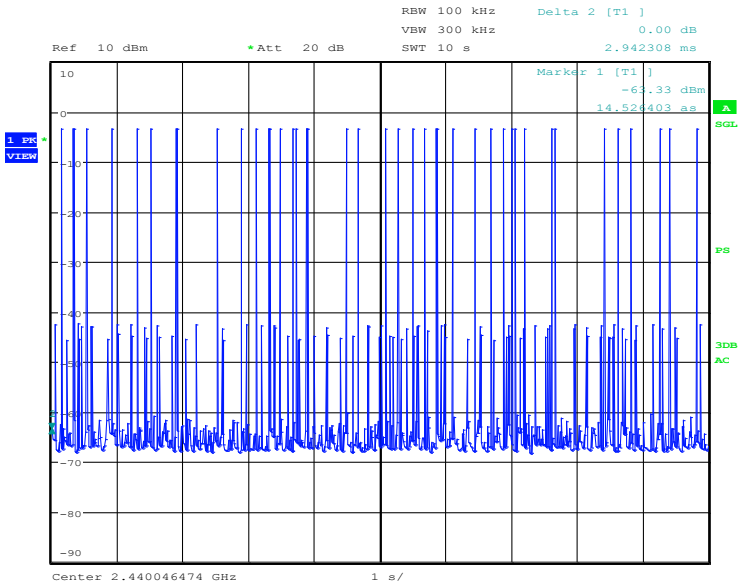
Average Time Of Occupancy, DH1 - 10s Scan
Date: 10.MAR.2016 10:59:12

Figure 24: Number of Hops, Mode D (Hopping), DH3, BDR (GFSK)



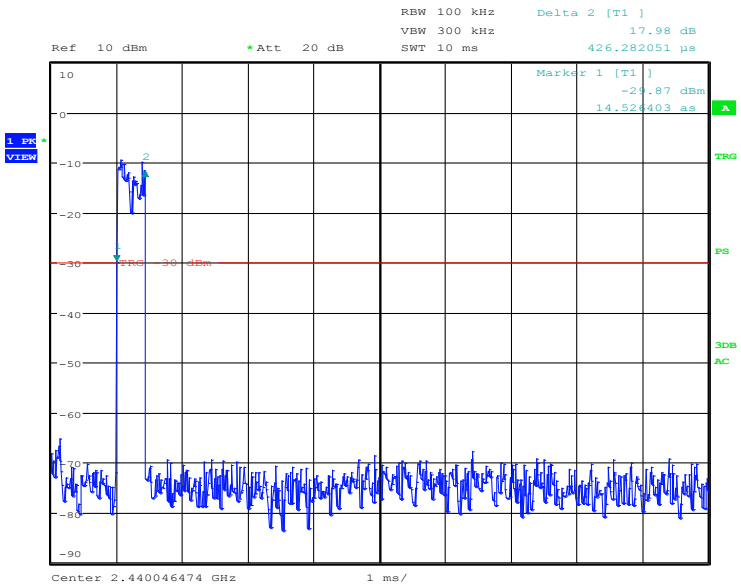
Average Time Of Occupancy, DH3 - 10s Scan
Date: 10.MAR.2016 10:58:21

Figure 25: Number of Hops, Mode D (Hopping), DH5, BDR (GFSK)



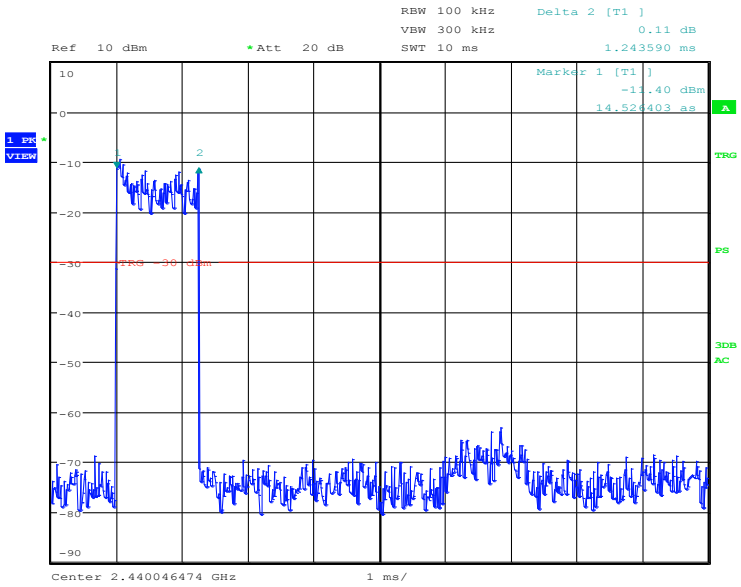
Average Time Of Occupancy, DH5 - 10s Scan
Date: 10.MAR.2016 10:56:16

Figure 26: Dwell Time, Mode D (Hopping), DH1, EDR (8DPSK)



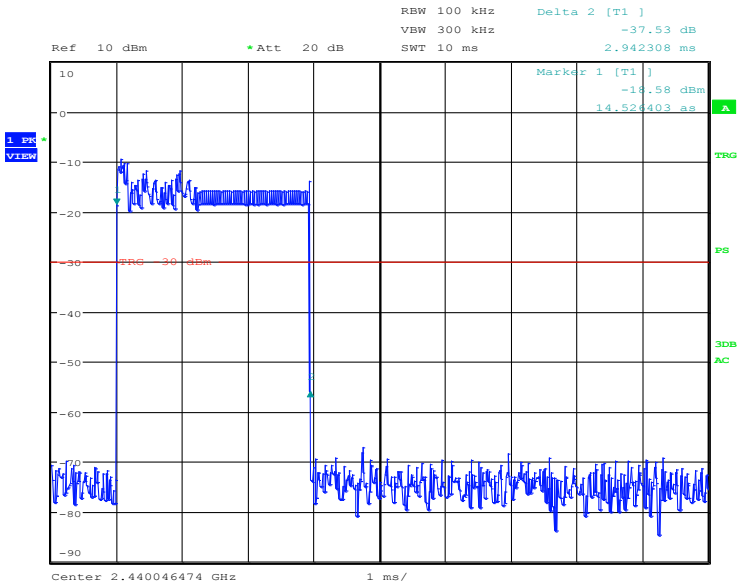
Average Time Of Occupancy, 3-DH1 - Single Burst
Date: 10.MAR.2016 10:43:02

Figure 27: Dwell Time, Mode D (Hopping), DH3, EDR (8DPSK)



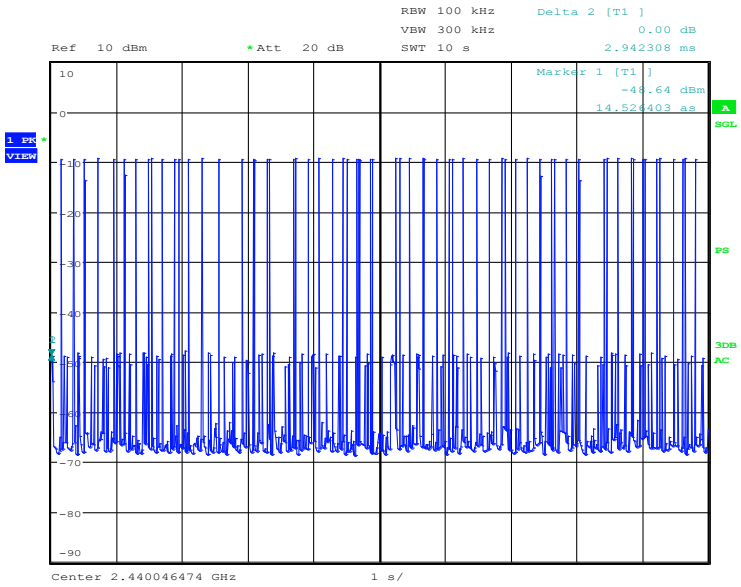
Average Time Of Occupancy, 3-DH3 - Single Burst
Date: 10.MAR.2016 10:43:37

Figure 28: Dwell Time, Mode D (Hopping), DH5, EDR (8DPSK)



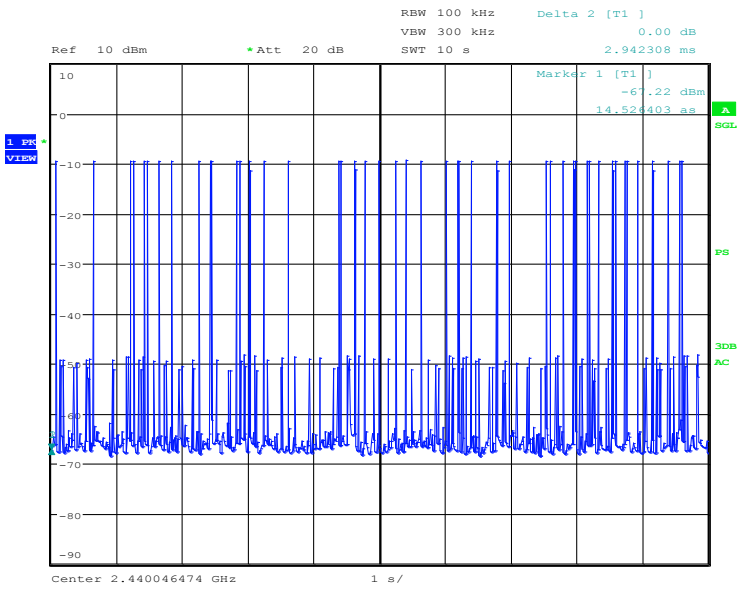
Average Time Of Occupancy, 3-DH5 - Single Burst
Date: 10.MAR.2016 10:48:09

Figure 29: Number of Hops, Mode D (Hopping), DH1, EDR (8DPSK)



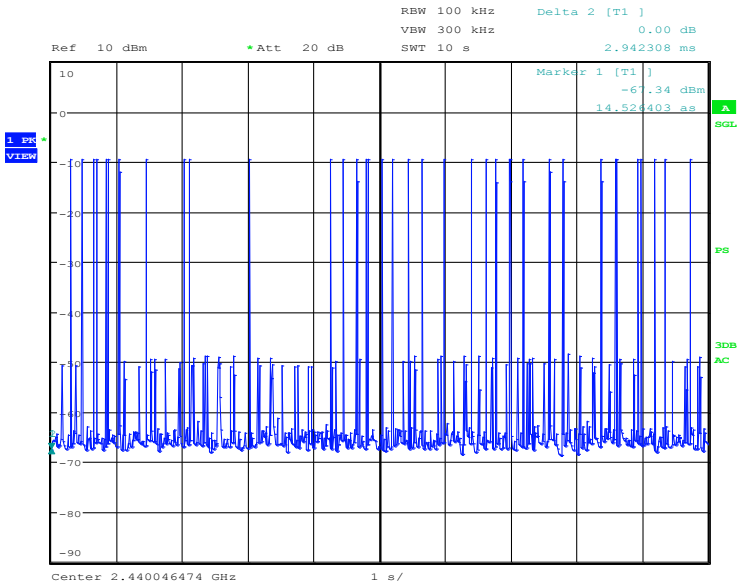
Average Time Of Occupancy, 3-DH1 - 10s Scan
Date: 10.MAR.2016 10:51:26

Figure 30: Number of Hops, Mode D (Hopping), DH3, EDR (8DPSK)



Average Time Of Occupancy, 3-DH3 - 10s Scan
Date: 10.MAR.2016 10:50:44

Figure 31: Number of Hops, Mode D (Hopping), DH5, EDR (8DPSK)



Average Time Of Occupancy, 3-DH5 - 10s Scan
Date: 10.MAR.2016 10:49:49

5.2.7 Conducted Spurious Emissions

RESULT: **PASS**

Date of testing: 2016-01-14, 2016-01-15

Ambient temperature: 23, 24°C
Relative humidity: 24, 24%
Atmospheric pressure: 1006, 1012hPa

Requirements:

FCC 15.247(d) and RSS-247 §5.5

In any 100kHz bandwidth outside the frequency band in which the intentional radiator is operating, the RF power shall be at least 20dB below that of the maximum in-band 100kHz emission.

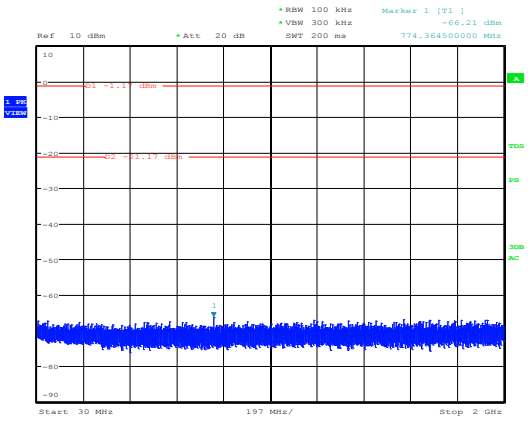
Test procedure:

ANSI C63.10-2013 §7.8.8 and RSS-Gen 6.13.

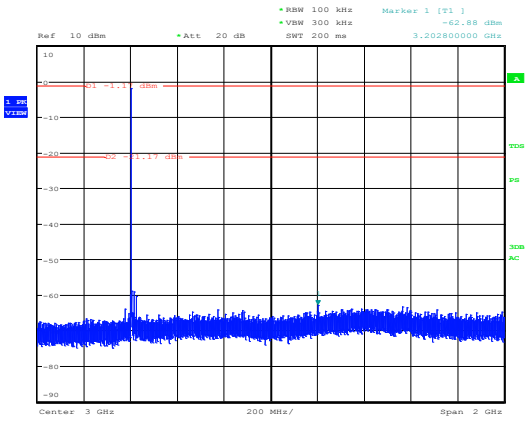
The conducted spurious emissions were measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. Measurements were performed from 30MHz to 25GHz (10^{th} harmonics).

