TÜVRheinland®

Produkte
Products

Prüfbericht - Nr.: *Test Report No.:*	**50001232 001**	**Seite 1 von 71** *Page 1 of 71*
Auftraggeber: *Client:*	**Hitachi Automotive Systems, Ltd.** 2520 Takaba Hitachinaka-shi, Ibaraki 312-8503 Japan	
Gegenstand der Prüfung: *Test Item:*	**CAN GW**	
Bezeichnung: *Identification:*	**SIB01-001A**	**Serien-Nr.:** *Serial No.:* **No.1, No.2-6**
Wareneingangs-Nr.: *Receipt No.:*	**A000040585, A000046174**	**Eingangsdatum:** *Date of Receipt:* **2014-03-10**
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, 2013)** ANSI C63.10-2009 Public Notice DA 00-705: Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems (March 30, 2000) **RSS-210 (Issue 8): 2010** **RSS-Gen (Issue 3): 2010** ANSI C63.10-2009	
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:*		
2014-05-08	A. Abe / Inspector		2014-05-08	Ralf Meiranke / Reviewer	
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges / *Other Aspects:*

Abkürzungen:	*P(ass)*	= *entspricht Prüfgrundlage*	*Abbreviations:*	*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: N/A

Contents

1. General Remarks 5
1.1 Complementary Materials 5
2. Test Sites 5
2.1 Test Facilities 5
2.2 List of Test and Measurement Instruments 6
2.3 Measurement Uncertainty 7
3. General Product Information 8
3.1 Product Function and Intended Use 8
3.2 System Details 8
3.3 Clock Frequencies 8
3.4 Noise Suppressing Parts 8
4. Test Set-up and Operation Modes 9
4.1 Test Methodology 9
4.2 Operation Modes 9
4.3 Physical Configuration for Testing 9
4.4 Test Software 11
4.5 Special Accessories and Auxiliary Equipment 11
4.6 Countermeasures to achieve EMC Compliance 12
5. Test Results RADIO 13
5.1 Technical Requirements 13
5.1.1 Supply Voltage Requirements 13
5.1.2 Antenna Requirements 13
5.1.3 Restricted Bands of Operation 14
5.2 Conducted Measurements at Antenna Port 15
5.2.1 Conducted Output Power 15
5.2.2 Carrier Frequency Separation 18
5.2.3 20dB Bandwidth 21
5.2.4 99% Bandwidth 26
5.2.5 Number of Hopping Frequencies 31
5.2.6 Average Time of Occupancy 34
5.2.7 Conducted Spurious Emissions 37
5.3 Radiated Measurements 56
5.3.1 Radiated Spurious Emissions of Transmitter 56
5.4 AC Power Line Conducted Measurements 65
5.4.1 AC Power Line Conducted Emission of Transmitter 65

6. PHOTOGRAPHS OF THE TEST SETUP 66

7. LIST OF TABLES 70

8. LIST OF FIGURES 70

9. LIST OF PHOTOGRAPHS 71

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.

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					
Spectrum Analyzer	Rohde & Schwarz	FSP30	100006/030	BT-8017	2014-10
RF Power Meter	Agilent	N1911A	MY45101737	RF-0393	2014-11
RF Peak Power Sensor	Agilent	N1921A	MY45242228	RF-0394	2014-11
Temperature Chamber	Voetsch	VT 4018	58566025090010	BT-8012	2014-08
For Radiated Emission					
Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	2014-09
Spectrum Analyzer	Rohde & Schwarz	FSP30	100006/030	BT-8017	2014-10
RF Selector (10m Chamber)	Toyo Corporation	NS4900	0703-182	RF-0029	2014-11
Trilog Antenna No. 2, 30-1000MHz	Schwarzbeck	VULB9168	9168-475	RF-0462	2015-01
10dB Attenuator	Hewlett Packard	8491A 10dB	58354	RF-0314	2014-11
Low Noise Preamplifier, 9kHz-1GHz	TSJ	MLA-10K01-B01-35	1370750	RF-0253	2014-11
Low Pass Filter, DC-1GHz	R&K	LP1000CH3	12104001	RF-0515	2014-11
Horn Antenna, 1-8GHz	Schwarzbeck	BBHA9120D	1059	RF-0553	2014-03
Microwave Preamplifier, 1-8GHz	Toyo Corporation	TPA0108-40	0634	RF-0052	2014-11
Band Reject Filter, 1-8GHz	Nitsuki	NF-49BT	027	RF-0131	2014-11
Horn Antenna with Preamplifier, 8-18GHz	Toyo Corporation	HAP06-18W	00000025	RF-0065	2014-05
High Pass Filter, 8-18GHz	Micro-Tronics	HPM50107	006	RF-0334	2014-05
Horn Antenna with Preamplifier, 18-26.5GHz	Toyo Corporation	HAP18-26N	00000010	RF-0070	2014-05
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
DC Power Supply	Conrad Electronic	PS-2403-D	-	Y3-0273	N/A
True RMS Multimeter	Fluke	87V	97680445	RF-0281	2015-01

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	20Hz - 40GHz	±1.5dB
Radiated Emission	9kHz – 150kHz	±4.0dB
	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) SIB01-001A is an Bluetooth device that transmits vehicle status information to a radio device (e.g. smartphone) with Bluetooth communication.

Note: GDL01-001A is an optional unit for SIB01-001A and stores GPS data into USB memory via USB interface. This optional unit GDL01-001A does not have any transmitter.

3.2 System Details

Radio standard:	Bluetooth 2.1 with EDR (class 2)
Specified output power:	Max. 4.0dBm
Antenna gain:	0.1dBi (Average), 1.6dBi (Peak)
Antenna type:	Chip antenna
Antenna mounting type:	Internal (Mounted on PCB)
Frequency range:	2402 - 2480MHz
Number of channels:	79
Channel spacing:	1MHz
Modulation type:	FHSS coupled with GFSK, π/4-DQPSK and 8DPSK
FCC classification:	DSS (Spread Spectrum Transmitter)
IC classification:	Bluetooth Device
Emission designator:	904KFXD (GFSK) and 1M18GXD (π/4-DQPSK & 8DPSK)
Rated voltage:	DC 9 - 16 V
Rated current:	Max. 1.0 A
Protection class:	III
Environment:	Vehicle use
Test voltage:	13.2V

3.3 Clock Frequencies

The highest frequency generated or used by the EUT are 4963MHz for Local VCO frequency in a Bluetooth module and 151.922MHz for the digital interface in a CPU.

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, 15.209 and Public Notice DA 00-705.

The test methods, which have been used, are based on ANSI C63.10-2009 and RSS-Gen (Issue 3).

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 (2441MHz) 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.

B. EUT transmits (TX mode), with full power, at middle channel (2441MHz), a continuous modulated signal streaming.

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

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

4.3 Physical Configuration for Testing

The EUT was tested on a stand-alone basis (only attached to the test jig) 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 C63.10-2009.

Figure 1: Block Diagram

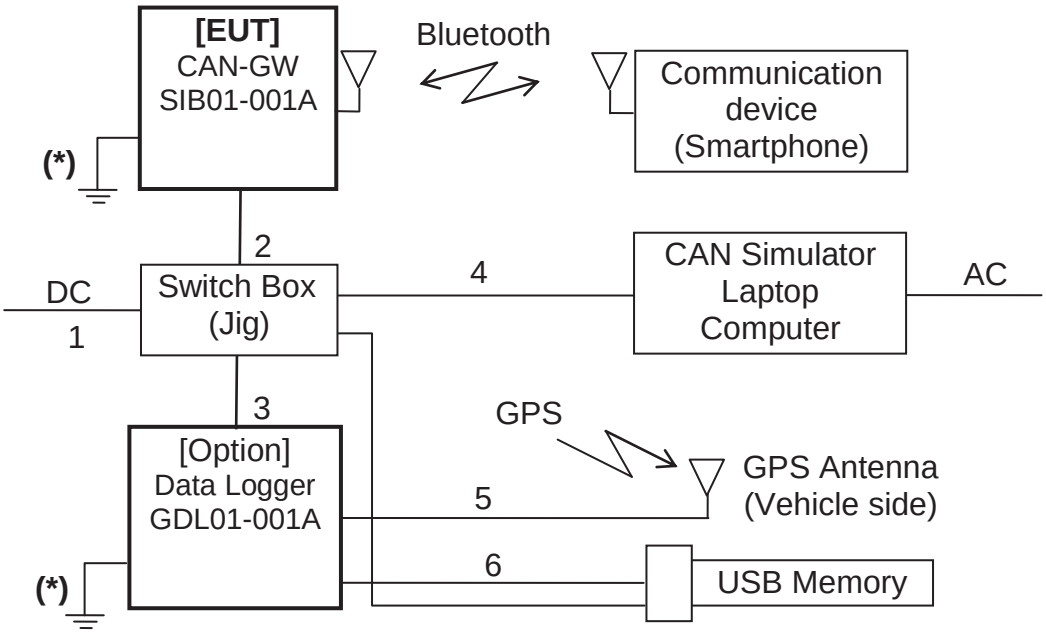


Table 3: Interfaces present on the EUT

No.	Interface	Cable Length for Testing, Shielding	Interface Classification
1.	DC Mains for CAN GW and Data Logger	2.0m, Un-shielded	DC Power Line
2.	CAN cable for CAN GW	5.2m, Un-shielded	Signal and DC Power Line
3.	CAN cable for CAN GW	5.2m, Un-shielded	Signal and DC Power Line
4.	Local bus Cable	10m, Un-shielded	Signal Line
5.	GPS Antenna Cable	1.3m, Shielded	Signal Line
6.	USB Cable	2.0m, Shielded	Signal Line

Notes:

Two test samples were available. Sample No. 2-6 was used for antenna conducted measurements and sample No. 1 was used for radiated measurements.

(*) In order to simulate vehicle environment, EUTs were grounded by cables.

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: CAN soft for Radio part version 2013/11/29 ver. by Hitachi Automotive Systems.
Software used for testing: CAN soft for EMC part version 2014/03/11 ver. by Hitachi Automotive Systems.

This software was running on the laptop computer connected to the EUT. 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. Product: Laptop Computer
   Manufacturer: HP
   Model: Compaq 6710b
   Rated Voltage: DC 19V
   Input Current: 4.74A
   Protection Class: III
   Serial Number: CNU83718YN

2. Product: AC Adapter for Laptop Computer
   Manufacturer: HP
   Model: HSTNN-DA12
   Rated Voltage: AC 100-240V
   Input Current: 3.5A
   Frequency: 50-60Hz
   Protection Class: II
   Serial Number: WBGYE0AAR1U67O

3. Product: Laptop Computer (Conducted Radio Part)
   Manufacturer: Hitachi, Ltd.
   Model: PC8NB9-X414CCAE0
   Rated Voltage: DC 19V
   Input Current: 3.42A
   Protection Class: III
   Serial Number: T616-014175

4. Product: AC Adapter for Laptop Computer (Conducted Radio Part)
   Manufacturer: Hitachi, Ltd.
   Model: PC-AP7900
   Rated Voltage: AC 100-240V
   Input Current: 1.5A
   Frequency: 50-60Hz
   Protection Class: II
   Serial Number: 9YW0608005174

5. Product: CAN Card Bus
   Manufacturer: Interface
   Model: CSI-485120
   Protection Class: III
   Serial Number: 0273725557

6. Product: GPS Antenna
   Model: Un-specified
   Serial Number 2683

7. Product: USB Memory
   Manufacturer: Silicon Power
   Model: Ultima110
   Rated Voltage: DC 5V
   Serial Number: D33B29

8. Product: USB Memory Adapter
   Model: Un-specified

9. Product: Cellular Phone (2nd Radio Device)
   Manufacturer: Sony
   Model: Xperia SO-04E
   Serial Number: CB5A1U5A7S

4.6 Countermeasures to achieve EMC 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 is battery operated and it was tested with a new battery. 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 7.2.2

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: 2014-03-13

Ambient temperature: 24°C
Relative humidity: 40%
Atmospheric pressure: 1005hPa

Requirements:

FCC 15.247(b) (1) and RSS-210 A8.4(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 (21dBm).

Test procedure:

ANSI C63.10-2009, RSS-Gen 4.8 and Public Notice DA 00-705.

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 modulations (data rates) in order to identify the one producing the highest output power. The results given here below show that the worst case output power is found at the data rate of 3Mbps for the radio DH5 and of 1Mbps for the radio DH5. Therefore, all the other measurements for the evaluation of the radio properties of the EUT have been performed using this data rates.

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

Data Rate [Mbps]	Reading [dBm]	Correction Factor [dB]	Output Power [dBm]	Output Power [mW]	Limit [dBm]	Limit [mW]	Margin [dB]
DH5	-1.50	0.50	-1.00	0.79	30.00	1000	31.00
DH3	-1.50	0.50	-1.00	0.79	30.00	1000	31.00
DH1	-1.50	0.50	-1.00	0.79	30.00	1000	31.00
2-DH5	0.50	0.50	1.00	1.26	20.97	125	19.97
2-DH3	0.49	0.50	0.99	1.26	20.97	125	19.98
2-DH1	0.49	0.50	0.99	1.26	20.97	125	19.98
3-DH5	0.90	0.50	1.40	1.38	20.97	125	19.57
3-DH3	0.79	0.50	1.29	1.35	20.97	125	19.68
3-DH1	0.86	0.50	1.36	1.37	20.97	125	19.61

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

Table 5: Conducted Output Power, Mode B (2441MHz), all Data Rates

Data Rate [Mbps]	Reading [dBm]	Correction Factor [dB]	Output Power [dBm]	Output Power [mW]	Limit [dBm]	Limit [mW]	Margin [dB]
DH5	-1.16	0.50	-0.66	0.86	30.00	1000	30.66
DH3	-1.17	0.50	-0.67	0.86	30.00	1000	30.67
DH1	-1.17	0.50	-0.67	0.86	30.00	1000	30.67
2-DH5	0.90	0.50	1.40	1.38	20.97	125	19.57
2-DH3	0.84	0.50	1.34	1.36	20.97	125	19.63
2-DH1	0.88	0.50	1.38	1.37	20.97	125	19.59
3-DH5	1.25	0.50	1.75	1.50	20.97	125	19.22
3-DH3	1.11	0.50	1.61	1.45	20.97	125	19.36
3-DH1	1.19	0.50	1.69	1.48	20.97	125	19.28

Grey shading area shows the highest power in the corresponding modulation.

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

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

Data Rate [Mbps]	Reading [dBm]	Correction Factor [dB]	Output Power [dBm]	Output Power [mW]	Limit [dBm]	Limit [mW]	Margin [dB]
DH5	-1.18	0.50	-0.68	0.86	30.00	1000	30.68
DH3	-1.19	0.50	-0.69	0.85	30.00	1000	30.69
DH1	-1.18	0.50	-0.68	0.86	30.00	1000	30.68
2-DH5	0.87	0.50	1.37	1.37	20.97	125	19.60
2-DH3	0.85	0.50	1.35	1.36	20.97	125	19.62
2-DH1	0.83	0.50	1.33	1.36	20.97	125	19.64
3-DH5	1.25	0.50	1.75	1.50	20.97	125	19.22
3-DH3	1.13	0.50	1.63	1.46	20.97	125	19.34
3-DH1	1.15	0.50	1.65	1.46	20.97	125	19.32

Grey shading area shows the highest power in the corresponding modulation.

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

5.2.2 Carrier Frequency Separation

RESULT: **PASS**

Date of testing: 2014-03-13

Ambient temperature: 24°C
Relative humidity: 40%
Atmospheric pressure: 1005hPa

Requirements:

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

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

Test procedure:

ANSI C63.10-2009 and Public Notice DA 00-705.

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

Modulation	Channel Separation [kHz]	Maximum 20dB Bandwidth [kHz]	Limit [kHz]
GFSK	1002	875.00	875.00
8DPSK	1002	1288.46	858.97

Notes: Limit = 20dB bandwidth * 2/3 since it is greater than 125kHz and the output power is less than 125mW.

Figure 2: Carrier Frequency Separation, GFSK

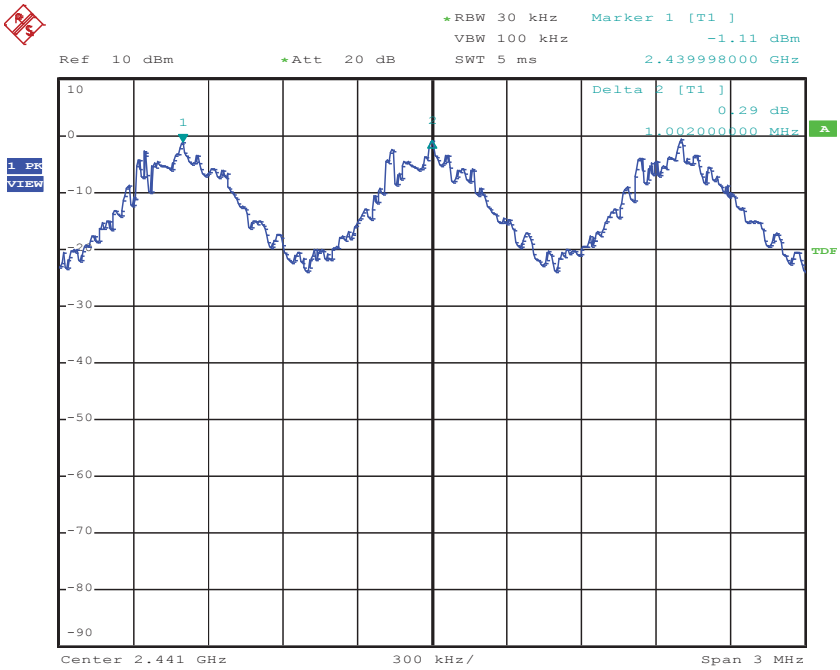
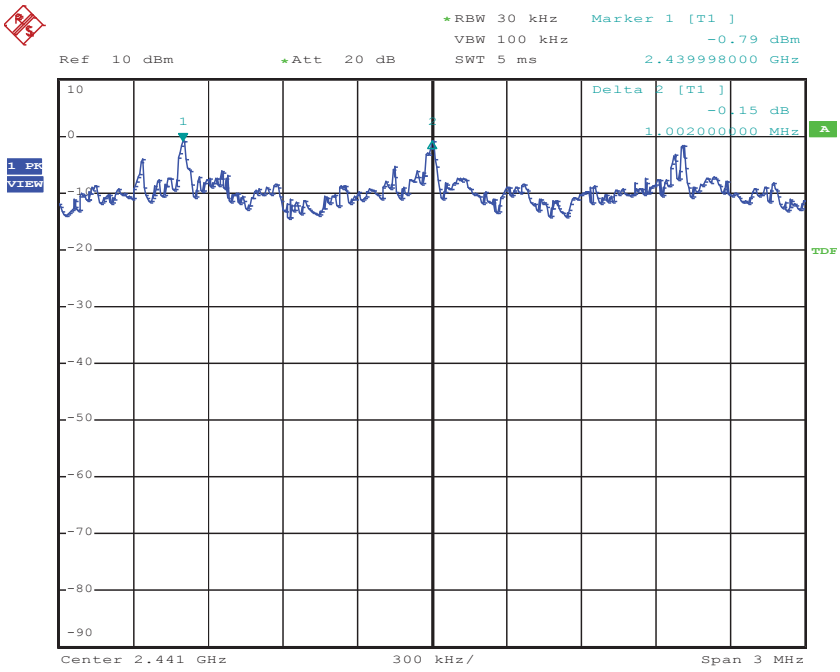


Figure 3: Carrier Frequency Separation, 8DPSK



Comment: Hopping Channel, 3-DH5
Date: 14.MAR.2014 15:28:07

5.2.3 20dB Bandwidth

Date of testing:	2014-03-13
Ambient temperature:	24°C
Relative humidity:	40%
Atmospheric pressure:	1005hPa

Requirements:

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

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 C63.10-2009, RSS-Gen 4.6.2 and Public Notice DA 00-705.

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

Modulation	Operating Frequency [MHz]	20dB Bandwidth [kHz]
GFSK	2402	966.00
GFSK	2441	972.00
GFSK	2480	972.00
8DPSK	2402	1278.00
8DPSK	2441	1284.00
8DPSK	2480	1284.00

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

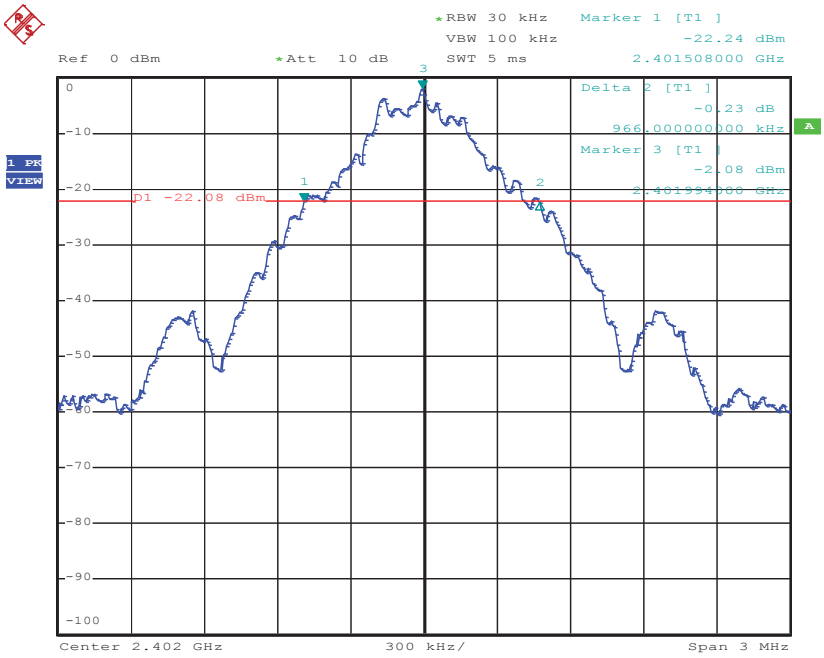
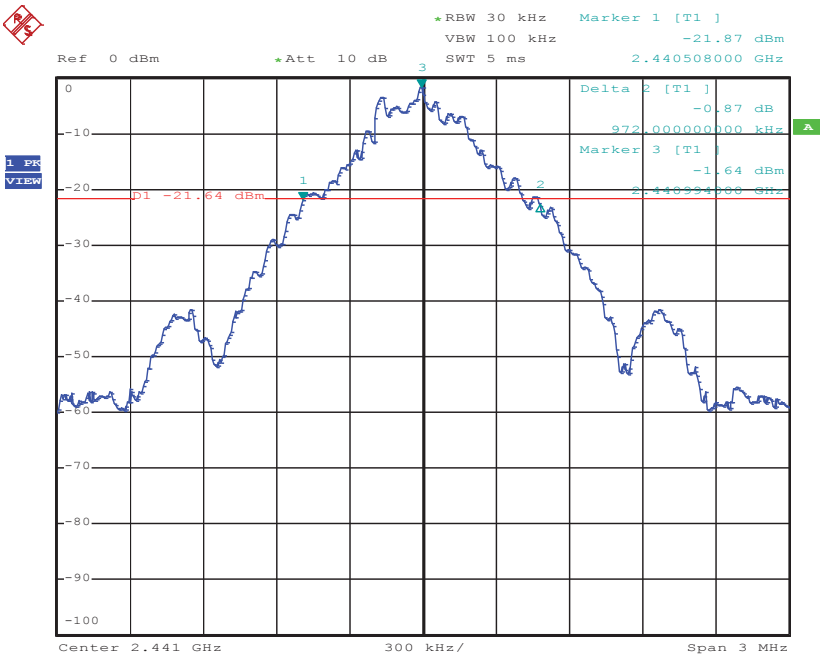
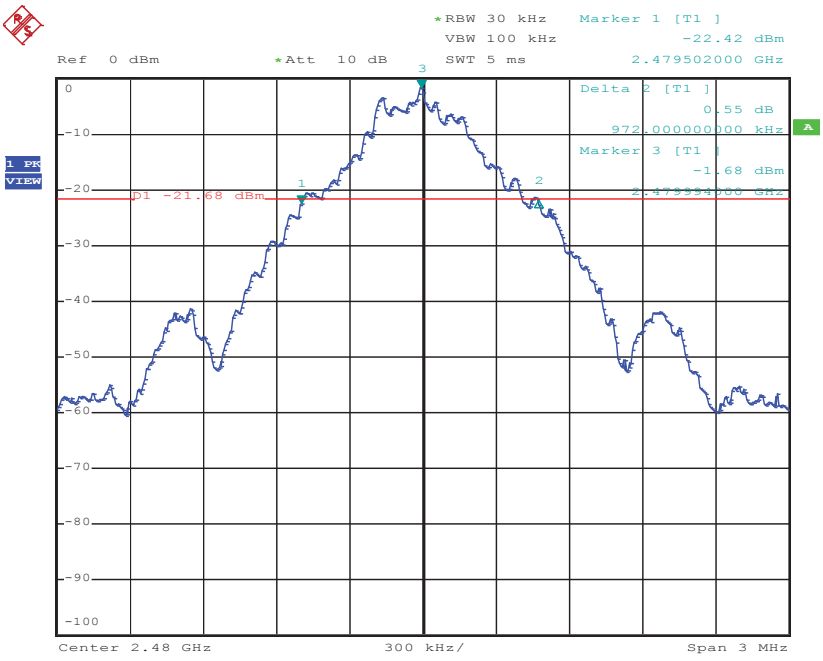