The readings of the measurements take into account the loss generated by all the involved cables.

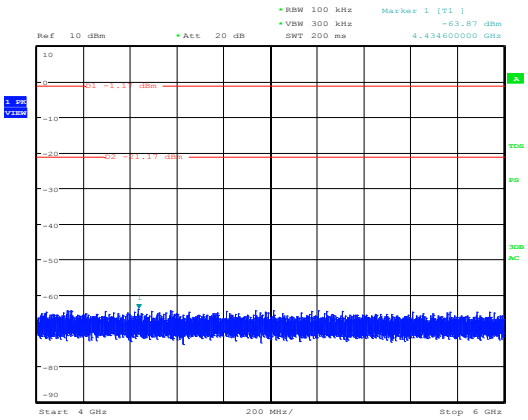
Figure 32: Conducted Spurious Emissions, 30MHz - 12GHz, Mode A (2402MHz), BDR (GFSK)



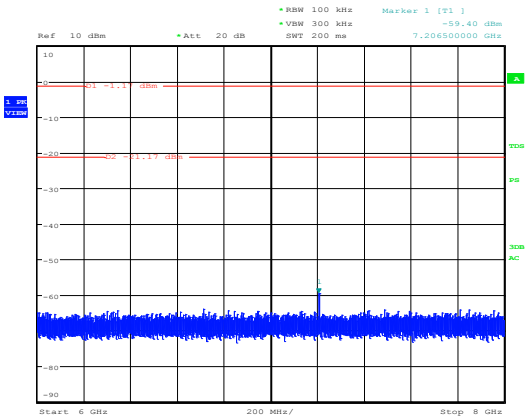
Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:53:12



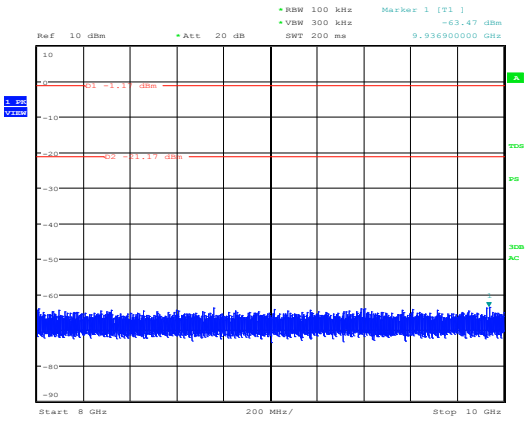
Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:54:02



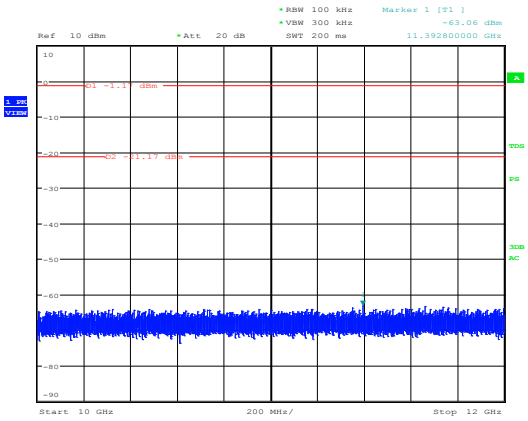
Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:54:22



Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:55:57

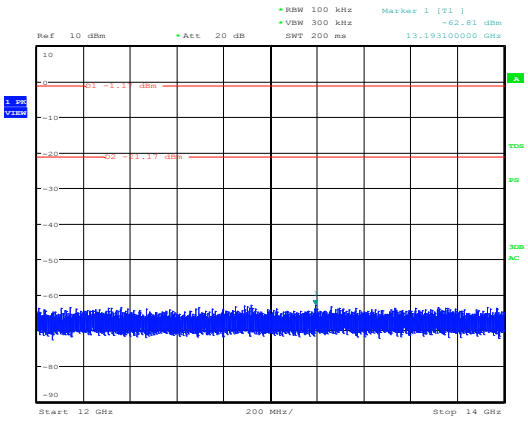


Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:56:20

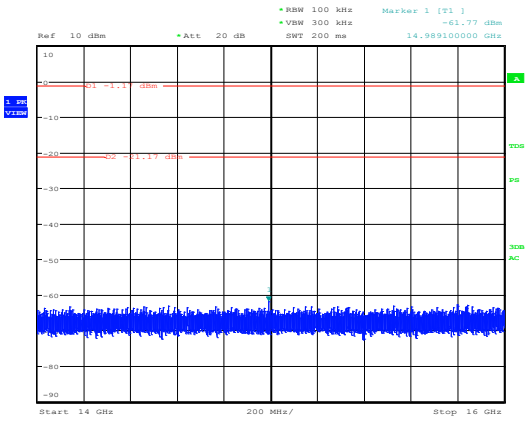


Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:56:39

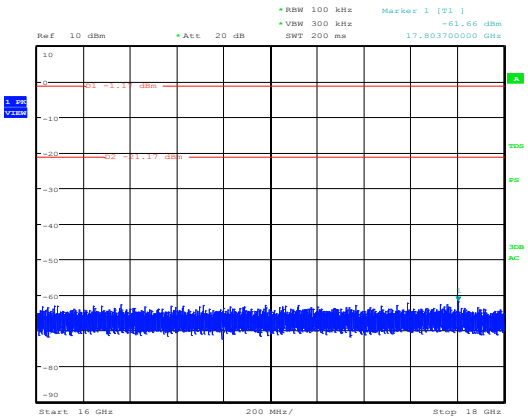
Figure 33: Conducted Spurious Emissions, 12 - 24GHz, Mode A (2402MHz), BDR (GFSK)



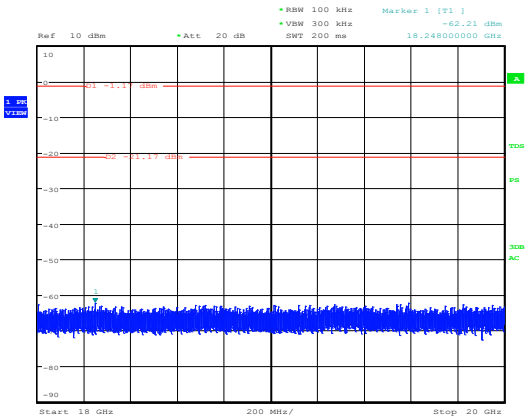
Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:57:19



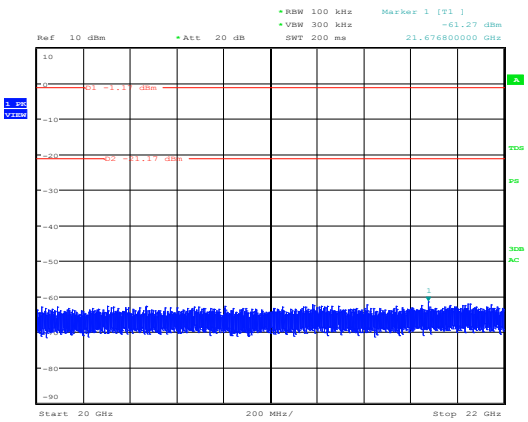
Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:57:39



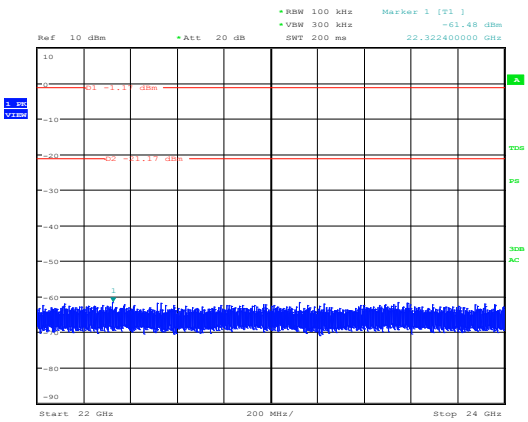
Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:58:01



Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:58:19

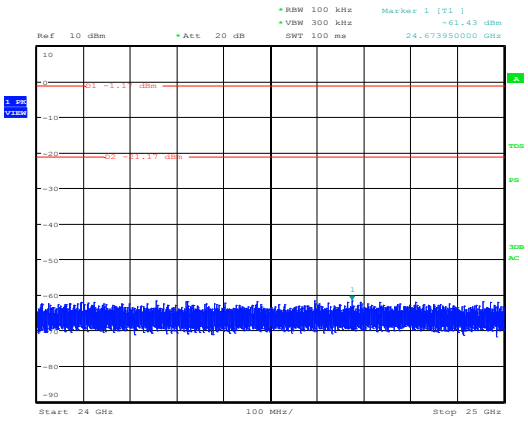


Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:59:02

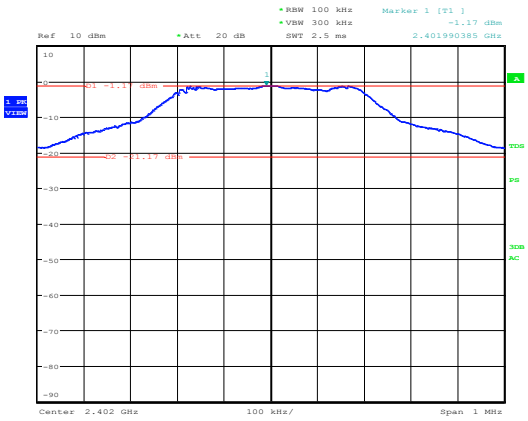


Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:59:19

Figure 34: Conducted Spurious Emissions, 24 - 25GHz, Mode A (2402MHz), BDR (GFSK)

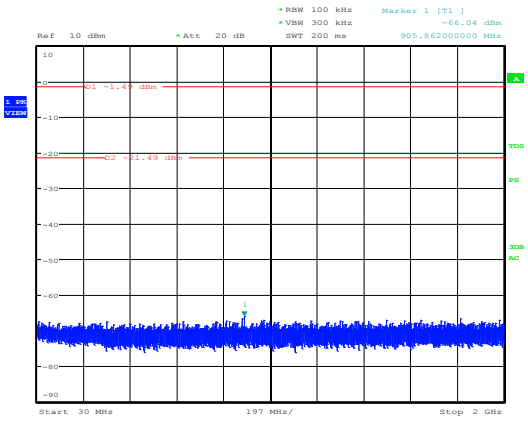


Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:59:37

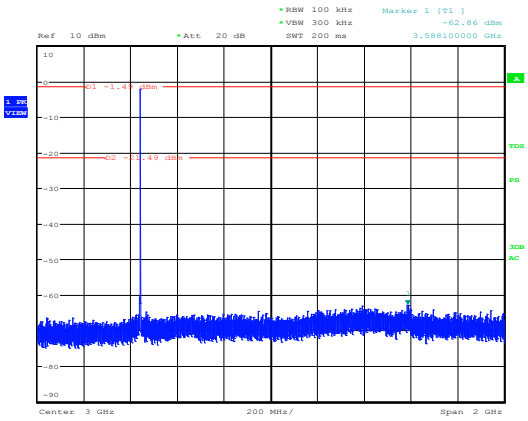


Conducted spurious emissions, mode DH5, A2
Date: 15.JAN.2016 09:52:53

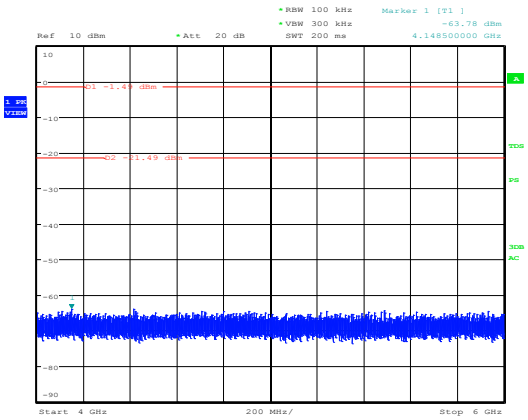
Figure 35: Conducted Spurious Emissions, 30MHz - 12GHz, Mode B (2440MHz), BDR (GFSK)



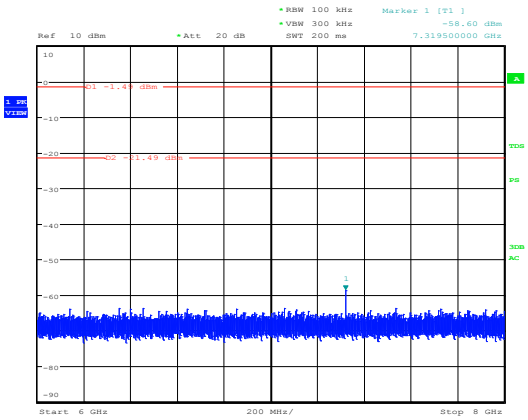
Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:02:40



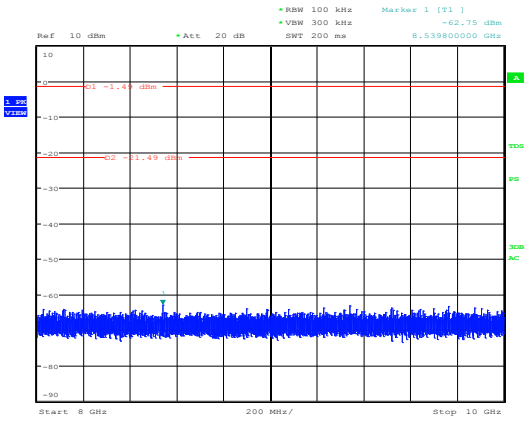
Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:03:15



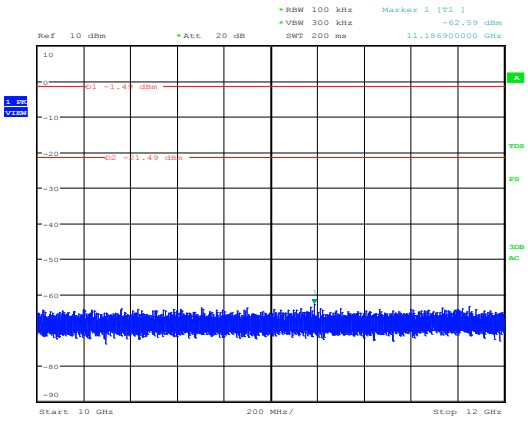
Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:03:36



Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:03:54

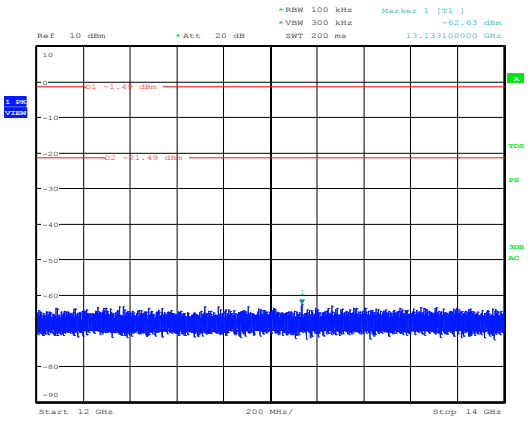


Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:04:49

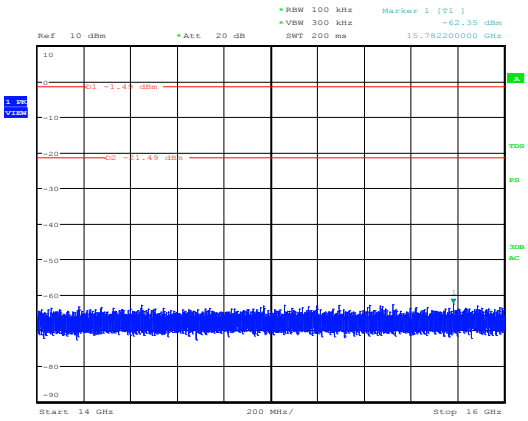


Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:05:09

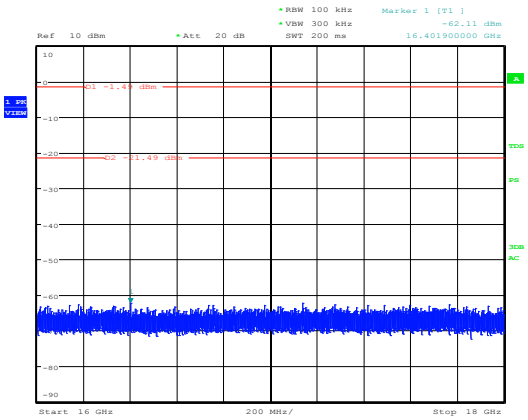
Figure 36: Conducted Spurious Emissions, 12 - 24GHz, Mode B (2440MHz), BDR (GFSK)



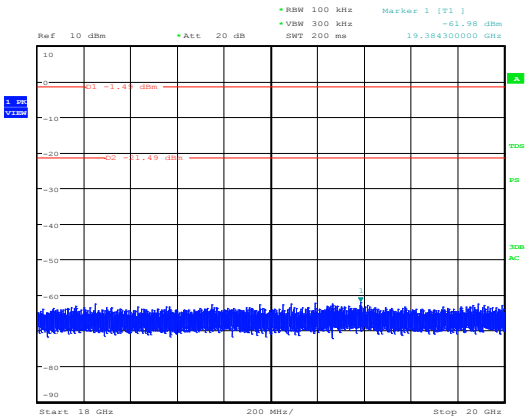
Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:06:12



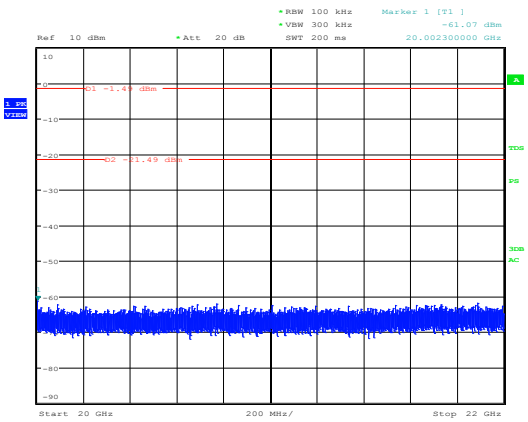
Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:06:40



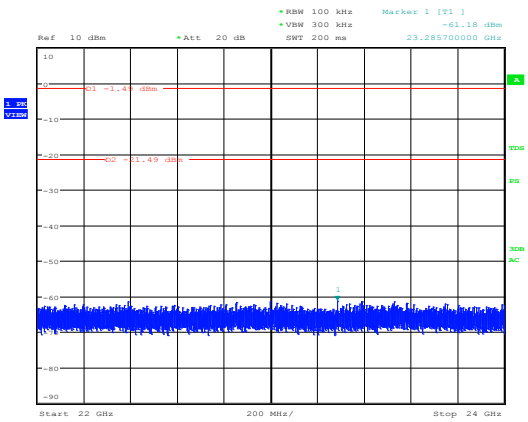
Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:06:58



Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:07:19

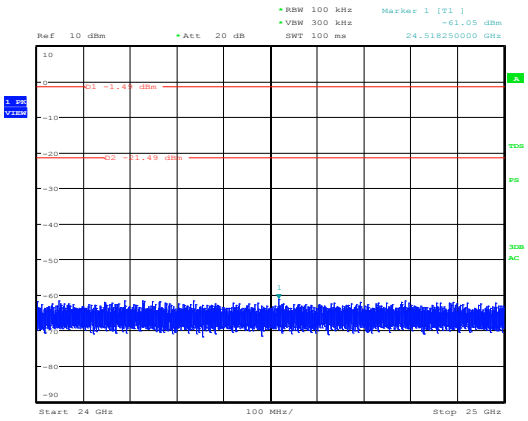


Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:07:36

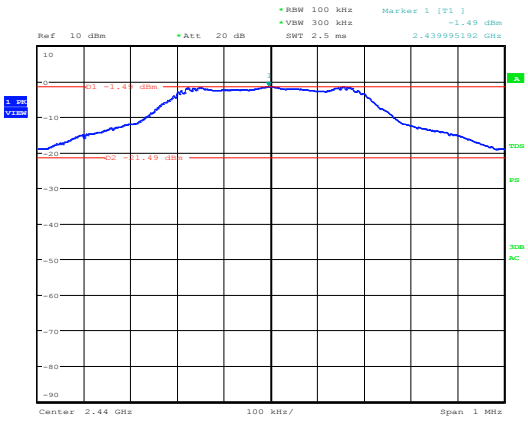


Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:07:54

Figure 37: Conducted Spurious Emissions, 24 - 25GHz, Mode B (2440MHz), BDR (GFSK)

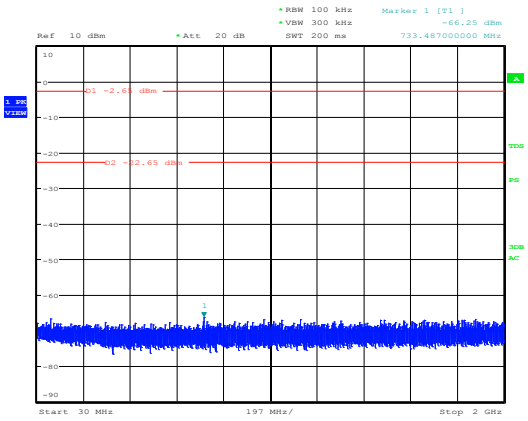


Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:08:12

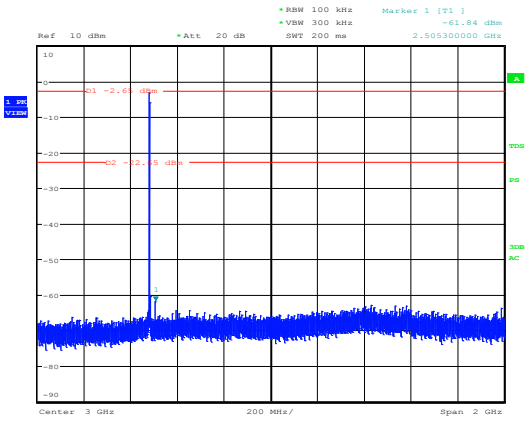


Conducted spurious emissions, mode DH5, B2
Date: 15.JAN.2016 10:02:21

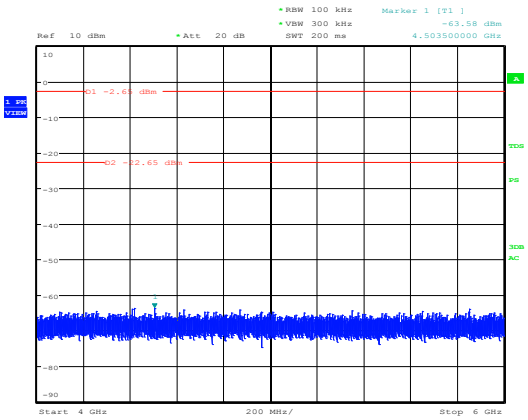
Figure 38: Conducted Spurious Emissions, 30MHz - 12GHz, Mode C (2480MHz), BDR (GFSK)



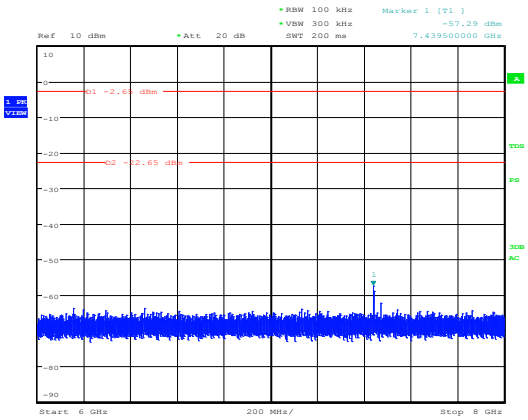
Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:11:10



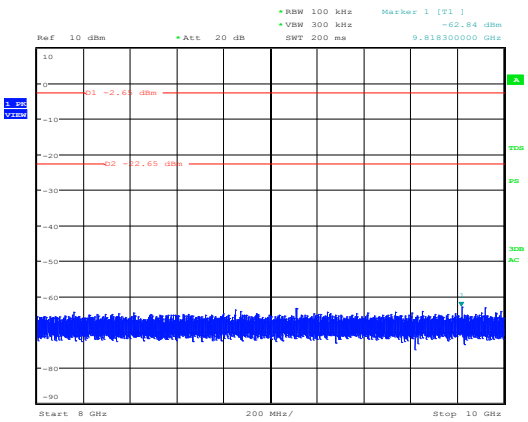
Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:11:57



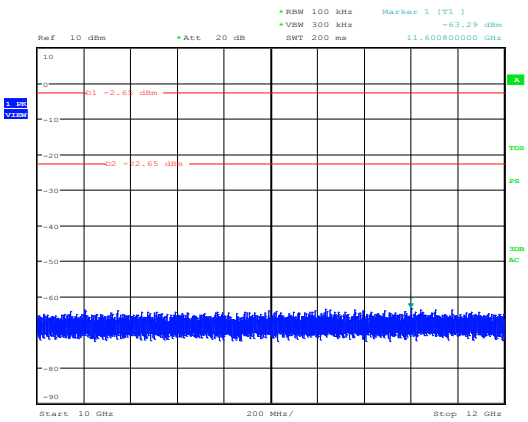
Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:12:18



Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:12:35

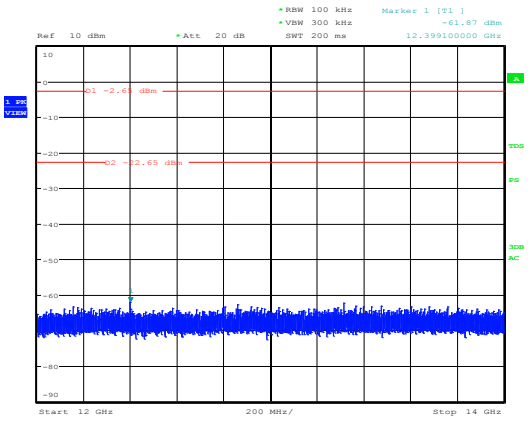


Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:12:58

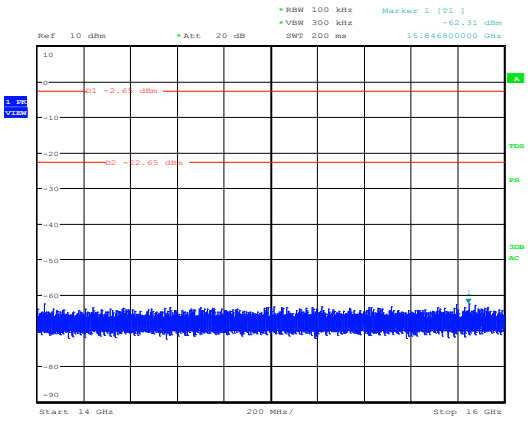


Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:13:21

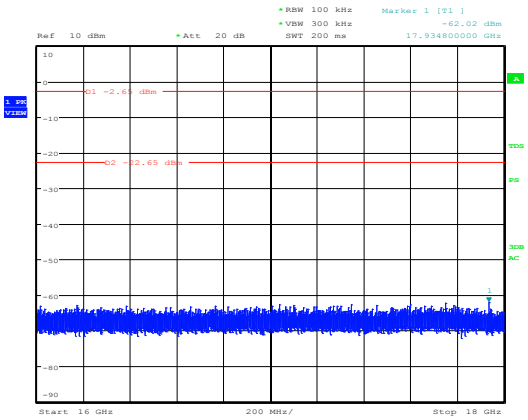
Figure 39: Conducted Spurious Emissions, 12 - 24GHz, Mode C (2480MHz), BDR (GFSK)



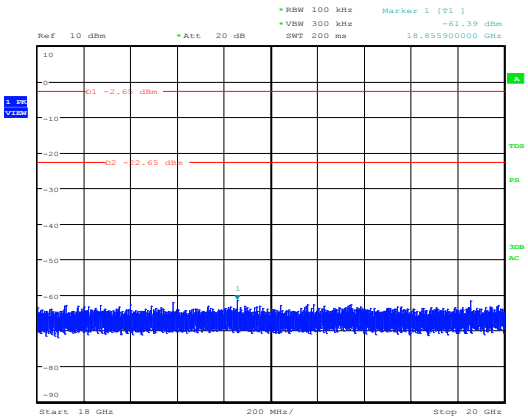
Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:13:41



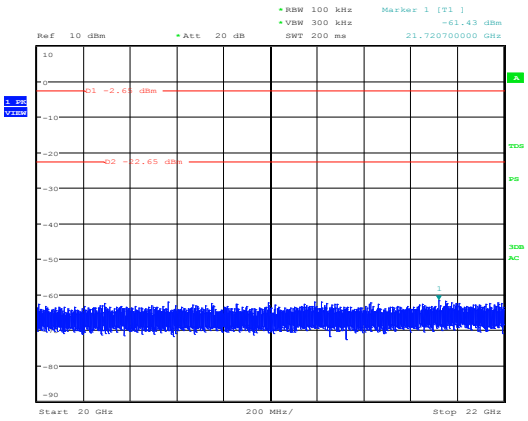
Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:13:58



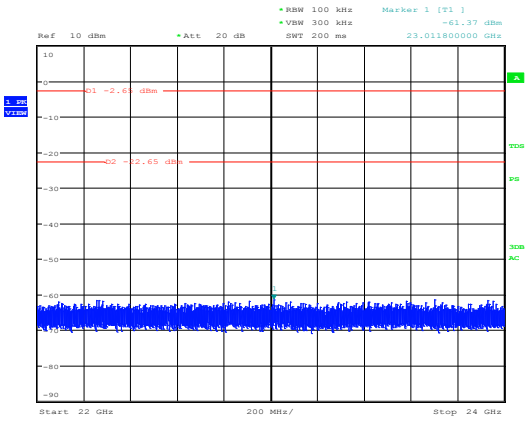
Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:14:16



Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:14:34

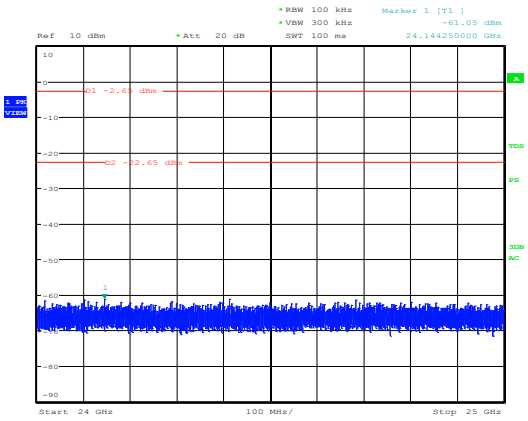


Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:14:52

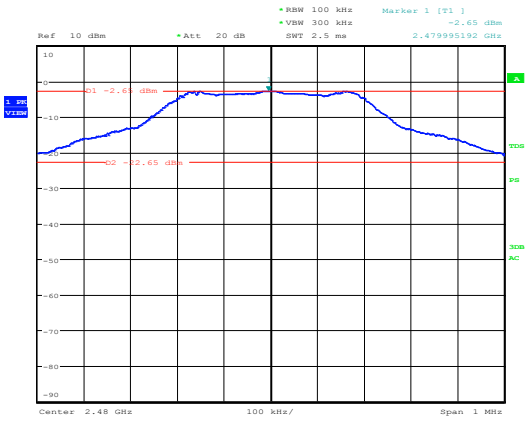


Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:15:13

Figure 40: Conducted Spurious Emissions, 24 - 25GHz, Mode C (2480MHz), BDR (GFSK)

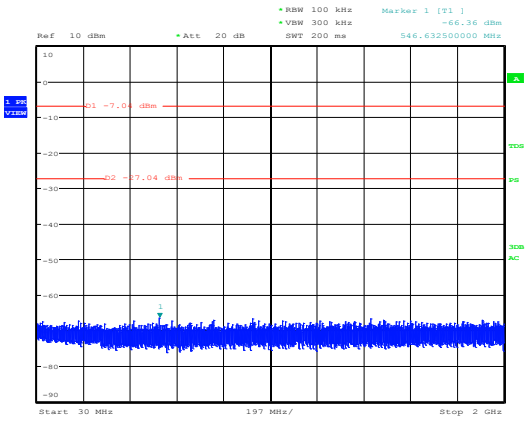


Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:15:31

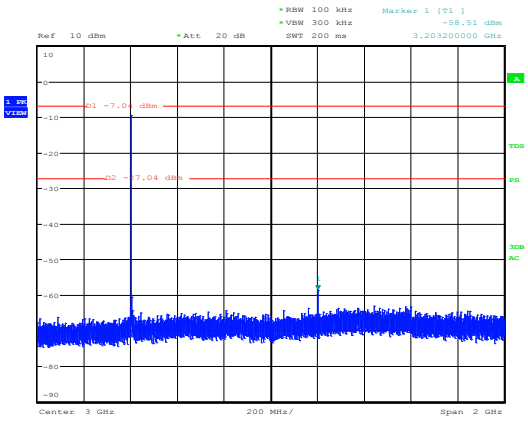


Conducted spurious emissions, mode DH5, C2
Date: 15.JAN.2016 10:10:52

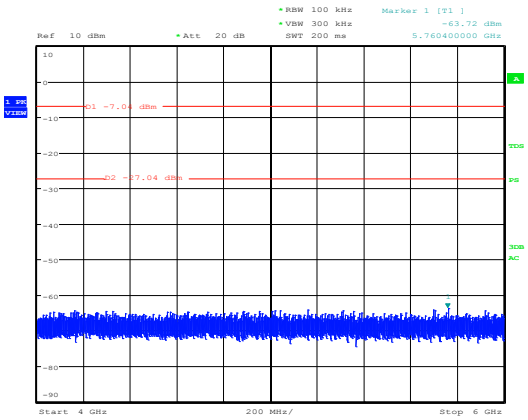
Figure 41: Conducted Spurious Emissions, 30MHz - 12GHz, Mode A (2402MHz), EDR (8DPSK)



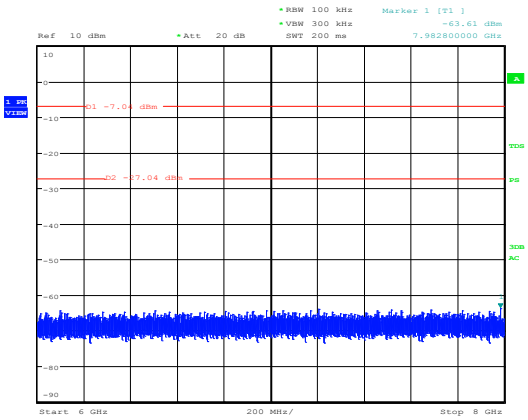
Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:48:42



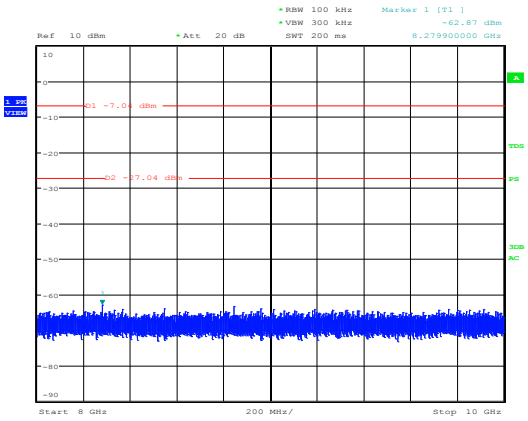
Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:49:13



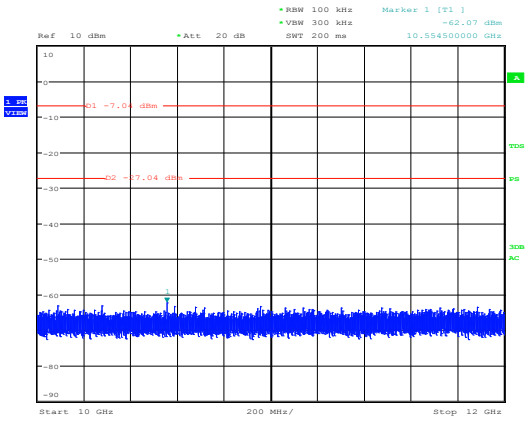
Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:49:39



Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:49:58

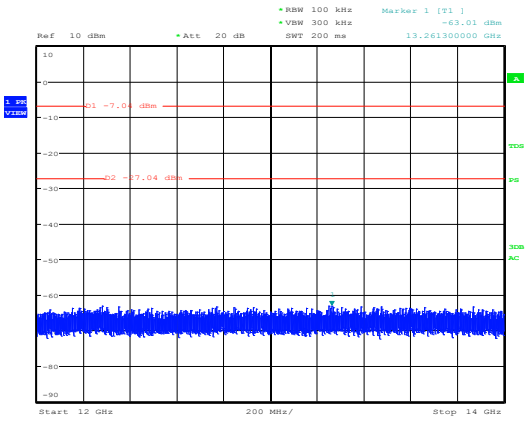


Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:50:50

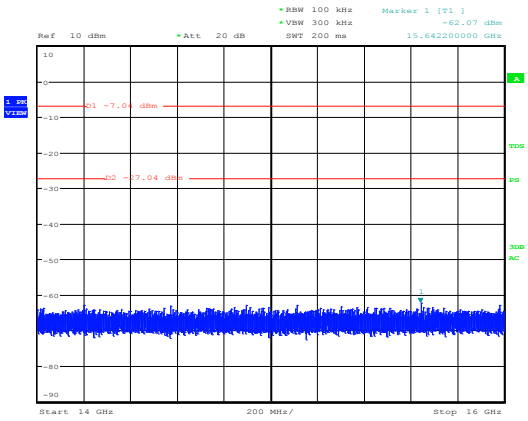


Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:51:08

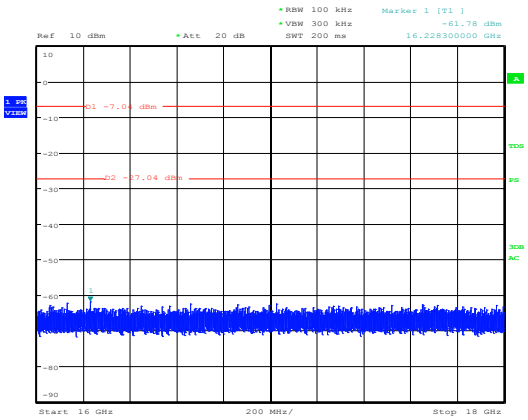
Figure 42: Conducted Spurious Emissions, 12 - 24GHz, Mode A (2402MHz), EDR (8DPSK)



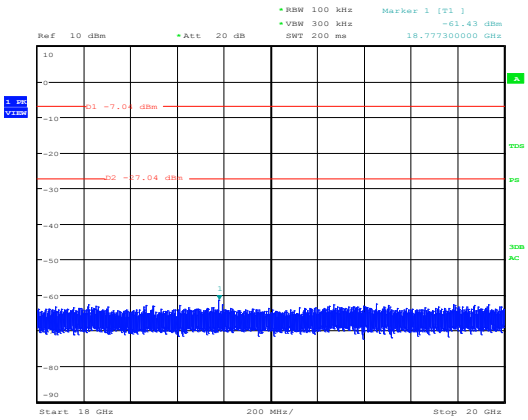
Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:51:26