Figure 5: 20dB Bandwidth, Mode B (2441MHz), GFSK



Comment: 20dB Bandwidth 2441MHz DH5
Date: 13.MAR.2014 12:57:29

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



Comment: 20dB Bandwidth 2480MHz DH5
Date: 13.MAR.2014 12:59:56

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

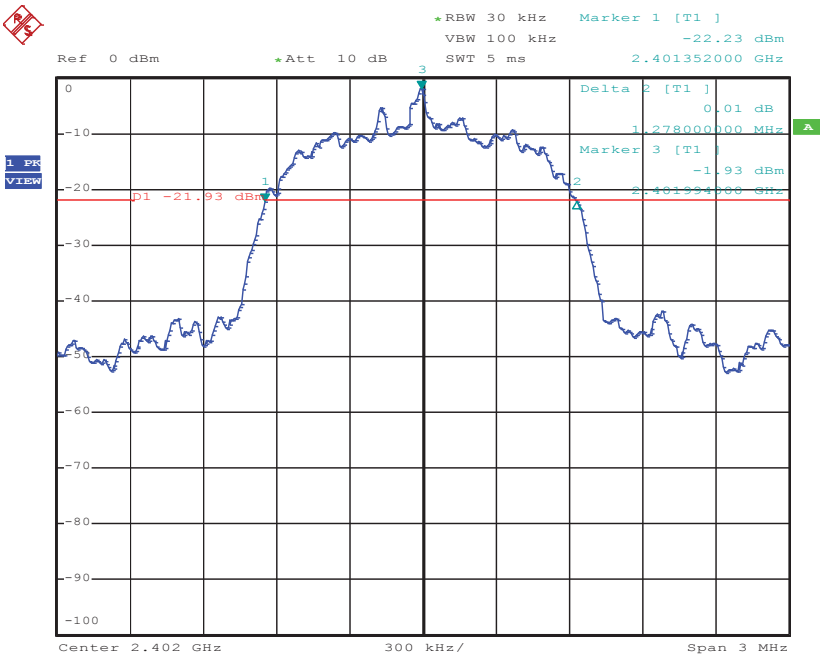


Figure 8: 20dB Bandwidth, Mode B (2441MHz), 8DPSK

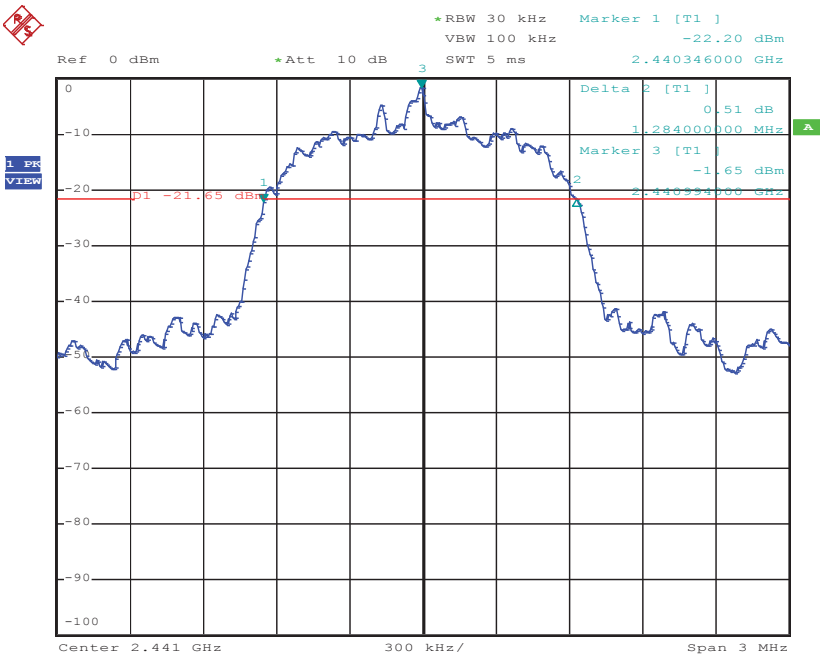
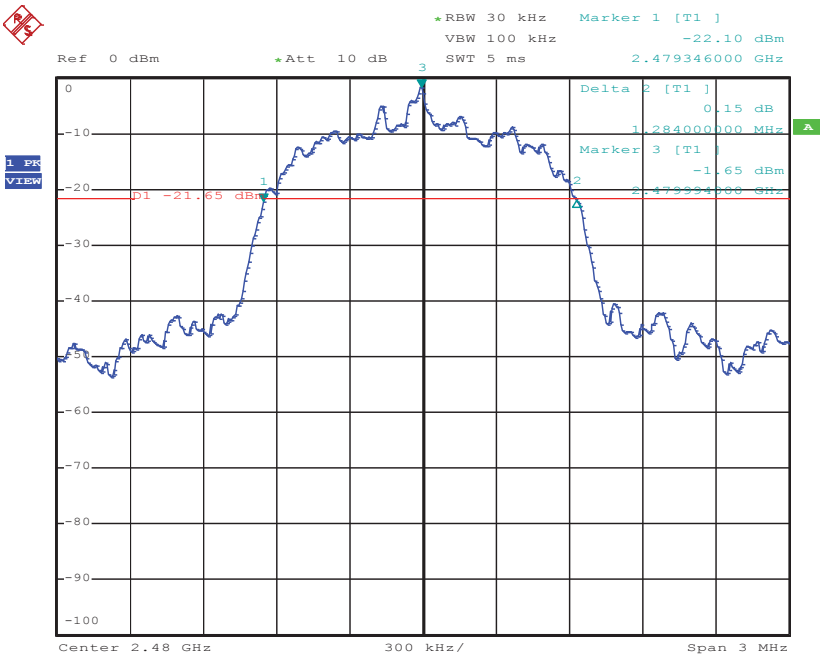


Figure 9: 20dB Bandwidth, Mode C (2480MHz), 8DPSK



Comment: 20dB Bandwidth 2480MHz 3-DH5
Date: 13.MAR.2014 13:04:08

5.2.4 99% Bandwidth

Date of testing:	2014-03-31
Ambient temperature:	22°C
Relative humidity:	20%
Atmospheric pressure:	1003hPa

Requirements:

RSS-Gen 4.6.1

The 99% bandwidth shall be reported according to RSS-Gen 4.6.1.

Test procedure:

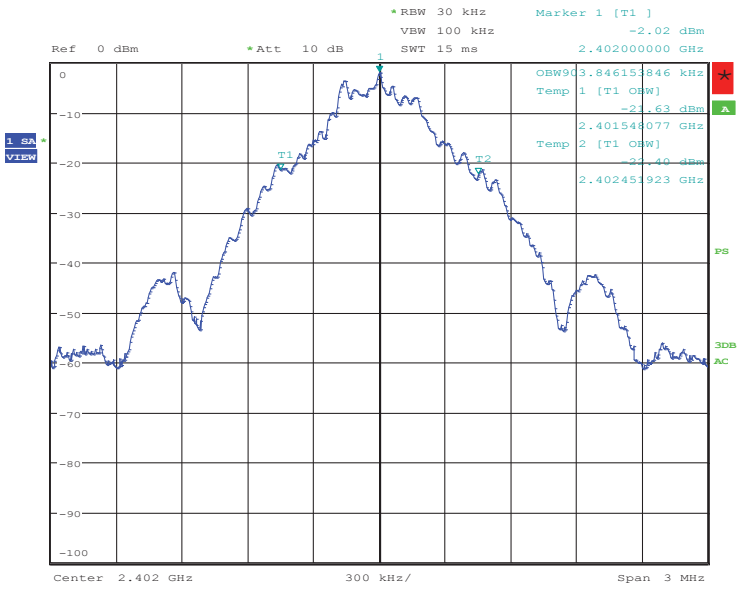
RSS-Gen 4.6.1.

The 99% bandwidth was measured at the antenna port with a spectrum analyzer using a sample detector. The resolution bandwidth was set to 1MHz (1% of the span) and the video bandwidth to 3MHz. The 99% bandwidth was measured by using the OBW function of the analyzer with a 99% coverage setting.

Table 9: 99% Bandwidth

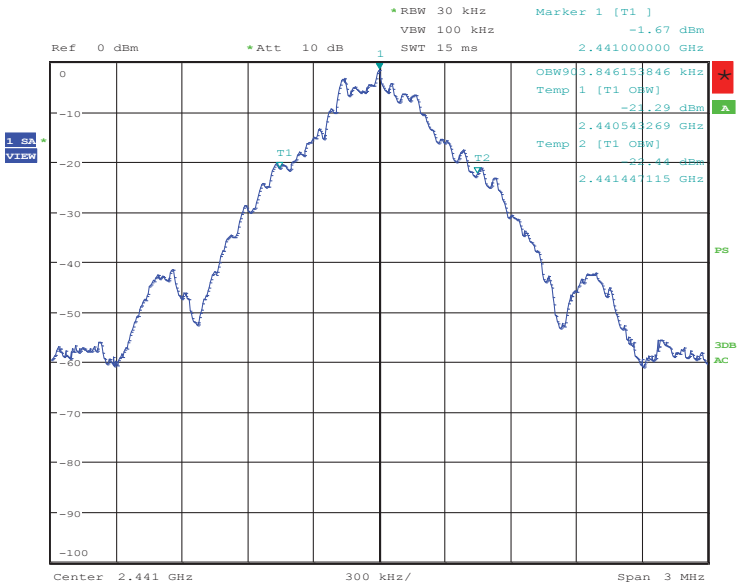
Modulation	Operating Frequency [MHz]	99% Bandwidth [kHz]
GFSK	2402	903.85
GFSK	2441	903.85
GFSK	2480	903.85
8DPSK	2402	1177.88
8DPSK	2441	1177.88
8DPSK	2480	1182.69

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



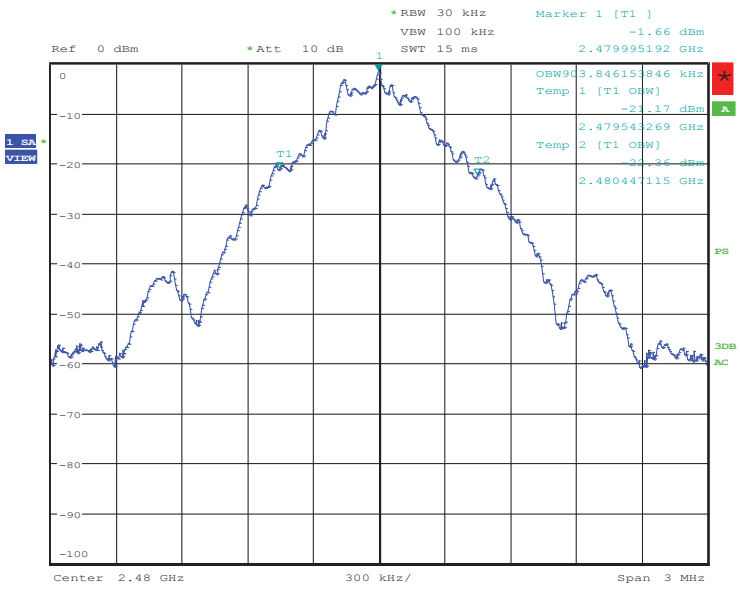
99% Bandwidth 2402MHz DH5
Date: 31.MAR.2014 10:57:00