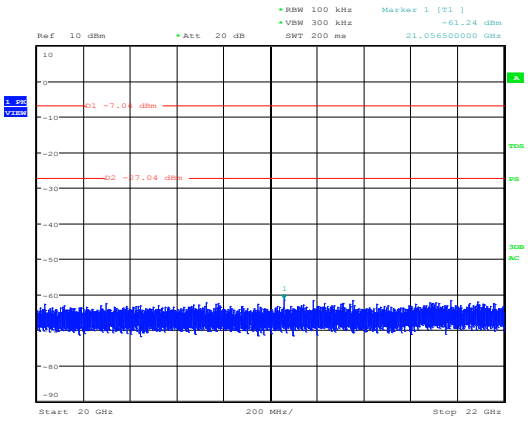
Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:51:45



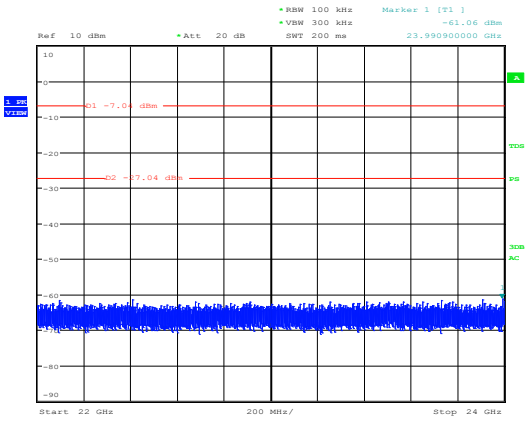
Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:52:04



Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:52:45

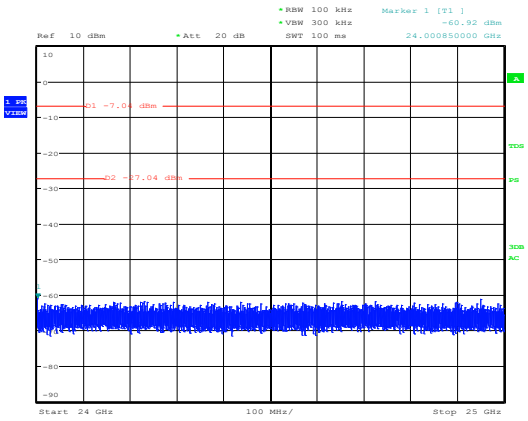


Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:53:04

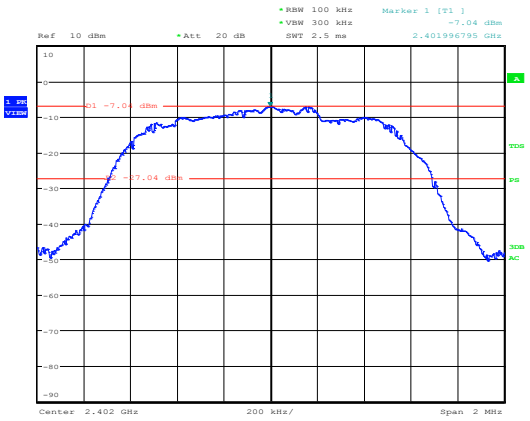


Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:53:23

Figure 43: Conducted Spurious Emissions, 24 - 25GHz, Mode A (2402MHz), EDR (8DPSK)

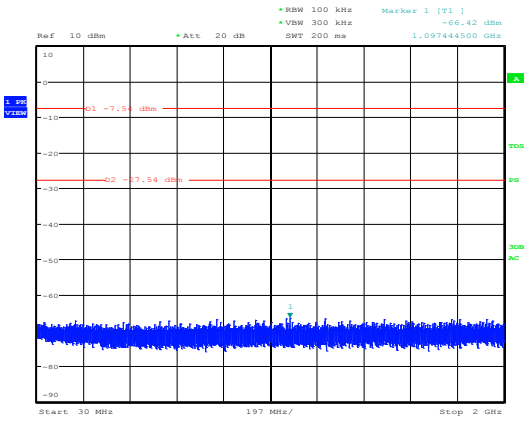


Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:53:41

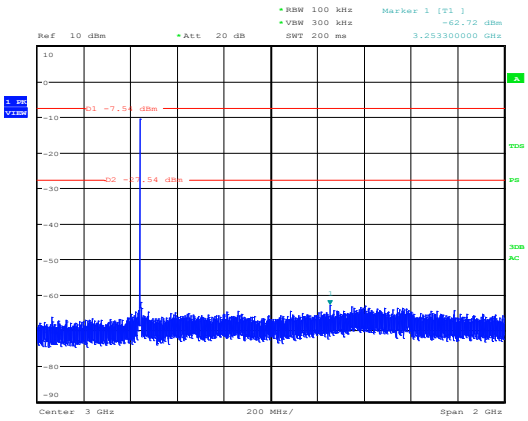


Conducted spurious emissions, mode 3-DH5, A2
Date: 15.JAN.2016 10:48:23

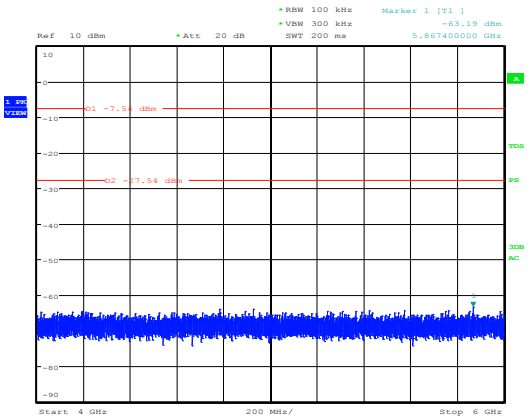
Figure 44: Conducted Spurious Emissions, 30MHz - 12GHz, Mode B (2440MHz), EDR (8DPSK)



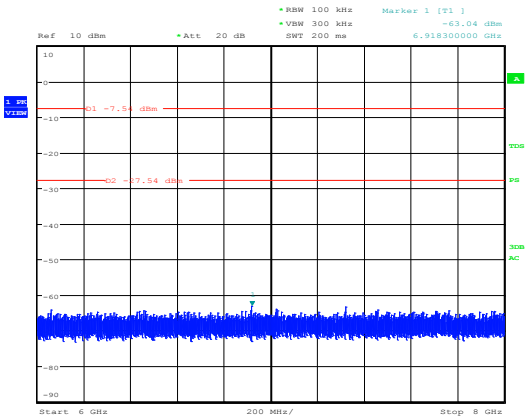
Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:56:54



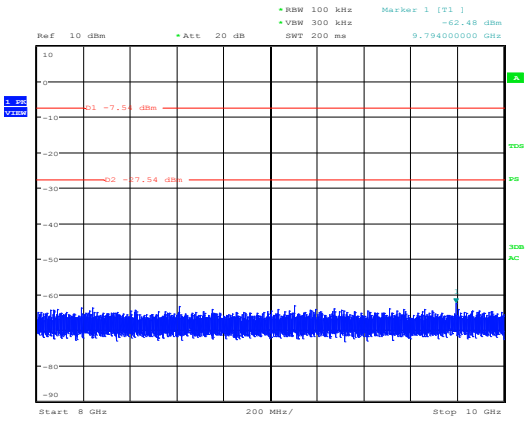
Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:58:13



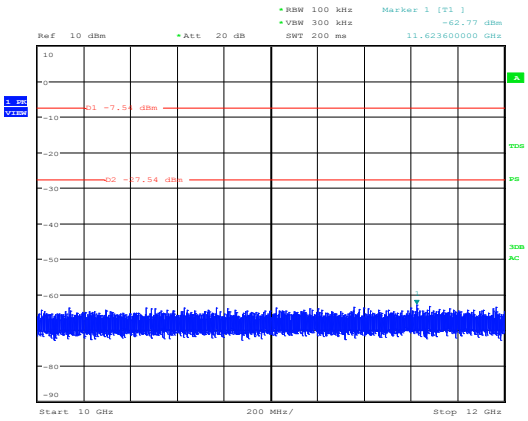
Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:58:31



Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:58:50

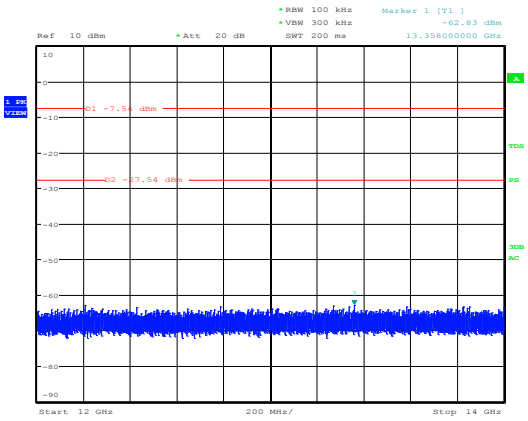


Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:59:21

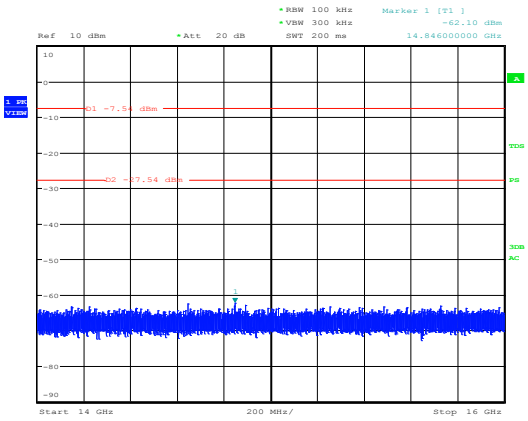


Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:59:39

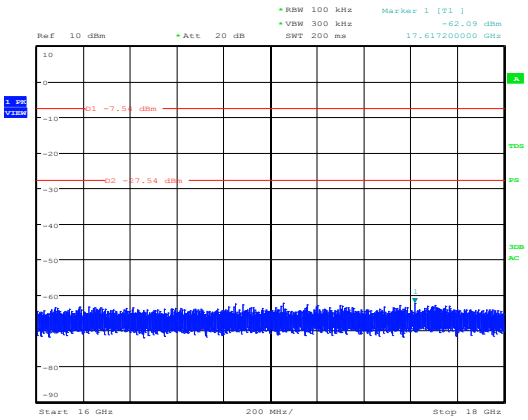
Figure 45: Conducted Spurious Emissions, 12 - 24GHz, Mode B (2440MHz), EDR (8DPSK)



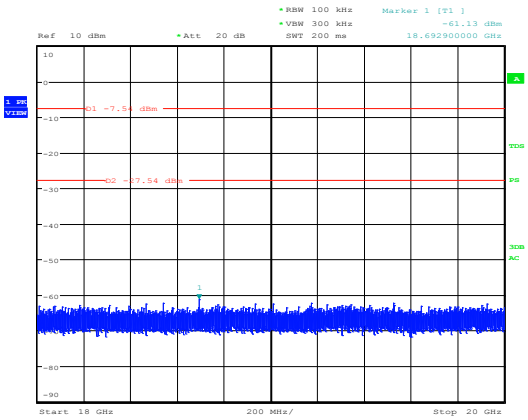
Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:00:03



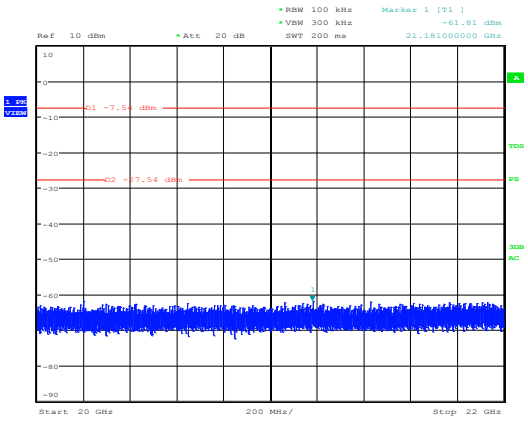
Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:00:21



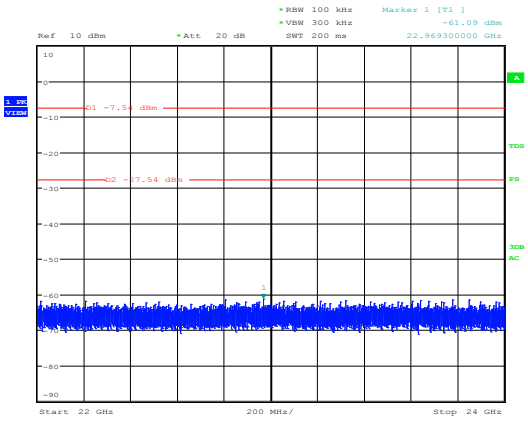
Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:00:42



Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:01:04

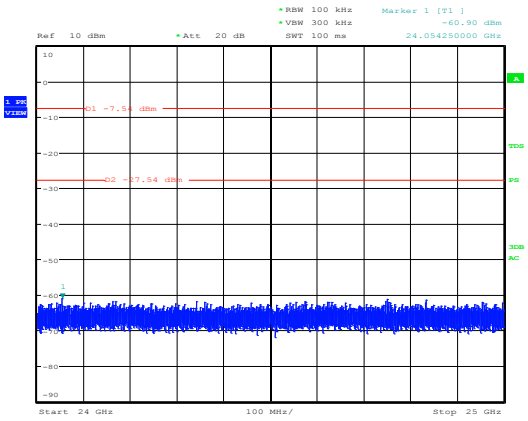


Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:01:26

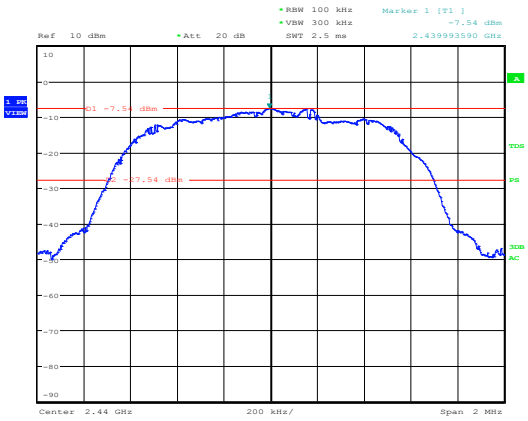


Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:01:45

Figure 46: Conducted Spurious Emissions, 24 - 25GHz, Mode B (2440MHz), EDR (8DPSK)

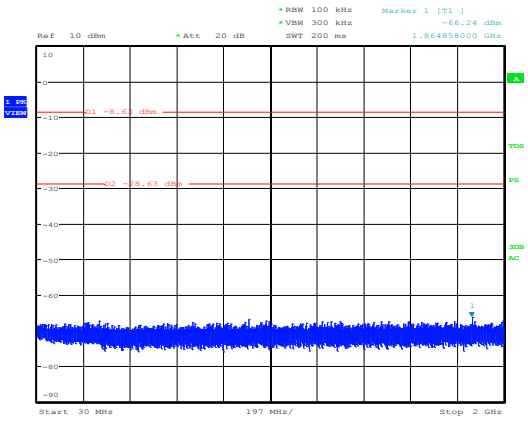


Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 11:02:09

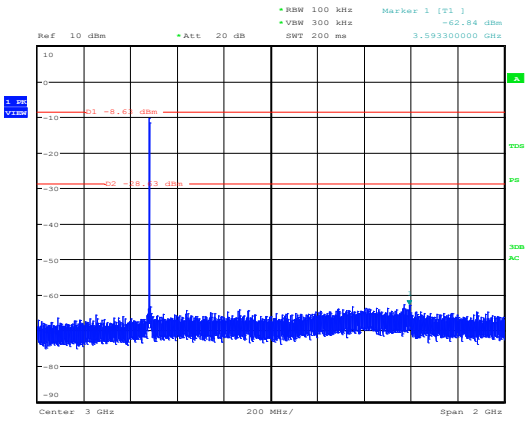


Conducted spurious emissions, mode 3-DH5, B2
Date: 15.JAN.2016 10:56:34

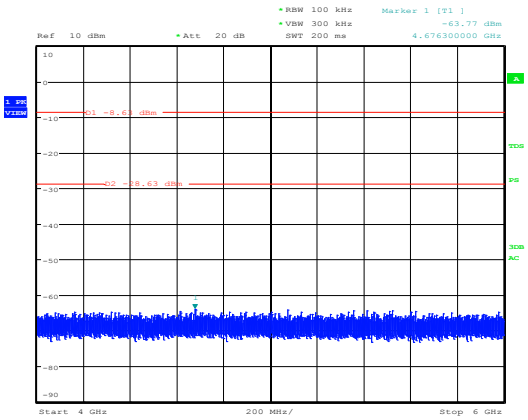
Figure 47: Conducted Spurious Emissions, 30MHz - 12GHz, Mode C (2480MHz), EDR (8DPSK)



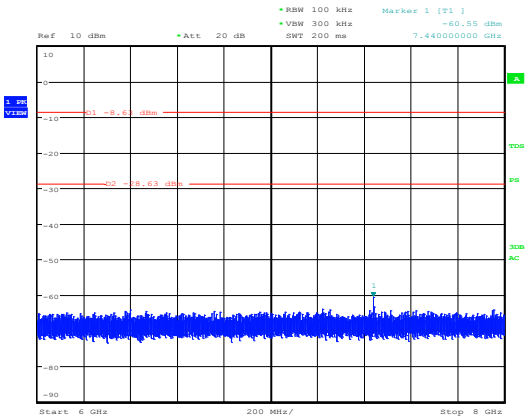
Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:04:51



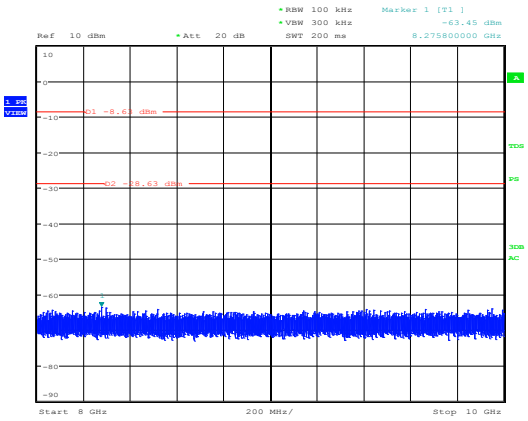
Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:05:33



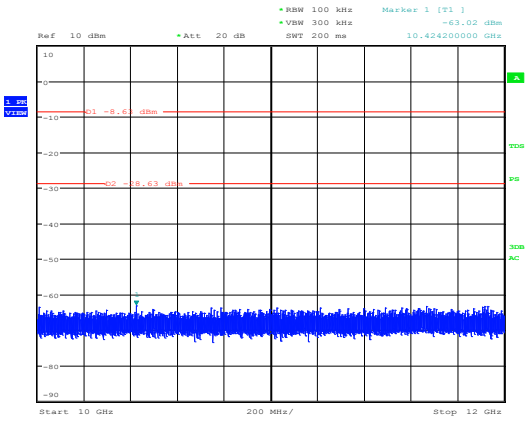
Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:05:51



Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:06:32

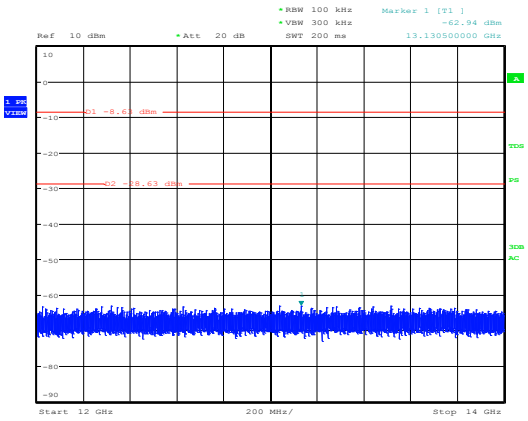


Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:06:53

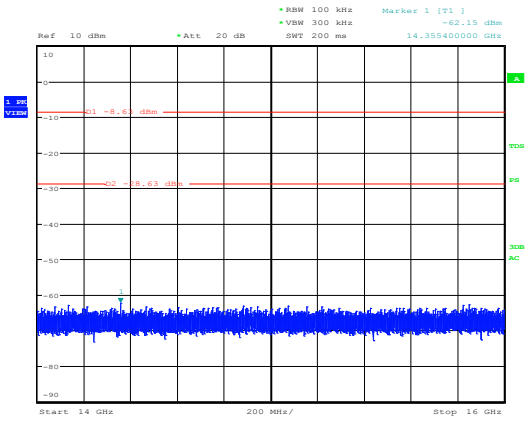


Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:07:13

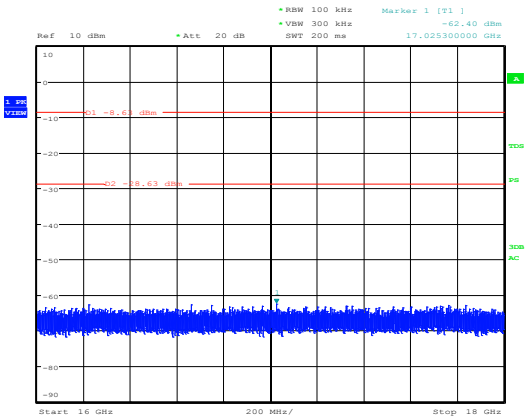
Figure 48: Conducted Spurious Emissions, 12 - 24GHz, Mode C (2480MHz), EDR (8DPSK)



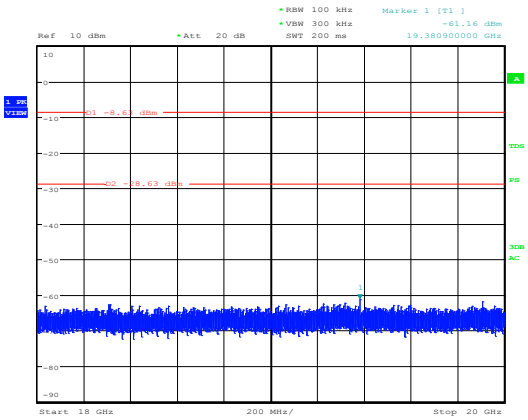
Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:07:32



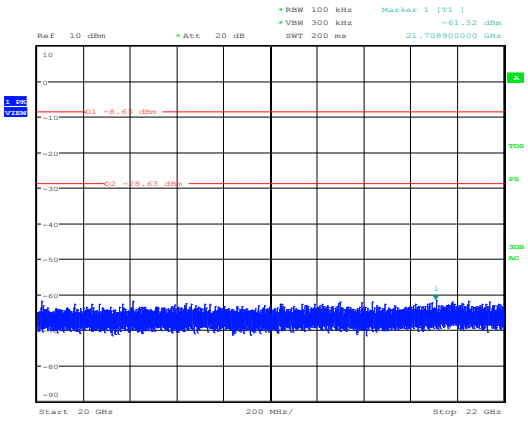
Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:08:06



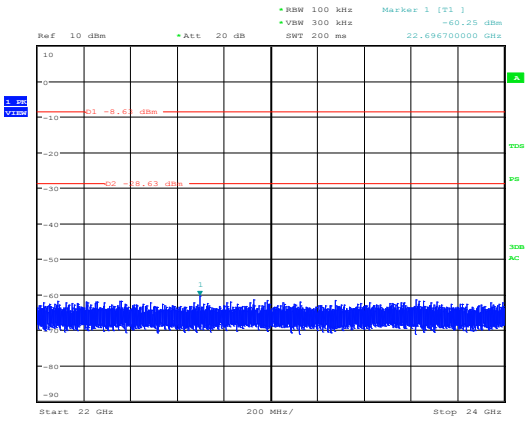
Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:08:26



Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:08:43

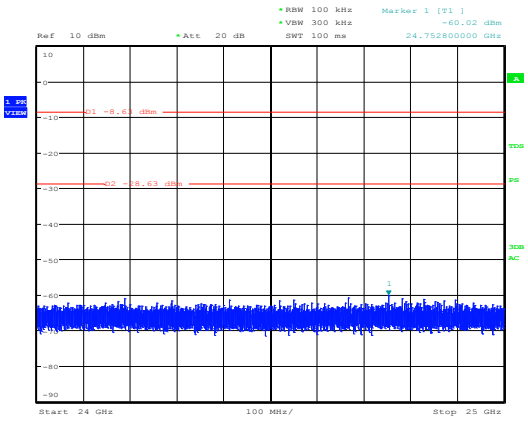


Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:09:04

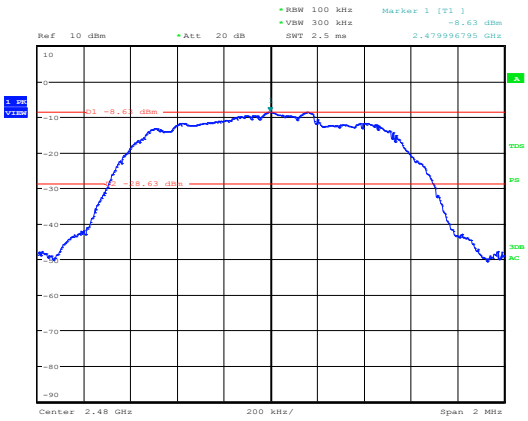


Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:09:26

Figure 49: Conducted Spurious Emissions, 24 - 25GHz, Mode C (2480MHz), EDR (8DPSK)



Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:09:46



Conducted spurious emissions, mode 3-DH5, C2
Date: 15.JAN.2016 11:04:31

5.3 Radiated Measurements

5.3.1 Radiated Spurious Emissions of Transmitter

RESULT: **PASS**

Date of testing:	2016-01-25, 2016-01-26, 2016-01-27 2016-01-28, 2016-01-29
Ambient temperature:	26, 23, 24, 25, 25°C
Relative humidity:	32, 34, 40, 39, 39%
Atmospheric pressure:	1013, 1020, 1020, 1023, 1022hPa
Frequency range:	9kHz - 25GHz
Measurement distance:	3m
Kind of test site:	Semi Anechoic Chamber

Requirements:

FCC 15.205, FCC 15.209, FCC 15.247(d), RSS-Gen 8.9 and 8.

Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a) and RSS-Gen 8.10 (table 6), must comply with the radiated emission limits specified in FCC 15.209(a) and RSS-Gen 8.9 (tables 4 and 5).

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) and RSS-Gen 8.9 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 C63.10-2013, RSS-Gen 6.13 and 8.1.

The EUT was placed on a nonconductive turntable above the ground plane. Each table height was 0.8m for below 1GHz and was 1.5m for above 1GHz. 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 was varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 9kHz 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.

For emissions between 30MHz and 1GHz, measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode. The receiver's 6dB bandwidth was set to 120kHz. For emissions above 1GHz, measurements were performed with a spectrum analyzer using the following settings: for peak field strength: RBW = 1MHz & VBW ≥ 1MHz; for average field strength: RBW = 1MHz & VBW = 10Hz.

Absorbers have been placed on the floor between the EUT and the measuring antenna for testing above 1GHz.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Emissions other than those mentioned are small or not detectable.