Figure 11: 99% Bandwidth, Mode B (2441MHz), GFSK



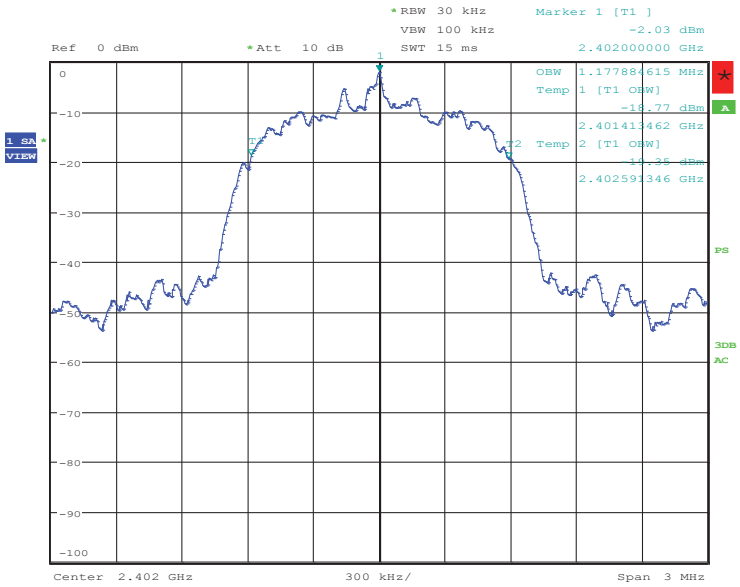
99% Bandwidth 2441MHz DH5
Date: 31.MAR.2014 11:02:34

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



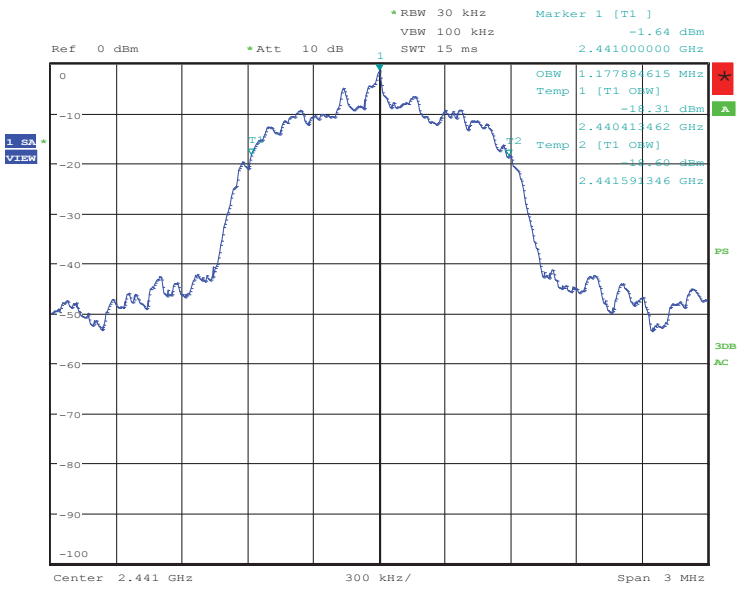
99% Bandwidth 2480MHz DH5
Date: 31.MAR.2014 11:04:37

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



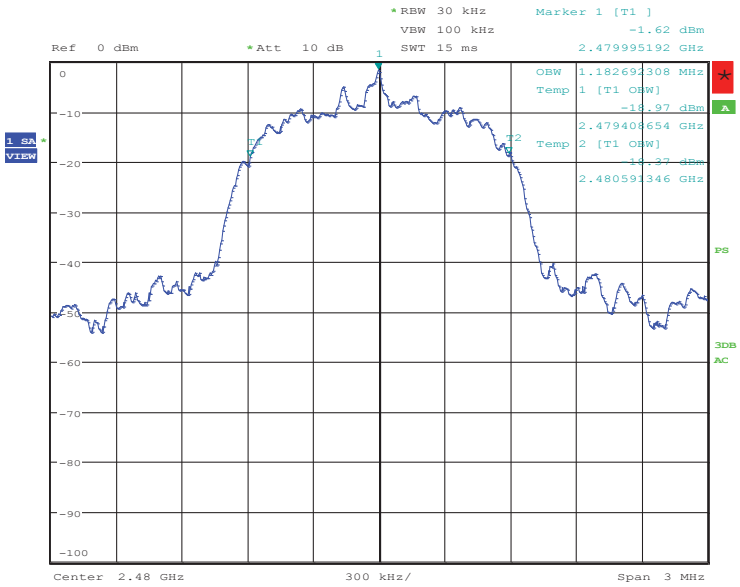
99% Bandwidth 2402MHz 3-DH5
Date: 31.MAR.2014 10:59:08

Figure 14: 99% Bandwidth, Mode B (2441MHz), 8DPSK



99% Bandwidth 2441MHz 3-DH5
Date: 31.MAR.2014 11:01:06

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



99% Bandwidth 2480MHz 3-DH5

Date: 31.MAR.2014 11:06:11

5.2.5 Number of Hopping Frequencies

RESULT: **PASS**

Date of testing:	2014-03-14
Ambient temperature:	24°C
Relative humidity:	33%
Atmospheric pressure:	1000hPa

Requirements:

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

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

Test procedure:

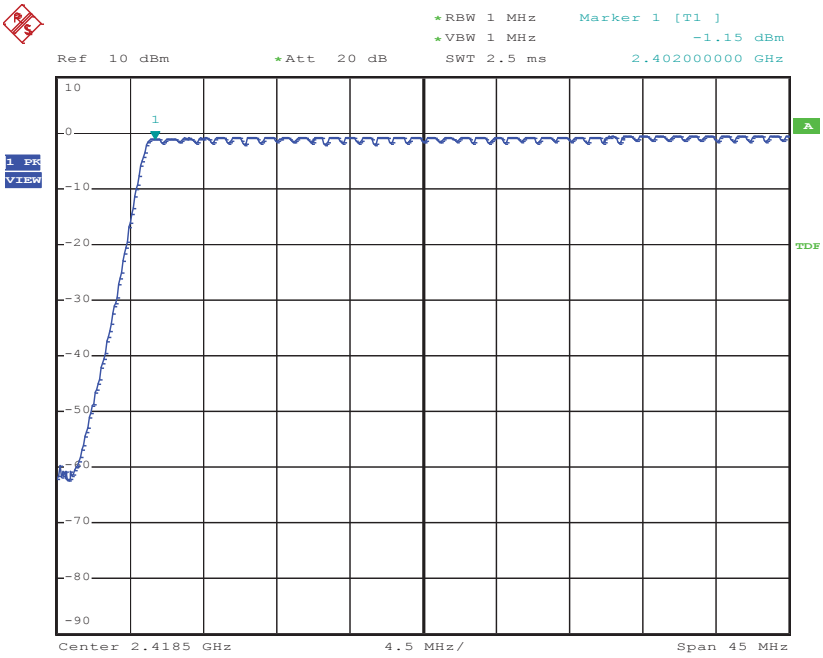
ANSI C63.10-2009 and Public Notice DA 00-705.

A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth and video bandwidth were set to 1MHz. The spectrum was broken in two plots having each a 45MHz span to show all the hopping frequencies.

Table 10: Number of Hopping Frequencies

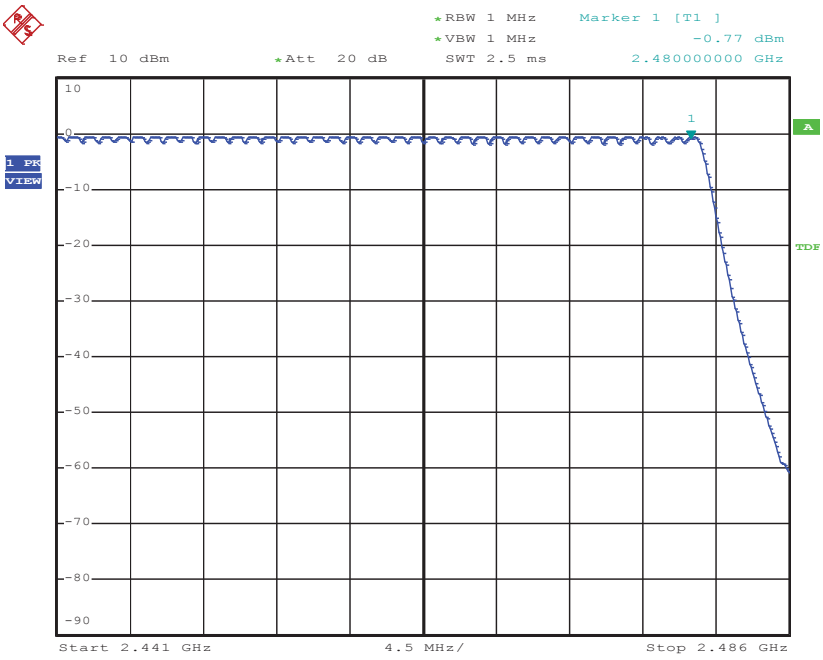
Number of Hopping Frequencies	Limit
79	15

Figure 16: Hopping Frequencies up to 2441MHz, Mode D (Hopping)



Comment: Hopping Sequence, DH5 - 1
Date: 14.MAR.2014 15:35:24

Figure 17: Hopping Frequencies above 2441MHz, Mode D (Hopping)



Comment: Hopping Sequence, DH5 - 2
Date: 14.MAR.2014 15:37:31

5.2.6 Average Time of Occupancy

RESULT: **PASS**

Date of testing: 2014-03-14

Ambient temperature: 24°C
Relative humidity: 33%
Atmospheric pressure: 1000hPa

Requirements:

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

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 C63.10-2009 and Public Notice DA 00-705.

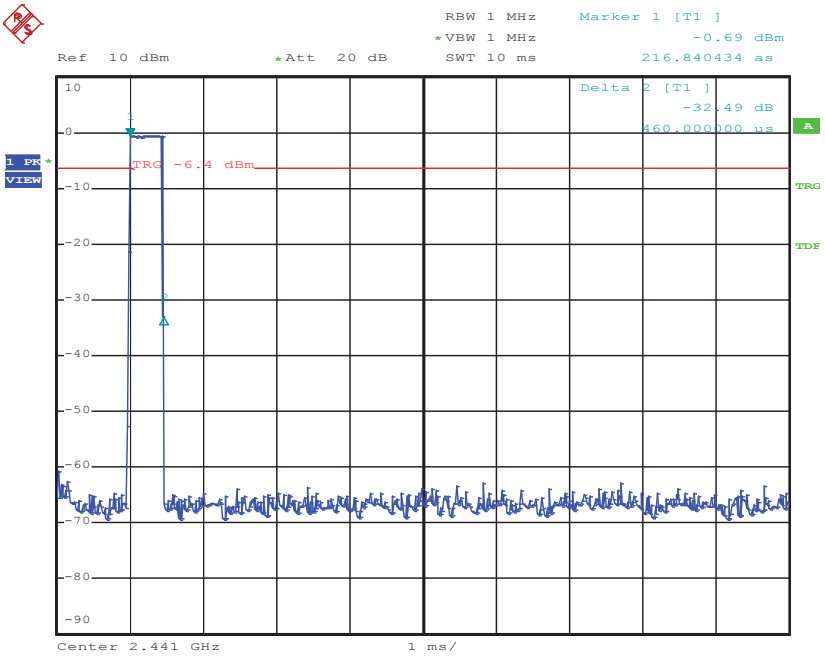
A spectrum analyzer was connected to the antenna port of the EUT. The analyzer resolution bandwidth and video bandwidth were set to 1MHz. The average time of occupancy was obtained by measuring first the dwell time of a single packet with the Delta Marker function using a zero span centered on a hopping channel and by counting then the number of hops per channel in a 31.6s period (0.4s times the number of hopping channels).