Precheck measurements were conducted first in both BDR and EDR configurations. Final measurement was performed in modes A, B and C for the following (worst case) configurations:

Frequency Range	Configuration for Final Measurement
9kHz-30MHz	N/A (no spurious emission was found)
30MHz-1GHz	EDR (8DPSK)
1-8GHz	BDR (GFSK) and EDR (8DPSK)
8-25GHz	BDR (GFSK)

Table 12: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
72.000	V	52.1	-17.4	34.7	40.0	5.3	100	238
96.000	V	55.7	-19.6	36.1	43.5	7.4	109	112
144.004	V	51.6	-15.5	36.1	43.5	7.4	100	129
192.000	H	55.4	-17.0	38.4	43.5	5.1	154	245
250.006	H	56.3	-15.5	40.8	46.0	5.2	118	183
278.665	V	52.1	-14.1	38.0	46.0	8.0	156	203
503.998	V	47.6	-7.8	39.8	46.0	6.2	100	162
552.010	H	47.9	-6.6	41.3	46.0	4.7 **(*)**	150	189
576.058	H	47.7	-6.1	41.6	46.0	4.4 **(*)**	139	183
822.498	V	31.3	-3.7	27.6	46.0	18.4	157	254

Note: Level QP = Reading QP + Factor

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

Table 13: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
72.001	V	52.2	-17.4	34.8	40.0	5.2	100	241
95.996	V	55.5	-19.6	35.9	43.5	7.6	107	108
143.997	V	51.6	-15.5	36.1	43.5	7.4	100	116
167.993	H	50.8	-14.8	36.0	43.5	7.5	171	244
192.001	H	55.1	-17.0	38.1	43.5	5.4	121	242
250.005	H	56.4	-15.5	40.9	46.0	5.1	105	176
275.881	H	52.7	-14.3	38.4	46.0	7.6	117	287
575.996	H	48.3	-6.1	42.2	46.0	3.8 **(*)**	136	178

Note: Level QP = Reading QP + Factor

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

Table 14: Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading QP [dBµV]	Factor [dB(1/m)]	Level QP [dBµV/m]	Limit [dBµV/m]	Margin QP [dB]	Height [cm]	Angle [°]
71.997	V	52.1	-17.4	34.7	40.0	5.3	100	238
96.002	V	55.7	-19.6	36.1	43.5	7.4	123	112
143.997	V	51.5	-15.5	36.0	43.5	7.5	100	128
167.996	H	50.8	-14.8	36.0	43.5	7.5	174	247
192.041	H	54.3	-17.0	37.3	43.5	6.2	160	257
250.003	H	56.4	-15.5	40.9	46.0	5.1	108	182
271.024	V	54.3	-14.4	39.9	46.0	6.1	159	193
552.029	H	48.1	-6.6	41.5	46.0	4.5 **(*)**	145	191
575.824	H	46.1	-6.1	40.0	46.0	6.0	140	174

Note: Level QP = Reading QP + Factor

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

Table 15: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), BDR (GFSK)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1199.858	V	43.2	-17.1	26.1	54.0	27.9	154	4
1597.595	V	42.2	-16.6	25.6	54.0	28.4	190	174
3192.451	V	41.1	-12.3	28.8	54.0	25.2	101	260
7205.972	V	46.6	-0.2	46.4	54.0	7.6	149	24
12010.151	H	40.7	-5.1	35.6	54.0	18.4	177	48
16814.670	H	41.4	-5.5	35.9	54.0	18.1	165	78
21616.850	H	42.8	-10.9	31.9	54.0	22.1	177	283

Note: Level AV = Reading AV + Factor

Table 16: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), BDR (GFSK)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1199.858	V	71.2	-17.1	54.1	74.0	19.9	154	4
1597.595	V	65.2	-16.6	48.6	74.0	25.4	190	174
3192.451	V	58.7	-12.3	46.4	74.0	27.6	101	260
7205.972	V	56.7	-0.2	56.5	74.0	17.5	149	24
12010.151	H	53.2	-5.1	48.1	74.0	25.9	177	48
16814.670	H	54.6	-5.5	49.1	74.0	24.9	165	78
21616.850	H	57.0	-10.9	46.1	74.0	27.9	177	283

Note: Level PK = Reading PK + Factor

Table 17: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), BDR (GFSK)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1199.769	V	43.3	-17.1	26.2	54.0	27.8	141	343
3186.763	V	41.4	-12.3	29.1	54.0	24.9	113	262
4851.224	H	38.3	-7.4	30.9	54.0	23.1	107	245
7319.964	V	47.5	0.3	47.8	54.0	6.2	113	67
12199.631	H	40.0	-5.6	34.4	54.0	19.6	152	48
21958.626	H	41.1	-10.8	30.3	54.0	23.7	155	330

Note: Level AV = Reading AV + Factor

Table 18: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), BDR (GFSK)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1199.769	V	73.7	-17.1	56.6	74.0	17.4	141	343
3186.763	V	59.0	-12.3	46.7	74.0	27.3	113	262
4851.224	H	54.0	-7.4	46.6	74.0	27.4	107	245
7319.964	V	57.3	0.3	57.6	74.0	16.4	113	67
12199.631	H	53.3	-5.6	47.7	74.0	26.3	152	48
21958.626	H	55.0	-10.8	44.2	74.0	29.8	155	330

Note: Level PK = Reading PK + Factor

Table 19: Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), BDR (GFSK)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1199.168	V	40.0	-17.1	22.9	54.0	31.1	148	149
1599.131	V	41.7	-16.6	25.1	54.0	28.9	104	21
3192.085	V	41.0	-12.3	28.7	54.0	25.3	124	260
7440.006	V	49.0	0.2	49.2	54.0	4.8	100	61
12399.958	H	42.4	-6.8	35.6	54.0	18.4	146	67
17360.684	H	40.6	-5.2	35.4	54.0	18.6	108	301
22318.822	H	42.6	-11.2	31.4	54.0	22.6	161	75

Note: Level AV = Reading AV + Factor

Table 20: Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), BDR (GFSK)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1199.168	V	72.1	-17.1	55.0	74.0	19.0	148	149
1599.131	V	63.3	-16.6	46.7	74.0	27.3	104	21
3192.085	V	58.1	-12.3	45.8	74.0	28.2	124	260
7440.006	V	58.7	0.2	58.9	74.0	15.1	100	61
12399.958	H	55.4	-6.8	48.6	74.0	25.4	146	67
17360.684	H	53.7	-5.2	48.5	74.0	25.5	108	301
22318.822	H	57.5	-11.2	46.3	74.0	27.7	161	75

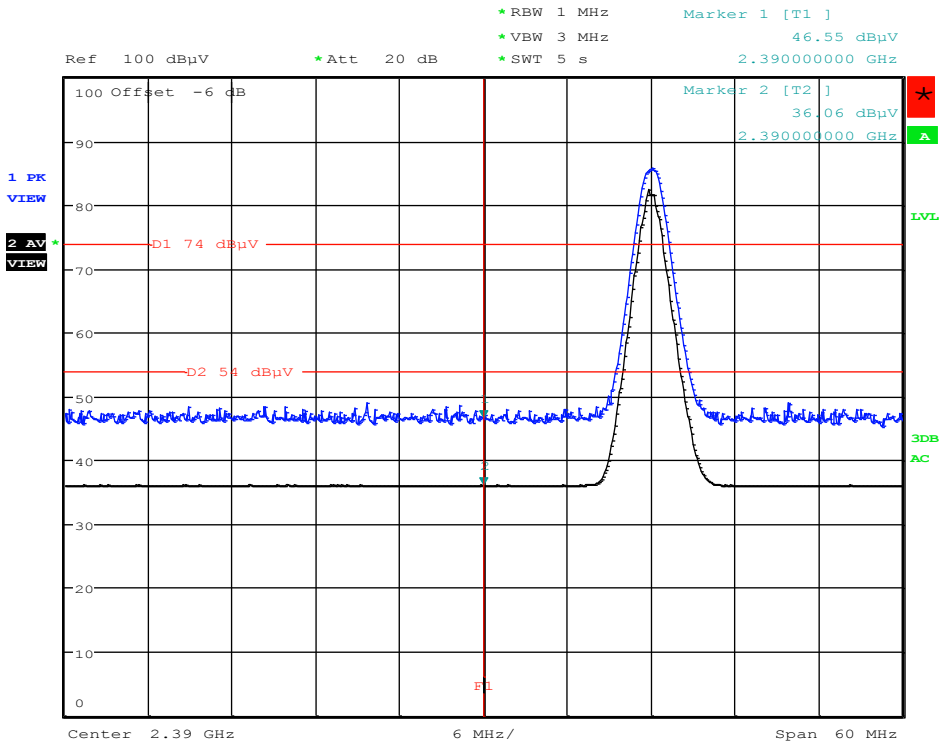
Note: Level PK = Reading PK + Factor

Table 21: Radiated Emissions at Band Edge, Average and Peak Data, Horizontal and Vertical Antenna Orientations, Modes A (2402MHz) and C (2480MHz), BDR (GFSK)

Operating Frequency [MHz]	Antenna Orientation	Level AV [dBµV/m]	Level PK [dBµV/m]	Limit AV [dBµV/m]	Limit PK [dBµV/m]	Margin AV [dB]	Margin PK [dB]
2402	V	36.06	46.55	54	74	17.94	27.45
2480	V	41.34	49.38	54	74	12.66	24.62

Notes: All correction factors (antenna, cable, pre-amplifier) are included in the measurement values.
Average limit in dBµV/m is calculated as follows: Average limit = 20 x log(500µV/m).
Peak limit in dBµV/m is calculated as follows: Peak limit = Average limit + 20dB.

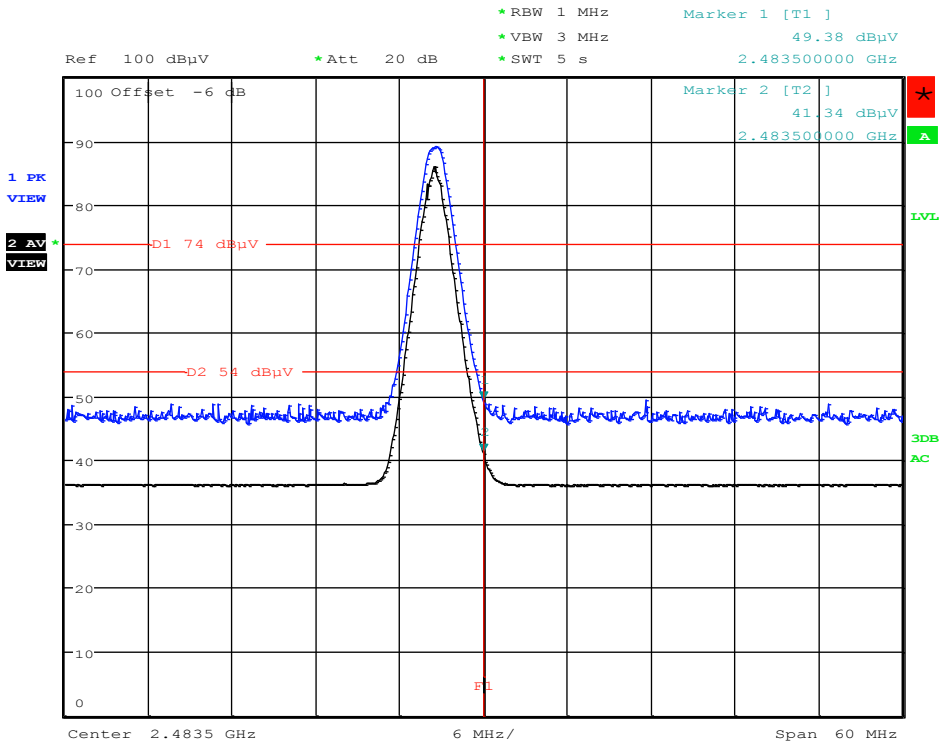
Figure 50: Radiated Emissions at Band Edge, Spectral Diagram, Mode A (2402MHz), BDR (GFSK)



Band Edge, 2.39GHz, Mode A2, DH5
Date: 29.JAN.2016 14:49:24

Note: The upper trace shows the peak value and the lower trace shows the average value.

Figure 51: Radiated Emissions at Band Edge, Spectral Diagram, Mode C (2480MHz), BDR (GFSK)



Band Edge, 2.4835GHz, Mode C2, DH5
Date: 29.JAN.2016 15:04:05

Note: The upper trace shows the peak value and the lower trace shows the average value.

Table 22: Radiated Emissions, Average Data, 1 - 8GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1196.642	V	44.2	-18.3	25.9	54.0	28.1	135	338
1596.875	V	42.3	-17.7	24.6	54.0	29.4	146	152
7204.356	H	48.6	-2.4	46.2	54.0	7.8	167	241

Note: Level AV = Reading AV + Factor

Table 23: Radiated Emissions, Peak Data, 1 - 8GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1196.642	V	76.8	-18.3	58.5	74.0	15.5	135	338
1596.875	V	62.5	-17.7	44.8	74.0	29.2	146	152
7204.356	H	58.2	-2.4	55.8	74.0	18.2	167	241

Note: Level PK = Reading PK + Factor

Table 24: Radiated Emissions, Average Data, 1 - 8GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1196.375	V	43.1	-18.3	24.8	54.0	29.2	168	332
1598.954	V	42.1	-17.7	24.4	54.0	29.6	154	235
3187.591	V	52.3	-13.0	39.3	54.0	14.7	155	275

Note: Level AV = Reading AV + Factor

Table 25: Radiated Emissions, Peak Data, 1 - 8GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1196.375	V	75.2	-18.3	56.9	74.0	17.1	168	332
1598.954	V	58.4	-17.7	40.7	74.0	33.3	154	235
3187.591	V	55.4	-13.0	42.4	74.0	31.6	155	275

Note: Level PK = Reading PK + Factor

Table 26: Radiated Emissions, Average Data, 1 - 8GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading AV [dBµV]	Factor [dB(1/m)]	Level AV [dBµV/m]	Limit [dBµV/m]	Margin AV [dB]	Height [cm]	Angle [°]
1198.879	V	43.5	-18.2	25.3	54.0	28.7	179	354
1595.754	V	40.1	-17.7	22.4	54.0	31.6	188	201
7440.231	V	44.8	-2.0	42.8	54.0	11.2	115	78

Note: Level AV = Reading AV + Factor

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

Table 27: Radiated Emissions, Peak Data, 1 - 8GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), EDR (8DPSK)

Freq. [MHz]	Antenna Orientation	Reading PK [dBµV]	Factor [dB(1/m)]	Level PK [dBµV/m]	Limit [dBµV/m]	Margin PK [dB]	Height [cm]	Angle [°]
1198.879	V	73.4	-18.2	55.2	74.0	18.8	179	354
1595.754	V	62.6	-17.7	44.9	74.0	29.1	188	201
7440.231	V	55.8	-2.0	53.8	74.0	20.2	115	78

Note: Level PK = Reading PK + Factor

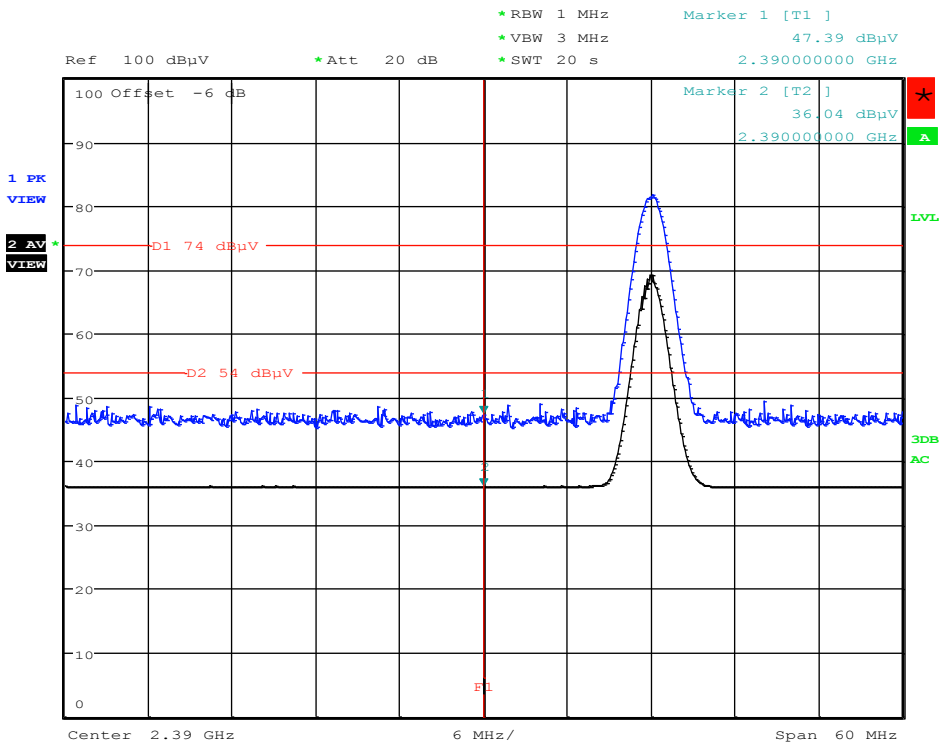
(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit

Table 28: Radiated Emissions at Band Edge, Average and Peak Data, Horizontal and Vertical Antenna Orientations, Modes A (2402MHz) and C (2480MHz), EDR (8DPSK)

Operating Frequency [MHz]	Antenna Orientation	Level AV [dBµV/m]	Level PK [dBµV/m]	Limit AV [dBµV/m]	Limit PK [dBµV/m]	Margin AV [dB]	Margin PK [dB]
2402	V	36.04	47.39	54	74	17.96	26.61
2480	V	38.81	48.80	54	74	15.19	25.20

Notes: All correction factors (antenna, cable, pre-amplifier) are included in the measurement values.
Average limit in dBµV/m is calculated as follows: Average limit = 20 x log(500µV/m).
Peak limit in dBµV/m is calculated as follows: Peak limit = Average limit + 20dB.

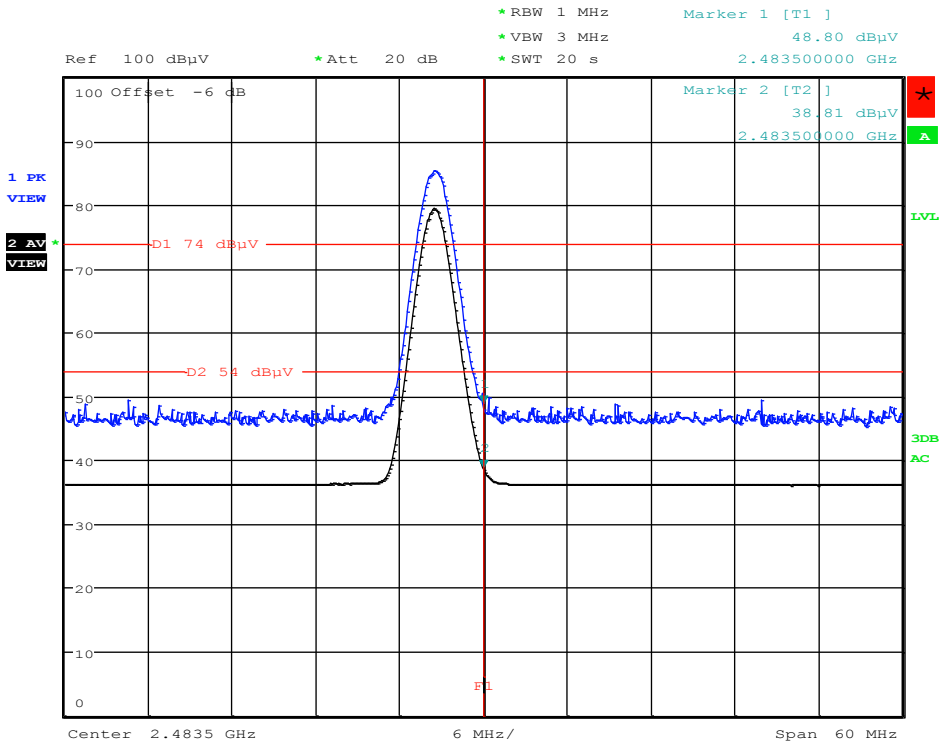
Figure 52: Radiated Emissions at Band Edge, Spectral Diagram, Mode A (2402MHz), EDR (8DPSK)



Band Edge, 2.39GHz, Mode A2, 3-DH5
Date: 29.JAN.2016 14:53:10

Note: The upper trace shows the peak value and the lower trace shows the average value.

Figure 53: Radiated Emissions at Band Edge, Spectral Diagram, Mode C (2480MHz), EDR (8DPSK)



Band Edge, 2.4835GHz, Mode C2, 3-DH5
Date: 29.JAN.2016 15:12:07

Note: The upper trace shows the peak value and the lower trace shows the average value.

5.4 AC Power Line Conducted Measurements

5.4.1 AC Power Line Conducted Emission of Transmitter

RESULT: **PASS**

Date of testing:	2016-01-13, 2016-01-29
Ambient temperature:	25, 25°C
Relative humidity:	39, 39%
Atmospheric pressure:	1012, 1019hPa
Frequency range:	0.15 - 30MHz
Kind of test site:	Shielded Room

Requirements:

FCC 15.207 and RSS-Gen 8.8

The AC power line conducted emission on any frequency within the band 150kHz to 30MHz shall not exceed the limits specified in FCC 15.207 and RSS-Gen 8.8 (table 3).

Test procedure:

ANSI C63.10-2013 and RSS-Gen 8.1

The EUT was placed on a wooden table raised 80cm above the reference ground plane. A vertical conducting plane of the screened room was located 40cm to the rear of the EUT. The AC adapter of the EUT was connected to a Line Impedance Stabilization Network (LISN).

The physical arrangement of the test system and associated cabling was varied to determine the effect on the EUT's emissions in amplitude and frequency in order to ensure that maximum emission amplitudes were attained.

The measurements were performed with a test receiver operating in the CISPR quasi-peak and average detection modes. The receiver’s 6dB bandwidth was set to 9kHz.

Precheck measurements were conducted first in both BDR and EDR configurations. Final measurement was performed in modes A, B and C for the worst case configuration only (BDR).

Disturbances other than those mentioned are small or not detectable.

Table 29: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode A (2402MHz), BDR (GFSK)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.15752	L1	47.4	30.2	9.6	57.0	39.8	65.6	55.6	8.6	15.8
0.18188	L1	44.0	26.2	9.6	53.6	35.8	64.4	54.4	10.8	18.6
0.21104	N	40.1	22.9	9.6	49.7	32.5	63.2	53.2	13.5	20.7
0.24046	N	36.8	20.9	9.6	46.4	30.5	62.1	52.1	15.7	21.6
0.24123	L1	37.1	22.0	9.6	46.7	31.6	62.1	52.1	15.4	20.5
0.27166	L1	34.1	20.4	9.6	43.7	30.0	61.1	51.1	17.4	21.1
0.39983	L1	27.1	18.5	9.7	36.8	28.2	57.9	47.9	21.1	19.7
0.48080	L1	33.0	25.5	9.7	42.7	35.2	56.3	46.3	13.6	11.1
0.70266	L1	26.6	19.5	9.7	36.3	29.2	56.0	46.0	19.7	16.8
2.67467	L1	21.8	16.6	9.8	31.6	26.4	56.0	46.0	24.4	19.6
16.85233	L1	25.1	18.3	10.2	35.3	28.5	60.0	50.0	24.7	21.5

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

Table 30: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode B (2440MHz), BDR (GFSK)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.15172	L1	48.2	30.0	9.6	57.8	39.6	65.9	55.9	8.1	16.3
0.18007	L1	43.4	24.5	9.6	53.0	34.1	64.5	54.5	11.5	20.4
0.21155	N	40.5	23.5	9.6	50.1	33.1	63.1	53.1	13.0	20.0
0.24226	N	37.7	22.8	9.6	47.3	32.4	62.0	52.0	14.7	19.6
0.28033	L1	33.6	22.0	9.6	43.2	31.6	60.8	50.8	17.6	19.2
0.30541	N	30.9	17.7	9.6	40.5	27.3	60.1	50.1	19.6	22.8
0.38302	N	27.9	16.9	9.7	37.6	26.6	58.2	48.2	20.6	21.6
0.48546	N	32.6	24.8	9.7	42.3	34.5	56.2	46.2	13.9	11.7
0.66476	L1	26.6	20.4	9.7	36.3	30.1	56.0	46.0	19.7	15.9
1.15096	N	24.8	18.5	9.7	34.5	28.2	56.0	46.0	21.5	17.8
16.80104	L1	25.2	18.1	10.2	35.4	28.3	60.0	50.0	24.6	21.7

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

Table 31: AC Power Line Conducted Emission, Quasi Peak and Average Data, 0.15 - 30MHz, Phase N (N) and L1 (L), Mode C (2480MHz), BDR (GFSK)

Freq. [MHz]	Phase	Reading QP [dBµV]	Reading AV [dBµV]	Factor [dB]	Level QP [dBµV]	Level AV [dBµV]	Limit QP [dBµV]	Limit AV [dBµV]	Margin QP [dB]	Margin AV [dB]
0.15040	L1	47.6	28.4	9.6	57.2	38.0	66.0	56.0	8.8	18.0
0.18079	L1	43.6	25.0	9.6	53.2	34.6	64.4	54.4	11.2	19.8
0.21144	L1	40.1	23.4	9.6	49.7	33.0	63.1	53.1	13.4	20.1
0.24127	N	37.1	21.7	9.6	46.7	31.3	62.1	52.1	15.4	20.8
0.27855	N	33.8	21.7	9.6	43.4	31.3	60.9	50.9	17.5	19.6
0.33355	N	28.6	15.1	9.6	38.2	24.7	59.4	49.4	21.2	24.7
0.39935	N	27.3	18.4	9.7	37.0	28.1	57.9	47.9	20.9	19.8
0.48148	L1	33.0	25.4	9.7	42.7	35.1	56.3	46.3	13.6	11.2
0.66765	L1	26.6	20.7	9.7	36.3	30.4	56.0	46.0	19.7	15.6
1.17290	L1	25.3	18.8	9.7	35.0	28.5	56.0	46.0	21.0	17.5
17.07093	L1	25.4	18.1	10.2	35.6	28.3	60.0	50.0	24.4	21.7

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

6. Photographs of the Test Setup

All photographs of the test setup are the same as in test report 50036571 001. For details, refer to the test report 50036571 001.

7. List of Tables

8. List of Figures