Table 11: Average Time of Occupancy

Packet Type	Packet Duration [ms]	Number of Hops per Channel in a 31.6s Period	Average Time of Occupancy [ms]	Limit [ms]
DH1	0.460	320	147.20	400
DH3	1.720	160	275.20	400
DH5	2.960	106.67	315.74	400

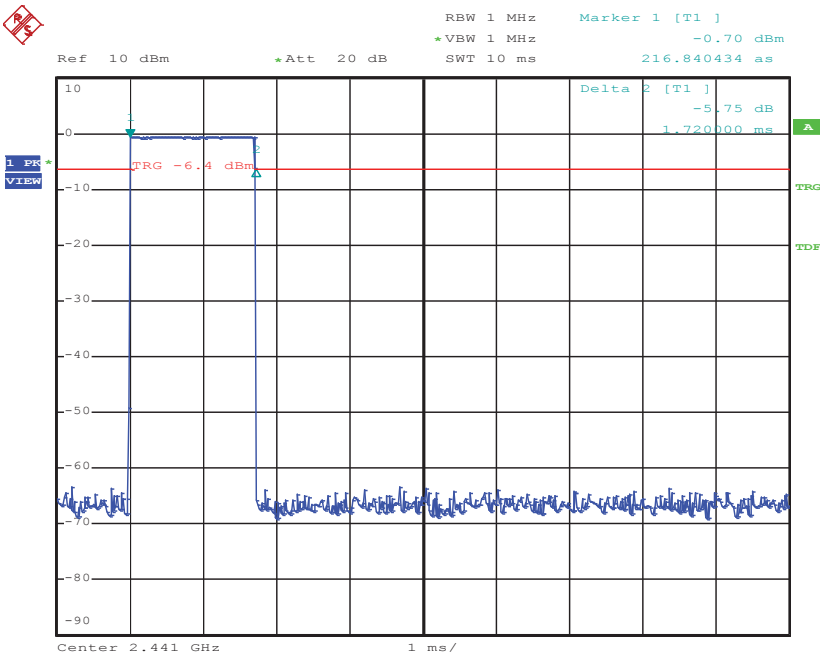
Notes: DH1 Packet type permits maximum 1600 / 79 / 2 = 10.13 hops per second in each channel (1 time slot for Tx and 1 time slot for Rx).The number of hops within 31.6 sec. = 320 hops in each channel.
DH3 Packet type permits maximum 1600 / 79 / 4 = 5.06 hops per second in each channel (3 time slot for Tx and 1 time slot for Rx).The number of hops within 31.6 sec. = 160 hops in each channel.
DH5 Packet type permits maximum 1600 / 79 / 6 = 3.38 hops per second in each channel (5 time slot for Tx and 1 time slot for Rx).The number of hops within 31.6 sec. = 106.67 hops in each channel.
Average time of occupancy = Packet duration * Number of hops per channel in a 31.6s period

Figure 18: Dwell Time, Mode D (Hopping), DH1



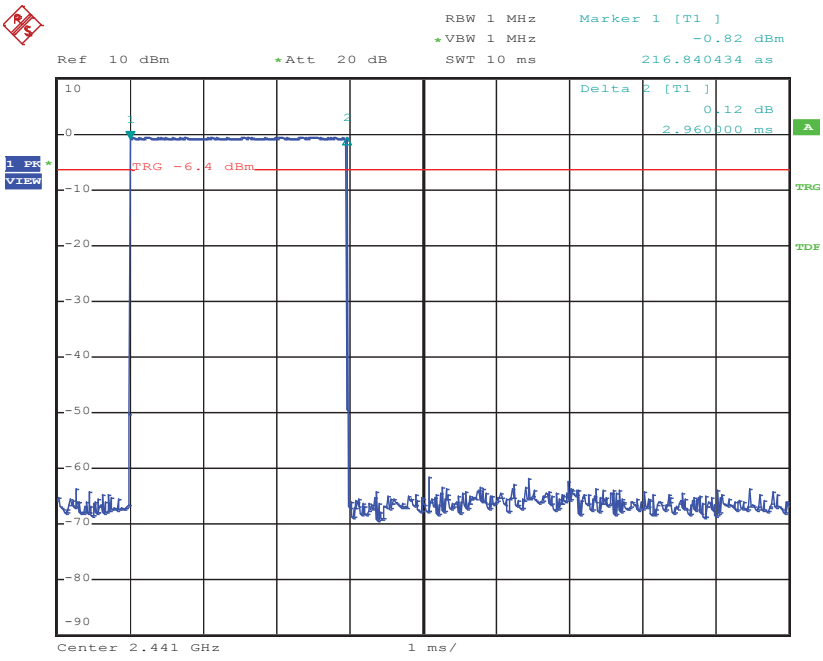
Comment: Dwell Time, DH1
Date: 14.MAR.2014 15:11:03

Figure 19: Dwell Time, Mode D (Hopping), DH3



Comment: Dwell Time, DH3
Date: 14.MAR.2014 15:10:07

Dwell Time, Mode D (Hopping), DH5



Comment: Dwell Time, DH5
Date: 14.MAR.2014 15:08:53

5.2.7 Conducted Spurious Emissions

RESULT: **PASS**

Date of testing:	2014-03-13
Ambient temperature:	25°C
Relative humidity:	48%
Atmospheric pressure:	991hPa

Requirements:

FCC 15.247(d) and RSS-210 A8.5

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:

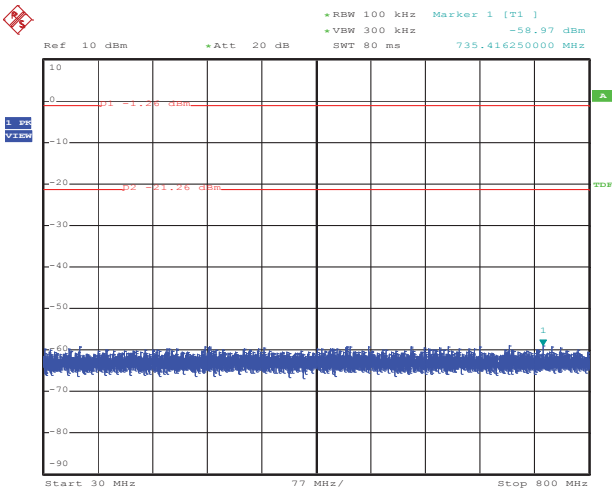
ANSI C63.10-2009, RSS-Gen 4.9 and Public Notice DA 00-705.

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).

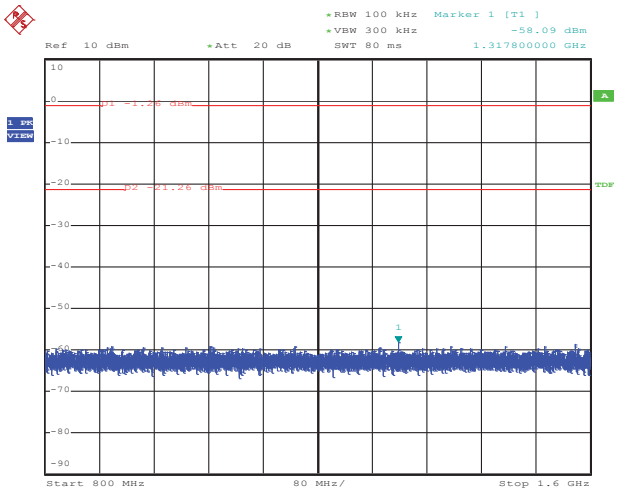
The worst case was found at the data rate of DH5 in 8DPSK (3-DH5) Therefore, the final measurement was reported accordingly.

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

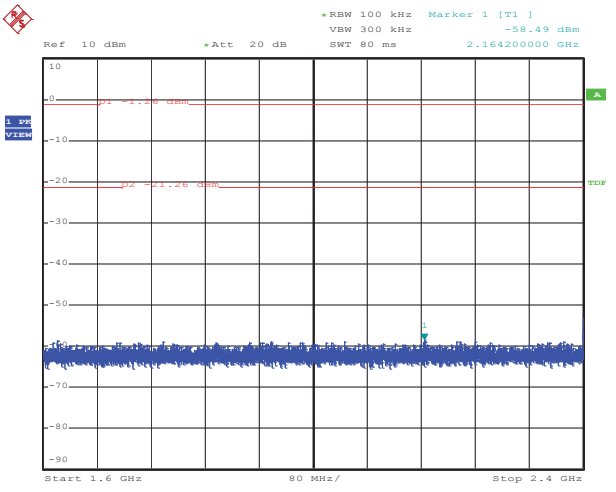
Figure 20: Conducted Spurious Emissions, 30MHz – 4.8GHz, Mode A (2402MHz)



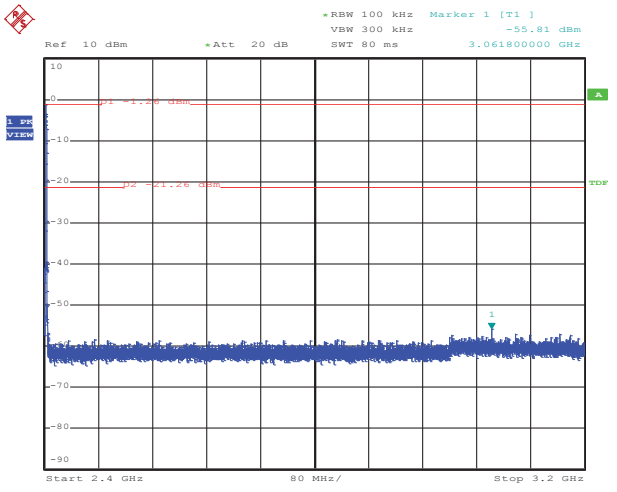
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 14:57:35



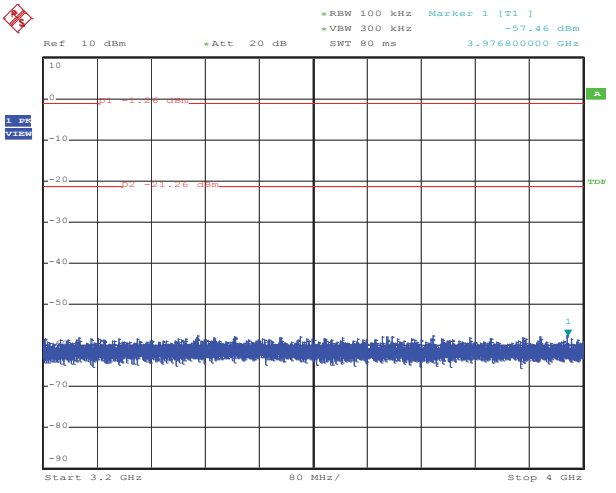
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 14:58:17



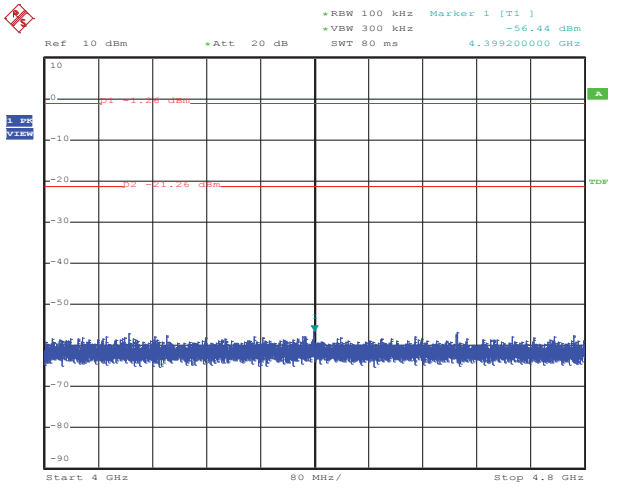
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:18:22



Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:50:30

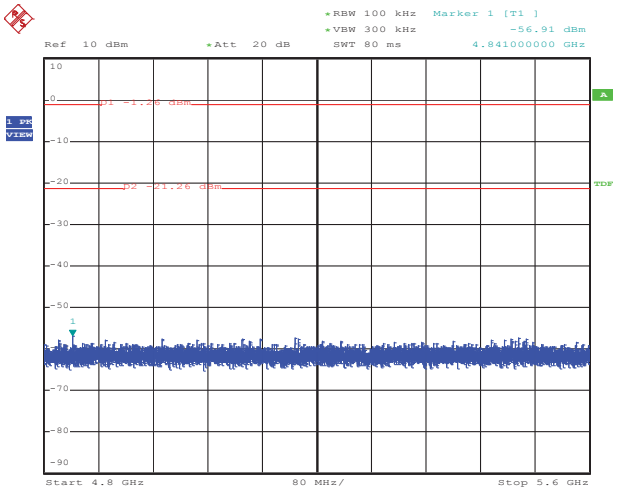


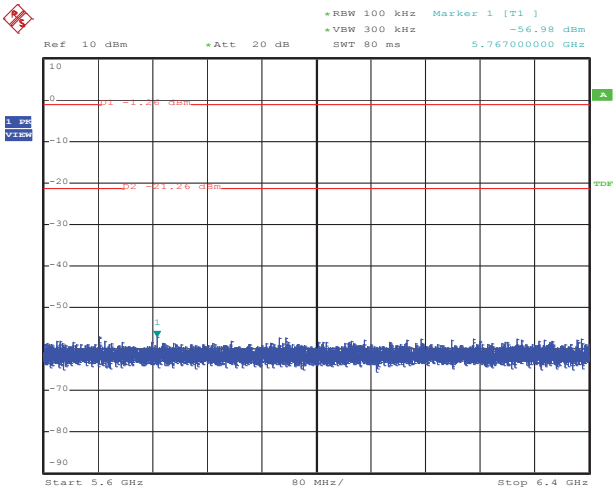
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:00:51



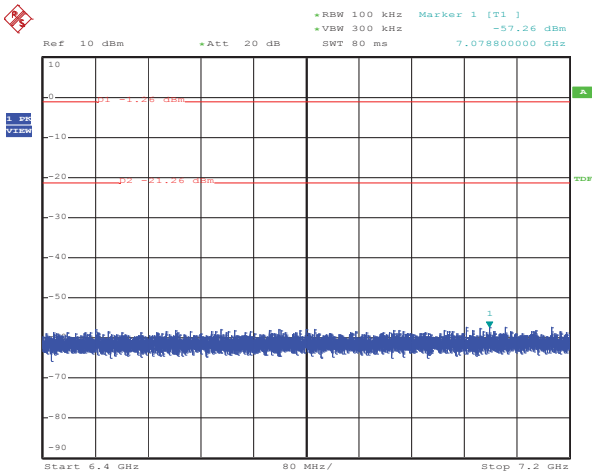
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:01:14

Figure 21: Conducted Spurious Emissions, 4.8 – 9.6GHz, Mode A (2402MHz)

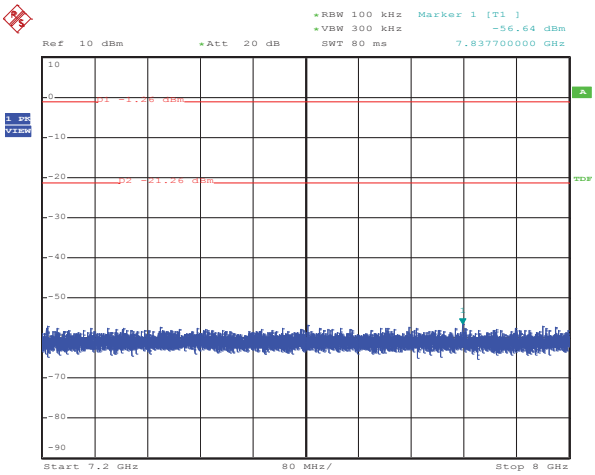




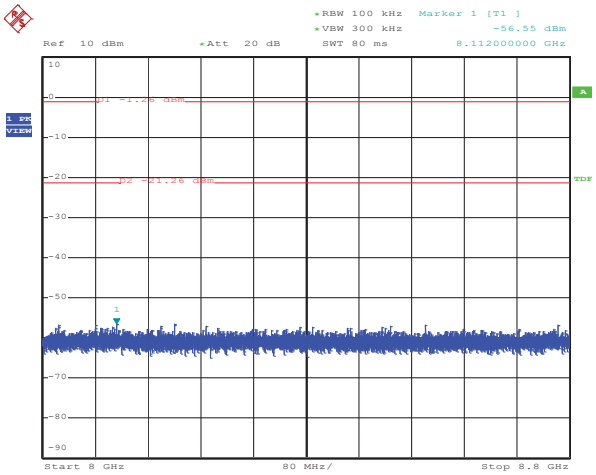
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:01:37



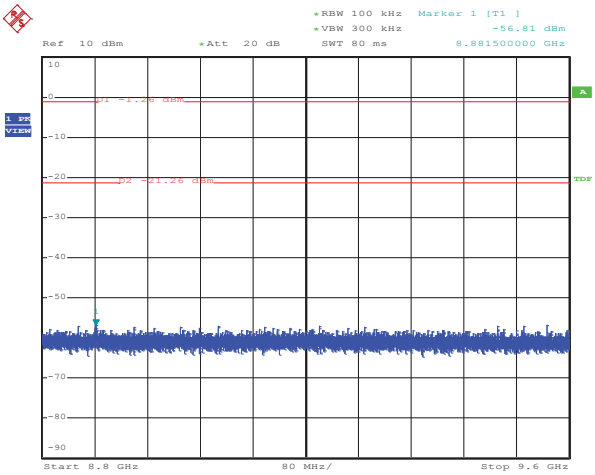
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:02:02



Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:02:25



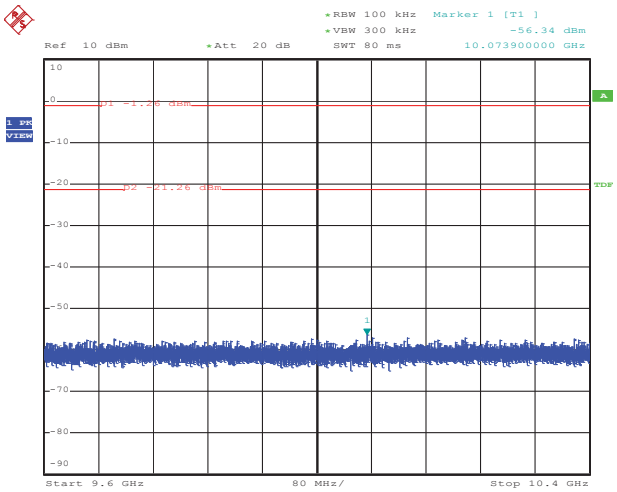
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:02:53

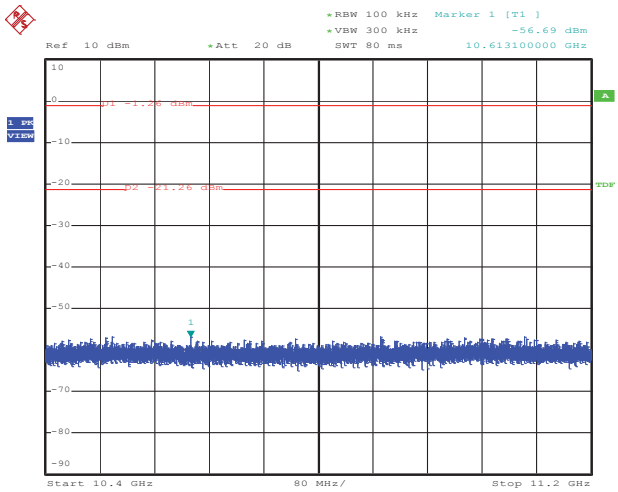


Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:03:19

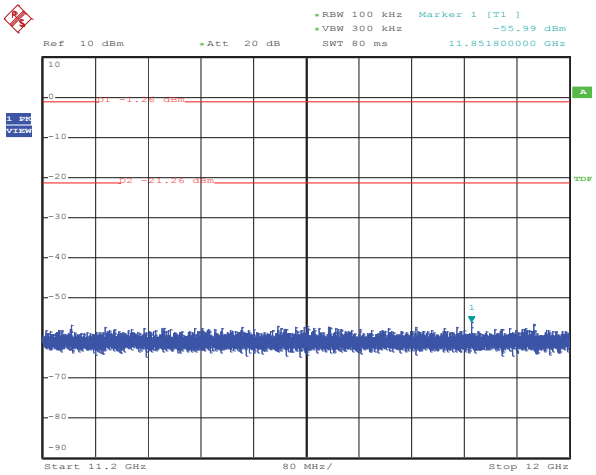
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:03:42

Figure 22: Conducted Spurious Emissions, 9.6 – 14.4GHz, Mode A (2402MHz)

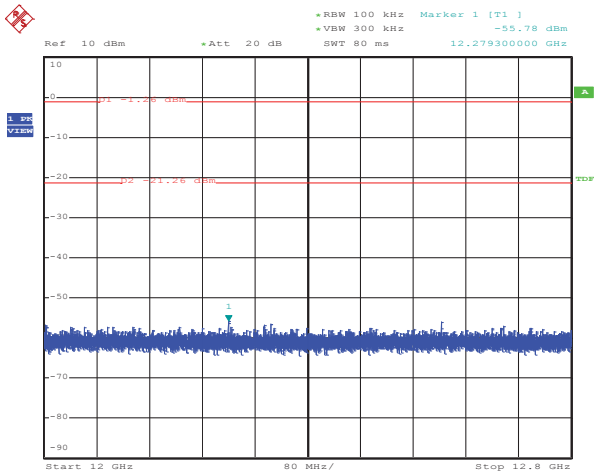




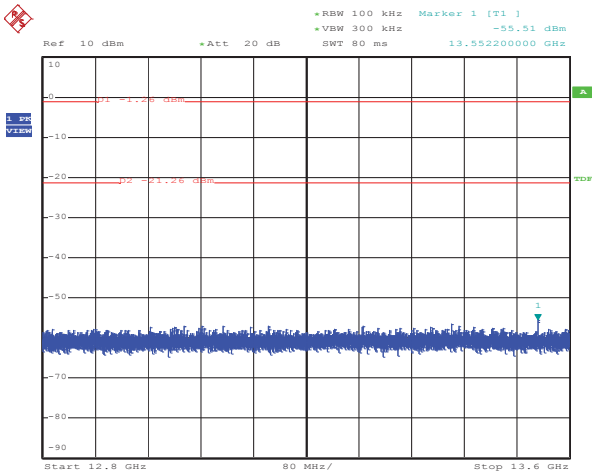
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:04:05



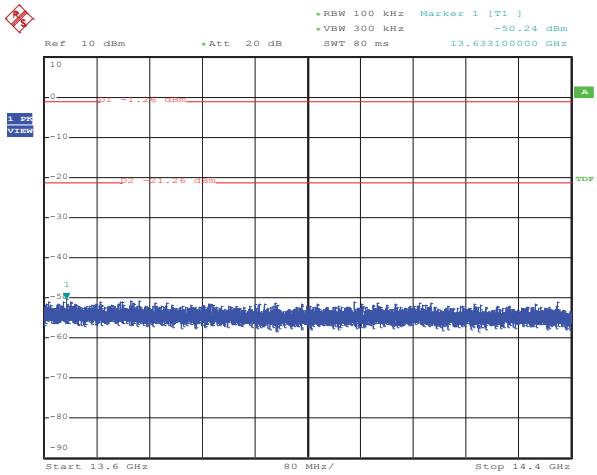
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:04:29



Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:04:51



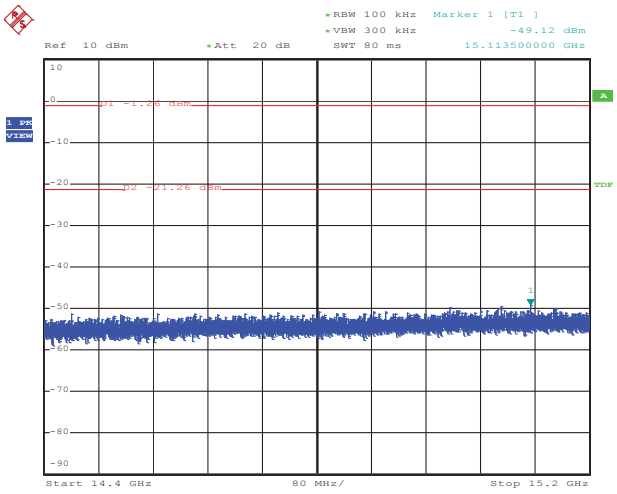
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:05:13

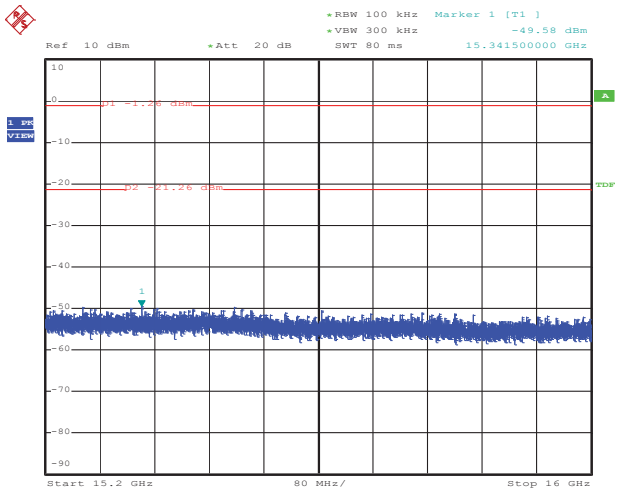


Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:05:36

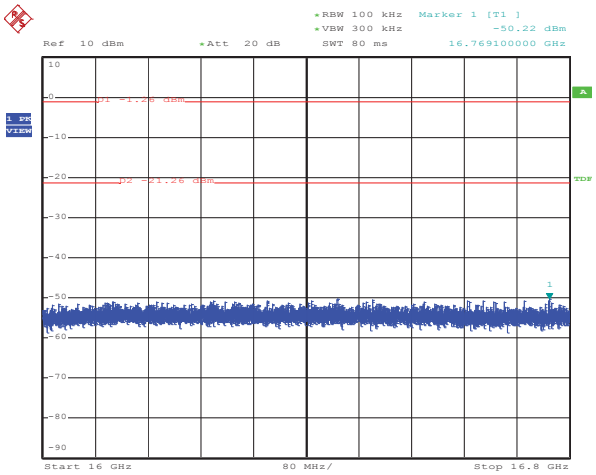
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:05:59

Figure 23: Conducted Spurious Emissions, 14.4 – 19.2GHz, Mode A (2402MHz)

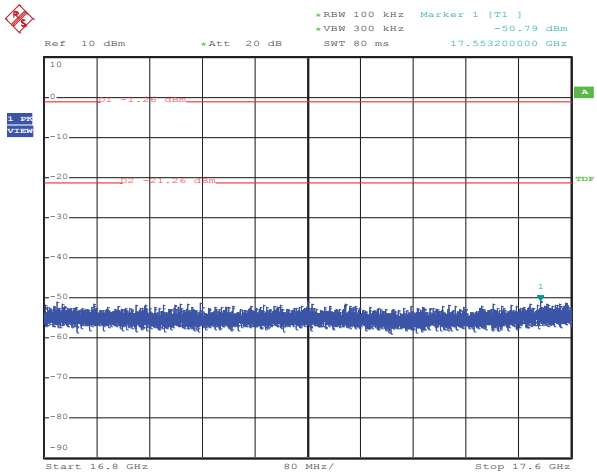




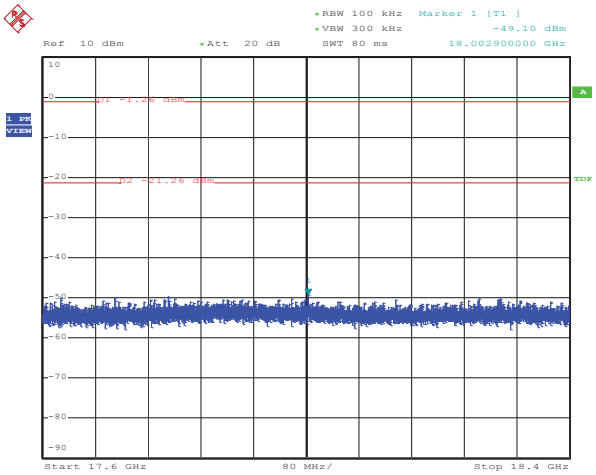
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:06:25



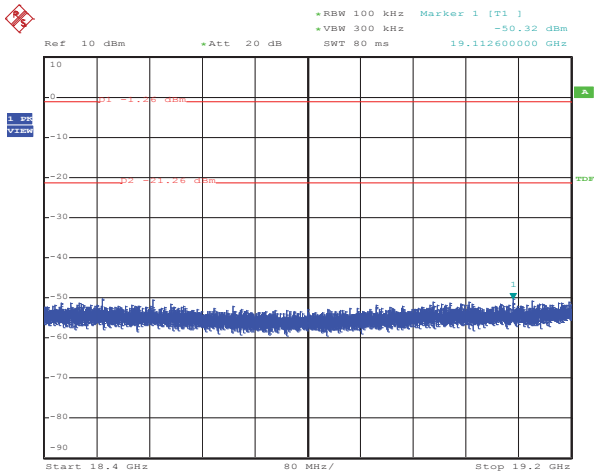
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:06:49



Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:07:12



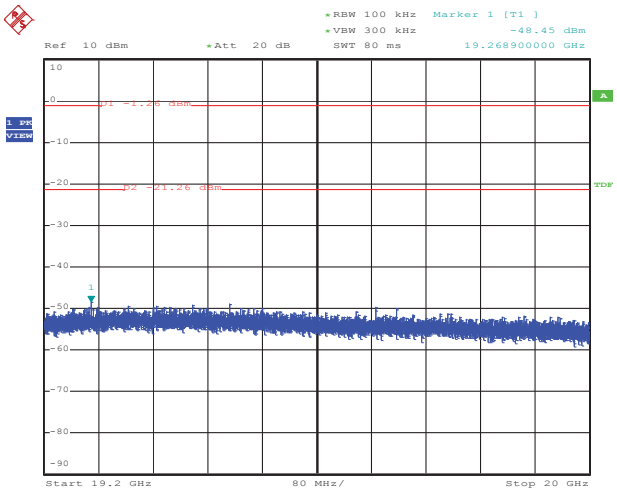
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:07:34

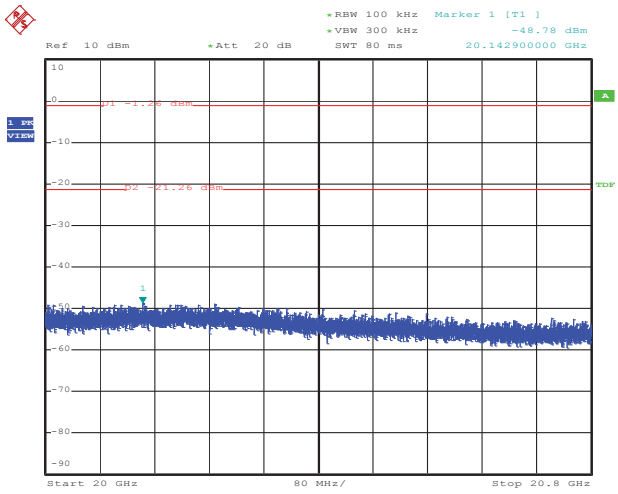


Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:07:57

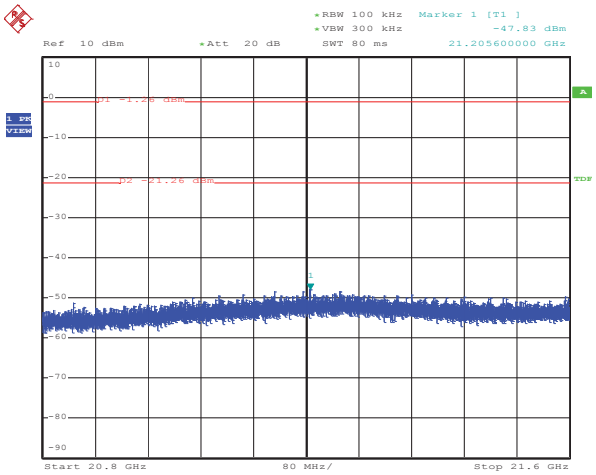
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:08:19

Figure 24: Conducted Spurious Emissions, 19.2 – 24.0GHz, Mode A (2402MHz)

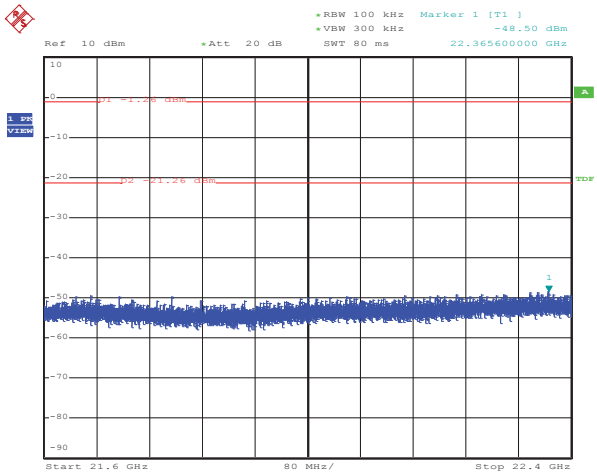




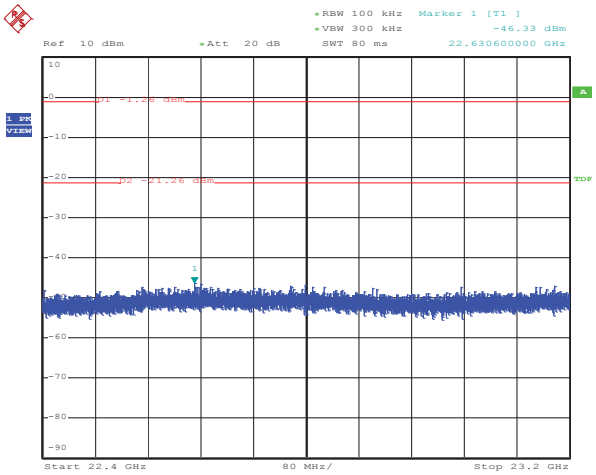
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:09:27



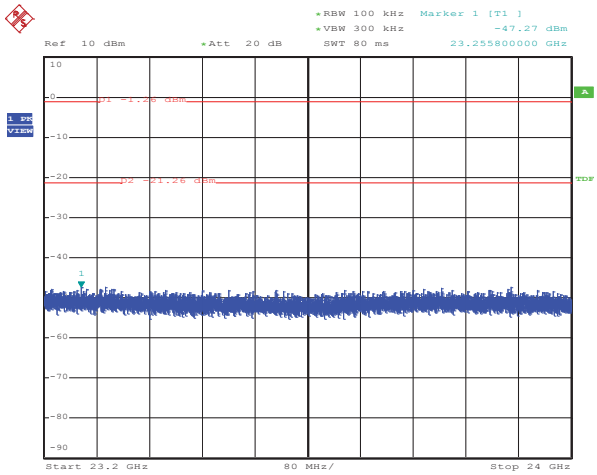
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:09:57



Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:10:22



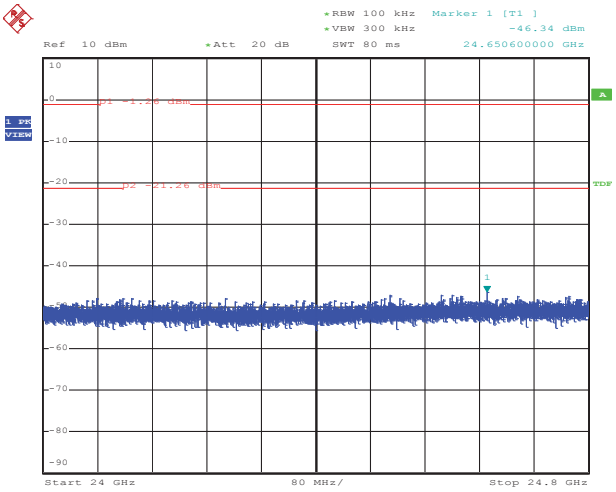
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:10:46



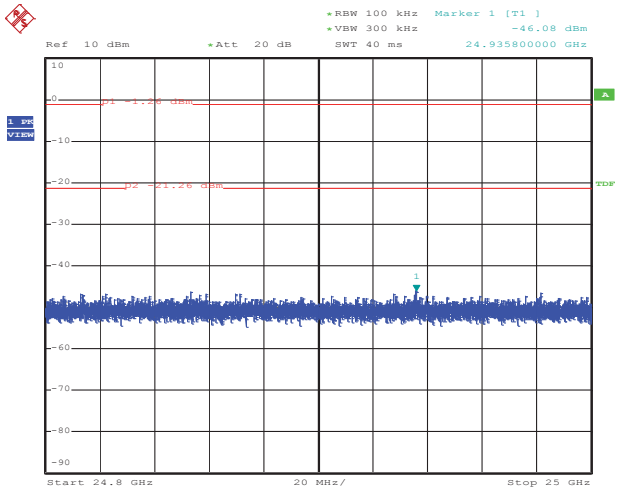
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:11:13

Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:11:37

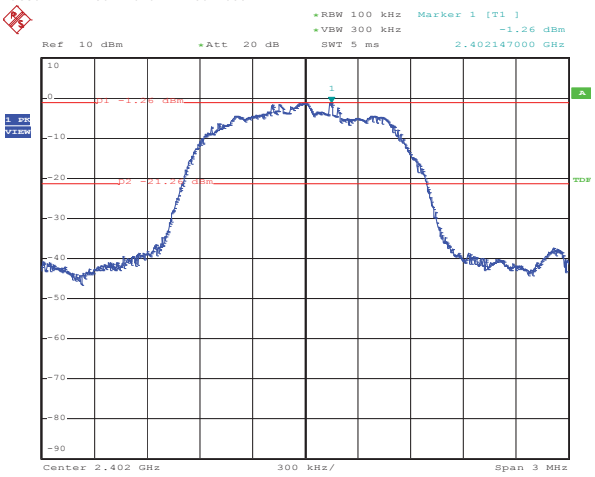
Figure 25: Conducted Spurious Emissions, 24.0– 25.0GHz and carrier, Mode A (2402MHz)



Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:11:58

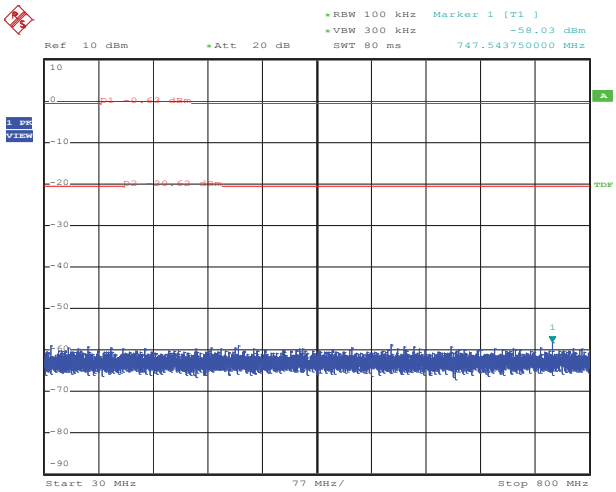


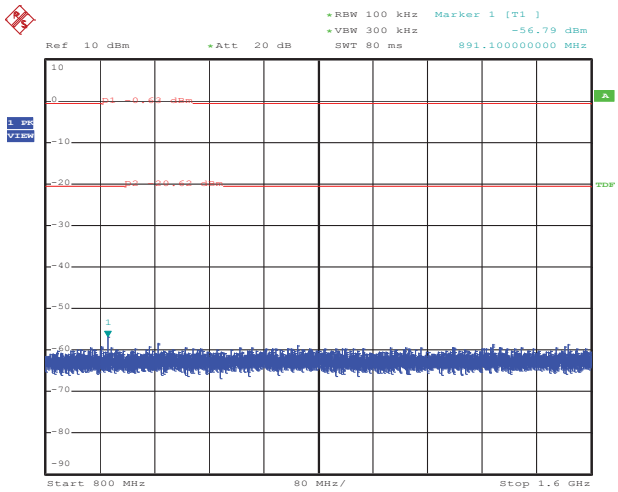
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 15:12:21



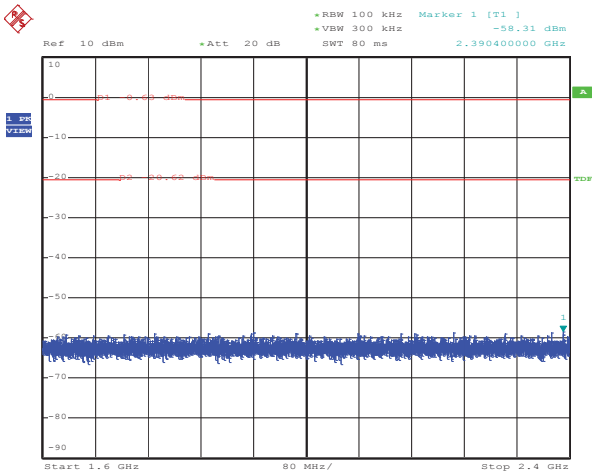
Comment: Conducted spurious emissions, mode A, 3-DH5
Date: 13.MAR.2014 14:57:06

Figure 26: Conducted Spurious Emissions, 30MHz – 4.8GHz, Mode B (2441MHz)

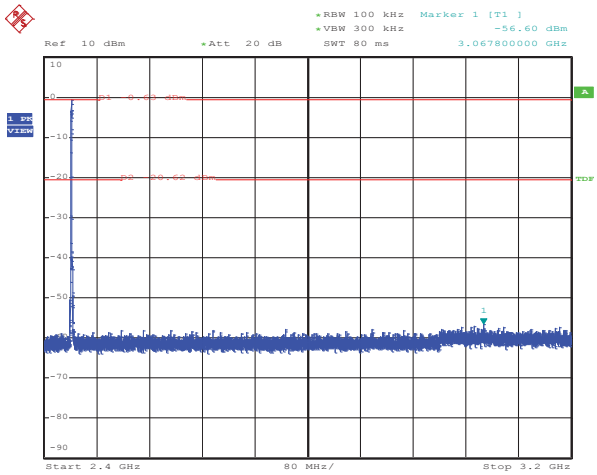




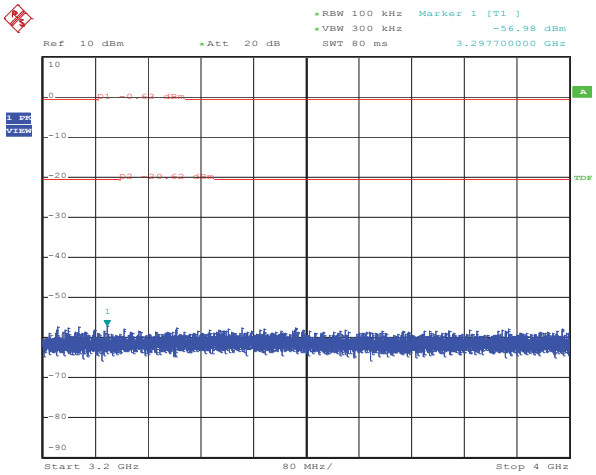
Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:14:40



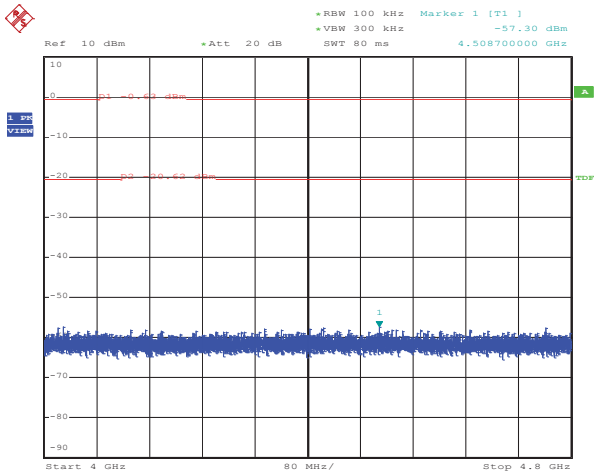
Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:15:03



Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:15:28



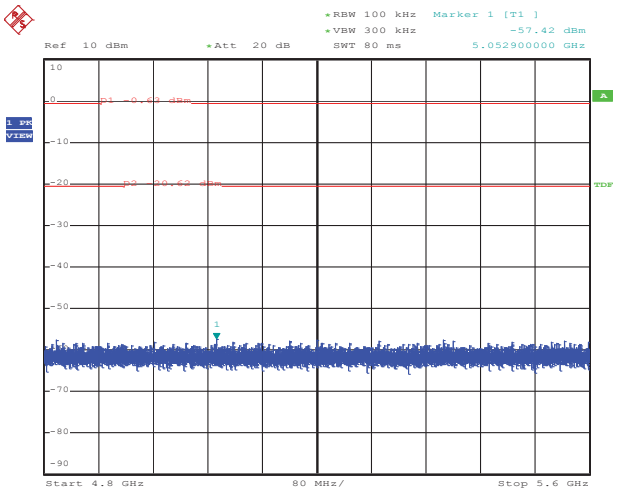
Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:16:55

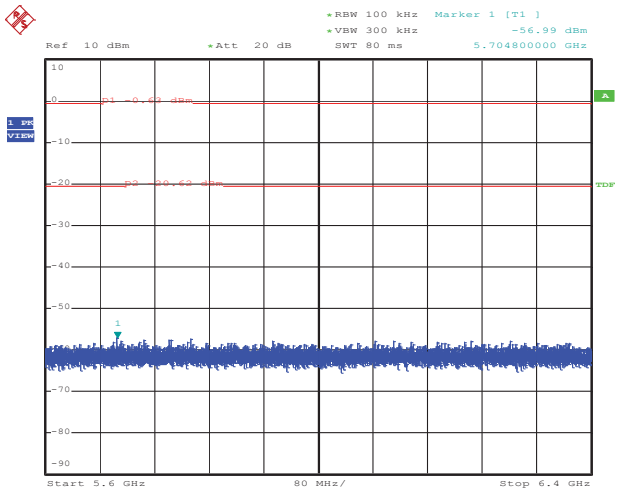


Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:17:19

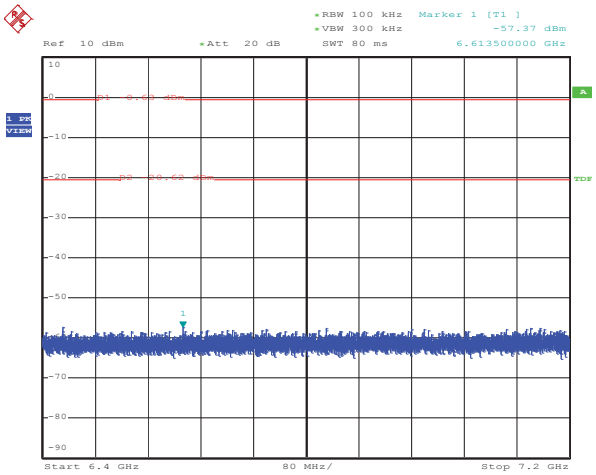
Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:18:10

Figure 27: Conducted Spurious Emissions, 4.8 – 9.6GHz, Mode B (2441MHz)

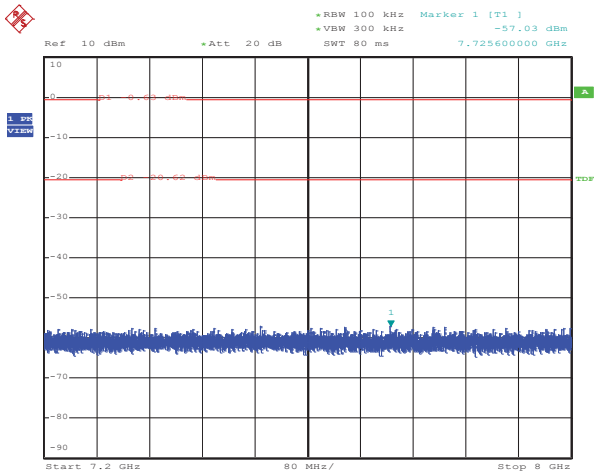




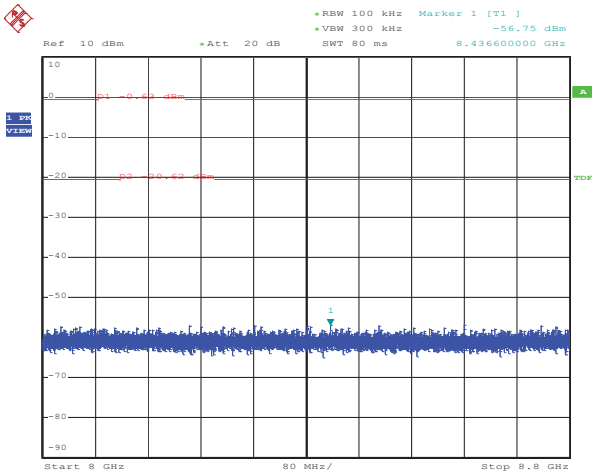
Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:18:31



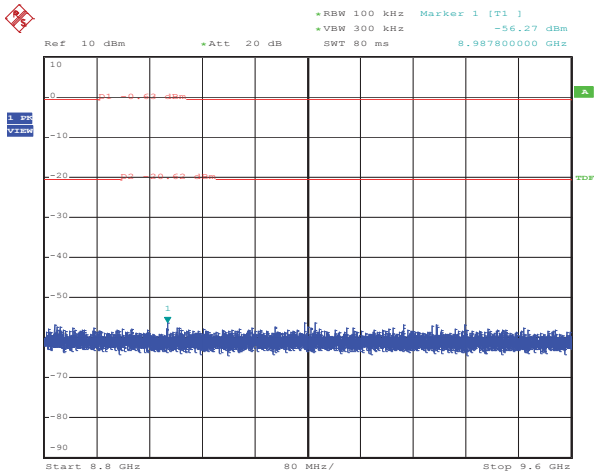
Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:18:54



Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:19:17



Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:19:39



Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:20:01

Comment: Conducted spurious emissions, mode B, 3-DH5
Date: 13.MAR.2014 16:20:22